PHYSICS

11th

Sahiwal Board	Multan Board	Bahawalpur Board
D.G Khan Board	Faisalabad Board	Sargodha Board
Lahore Board	Rawalpindi Board	Gujranwala Board

CONTENTS

OBJECTIVES (MCQ'S) OF CHAPTER-1 IN ALL PUNJAB BOARDS 2011-2021

Topic I: Introduction to Physics:

1. Computer chips are made of:
(A) Silicon (B) Germanium (C) Iron (D) Cadmium

2. Silicon is obtained from: **(2 Times)**
(A) Water (B) Metals (C) Wood (D) Sand

3. The branch of physics which is concerned with ultimate particles of which matter is composed of:
(A) Atomic Physics (B) Nuclear Physics (C) Plasma Physics (D) Particle Physics

4. Relativistics Mechanics was developed by:
(A) Newton (B) Faraday (C) Kepler (D) Einstein

Topic II: Physical Quantities:

5. Which is the base quantity:
(A) Time (B) Force (C) Power (D) Velocity

6. The force and torque are analogous to:
(A) Velocity (B) Mass and weight (C) Moment of inertia (D) Each other

7. Units of some physical quantities are given below. Which of these is a base unit:
(A) Joule (B) Newton (C) Mole (D) Centigrade

8. The number of basic physical quantity in the SI system is:
(A) 4 (B) 5 (C) 6 (D) 7

9. The approximate age of earth is:
(A) 1.4×10^{16} S (B) 2.8×10^{16} S (C) 1.4×10^{17} S (D) 2.8×10^{17} S

10. Which is not a base unit in SI units?
(a) Kilogram (b) joule (c) ampere (a) kelvin

11. A light year is the ____________. **(2 Times)**
(A) Speed (B) Distance light travel in one year
(C) Distance (D) Time

12. Which one of the following is not allowed as standard Prefix.
(A) Kilo (B) Nano (C) Mega (D) Micro Micro

13. 1 Peta = ____________:
(A) 10^9 (B) 10^{12} (C) 10^{15} (D) 10^{18}

Topic III: International System of Units:

14. The unit of pressure in terms of base units are:
(A) $kgm^{-1}s^{-2}$ (B) $kgm^{-1}s^{-3}$ (C) $kgm^{-1}s^{-1}$ (D) $kgms^{-1}$

15. Which of following is least multiple:
(A) pico (B) femto (C) nano (D) atto

16. SI unit of pressure is:
(A) Nm^2 (B) N^2m (C) Nm^{-2} (D) $N^{-2}m$

17. Radian and steradian are:
(A) Base units (B) Derived units (C) Supplementary units (D) Complementary units

18. The angle made by ice cone at its edge is a:
(A) Plane angle (B) Solid angle (C) Critical angle (D) Obtuse angle

19. One revolution is equal to:
(A) 2π rad (B) π rad (C) $\frac{\pi}{2}$ rad (D) $\frac{\pi}{4}$ rad

20. The angle subtended at the center by circumference of circle is: **(2 Times)**
(A) $\frac{\pi}{4} rad$ (B) $\frac{\pi}{2} rad$ (C) $2\pi\ rad$ (D) $4\pi\ rad$

21. The ratio of circumference of a circle to its diameter is equal to:
(A) 2π radian (B) π (C) $\frac{\pi}{2}$ radian (D) one steradian

22. The prefix pico is equal to:
(A) 10^{-6} (B) 10^{-12} (C) 10^{-18} (D) 10^{-11}

23.______ is not a derived unit:
(A) Newton (B) Joule (C) Coulomb (D) Ampere

24. The unit of work in base units is:
(A) $kgm^{-1}s^{-2}$ (B) $kgms^{-2}$ (C) kgm^2s^{-2} (D) $kgm^{-1}s^{-1}$

25. One giga is equal to: **(2 times)**
(A) 10^3 (B) 10^6 (C) 10^9 (D) 10^{12}

26. Solid angle subtended at the center by a sphere is: **(2 Times)**
(A) 2π (B) 4π (C) 6π (D) 8π

27. One radian is equal to: **(5 Times)**
(A) 360° (B) 57.3° (C) 180° (D) 55.3°

28. One radian is equal to:
(A) 67.3° (B) 57.3° (C) 87.3° (D) 97.3°

29. The SI unit of solid angle is:
(A) Degree (B) Steradian (C) Revolution (D)Radian

30. A light year is a unit for: **(3 Times)**
(A) Intensity of light (B) Time (C) Distance (D) Velocity

31. One light year is equal to: **(4 times)**
(A) $9.5 \times 10^{15}\ m$ (B) $9.6 \times 10^{15}\ m$ (C) $9.5 \times 10^{-15}\ m$ (D) $9.6 \times 10^{-15}\ m$

32. SI unit of torque is:
(A) Nkg^{-1} (B) $N^{-2}kg$ (C) Nm (D) Nm^2

33. One femto is equal to: **(3 Times)**
(A) 10^{-15} (B) 10^{-12} (C) 10^{12} (D) 10^{15}

34. An alternative unit to $kgms^{-1}$ is:
(A) Js (B) Ns (C) Nm (D) N

35. Candela is the SI unit of:
(A) Charge (B) Luminous intensity (C) Power (D) Refractive index

36. One tera is equal to: **(2 times)**
(A) 10^{10} (B) 10^9 (C) 10^{12} (D) 10^{15}

37. How many nanometers in a meter?
(A) 10^{-19} (B) 10^{19} (C) 10^9 (D) 10^{-9}

38. SI unit of plane angle is:-
(a) Radian (b) Degree (c) Steradian (d) Revolution

39. The angle subtended at the centre by circumference of a circle is:
(a) π rad (b) 3π rad (c) 2π rad (d) $\pi/2$ rad

40. The ratio of 1 nanometer to 1-atto-meter is:
(a) 10^0 (b) 10^8 (c) 10^9 (d) 10^{-8}

41. S.I unit of intensity of light is:
(a) Ampere (b) Mole (c) Candela (d) Joule

Topic IV: Errors and Uncertainities:

42. The sum of three numbers, 2.7543, 4.10 and 1.273 up-to correct decimal place is: **(2 times)**
(A) 8.12 (B) 8.13 (C) 8.1273 (D) 8.127

43. The percentage uncertainty in measurement of mass and velocity are 2% and 3%. The maximum uncertainty in the measurement of kinetic energy is: **(2 times)**
(A) 11% (B) 8% (C) 6% (D) 1%

44. The error in the value of speed of sound calculated by Newton at S.T.P is about:
(A) 14% (B) 15% (C) 16% (D) 20%

45. The percentage uncertainty in radius of a sphere is 2%. The total percentage uncertainty in the volume of a sphere is:
(A) 2% (B) 4 % (C) 6 % (D) 8 %

46. The absolute uncertainty for verniear calipers of v.c = 0.01 cm is
(A) 0.1 mm (B) 0.01 m (C) 0.001 cm (D) 0.001 mm

Topic V: Significant Figures:

47. 1275 has significant digits:
(A) 2 (B) 3 (C) 4 (D) 5

48. A student added three figures 72.1, 3.32 and 0.003. The correct answer regarding the rules of addition of the significant figures will be: (2 times)
(A) 75.423 (B) 75.42 (C) 75.4 (D) 75

49. Significant figures in 0.0010 are: (2 times)
(a) 1 (b) 2 (c) 3 (d) 4

50. Significant figures in 1.00110 are:
(A) 6 (B) 5 (C) 3 (D) 1

51. Significant figures in 0.00846 are:
(A) 3 (B) 4 (C) 6 (D) 7

52. Significant figures in 0.00567 are:
(A) 2 (B) 3 (C) 4 (D) 5

53. Significant figures in 0.00876 are:
(a) 3 (b) 4 (c) 5 (d) 6

54. If we round off 64.34546 up to three significant figures, the best answer is.
(A) 64.3 (B) 64.4 (C) 64.5 (D) 64.6

55. The significant figures in 0.04060 are.
(A) 2 (B) 4 (C) 5 (D) 6

56. Significant figures in 0.0004813 are: (2 Times)
(A) 8 (B) 7 (C) 4 (D) 3

Topic VI: Precision and Accuracy:

57. Which of the following measurements of length is most precise?
(A) 5 cm (B) 5.4 cm (C) 5.41 cm (D) 5.412 cm

58. Which is the correct record for the diameter of wire when measured by a screw gauge of least count 0.001 cm?
(A) 2.3 cm (B) 2.31 cm (C) 2.312 cm (D) 2.3124 cm

59. A student is calculating the area of a sheet whose length and width are 27.9 cm and 21.6 cm respectively. The correct answer will be:
(A) 602.64 cm^2 (B) 602.6 cm^2 (C) 602 cm^2 (D) 603 cm^2

Topic VIII: Dimension of Physical Quantities:

60. The dimensions of coefficient of viscosity is: (2 Times)
(A) $[M^2L^{-1}T^{-1}]$ (B) $[ML^{-1}T^2]$ (C) $[ML^{-1}T^{-1}]$ (D) $[MLT]$

61. The dimension of work is: (2 Times)
(A) $[MLT]$ (B) $[MLT^{-1}]$ (C) $[ML^2T^{-2}]$ (D) $[ML^{-1}T^{-1}]$

62. The dimensional unit of impulse is:
(a) $[MLT]$ (b) $[MLT^{-1}]$ (c) $[ML^{-1}T^{-1}]$ (d) $[M^{-1}L^{-1}T^{-1}]$

63. Which of the following pair has same dimensions?
(A) Work and power (B) Momentum and energy
(C) Work and torque (D) Power and pressure

64. The dimension of force is:
(A) $[MLT^{-1}]$ (B) $[ML^{-1}T^{-1}]$ (C) $[MLT^{-2}]$ (D) $[ML^{-2}T^{-2}]$

65. According to Einstein's equation $E = mc^2$ 1 kg mass is equivalent to energy:
(A) $3\times10^6 J$ (B) $9\times10^{16} J$ (C) $9\times10^8 J$ (D) $3\times10^8 J$

66. The dimensional formula for the quantity light year is:
(A) $[LT^{-1}]$ (B) $[T]$ (C) $[ML^2T^2]$ (D) $[L]$

67. The dimensional $[ML^0T^0]$ represent the quantity:
(A) Length (B) Mass (C) Time (D) Velocity

68. The ratio of dimensions of power to work is:
(A) 1: T (B) T: 1 (C) 1: T^{-2} (D) T^{-2} : 1

69. The dimension of angular velocity are:
(a) $[LT^{-1}]$ (b) $[LT^{-2}]$ (c) $[L^{-1}T]$ (d) $[T^{-1}]$

70. In the relation F = 6πηrv Dimension of co-efficient of viscosity η is: (3 Times)
(A) $[ML^{-1}T^{-1}]$ (B) $[MLT^{-1}]$ (C) $[ML^{-2}T^{-1}]$ (D) $[MLT]$

71. The dimensions of Angular momentum are: **(2 times)**
(a) $[MLT^{-2}]$ (b) $[MLT^{-1}]$ (c) $[ML^2T^{-1}]$ (d) $[ML^{-2}T^{-2}]$
72. Work has dimension like: **(2 times)**
(a) torque (b) momentum (c) velocity (d) power
73. The dimension of $\sqrt{\frac{\ell}{g}}$ is same as that of: **(2 Times)**
(A) Time (B) Energy (C) Velocity (D) Force
74. The dimension of density are:
(A) $[ML^{-2}]$ (B) $[M^2L^{-2}]$ (C) $[ML^{-3}]$ (D) None of these
75. The dimensions of the relation $\sqrt{\frac{F\times l}{m}}$ are equal to the dimensions of: **(2 times)**
(A) Force (B) Momentum (C) Acceleration (D) Velocity

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76. In the light of Einstein's famous equation E = mc^2, the energy for mass of 2 kg is equal to:
(a) 3×10^8 joule (b) 9×10^{16} joule (c) 4×10^{16} joule (d) 18×10^{16} joule
77. The number of significant figures in 0.00232 are:
(a) 6 (b) 5 (c) 3 (d) 4
78. How many seconds are there in one year:
(a) 3.156×10^6 s (b) 3.1536×10^8 s (c) 3.1536×10^{10} s (d) 3.1536×10^7 s
79. Zero Error belongs to:
(a) Personal Error (b) Random Error (c) Systematic Error (d) Collective Error
80. For total assessment of uncertainty in the final result obtained by multiplication we add: **(2 times)**
(A) absolute uncertainty (B) fractional uncertainty
(C) percentage uncertainty (D) errors
81. Solid angle is:
(A) one dimensional (B) two dimensional (C) thre dimensional (D) four dimensional
82. In colour printing the whole range of colours can be obtained by mixing:
(A) three colours (B) four colours (C) five colours (D) seven colours
83. Error in the measurement of radius of sphere is 1%. The error in the calculated value of its area is:
(A) 1% (B) 2% (C) 3% (D) 4%
84. Which is the base quantity:
(A) charge (B) area (C) force (D) electric current
85. Number of Steradians in a Solid Sphere is:
(A) π (B) 2π (C) 4π (D) $\frac{\pi}{2}$
86. Which of the following is a derived quantity:
(A) mass (B) velocity (C) length (D) time
87. In 5.47 × 19.89 = 108.7983; answer should be written as:
(A) 108.8 (B) 108.9 (C) 109 (D) 108.79

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88- The quantity 1 $(km)^2$ is equal to:
(A) $1 \times 10^6 m^2$ (B) $1\times10^5 m^2$ (C) $1\times10^7 m^2$ (D) $1\times10^4 m^2$
89- Which pair has same unit: **(2 times)**
(A) Work and power (B) Momentum and impulse
(C) Force and torque (D) Torque and power
90. Pascal is the unit of:
(A) pressure (B) force (C) tension (D) weight
91. The time taken by light from moon to earth is: **(2 times)**
(A) 1 min 10 sec. (B) 1 min 20 sec. (C) 1 min 30 sec. (D) 1 min 40 sec.
92. One year has sceonds:
(A) 3.1536×10^7 (B) 3.1536×10^6 (C) 3.153×10^8 (D) 3.153×10^9
93. The term 134.7 can be written scientific notation as:
(A) 1.347×10^2 (B) 1.347×10^3 (C) 1.347×10^1 (D) 1.347×10^4

94. The quantity 0.00467 has significant figures.
(A) 3 (B) 4 (C) 5 (D) 6

95. Absolute uncertainty in a measuring instrument is equal to:
(A) Least count (B) Accuracy
(C) Fractional uncvertainty (D) Percentage uncertainity

96. Dimension of moment arm is: **(2 times)**
(A) [M] (B) [T] (C) [LT] (D) [L]

97. Which is the base quanity?
(A) Area (B) Volume (C) Length (D) Density

98. If least count is 10 kg, then 8.00 x 10^3 kg has significant figures:
(A) 1 (B) 2 (C) 3 (D) 4

99. How many years in one second:
(A) 3.1536x10^7 years (B) 1.536 years (C) 3.1 x 10^{-8} years (D) 3.1 x 10^8 years

100. ________ is derived unit:
(A) Candela (B) Ampere (C) Kelvin (D) Newton

101. At constant temperature, if pressure is halved then its volume is:
(A) constant (B) halved (C) four times (D) doubled

102. The dimension [M^oLT^o] represents the quantity:
(A) length (B) mass (C) time (D) velocity

103. The quantity 2.3 x 10^{-3} can be written as:
(A) 0.0023 (B) 0.023 (C) 0.23 (D) 2.3

104. A measurement taken by Varnier Calliper with least count as 0.01cm is recorded as 0.45cm, it has fractional uncertainity: **(2 times)**
(A) 0.01 (B) 0.02 (C) 0.03 (D) 0.45

105. The numerical value of constant in any formula canot be determined by dimensional analysis, however it can be found by:
(A) Addition (B) Physical Quantities (C) Experiments (D) Uncertainity

106. How many significant zeros are there in the amount 0.00501:
(A) 1 (B) 2 (C) 3 (D) 4

107. Which one of the following is not a unit of energy:
(A) Kilowatt (B) Erg (C) Joule (D) Kilowatt hour

108- The ratio of 1 femtometer to nanometer is:
(A)10^{-6} (B) 10^6 (C) 10^{-7} (D) 10^8

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109. The dimensions of volume flow rate of a fluid are:
(A) [LT^{-1}] (B) $[L^2T^{-2}]$ (C) $[L^3T^{-1}]$ (D) $[L^3T^{-2}]$

110. In order to reduce the uncertainty in finging time period of a vibrating body, it is advised to count
(A) Small number of swings (B) Large number of swings
(C) Inficite number of swings (D) Both A and C

111. The dimensions of Einstein equation are E = mc^2
(A) $[MLT^{-2}]$ (B) $[ML^{-1}T^2]$ (C) $[ML^2T^{-2}]$ (D) $[ML^{-2}T^2]$

112. The dimensions of relation mc^2 are equal to the dimensions of:
(A) Force (B) Momentum (C) Energy (D) Torque

113. $[M^0L^0T^{-1}]$ **refer to quantity:**
(A) Velocity (B) Frequency (C) Time period (D) Force

114. The dimensions of torque are:

(A) $[MLT^{-2}]$ (B) $[ML^{-1}T^{-2}]$ (C) $[ML^{-1}T^{-1}]$ (D) $[ML^{2}T^{-2}]$

115. The uncertainty in the time period of a vibrating body is:

(A) least count × No.of vibrations (B) least count + No. of vibrations
(C) least count ÷ No.of vibrations (D) least count - No. of vibrations

116. The dimensions of $\sqrt{\frac{m}{k}}$ is same as that of:

(A) Momentum (B) Time (C) Acceleration (D) Force

117. The appropriate precision on addition of following masses 0.089, 2.189, 5.32, 11.8 in kg is:

(A) 19.398 kg (B) 19.39 kg (C) 19.4 kg (D) 19.41 kg

118. Which of the following pair has same dimension

(A) Work and Power (B) Work and Torque
(C) Momentum and Enegry (D) Power and Pressure

119. Least count of meter rod is:

(A) 0.01 cm (B) 0.001 cm (C) 0.1 cm (D) 1 cm

120. Which one of the following is correct?

(A) $m = E/c^2$ (B) $m = c^2/E$ (C) $m = c^2E$ (D) $m = cE$

121. The units of gravitational constant have units:

(A) Nm^2kg^{-1} (B) $Nm\,kg^{-2}$ (C) Nm^2kg^2 (D) Nm^2kg^{-2}

122. Dimensions of $\sqrt{F\frac{l}{m}}$ are:

(A) $[M^oLT^{-1}]$ (B) $[ML^{-1}T]$ (C) $[ML^2T^{-3}]$ (D) $[ML^{-1}T^{-1}]$

123. Dimensions of ratio of angular momentum to linear momentum is:

(A) $[M^oLT^o]$ (B) $[M^1L^1T^1]$ (C) $[M^1L^2T^{-1}]$ (D) $[M^{-1}L^{-1}T^{-1}]$

ANSWERS OF THE MULTIPLE CHOICE QUESTIONS

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
A	D	D	D	A	D	C	D	C	B	B	D	C	A	D
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
C	C	B	A	C	B	B	D	C	C	B	B	B	B	C
31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
A	C	A	B	B	C	C	A	C	C	C	B	B	C	C
46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
A	C	C	B	A	A	B	A	B	B	C	C	C	D	C
61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
C	B	C	C	B	D	B	A	D	A	C	A	A	C	D
76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
D	C	D	C	C	C	B	B	D	C	B	C	A	B	A
91	92	93	94	95	96	97	98	99	100	101	102	103	104	105
B	A	A	A	A	D	C	C	C	D	D	A	A	B	C
106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
A	A	A	C	B	C	C	B	D	C	B	C	B	C	A
121	122	123												
D	A	A												

SHORT QUESTIONS OF CHAPTER-1 IN ALL PUNJAB BOARDS 2011-2021

Topic I: Introduction to Physics:

1. Define physics.

Ans: The branch of science which deals with the study of matter and energy and the relationship between them is called physics.

2. Define nuclear physics.

Ans: The branch of physics which deals with the study of the constituent particles and interactions of atomic nuclei is called Nuclear Physics.

3. What are three fundamental frontiers of fundamental science? (5 Times)

Ans: The three fundamental frontiers of fundamental science are:

i. The world of extremely large bodies
ii. The world of extremely small objects.
iii. The world of middle sized objects. OR The world of complex matter.

Topic II: Physical Quantities:

4. Define base quantities, derived quantities. $(5\ times)$

Ans: <u>Base quantities</u>: Those physical quantities in terms of which other physical quantities are defined, are called base quantities. For example, length, mass, time etc.

<u>Derived quantities</u>: The quantities which are defined in terms of base quantities, are called derived quantities. For example, velocity, acceleration, force etc.

5. According to Einstein's mass energy equation, find the energy equivalent to mass 1 kilogram.

Ans: Since

$$E = mc^2$$
$$E = 1 \times (3 \times 10^8)^2$$
$$E = 9 \times 10^{16}\,J$$

6. Give the drawbacks to use the period of a pendulum as a time standard. (21 Times)

Ans: As

$$T = 2\pi\sqrt{\frac{l}{g}}$$

The value of time period of a simple pendulum depends upon its length and gravitational acceleration. So, the following drawbacks will be observed.

i. The value of g varies with altitudes.
ii. Length of the pendulum varies due to the increase or decrease in temperature.
iii. Air resistance will affect the time period.

7. Name several repetitive phenomenon occurring in nature which could serve as reasonable time standard. (16 Times)

Ans: Some of the natural phenomena that can be used as time standard are as follows:

i. The rotation of earth around the sun.
ii. The revolution of earth.
iii. The rotation of moon around the earth.
iv. Atomic vibrations in crystals.

8. How many seconds are there in one year? (8 times)

Ans: Now

$$1\,year = 1 \times 365\,days$$
$$1\,year = 365 \times 1\,days$$
$$1\,year = 365 \times 24\,hours$$
$$1\,year = 8760 \times 1\,hour$$
$$1\,year = 8760 \times 3600\,seconds$$
$$1\,year = 3.1536 \times 10^7\,s$$

9. How many nanoseconds are there in 1 year? (7 times)

Ans: As

$$1\,year = 3.1536 \times 10^7 s$$

$$1\ year = 3.1536 \times 10^7 \times 1s$$
$$1\ year = 3.1536 \times 10^7 \times 10^9 \times 10^{-9} s$$
$$1\ year = 3.1536 \times 10^7 \times 10^9\ ns$$
$$\mathbf{1\ year = 3.1536 \times 10^{16}\ ns}$$

10. How many metres are there in one light year? **(3 Times)**

Ans: Since

$$S = vt$$
$$S = ct$$
$$S = (3 \times 10^8\ ms^{-1})(365 \times 24 \times 60 \times 60\ s)$$
$$\mathbf{S = 9.46 \times 10^{15}\ m}$$

11. How many years in 1 sec. **(3 Times)**

Ans:

$$1\ year = 1 \times 365\ days$$
$$1\ year = 365 \times 1\ days$$
$$1\ year = 365 \times 24\ hours$$
$$1\ year = 8760 \times 1\ hour$$
$$1\ year = 8760 \times 3600\ seconds$$
$$1\ year = 3.1536 \times 10^7\ s$$
$$1\ sec = \frac{1}{3.1536 \times 10^7}\ years$$
$$1\ \ sec = 0.317 \times 10^{-7} years$$
$$1 sec = 3.17 \times 10^{-8} years$$

12. Define light year. How many meters are there in one light year? **(3 times)**
(Speed of Light = $3 \times 10^8\ ms^{-1}$)

Ans: A light year is the distance light travels in one year.

Since

$$S = vt$$

or

$$S = ct$$
$$S = (3 \times 10^8\ ms^{-1})(365 \times 24 \times 60 \times 60\ s)$$
$$S = 9.46 \times 10^{15}\ m$$

13. How many years are there in a nanosecond?

Ans: 1 year = 365 x 24 x 60 x 60 s = 3.1536×10^7s = $3.1536 \times 10^7 \times 10^9 \times 10^{-9}$s.

1 year = 3.1536×10^{16}ns

1 ns = $\frac{1}{3.1536 \times 10^{16}}$ years= 3.17×10^{-17} years

14. The length and width of a rectangular plate are measured to be 15.3 cm and 12.80 cm respectively. Find the area of the plate.

Ans: Length = 15.3 cm , Width = 12.80 cm

Area of rectangular plate = Length x Width
= 15.3 cm x 12.80 cm
= 195.84 cm^2
= 196 cm^2

15. Give the definition of unit of solid angle.

Ans: Steradian is the unit of solid angle.
The angle subtended at the centre of a sphere by an area of its surface equal to the square of radius of the sphere is one steradian.

16. How many micro seconds in one year?

Ans:

$$1\ year = 365\ days$$
$$= 365 \times 24 \times 60 \times 60\ s$$
$$= 3.1536 \times 10^7\ S$$
$$= 3.1536 \times 10^7 \times 10^6 \times 10^{-6}\ s$$
$$= 3.1536 \times 10^{13}\ \mu s$$
$$(\because 1\mu s = 10^{-6} s)$$

17. The period of a Pendulum cannot be used as a Time Standard. Why?

Ans: Period of a pendulum is given as

$$T = 2\pi\sqrt{l/g}$$

It cannot be used as a Time Standard because

i. The value of g varies with altitudes.

ii. Length of pendulum varies with temperature.

Air resistance will effect the time period.

Topic III: International System of Units:

18. Define base units. **(2 times)**

Ans: The units associated with the base quantities are called base units. These are metre, kilogram, second, ampere, kelvin, candela, mole.

19. Define derived units. **(2 times)**

Ans: The units associated with the derived quantities are called derived units. SI units for measuring all other physical quantities are derived from the base and supplementary units. For example, newton, joule, watt, pascal etc.

20. What are supplementary units? Write their names.

Ans: The General Conference on Weights and Measures has not yet classified certain unit of SI under either base or derived units. These SI units are called supplementary units.

Radian and Steradian are supplementary units.

21. Draw a table for base units. **(4 Times)**

Ans:

Base Quantity	*Base Unit*	*Symbol*
Length	Metre	m
Mass	kilogram	kg
Time	Second	s
Electric Current	ampere	A
Thermodynamic Temperature	Kelvin	K
Amount of Substance	Mole	mol
Luminous Intensity	candela	cd

22. What do you mean by scientific notation? Give an example. **(3 times)**

Ans: The standard form to represent numbers using power of ten is called scientific notation. The accepted practice is that there should be only one non-zero digit left of decimal. For example

The scientific notation of measurement 134.7 is 1.347×10^2.

23. Write down four conventions for indicating units.

Ans: The convections for indicating units are as follows:

i. Full name of the unit does not begin with the capital letter even if named after a scientist e.g. *newton*.

ii. The symbol of unit named after a scientists has initial capital letter e.g. N for *newton*.

iii. The prefix should be written before the unit without any space e.g. $1 \times 10^{-6} m = 1\ \mu m$

iv. Compound prefixes are not allowed. For example $1\ \mu\mu F$ should be written as $1\ pF$.

24. Density of air is $1.2\ {kg}/{m^3}$. Change it into ${g}/{cm^3}$.

Ans: Now

$$1.2\ {kg}/{m^3} = \frac{1.2 \times 1000}{(100)^3}\ {g}/{cm^3}$$

$$1.2\ {kg}/{m^3} = \frac{1.2 \times 1000}{100 \times 100 \times 100}\ {g}/{cm^3}$$

$$1.2\ {kg}/{m^3} = 0.0012\ {g}/{cm^3}$$

25. What are two principal characteristics of an ideal standard? **(2 Times)**

Ans: An ideal standard has two principle characteristics.

i. It is accessible. ii. It is invariable.

26. Why do we find it useful to have two units for the amount of substance kilogram and mole? (21 *times*)

Ans: Both units are used to describe the amount of the substance. Kilogram is used for macroscopic objects or for macroscopic behavior of the objects while mole is used for microscopic objects or on microscopic scale when number of atoms or molecules are concerned.

27. Define and explain supplementary units? (3 times)
OR Differentiate between Radian and Steradian.
OR Define radian and Steradian. (12 times)
OR Define the supplementary unit of plane and solid angle.

Ans: The General Conference on Weights and Measures has not yet classified certain unit of SI under either base or derived units. These SI units are called supplementary units.
Radian and Steradian are supplementary units.
Radian: The radian is the plane angle between two radii of a circle which cut off on the circumference an arc, equal in length to the radius. It is two dimensional angles.
Steradian: The Steradian is the solid angle subtended at the center of the sphere by an area of its surface equal to the square of radius of the sphere. It is three dimensional angles.

28. Differentiate between Base Units and Derived Units. (2 times)
OR What are base units and derived units? Give its examples. (2 Times)

Ans: **Base Units:** The units associated with the base quantities are called base units. Other units are derived from base units. These are meter, kilogram, second, ampere, kelvin, candela, mole.
Derived Units: The units associated with the derived quantities are called derived units. SI units for measuring all other physical quantities are derived from the base and supplementary units. For example, newton, joule, watt, pascal etc

29. Define metre and kelvin.

Ans: **Meter:** One meter is the distance travelled by light in vacuum during a time of 1/299,792,458 seconds.
Kelvin: one kelvin is the fraction 1/273.16 of the thermodynamic temperature of the triple point of water.

30. Write any two points which should be kept in mind, while using units.

Ans: (i) The symbol of unit named after a scientist has initial capital letter such as N for newton.
(ii) Compound prefixes are not allowed. For example, $1\mu\mu F$ may be written as 1pF.

31. What is the difference between Kilogram and Mole?

Ans: Kilogram is used for macroscopic behavior of the object while mole is used for objects on microscopic scale when number of atoms or molecules are concerned.

Topic IV: Errors and Uncertainities:

32. How can we reduce random and systematic error?

Ans: **Reduce random error**: Repeating the measurement several times and taking an average can reduce the effect of random error.
Reduce systematic error: The systematic error can be reduced by comparing the instrument with another which is known to be more accurate and a correction factor is applied.

33. How can you determine the uncertainty in time period? (3 times)

Ans: The uncertainty in the time period of a vibrating body is found by dividing the least count of timing device by the number of vibrations.
For example, The time of 20 vibrations recorded by stopwatch up to the tenth of a second is 40 s.

Its period will be $T = \frac{40\,s}{20} = 2\,s$

And uncertainty is $\frac{0.1\,s}{20} = 0.005\,s$

Thus the period is $T = 2\,s \pm 0.005\,s$

34. The period of simple pendulum is measured by a stop watch. What type of errors are possible in the time period? (25 *times*)

Ans: The two types of errors are possible.
Random error which is due to the negligence or inexperience of a person at the time of starting and stopping the stopwatch. And systematic error which occurs due to the poor calibration of the instrument.

35. Define systematic errors. Explain how can we remove the effect of systematic errors?

Ans: **Systematic Error:** Systematic error occurs when repeated measurements of a quantity give the same values under the same conditions. This error is due to poor calibration or zero error in the stop watch. This error can be removed by applying correction factor.

36. A measurement taken by Vernier Caliper with least count as 0.01cm is 0.45cm, find absolute, fractional and percentage uncertainties. (2 times)

Ans:

$$Precision\ or\ Absolute\ uncrtainty = least\ count = \pm 0.01\ cm$$

$$Fractional\ uncrtainty = \frac{0.01\ cm}{0.45\ cm} = 0.02$$

$$Percentage\ uncrtainty = \frac{0.01\ cm}{0.45\ cm} \times \frac{100}{100} = \frac{2}{100} = 2.0\%$$

37. Name two major types of errors in measurement and also define them.

OR Write the difference between Systematic and Random Error. (2 Times)

OR Differentiate between random error and systematic error. (3 times)

OR Write the main type of error. (7 *times*)

Ans: Two major types of errors in measurement are Systematic Error and Random Error.

i. **Systematic Error:**
Systematic error occurs when repeated measurements of a quantity give the same values under the same conditions. This error is due to poor calibration or zero error in the stop watch. This error can be removed by applying correction factor.

ii. **Random Error:**
Random error occurs when repeated measurements of a quantity give different values under the same conditions. This error is due to faulty procedure or negligence and inexperience of person at the time to start or stop the stop watch. This can be reduced by taking average value of observed readings.

38. How can you assess the uncertainty in the average value of many measurements? (2 times)

Ans: To assess the uncertainty, we find the deviation of each measured value from the average value. The mean deviation is the uncertainty in the average value.

39. How will you assess the total uncertainty in case of power factor? Give an example. (2 times)

Ans: Multiply the percentage uncertainty by that power.
For example , volume of sphere is calculated by using $V = \frac{4}{3}\pi r^3$
If the radius of a small sphere is measured as 2.25 cm by a Vernier callipers with least count 0.01cm then percentage uncertainty in r = $\frac{0.01}{2.25} \times 100\% = 0.4\%$
Total %age uncertainty in V= 3 x 0.4% =1.2 %
Thus V = $\frac{4}{3}\pi r^3 = \frac{4}{3}(3.14)(2.25)^3 = 47.689\ cm^3$ with 1.2% uncertainty=47.7 $\pm 0.6 cm^3$

40. What is the cause of random error and how can it be reduced?

Ans: It is due to some unknown causes. Repeating the measurement several times and taking an average can reduce, the effect of random errors.

41. Given that $V = (5.2 \pm 0.1)$ volt. Find its percentage uncertainty.

Ans: Percentage uncertainty for V is

$$= \frac{0.1V}{5.2V} \times \frac{100}{100} = \frac{0.1}{5.2} \times 100\%$$

= about 2%

42. What is the cause of systematic error? How can it be reduced?

Ans: It may occur due to zero error of instrument, poor calibration of instruments or incorrect marking etc.
It can be reduced by comparing the instruments with another which is known to be more accurate and a correction factor is applied.

Topic V: Significant Figures:

43. Define significant figures. **(4 Times)**

Ans: In any measurement, the accurately known digits and the first doubtful digit are called the significant figures. For example, The number of significant figures in the measurement 02.59 are 3.

44. What rules are of rounded off the significant figure? **(2 times)**

Ans: i) If the first digit dropped is less than 5, the last digit retained should remain unchanged.
ii) If the first digit dropped is more than 5 , the digit to be retained is increased by one.
iii) If the first digit to be dropped is 5, the previous digit which is to be retained is increased by one if it is odd and retained as such if it is even.

45. Using rules of Significant figures, compute $\frac{5.348\times10^{-2}\times3.64\times10^{4}}{1.336}$ upto appropriate significant figures.

Ans: $$\frac{5.348\times10^{-2}\times3.64\times10^{4}}{1.336} = 1.45768982 \times 10^{3}$$
As the factor 3.64×10^4, least accurate in the above calculations has three significant figures ,thus the answer should also be written to three significant figures only which is 1.46×10^3.

46. Is a zero significant or not? Explain. **(3 times)**

Ans: A zero may or may not be significant. The following rules are used.
(a) A zero between two significant figures is itself significant.
(b) Zeros to the left of significant figures are not significant.
(c) In decimal fraction, zeros to the right of a significant figure are significant. However, in integers, the number of significant zeros is determined by the accuracy of the measuring instrument.
(d) In scientific notation, the digits other than the powers of ten are significant.

47. How the digit 5, if insignificant, will be rounded off?

Ans: If the digit to be dropped is 5, the previous digit which is to be retained is increased by one if it is odd and retained as such if it is even.

Topic VI: Precision and Accuracy:

48. Add the mass given in kg up to appropriate precision: 2.189, 0.089, 11.8 and 5.32. **(5 Times)**

Ans: As
$$m = 2.189 + 0.089 + 11.8 + 5.32 = 19.398\ kg$$
By appropriate precision $m = 19.4\ kg$

49. Differentiate between the precision and accuracy. **(7 Times)**

OR Write the difference between precise and accurate measurement. **(7 times)**

Ans: **Precision:** A measurement which has less absolute uncertainty is called precise measurement. The precision of a measurement is determined by the instrument being used. Absolute uncertainty, in effect, is equal to the least count of measuring instrument.
Accuracy: is the one which has less fractional or percentage error. Accuracy measures, how close a measured value is to the actual value.

50. If a precise measurement is also an accurate measurement. Explain your answer.

Ans: A precise measurement in the one which has less absolute uncertainty (least count) and an accurate measurement is the one which has less percentage uncertainty or error.

Topic VII: Assessment of Total Uncertainty in the Final Result:

51. Assess the total uncertainty in the final result of a timing experiment with the help of an example.

Ans: The time of 20 vibrations recorded by stopwatch up to the tenth of a second is 40 s.

Its period will be $T = \frac{40\ s}{20} = 2\ s$

And uncertainty is $\frac{0.1\ s}{20} = 0.005\ s$

Thus the period is $T = 2\ s \pm 0.005\ s$

52. What will be the percentage uncertainty in a radius of a small sphere measured as 2.25 cm?

Ans: $Absolute\ uncrtainty = least\ count = \pm 0.01\ cm$

$$Percentage\ uncrtainty\ in\ radius\ 'r' = \frac{0.01\ cm}{2.25\ cm} \times \frac{100}{100} = 0.4\ \%$$

53. How can the total uncertainty be found in the final results for multiplication and division?

Ans: The total uncertainty in the final results for multiplication and division can be found by adding percentage uncertainties.

Topic VIII: Dimension of Physical Quantities:

54. Describe the principle of homogeneity of dimensional analysis. (2 times)

Ans: According to homogeneity principle

"If the dimensions of physical quantities on both sides of equation are the same, then the equation will be dimensionally correct".

55. Does dimensional analysis give any information on constant of proportionality that may appear in algebraic expression? Explain. (10 Times)

Ans: Dimensional analysis does not give any information about constant of proportionality in any expression. This constant can be determined by experiments.

For example, in the time period of a pendulum

$$T = 2\pi\sqrt{\frac{l}{g}}$$

2π is not included in dimensional analysis.

56. Write the dimensions of pressure and density. (23 Times)

Ans: Since, Pressure $[P] = \frac{[F]}{[A]}$

$$[P] = \frac{[MLT^{-2}]}{[L^2]}$$

$$[P] = [ML^{-1}T^{-2}]$$

And density $[\rho] = \frac{[m]}{[V]}$

$$[\rho] = \frac{[M]}{[L^3]}$$

$$[\rho] = [ML^{-3}]$$

57. Write the dimensions of velocity. (2 Times)

Ans: Since $[v] = \frac{[d]}{[t]}$

$$[v] = \frac{[L]}{[T]}$$

$$[v] = [LT^{-1}]$$

58. Write the dimensions of force and acceleration. (6 times)

Ans: Since, Force $F = ma$

$$[F] = [m][a]$$

$$[F] = [M][LT^{-2}]$$

$$[F] = [MLT^{-2}]$$

and acceleration $[a] = \frac{[v]}{[t]} = \frac{[LT^{-1}]}{[T]} = [LT^{-2}]$

59. What are the dimensions and units of gravitational constant G in the formula $F = G\frac{m_1 m_2}{r^2}$. **(16 times)**

Ans: As
$$F = G\frac{m_1 m_2}{r^2}$$
$$G = \frac{Fr^2}{m_1 m_2}$$
$$[G] = \frac{[F][r^2]}{[m_1][m_2]}$$
$$[G] = \frac{[MLT^{-2}][L^2]}{[M][M]} = [M^{1-2}L^3T^{-2}]$$
$$[G] = [M^{-1}L^3T^{-2}]$$

And
$$G = \frac{Fr^2}{m_1 m_2}$$
$$Units\ of\ G = \frac{Nm^2}{kg^2} = Nm^2kg^{-2}$$

60. Show that the equation $S = v_i t + \frac{1}{2}at^2$ is dimensionally correct.

Ans: As
$$S = v_i t + \frac{1}{2}at^2$$
$$[S] = [v_i][t] + \frac{1}{2}[a][t^2]$$
$$[L] = [LT^{-1}][T] + \frac{1}{2}[LT^{-2}][T^2]$$
$$[L] = [L] + \frac{1}{2}[L]$$
$$[L] = \frac{3}{2}[L]$$

$3/2$ is a dimensionless number.
$$[L] = [L]$$
$$L.H.S. = R.H.S.$$

Hence the equation $S = v_i t + \frac{1}{2}at^2$ is dimensionally correct.

61. Show that the equation $E = mc^2$ is dimensionally correct. **(8 times)**

Ans: As
$$E = mc^2$$

<u>L.H.S.</u>
$$[E] = [F][d] = [ma][d]$$
$$[E] = [MLT^{-2}][L]$$
$$[E] = [ML^2T^{-2}]$$

<u>R.H.S.</u>
$$[m][c^2] = [M][(LT^{-1})^2]$$
$$[mc^2] = [ML^2T^{-2}]$$

Hence
$$L.H.S. = R.H.S.$$

So, the equation $E = mc^2$ is dimensionally correct.

62. Show that the expression $v_f = v_i + at$ is dimensionally correct. **(4 times)**

Ans: As
$$v_f = v_i + at$$

<u>L.H.S.</u>
$$[v_f] = [LT^{-1}]$$

<u>R.H.S.</u>
$$[v_i] + [at] = [LT^{-1}] + [LT^{-2}][T]$$
$$[v_i] + [at] = [LT^{-1}] + [LT^{-1}]$$
$$[v_i] + [at] = 2[LT^{-1}]$$

2 is a dimensionless number.
$$[v_i] + [at] = [LT^{-1}]$$

2

Hence $L.H.S. = R.H.S.$

So, the equation $v_f = v_i + at$ is dimensionally correct.

63. **Show that the relation $v = f\lambda$ is dimensionally correct.**

Ans: As
$$v = f\lambda$$

L.H.S.
$$[v] = [LT^{-1}]$$

R.H.S.
$$[f][\lambda] = [T^{-1}][L]$$
$$[f\lambda] = [LT^{-1}]$$

Hence $L.H.S. = R.H.S.$

So, the equation $v = f\lambda$ is dimensionally correct.

64. **The wavelength λ of a wave depends on the speed v of the wave and its frequency f. Knowing that $[\lambda] = [L], [v] = [LT^{-1}]$ and $[f] = [T^{-1}]$. Decide which of these is correct? $f = v\lambda$ or $f = \frac{v}{\lambda}$. (3 times)**

Ans: As
$$f = \frac{v}{\lambda}$$

L.H.S.
$$[f] = \frac{1}{[t]} = \frac{1}{[T]}$$
$$[f] = [T^{-1}]$$

R.H.S.
$$\frac{[v]}{[\lambda]} = \frac{[LT^{-1}]}{[L]}$$
$$\frac{[v]}{[\lambda]} = [T^{-1}]$$

Hence $L.H.S. = R.H.S.$

So, the equation $f = \frac{v}{\lambda}$ is dimensionally correct.

And as
$$f = v\lambda$$

L.H.S.
$$[f] = [T^{-1}]$$

R.H.S.
$$[v][\lambda] = [LT^{-1}][L]$$
$$[v\lambda] = [L^2T^{-1}]$$

Hence
$$L.H.S. \neq R.H.S.$$

So, the equation $f = v\lambda$ is not dimensionally correct.

65. **Write the dimensions of angular momentum.**

Ans: Since
$$L = mrv$$
$$[L] = [m][r][v]$$
$$[L] = [M][L][LT^{-1}] = [ML^2T^{-1}]$$

66. **Check the correctness of relation $V = \sqrt{\frac{F \times l}{m}}$. (3 times)**

Ans: Dimensions of L.H.S. $[v] = [LT^{-1}]$

Dimensions of R.H.S. Dimensions of $\sqrt{\frac{F \times l}{m}} = \sqrt{\frac{[MLT^{-2}] \times [L]}{[M]}}$

$$= \left(\frac{[MLT^{-2}] \times [L]}{[M]}\right)^{\frac{1}{2}}$$
$$= [L^2T^{-2}]^{\frac{1}{2}}$$
$$= [LT^{-1}]$$

As

Dimensions of L.H.S. = Dimensions of R.H.S.

So the equation is dimensionally correct.

67. Find the dimensions and hence the SI units of co-efficient of viscosity. (4 Times)
OR Find the dimensions of coefficient of viscosity in case of drag force of an object is given by $F = 6\pi\eta r v_t$. (7 Times)

Ans: As

$$F = 6\pi\eta r v$$
$$\eta = \frac{F}{6\pi r v}$$

6π is a dimensionless number, so

$$[\eta] = \frac{[F]}{[r][v]}$$
$$[\eta] = \frac{[MLT^{-2}]}{[L][LT^{-1}]}$$
$$[\eta] = [ML^{-1}T^{-1}]$$
$$[\eta] = [ML^{-1}T^{-1}]$$

Hence its SI unit is Nsm^{-2} or $kg\ m^{-1}\ s^{-1}$.

68. Write down the two uses of dimensional analysis. (6 times)

Ans: It is used for
i. Checking the homogeneity of the physical equation.
ii. Deriving the possible formula.

69. What is physical significance of dimension of physical quantity? OR What do you mean by dimension of a physical quantity? (2 times)

Ans: Each base quantity is considered a dimension. It stands for the qualitative nature of the physical quantity. Dimensions give information about the nature of a physical quantity, its units of measure and correctness of physical equation.

70. Check the correctness of relation F = ma.

Ans: <u>L.H.S.</u> $[F] = [M\,L\,T^{-2}]$

<u>R.H.S.</u> $[m][a] = [M][\,L\,T^{-2}]$
$= [MLT^{-2}]$

Hence $L.H.S. = R.H.S.$

So, the equation $F = ma$ is dimensionally correct.

71. Define light year and what are the units and dimensions of light year.

Ans: A light year is the distance light travels in one year.
S.I units = m
Dimensions = [L]

72. Verify $T = 2\pi\sqrt{\frac{\ell}{g}}$ obeys the principle of homogeneity. OR

Show that $T = 2\pi\sqrt{\frac{\ell}{g}}$ is dimensionally correct. (3 times)

Ans: Dimensions of L.H.S. $= [T]$

Dimensions of R.H.S. = Dimensions of $2\pi\sqrt{\frac{l}{g}}$

$$= \left(\frac{[L]}{[LT^{-2}]}\right)^{\frac{1}{2}}$$

(2π is dimensionless)

$$= [T^2]^{\frac{1}{2}}$$
$$= [T]$$

As Dimensions of L.H.S. = Dimensions of R.H.S.

So, the equation obeys the principle of homogeneity.

73. Derive the dimensions of coefficient of viscosity and pressure.

Ans: **(i)** From Stoke's law

$$F = 6\pi\eta rv$$

6π is dimensionless, so

$$\eta = \frac{F}{6\pi rv}$$

$$[\eta] = \frac{[F]}{[r][v]}$$

$$[\eta] = \frac{[MLT^{-2}]}{[L][LT^{-1}]}$$

$$[\eta] = [ML^{-1}T^{-1}]$$

(ii) Since

$$[P] = \frac{[F]}{[A]}$$

$$[P] = \frac{[MLT^{-2}]}{[L^2]}$$

$$[P] = [ML^{-1}T^{-2}]$$

74. What are the dimensions and unit of $\left[\frac{F\times \ell}{M}\right]^{1/2}$?

Ans: Dimensions of $\left(\frac{F\times L}{M}\right)^{\frac{1}{2}} = \left(\frac{[MLT^{-2}]\times[L]}{[M]}\right)^{\frac{1}{2}}$

$$= [L^2T^{-2}]^{\frac{1}{2}}$$

$$= [LT^{-1}]$$

S.I units of $\left(\frac{F\times L}{M}\right)^{\frac{1}{2}} = \left(\frac{Nm}{kg}\right)^{\frac{1}{2}} = m/s$

75. Write down the dimensions of viscosity & angular velocity.

Ans: (i) From Stoke's law F = $6\pi\eta rv$

6π is a number having no dimensions. So [F] = $[\eta rv]$

Or $[\eta] = \frac{[F]}{[r][v]} = \frac{[MLT^{-2}]}{[L][LT^{-1}]} = [ML^{-1}T^{-1}]$

(ii) $\omega = \frac{\theta}{t}$,

$$[\omega] = \frac{[\theta]}{[t]} = \frac{[L^0]}{T} = [L^0T^{-1}]$$

76. Write dimensions (i) work (ii) torque

Ans: (i) W = F.d

Dim. of W = Dim of F.d

Dim. of W = [F][d] = $[MLT^{-2}][L] = [ML^2T^{-2}]$

(ii) $\tau = rF$

Dim of τ = Dim of rF => Dim of $\tau = [r][F] = [L][MLT^{-2}] = [ML^2T^{-2}]$

77. Write the dimensions of (i) Angular Momentum (ii) Torque

Ans: (i) Since

$$L = mrv$$

$$[L] = [m][r][v]$$

$$[L] = [M][L][LT^{-1}]$$

$$[L] = [ML^2T^{-1}]$$

(ii) Since

$$\tau = rF\sin\theta$$

$$[\tau] = [r][F]\sin\theta$$

(sin θ is dimensionless)

$$[\tau] = [L][MLT^{-2}]$$

$$[\tau] = [ML^2T^{-2}]$$

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78. Three students measured the length of a needle with a scale on which minimum division is 1 mm and recorded as (i) 0.2145 m (ii) 0.21 m (iii) 0.214 m. Which record is correct and why? (2 Times)

Ans. The record (iii) is correct.

Reason: As the scale used for measurement has the least count of 1 mm = 0.001 m. So, the reading must be taken up to three decimal places when it is written in meters. Therefore, the reading 0.214 m is correct.

79. Calculate the volume of the cube and its uncertainty whose edge length is 2.25 ±0.01 cm.

Ans:

Given that: $r = 2.25 \pm 0.01$ cm

$$V = \frac{4}{3}\pi r^3$$

$$V = \frac{4}{3} \times 3.14 \times (2.25)^3 = 47.7 \text{ cm}^3$$

Uncertainty:

$$\% \text{ Uncertainty in r} = \frac{0.01}{2.25} \times \frac{100}{100} = 0.4\ \%$$

$$\text{Total Uncertainty in V} = 3 \times 0.4\% = 1.2\ \%$$

Therefore, V=47.7 cm^3 with 1.2%. OR $V = 47.7 \pm 0.6$ cm^3

80 The volume of sphere V = 47.689 cm^3 with 1.2 % uncertainty. What is the correct range of volume measurement?

Ans:

$$1.2\ \% \text{ of } 47.689 = 47.689 \times \frac{1.2}{100} = 0.572$$

So, the correct range of volume is $V = 47.689 \pm 0.572$ cm^3.

81. Define the terms (a) Precision (b) Dimension of the physical quantities.

Ans:

(a) **Precision:** A measurement which has less absolute uncertainty is called precise measurement. The precision of a measurement is determined by the instrument being used. Absolute uncertainty, in effect, is equal to the least count of measuring instrument.

(b) **Dimension of the physical quantities:** To express any physical quantity in terms of specific symbols of corresponding base quantities, written within square brackets, is called the dimension of that physical quantity. The scientific symbols used to express the dimensions of different physical quantities are as follows:

Dimension of mass = [M]
Dimension of length = [L]
Dimension of time = [T]

82. Write down the dimension of (a) Coefficient of viscosity (b) Energy.

Ans:

(a) As we know that

$$F = 6\pi\eta rv$$

$$\eta = \frac{F}{6\pi rv}$$

6π is a dimensionless number, so

$$[\eta] = \frac{[F]}{[r][v]}$$

$$[\eta] = \frac{[MLT^{-2}]}{[L][LT^{-1}]}$$

$$[\eta] = [ML^{-1}T^{-1}]$$

$$[\eta] = [ML^{-1}T^{-1}]$$

(b) As we know that Energy = Work = Fd

Therefore,

$$[E] = [F][d] = [ma][d]$$
$$[E] = [MLT^{-2}][L]$$
$$[E] = [ML^2T^{-2}]$$

NUMERICAL PROBLEMS OF CHAPTER-1 IN ALL PUNJAB BOARDS 2011-2021

1. Suppose, we are told that the acceleration of a particle moving in a circle or radius r with uniform speed v is proportional to some powers of r, say r^n and some powers of v, say v^m, determine the powers of r and v.

Sol: Given that

$\alpha \propto r^n \rightarrow$ (i)

$\alpha \propto v^m \rightarrow$ (ii)

$n = ?$

$m = ?$

By combining relation (i) and (ii) we get

$\alpha \propto r^n v^m \rightarrow (iii)$

Or $\alpha = Constant\ .r^n v^m$

Writing dimensions of both sides in equation (iii)

$[a] =$ constant $[r^n v^m]$

$[LT^{-2}] = [L^n][LT^{-1}]^m$

$[LT^{-2}] = [L^{n+m}T^{-m}]$

Comparing the powers of L and T on both sides.

$-m = -2 \Rightarrow m = 2$

And $n + m = 1$

Or $n + 2 = 1 \Rightarrow n = -1$

2. The speed "v" of sound waves through a medium may be assumed is depend on (i) The density (ρ) of the medium and (ii) its modulus of elasticity 'E' which is the ratio of stress to strain. Deduce by the method of dimensions the formula for the speed of sound.

Sol: Suppose $v \propto \rho^a \rightarrow (i)$

$v \propto E^b \rightarrow (ii)$

By combing relation (i) and (ii) we get

$v \propto \rho^a E^b$

Or $v =$ constant $\rho^a . E^b \rightarrow (iii)$

Dimensions of speed $= [v] = [LT^{-1}]$

Dimensions of density $= [\rho] = \frac{[mass]}{[Volume]} = [ML^{-3}]$

Dimensions of modulus of elasticity

$[E] = \frac{[stress]}{[strain]} = \frac{[ML^{-1}T^{-2}]}{No\ dimensions} = [MLT^{-1}T^{-2}]$

Writing dimensions of both sides in equation (iii)

$[v] = Constant[\rho]^a\ [E]^b$

$$\left[LT^{-1}\right]=\left[ML^{-3}\right]^{a}\left[ML^{-1}T^{-2}\right]^{b}$$

$$\left[LT^{-1}\right]=\left[M^{a+b}L^{-3a-b}T^{-2b}\right]$$

Comparing the powers of M, L and T on both sides,

$a+b=0$ or $a=-b \rightarrow (iv)$

and $-3a-b=1$

and $-2b=-1 \rightarrow b=\frac{1}{2}$

putting value of b in equation (iv), we get $a=-\frac{1}{2}$

from eq. (iii) $v=$ constant $P^{-1/2}E^{1/2}$ or $v=$ constant $\sqrt{\frac{E}{P}}$

3. The diameter and length of a metal cylinder measured with the help of Vernier calipers of least count 0.01cm are 1.22 cm and 5.35 cm. calculate the volume of cyclinder and uncertainty in it.

Sol: length of cylinder $=(5.35\pm0.01)cm$

Diameter of cylinder $=(1.22\pm0.01)cm$

Volume of cylinder = ?

Uncertainty in volume =?

Y age uncertainty in length = $\frac{0.01}{5.35}\times100\%$

$=0.2\%$

Y age uncertainty in diameter $=\frac{0.01}{1.22}\times100\%$

$=0.8\%$

As

$$V=\frac{\pi d^2 l}{4}\rightarrow(i)$$

Total uncertainty in volume $=(2\times0.8\%)+0.2\%$

$=1.8\%$

Putting values in eq. (i)

$$V=\frac{(3.14)(1.22)^2(5.35)}{4}$$

$V=6.25cm^3$ with 1.8% uncertainty

Thus $V=(6.25\pm0.1)\ cm^3$

4. Derive a relation for the time period of a simple pendulum by using dimensional analysis.

Sol: The relation for the time period will be of the form

$T\propto m^a l^b \theta^c g^d$

Or T= constant $\times\ m^a l^b \theta^c g^d \rightarrow(i)$

Taking dimensions of both sides

$$[T]=\text{constant}\ [M]^a[L]^b\left[LL^{-1}\right]^c\left[LT^{-2}\right]^d$$

$$[T]=\text{constant}\ \left[M^a\right]\left[L^b\right]\left[L^cL^{-c}\right]\left[L^dT^{-2d}\right]$$

$$[T]=\text{constant}\ [M]^a[L]^{b+c-c+d}[T]^{-2d}$$

Comparing the powers of M,L and T on both sides

$a=0$

And $b+c-c+d=0$

$b+d=0 \rightarrow (ii)$

And $-2d=1$

or $d=-\frac{1}{2}$

putting in eq. (ii)

$b-\frac{1}{2}=0$

or $b=\frac{1}{2}$

$\theta=\left[LL^{-1}\right]^c=\left[L^0\right]^c=1$

Putting values of a,b,Q and d in eq. (i)

$T=$ constant $m^0\times l^{\frac{1}{2}}\times 1\times g^{-\frac{1}{2}}$

$T=$ constant $1\times\sqrt{l}\times\frac{1}{\sqrt{g}}$

$T=$ constant $\sqrt{\frac{l}{g}}$

The numerical value of the constant can not be determined by dimensional analysis, however it can be found by experiments.

5. The length and width of rectangular plate are measured to be $15.3\,cm$ and 12.80 cm respectively. Find the correct area of the plate.

Sol: Length of plate $=L=15.3\,cm$

Width of plate $=W=12.80\,cm$

Correct area of plate = A = ?

For rectangular plate

$A=L\times W$

$=15.3\,cm\times 12.80\,cm$

$=195.84\,cm^2$

It is rounded off upto appropriate precision and correct area is

$A=196\,cm^2$

6. Show that the famous "Einstein equation $E=mc^2$" is dimensionally consistent. Calculate equivalence energy of 1 kg.

Sol: As

$E=mc^2=W=(W)(d)$

$L.H.S=E$

$=(ma)(d)$

$=\left[MLT^{-2}\right][L]$

$=\left[ML^2T^{-2}\right]$

R.H.S = $mc^2=(m)(c^2)$

$=[M]\left(LT^{-1}\right)^2$

$=[M]\left[L^2T^{-2}\right]$

$=\left[ML^2T^{-2}\right]$

Hence L.H.S= R.H.S

So, the equation $E = mc^2$ is dimensionally correct.
Since $E = mc^2$.

$E = 1(3\times10^8)^2$

$E = 9\times10^{16}\ J$

7. i. How many seconds are there in one year.
ii. How many nanoseconds in one year.
iii. How many years in one second?

Sol: Seconds in one year:
1 year = 365 days
1 year = 365×24 hours
1 year= $365\times24\times3600\,s$
1 year= $3.1536\times10^7\,s$
Nanoseconds in one year:
1 year = $3.1536\times10^7\,s$
1 year = $3.1536\times10^7\times10^9\times10^{-9}\,s$
1 year= $3.1536\times10^{16}\times10^{-9}\,s$
1 year = $3.1536\times10^{16}\,ns$
Year in one second:
1 year = $3.1536\times10^7\,s$

$1s = \frac{1}{3.1536\times10^7}\,Years$

$1s = 0.317\times10^{-7}$ Years
1s = 0.317×10^{-8} Years

OBJECTIVES (MCQ'S) OF CHAPTER-2 IN ALL PUNJAB BOARDS 2011-2021

Topic I: Basic Concepts of Vectors:

1. The resultant magnitude of 6N force acting at right angle to 8N force is: (4 times)
(A) 2N (B) 14N (C) 8N (D) 10N

2. Position vector of a point P(a,b,c) in YZ-Plane is given by:
(A) $\vec{r} = a\hat{i}+b\hat{j}$ (B) $\vec{r} = a\hat{i}+c\hat{k}$ (C) $\vec{r} = b\hat{j}+c\hat{k}$ (D) $\vec{r} = a\hat{i}+b\hat{j}+c\hat{k}$

3. Two vectors to be combined have magnitudes 60 N and 35 N. The correct answer will be:
(A) 15 N (B) 20 N (C) 70 N (D) 100 N

4. A single vector having same effect as all the original vectors taken together is:
(A) Resultant vector (B) Equal vector (C) Position vector (D) Unit vector

5. The vector A has the components A_x and A_y. The magnitude A_x is given by:
(A) $A-A_y$ (B) $(A-A_y)^{1/2}$ (C) $(A)-(A_y)^{1/2}$ (D) $(A^2-A_y^2)^{1/2}$

6. If R_x is positive and R_y is negative. The resultant lies in the:
(A) 1st quadrant (B) 2nd quadrant (C) 3rd quadrant (D) 4th quadrant

7. Mathematically unit vector is given by:
(A) $\hat{A} = A\vec{A}$ (B) $\hat{A} = A/\vec{A}$ (C) $\hat{A} = \vec{A}/A$ (D) $\hat{A} = \vec{A}.\vec{A}$

8. Projection of $\vec{B}$ along $\vec{A}$ will be given as: (2 times)
(A) $\hat{A}.\vec{B}$ (B) $\vec{B}.\hat{A}$ (C) $\frac{\vec{A}.\vec{B}}{B}$ (D) $\frac{\vec{A}.\vec{B}}{\cos\theta}$

9. In third quadrant direction of resultant vector is $\left(\phi = \tan^{-1}\frac{R_y}{R_x}\right)$

(A) $180^o - \varphi$ (B) $180^o + \varphi$ (C) $360^o - \varphi$ (D) $360^o + \varphi$

10. The result of adding A into –A is:

(A) A (B) 2A (C) 0 (D) -A

11. Which one is a vector:

(A) Length (B) Volume (C) Velocity (D) Work

12. The magnitude of a vector $\vec{A} = A_x\hat{\imath} + A_y\hat{\jmath}$ is:

(A) $A_x^2 + A_y^2$ (B) $A_x^2 - A_y^2$ (C) $\sqrt{A_x^2 + A_y^2}$ (D) $\sqrt{A_x^2 - A_y^2}$

13. The vector in space has components:

(A) 1 (B) 2 (C) 3 (D) 4

14. Reverse process of vector addition is called:

(A) Subtraction of vector (B) resolution of vector
(C) Obtaining unit vector (D) Making a vector negative

15. $\vec{A}+\vec{B}=\vec{B}+\vec{A}$ this shows that addition of vector is:

(A) Associative (B) Commutative (C) Additive (D) Additive inverse

16. A vector in space has components:

(A) 1 (B) 2 (C) 3 (D) 4

17. If $\vec{B} = 4\hat{\imath} + \hat{k}$, then its magnitude will be:

(A) 9 (B) $\sqrt{17}$ (C) 7 (D) 3

18. If $\vec{A} = 2\hat{\imath} + \hat{\jmath} + 2\hat{k}$ then $|\vec{A}|$ is :

(A) Zero (B) 3 (C) 5 (D) 9

19. The direction of vector in space is specified by:

(A) 1-Angle (B) 2-Angle (C) 3-Angle (D) 4-Angle

20. Two vectors can be added by simple arithmetical method when they are at an angle of.

(A) 120° (B) 90° (C) 45° (D) 0°

21. If two unit vectors perpendicular to each other are added, magnitude of resultant.

(A) 2 (B) $\sqrt{2}$ (C) $\frac{1}{\sqrt{2}}$ (D) 4

22. Projection of $\bar{B}$ on $\bar{A}$ is:

(A) A Cos θ (B) B Sin θ (C) A Sin θ (D) B Cos θ

23. The angle of $\vec{A} = A_x\hat{i} - A_y\hat{j}$ with X-axis will be in between.

(A) 0° and 90° (B) 90° and 180° (C) 180° and 270° (D) 270° and 360°

24. If |a + b| = |a – b| then angle between $\vec{a}$ and $\vec{b}$ is:

(A) 0° (B) 45° (C) 90° (D) 180°

25. The resultant of 120 N and 20 N forces can not be:

(A) 141 N (B) 100 N (C) 101 N (D) 130 N

Topic II: Vector Addition by Rectangular Components:

26. The magnitudes of rectangular components of a vector are equal, if its angle with x-axis is: **(2 times)**

(A) 0° (B) 30° (C) 45° (D) 90°

27. If both components of vector are negative, then resultant lies in: **(3 Times)**

(A) 1st quadrant (B) 2nd quadrant (C) 3rd quadrant (D) 4th quadrant

28. The direction of resultant vector having both components R_x and R_y positive will lie in quadrant:

(A) 1st (B) 2nd (C) 3rd (D) 4th

29. If R_x and R_y both are negative. Then the resultant vector lies in: **(3 times)**

(A) 1st quadrant (B) 2nd quadrant (C) 3rd quadrant (D) 4th quadrant

30. The resultant of two force 3N and 4N acting at right angle to each other is: (2 Times)

(A) 6N (B) 5N (C) 2N (D) 7N

31. A force of 10N makes an angle of 30° with y-axis. The magnitude of x component will be: (3 times)

(A) 5N (B) 8.66N (C) 10N (D) Zero

32. The resultant of two forces 30N and 40N acting at an angle of 90° with each other is: (2 Times)

(A) 50N (B) 30N (C) 40N (D) 70N

33. The resultant of two forces 5 N and 12 N making an angle of 90° with each other is:

(A) 17 N (B) 7 N (C) 13 N (D) 15 N

34. If two equal magnitude and perpendicular to each other vectors are added then their resultant makes angle with x-axis is:

(A) 0° (B) 90° (C) 45° (D) 60°

35. A force of 20N acts along x-axis its x-component is:

(A) 0N (B) 10N (C) 20 N (D) 30 N

36. Both the dot product and cross product of two vectors $\vec{A}$ and $\vec{B}$ is zero, when:

(A) $\vec{A}$ and $\vec{B}$ are parallel to each other (B) $\vec{A}$ and $\vec{B}$ are antiparallel

(C) $\vec{A}$ and $\vec{B}$ are perpendicular to each other (D) Either the vector is zero

37. If R_x is negative and R_y is positive, then the resultant vector lies in: (2 Times)

(a) 2^{nd} quadrant (b) 3^{rd} quadrant (c) 4^{th} quadrant (d) 1^{st} quadrant

Topic III: Product of Two Vectors:

38. The magnitude of vector product of two non-zero vectors $\vec{A}$ and $\vec{B}$ making an angle θ with each other is: (2 times)

(A) $AB\sin\theta\,\hat{n}$ (B) $AB\sin\theta$ (C) $AB\cos\theta$ (D) AB

39. $\hat{i}.(\hat{j}.\hat{k})$ is equal to:

(A) $\hat{k}$ (B) 1 (C) 2 (D) 0

40. The magnitude of dot and cross products of two vectors are $6\sqrt{3}$ and 6 respectively. The angle between them will be:

(A) 0° (B) 30° (C) 45° (D) 60°

41. The magnitude of cross and dot product of two vectors are equal. The angle between the vectors is: (4 Times)

(A) Zero (B) 90° (C) 180° (D) 45°

42. If $\vec{F} = 2\hat{i}+3\hat{j}$ N and $\vec{d} = 4\hat{i}+4\hat{j}$ m, the work done will be:

(A) 13 J (B) 18 J (C) 20 J (D) 24 J

43. The self-dot product of a vector $\vec{A}$ is: (3 Times)

(A) 0 (B) 1 (C) A (D) A^2

44. The cross product of vectors will be minimum when angle between vectors is:

(A) 35° (B) 90° (C) 0° (D) 45°

45. Dot product of two non-zero vectors is zero if angle between them is:

(A) 30° (B) 60° (C) 45° (D) 90°

46. The cross product of a vector $\vec{F}$ with itself results:

(A) $\vec{F}$ (B) F^2 (C) Zero (D) null vector

47. If the magnitude of $\vec{A}.\vec{B} = \frac{1}{2}AB$ Then an angle between $\vec{A}$ and $\vec{B}$ is: (2 times)

(A) 30° (B) 45° (C) 60° (D) 90°

48. If two non zero vectors $\overline{A}$ and $\overline{B}$ are parallel to each other then: (2 times)

(a) $\overline{A}.\overline{B} = 0$ (b) $\overline{A}.\overline{B} = AB$ (c) $|\overline{A} \times \overline{B}| = AB$ (d) $|\overline{A} \times \overline{B}| = \overline{A}.\overline{B}$

49. The vector product $(\vec{A} \times \vec{A})$is:

(a) θ (b) 1 (c) A^2 (d) zero

50. The resultant of two forces 30 N and 40 N acting parallel to each other is:

(a) 30 N (b) 40 N (c) 70 N (d) 10 N

51. The magnitude of $\hat{i}.(\hat{j}\times\hat{k})$ is: (4 Times)
(A) 0 (B) 1 (C) -1 (D) 2

52. $AB\sin\theta\,\hat{n}\times AB\sin\theta\,\hat{n}$ is
(A) $A^2B^2\sin^2\theta$ (B) A^2B^2 (C) $A^2B^2\,\hat{n}$ (D) $\vec{o}$

53. If $\vec{A}\times\vec{B}=\vec{O}$, then angle between the vectors is:
(A) 90° (B) 270° (C) 0° (D) None of these

54. If $\vec{A}=-4\hat{i}$ and $\vec{B}=6\hat{j}$ then $\vec{A}.\vec{B}$ will be.
(A) $24\hat{k}$ (B) 24 (C) Zero (D) $-24\hat{k}$

55. $\hat{i}.(\hat{k}\times\hat{i})$ = ____________: (2 times)
(A) 1 (B) 0 (C) $\hat{i}$ (D) $\hat{k}$

56. An area of parallelogram formed by A and B two adjacent sides is given as: (2 times)
(A) AB Sinθ (B) AB cosθ (C) AB tan θ (D) $\vec{A}.\vec{B}$

57. If $\vec{F}=2\hat{i}+3\hat{j}N$ and $\vec{d}=4\hat{i}+4\hat{j}m$ then the work done will be.
(A) 13 J (B) 18 J (C) 20 J (D) 24 J

Topic IV: Torque:

58. Torque of a force is given by $\tau=\vec{r}\times\vec{F}$. If has maximum value when r and F are at an angle of:
(A) 90° (B) 0° (C) 30° (D) 60°

59. When torque acting on a system is zero which of the following will be constant:
(A) Linear momentum (B) Force (C) Angular momentum (D) Impulse

60. The direction of torque can be found by:
(A) Head to tail rule (B) Right hand rule (C) Left hand rule (D) Fleming rule

61. Torque acting on body is given by:
(A) $\tau=I^2$ (B) $\tau=I\alpha^2$ (C) $\tau=I^2\alpha^2$ (D) $\tau=I\alpha$

62. If r = 5 m and F = 4 N are along same direction, then torque is:
(A) 20 N.m (B) 5 N.m (C) 10 Nm (D) Zero

Topic V: Equilibrium of Forces:

63. If the second condition of equilibrium is fulfilled, the body will be in:
(A) Rotational equilibrium (B) static equilibrium
(C) Dynamic equilibrium (D) complete equilibrium

64. The complete requirements for a body to be in equilibrium is: (2 times)
(A) $\sum F=0$ (B) $\sum\tau=0$ (C) $\sum P=0$ (D) $\sum F=0,\sum\tau=0$

65. If a body is at rest, then it will be in:
(A) Static equilibrium (B) Dynamic
(C) Translational equilibrium (D) Unstable equilibrium

66. The first condition of equilibrium implies that:
(A) $\sum\tau=0$ (B) $\sum F_y=0$ (C) $\sum F_y=0$ (D) $\sum F_x=\sum F_y=0$

67. A layer of rock holding water that allows water to percolate through it with pressure is called:
(A) Geyser (B) Aquifer (C) Steam vent (D) Hot spring

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68. The magnitude of $\hat{A}$ will be:
(a) zero (b) A^2 (c) 1 (d) A

69. Which is correct formula:
(a) $\vec{\tau}=rF$ (b) $\vec{\tau}=rFSin\,\theta$ (c) $\vec{\tau}=\vec{r}\times F$ (d) $\vec{\tau}=rFcos\,\theta\cdot\hat{n}$

70. The cross product of a vector $\vec{A}$ with itself results:
(A) $\vec{A}$ (B) A^2 (C) Zero (D) Null vector

71. Minimum number of unequal forces whose vector sum can be zero are:
(A) 5 (B) 4 (C) 3 (D) 2

72. If $\vec{A} = 2\hat{i} + 3\hat{j} - \hat{k}$ and $\vec{B} = 4\hat{i} + 6\hat{j} - 2\hat{k}$. The angle between them will be:
(A) 0° (B) 45° (C) 60° (D) 90°

73. The cross product of two anti-parallel vectors is:
(A) 0 (B) 1 (C) maximum (D) negative

74. The Magnitude of $\hat{i} \times \hat{j}$ is equal to: (Topic III) (2 times)
(A) 1 (B) $\hat{K}$ (C) $-\hat{K}$ (D) zero

75. If a Vector $\vec{A}$ makes an angle 0^0 with x-axis then its x-component is:
(A) A $Cos\emptyset$ (B) A^2 (C) A (D) $A\ Sin\emptyset$

76. A force for 100N makes an angle of 60^0 with Y-axis, its horizontal component is:
(A) 50N (B) 60N (C) 70.7N (D) 86.6N

77. The direction of torque is:
(A) Along the position vector $\vec{r}$
(B) Perpendicular to both $\vec{r}$ and $\vec{F}$
(C) Along the direction of force $\vec{F}$
(D) Opposite to the direction of $\vec{r}$

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78- Cross porudct of $\hat{j} \times \hat{k}$ is.
(A) Zero (B) 1 (C) $\hat{i}$ (D) $-\hat{i}$

79. If the magnitudes of scalar and vector product of two vectors are $2\sqrt{3}$ and 2 respectively. The angle between vectors is:
(A) 30° (B) 6 (C) 120° (D) 180°

80. The resultant two perpendicular vectors each of magnitude A is:
(A) A (B) 2A (C) $\sqrt{2}$ A (D) A^2

81. If two components of a vector are equal in magnitude, the vector making angle with x-axis will be. (2 times)
(A) 30° (B) 45° (C) 60° (D) 90°

82. Two forces of magnitudes 10 N and 20 N act on a body in directions making angle of 30°, the X-component of the resultant force will be:
(A) 25.98 N (B) 30.98 N (C) 20.98 N (D) 17.98 N

83. The force of 15 N makes an angle of 90° with x-axis, its y-component is.
(A) 15 N (B) Zero N (C) 30 N (D) 45 N

84. The position vector $\vec{r}$ in xz-plane is:
(A) $y\hat{i} + z\hat{k}$ (B) $x\hat{i} + y\hat{k}$ (C) $x\hat{i} + z\hat{k}$ (D) $x\hat{i} + y\hat{j} + z\hat{k}$

85. Unit vector of a given vector $\vec{A} = 4\hat{i} + 3\hat{j}$ is.
(A) $\frac{4\hat{i} + 3\hat{j}}{25}$ (B) 1 (C) $\frac{4\hat{i} + 3\hat{j}}{5}$ (D) $\sqrt{\frac{4\hat{i} + 3\hat{j}}{5}}$

86. If cross product of two vectors $\vec{A} \times \vec{B}$ points along positive z-axis, then the vectors $\vec{A}$ and $\vec{B}$ must lie in.
(A) yz – plane (B) xz – plane (C) xy – plane (D) No plane

87. If AB Sin θ= AB Cosθ the the angle between $\vec{A}$ and $\vec{B}$ is:
(A) 30° (B) 45° (C) 60° (D) 180°

88. IF the resultant of two vectors each of magnitude of 'F' is also of magnitude 'F' then the angle between them will be:
(A) 30° (B) 60° (C) 90° (D) 120°

89. If a force of 10N is acting along x-axis then its component along y-axis is:
(A) zero (B) 5 N (C) 10 N (D) 15 N

90. The dot product of $\vec{A}$ with itself is equal to:
(A) A (B) A^2 (C) zero (D) 2 A

91. In which quadrant vector $-2\hat{i}-3\hat{j}$ lies.
(A) 1st (B) 2nd (C) 4th (D) 3rd

92. Rectangular components have angle between them is:
(A) 30° (B) 45° (C) 60° (D) 90°

93. Cross-product of $\hat{j}\times\hat{k}$ is:
(A) Zero (B) 1 (C) $\hat{i}$ (D) $-\hat{i}$

94. The unit Vector in the direction of $\vec{A}$ is:
(A) $\hat{A}=\frac{A}{\vec{A}}$ (B) $\hat{A}=A\vec{A}$ (C) $\hat{A}=\frac{\vec{A}}{A}$ (D) $\vec{A}=\frac{A}{\hat{A}}$

95. If $\vec{A}\times\vec{B}$ is along y-axis, then $\vec{A}$ and $\vec{B}$ are in:
(A) x-y plane (B) y-z plane (C) Space (D) x-y plane

96. IF a Force of 5N is applied parallel to Moment Arm of 5m, then Torque is equal to: (2 times)
(A) 25 Nm (B) 5 Nm (C) 10 Nm (D) Zero Nm

97- If $\vec{F}$ = (2i + 4j) N ; d = (5i + 2j) m work done is:
(A) 15 J (B) 18 J (C) zero (D) -18 J

98- The sum of two prependicular forces 8 N and 6 N is:
(A) 2N (B) 14 N (C) 10 N (D) -2 N

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99. Magnitude of cross product of two perpendicular vectors is:
(A) $\vec{A}\,\vec{B}$ (B) $AB\hat{n}$ (C) 0 (D) AB

100. At what angle Dot product and Cross product have the same magnitude
(A) 0^o (B) 45^o (C) 30^o (D) 60^o

101. The magnitude of a vector $\vec{\gamma}=3\hat{i}+6\hat{j}+2\hat{k}$
(A) 3 (B) 6 (C) 7 (D) 8

102. When line of action of applied force passes through the axis of rotation, then the torque is
(A) Zero (B) 1 (C) Maximum (D) Minimum

103. Unit of torque in SI unit is:
(A) $N-m^{-1}$ (B) $N^{-1}-m$ (C) $N^{-1}-m^{-1}$ (D) $N-m$

104. The dot produst $\hat{i}.\hat{i}$ is equal to
(A) 0 (B) 1 (C) -1 (D) $\hat{j}$

105. Which of the following is the only scalary quantity?
(A) Energy (B) Velocity (C) Force (D) Torque

106. If $|\vec{A}\times\vec{B}|=|\vec{A}.\vec{B}|$ then angle between vectors $\vec{A}$ and $\vec{B}$ is:
(A) 60^o (B) 90^o (C) 45^o (D) 30^o

107. Projection of $\vec{A}$ on $\vec{B}$ is:
(A) B cos θ (B) A sin θ (C) $\vec{B}\,.\,\hat{A}$ (D) $\vec{A}\,.\,\hat{B}$

108. The resultant magnitude of two forces 6N and 8N acting at right angle to each other is:
(A) 10N (B) -8N (C) 6N (D) 4N

109. The angle between the vectors $\hat{i}+3\hat{j}-2\hat{k}$ and $\hat{i}-\hat{j}-\hat{k}$ is:
(A) 0^o (B) 45^o (C) 90^o (D) 180^o

110. If $\vec{A}\times\vec{B}$ points along +ve Z-axis, then vector $\vec{A}$ and $\vec{B}$ must lie,
(A) yz-plane (B) xz-plane (C) xy-plane (D) zz-plane

111. In unit vectors $(\hat{i}\times\hat{j})\times\hat{k}$ is equal to
(A) Null vector (B) $\hat{i}$ (C) $\hat{j}$ (D) 1

112. Which of the following is perpendicular to $4\hat{i}-3\hat{j}$:

(A) $4\hat{i}+3\hat{j}$ (B) $6\hat{i}$ (C) $7\hat{k}+\hat{i}$ (D) $3\hat{i}+4\hat{j}$

113. Torque is rotational analogous of:

(A) Momentum (B) Force (C) Weight (D) Axis of rotation

114. The area of the parallelogram formed with $\overline{A}$ and $\overline{B}$ as two adjacent sides is equal to:

(A) $AB\sin\theta$ (B) $AB\cos\theta$ (C) $AB\tan\theta$ (D) AB

115. If $\overline{A}=2\hat{i}-\hat{j}+2\hat{k}$ then A= :

(A)2 (B) 3 (C)5 (D) 9

116. If $|\vec{A}.\vec{B}|=|\vec{A}\times\vec{B}|$ then angle between vectors $\vec{A}$ and $\vec{B}$ is:

(A) 0 (B) $\frac{\pi}{4}$ (C) $\frac{\pi}{2}$ (D) π

117. $\hat{i}.\hat{i}=\hat{j}.\hat{j}=\hat{k}.\hat{k}$ is equal to:

(A) 0 (B) 1 (C) -1 (D) 2

ANSWERS OF THE MULTIPLE CHOICE QUESTIONS

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
D	C	C	A	D	D	C	A	B	C	C	C	C	B	B
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
C	B	B	C	D	B	D	D	C	A	C	C	A	C	B
31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
A	A	C	C	C	D	A	B	D	B	D	C	D	C	D
46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
D	C	B	D	C	B	D	C	C	B	A	C	A	C	B
61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
D	D	A	D	A	D	B	C	C	D	C	A	A	A	C
76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
D	B	C	A	C	B	A	A	C	C	C	B	D	A	B
91	92	93	94	95	96	97	98	99	100	101	102	103	104	105
D	D	C	C	D	D	B	C	D	B	C	A	D	B	A
106	107	108	109	110	111	112	113	114	115	116	117			
C	D	A	C	C	A	D	B	A	B	B	B			

SHORT QUESTIONS OF CHAPTER-2 IN ALL PUNJAB BOARDS 2011-2021

Topic I: Basic Concepts of Vectors:

1. Define null and equal vectors. **(4 times)**

Ans: **Null vector:** A vector of zero magnitude and arbitrary direction is called null vector. Null vector is denoted as $\vec{O}$.

Equal vector: Two vectors are said to be equal if they have same magnitude and direction.

2. Define position vector and give its mathematical expression? **(7 times)**

Ans: A vector which describes the location of a point with respect to origin is called position vector.

In two dimensions $\vec{r}=a\hat{i}+b\hat{j}$

And magnitude $r=\sqrt{a^2+b^2}$

In three dimensions $\vec{r}=a\hat{i}+b\hat{j}+c\hat{k}$

And magnitude $r=\sqrt{a^2+b^2+c^2}$

3. Define the term unit vector. **(2 times)**

OR **Define Unit Vector. How we find it.** **(6 times)**

Ans: A vector having the unit magnitude is called the unit vector. It is used to indicate the direction of a given vector.

$$\hat{A} = \frac{\vec{A}}{A}$$

4. **Find the unit vector of vector $\vec{A} = 4\hat{\imath} + 3\hat{\jmath}$.** **(6 times)**

Ans: Since

$$\hat{A} = \frac{\vec{A}}{A}$$

$$\hat{A} = \frac{4\hat{\imath} + 3\hat{\jmath}}{\sqrt{(4)^2 + (3)^2}}$$

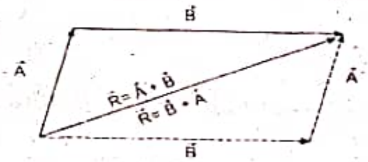
$$\hat{A} = \frac{4\hat{\imath} + 3\hat{\jmath}}{\sqrt{16 + 9}}$$

$$\hat{A} = \frac{4\hat{\imath} + 3\hat{\jmath}}{\sqrt{25}}$$

$$\hat{A} = \frac{4\hat{\imath} + 3\hat{\jmath}}{5}$$

5. **Prove that addition of two non-zero vectors $\vec{A}$ and $\vec{B}$ is commutative. (4 Times)**

Ans: The two vectors $\vec{A}$ and $\vec{B}$ are added by head to tail rule. The tail of vector $\vec{B}$ coincides with the head of vector $\vec{A}$ and the resultant is obtained by joining the tail of $\vec{A}$ to the head of $\vec{B}$. Similarly the sum $\vec{B} + \vec{A}$ is illustrated by dotted lines in figure.



It is seen that $\vec{A} + \vec{B} = \vec{B} + \vec{A}$

Hence the addition of two non-zero vectors is commutative.

6. **What is negative of $\vec{A}$ vector? How a vector $\vec{B}$ is subtracted from a vector $\vec{A}$.**

Ans: The vector which has the same magnitude as that of vector $\vec{A}$, but opposite in direction is called negative of vector $\vec{A}$. It is represented by $-\vec{A}$.

To subtract vector $\vec{B}$ from vector $\vec{A}$ $\quad \vec{A} - \vec{B} = \vec{A} + (-\vec{B})$

7. **How would the two vectors of the same magnitudes have to be oriented, if they were to be combined to give a vector of the same magnitude? (3 Times)**

OR **What is the angle between two vectors of same magnitude? If they were to be combined to give a resultant equal to a vector of the same magnitude.(2 times)**

Ans: The two vectors of equal magnitudes are combined to give a resultant vector of same magnitude when must be oriented at an angle of 120^0 with each other.

8. **Can a vector have a component greater than the vector's magnitude? (7 Times)**

Ans: No, the magnitude of the component of a vector can never be greater than the vector's magnitude. The maximum value of magnitude of component can be equal to the magnitude of the vector.

9. **Two vectors have unequal magnitude. Can their sum be zero? Explain.(12 Times)**

Ans: No, the sum of two vectors having unequal magnitudes can't be zero. The sum of two vectors will be zero only when their magnitudes are equal and they act in opposite direction.

10. **Can you add zero to a null vector?** **(9 Times)**

Ans: No, zero can't be added to a null vector because zero is a scalar and scalars can't be added to vectors. Only the physical quantities of same nature can be added.

11. **The vector sums of three vectors give a null vector. What can be orientation of the vectors?** **(3 times)**

Ans: If the three vectors are oriented in cyclic order i.e. in the form of triangle, then they will give rise to null vector.

12. Can the magnitude of a vector have a negative value? **(10 Times)**

Ans: No, the magnitude of a vector cannot have negative value.
Because

$$A = \sqrt{A_x^{\,2} + A_y^{\,2}}$$

And the square of negative will always positive.

13. If $\vec{A} + \vec{B} = 0$ what can you say about the components of the two vectors? **(5 Times)**

Ans: Given that

$$\vec{A} + \vec{B} = 0$$
$$\vec{A} = -\vec{B}$$
$$A_x\hat{\imath} + A_y\hat{\jmath} = -(B_x\hat{\imath} + B_y\hat{\jmath})$$
$$A_x\hat{\imath} + A_y\hat{\jmath} = -B_x\hat{\imath} - B_y\hat{\jmath}$$

Comparing gives $A_x = -B_x \quad ; \quad A_y = -B_y$

Hence the components of both vectors are equal in magnitude but opposite in direction.

14. Is it possible to add a vector quantity to a scalar quantity? Explain. **(11 Times)**

Ans: No it is not possible to add a vector quantity to a scalar quantity because the physical quantities of same nature can be added. Vectors can be added to vectors and scalars are added in scalars, but the vectors can't be added to scalar.

15. Two vectors have unequal magnitude. Can their components be equal in magnitude?

Ans: No, the components of two vectors cannot be equal in magnitude if the two vector have unequal magnitudes.

16. The subtraction of a vector is equivalent to the addition of the negative of the same vector. Prove it.

Ans: The vector which has the same magnitude as that of vector $\vec{A}$, but opposite in direction is called negative of vector $\vec{A}$. So to subtract vector $\vec{B}$ from vector $\vec{A}$, reverse the direction of $\vec{B}$ and add it to $\vec{A}$. $\vec{A} - \vec{B} = \vec{A} + (-\vec{B})$

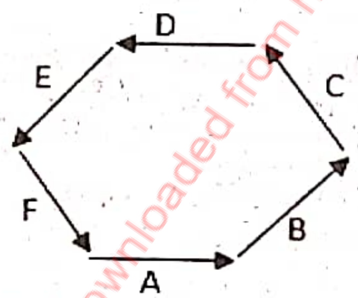
17. How can we subtract the vectors? **(2 times)**

Ans: The vector which has the same magnitude as that of vector $\vec{A}$, but opposite in direction is called negative of vector $\vec{A}$. So to subtract vector $\vec{B}$ from vector $\vec{A}$, reverse the direction of $\vec{B}$ and add it to $\vec{A}$ by head to tail rule.

$$\vec{A} - \vec{B} = \vec{A} + (-\vec{B})$$

18. Suppose that sides of a closed polygon represent vectors arranged head to tail. What is the sum of these vectors? **(7 times)**

Ans.: The sum will be zero. In this case, the tail of the first vector coincides with the head of the last vector as shown in figure.



According to head to tail rule, the resultant is zero.

$$\vec{R} = \vec{A} + \vec{B} + \vec{C} + \vec{D} + \vec{E} + \vec{F} = 0$$

19. Define unit vector and position vector. **(8 Times)**

Ans: A <u>unit vector</u> in a given direction is a vector with magnitude one in that direction. It is used to represent the direction of a vector.

A unit vector in the direction of a vector $\vec{A}$ is given by

$$\hat{A} = \frac{\vec{A}}{A}$$

The direction along x, y and z axes are generally represented by unit vectors $\hat{i}, \hat{j}$ and $\hat{k}$ respectively.

The **position vector** is a vector that describes the location of a particle with respect to the origin.

The position vector of a point P (a, b, c) in three dimensional space is represented by $\vec{r} = a\,\hat{i} + b\,\hat{j} + c\,\hat{k}$.

The tail of position vector coincides with the origin and the head with point P.

20. Why can a vector not have a component greater than the vector's magnitude?

Ans.: The magnitude of the component of a vector can not be greater than the vector's magnitude because component is always a part of the resultant vector.

The magnitude of a vector $\vec{A}$ is given by

$$A^2 = A_x^2 + A_y^2 + A_z^2 \quad \text{Or} \quad A = \sqrt{A_x^2 + A_y^2 + A_z^2}$$

This relation shows that if any two components of a vector are zero then the magnitude of the third component may be equal to the vector's magnitude but it can never be greater.

21. Mention the criterion for positive and negative torque.

Ans: **Positive torque:** Anti-Clockwise torque is taken as positive.

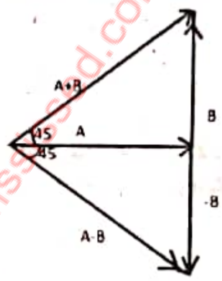
Negative torque: Clockwise torque is taken as negative.

22. Show that the sum and differences of two perpendicular vectors of equal lengths are also perpendicular. **(4 times)**

Ans.: Consider $\vec{A}$ and $\vec{B}$ are two perpendicular vectors of equal lengths, then their sum $\vec{A} + \vec{B}$ and difference $\vec{A} - \vec{B}$ are equal in length.

Magnitude of $\vec{A} + \vec{B} = \sqrt{A^2 + B^2}$

Magnitude of $\vec{A} - \vec{B} = \vec{A} + (-\vec{B}) = \sqrt{A^2 + (-B^2)} = \sqrt{A^2 + B^2}$



$\vec{A} + \vec{B}$ makes an angle of 45° with $\vec{A}$ and $\vec{A} - \vec{B}$ makes an angle of - 45° with $\vec{A}$. So, $\vec{A} + \vec{B}$ and $\vec{A} - \vec{B}$ are perpendicular to each other.

23. Explain rectangular coordinates system.

Ans: Two lines drawn at right angles to each other are known as coordinate axes and their point of intersection is known as origin. This system of coordinate axes is called rectangular coordinate system.

The horizontal line is named x-axis and vertical line y-axis. The direction of x-axis is positive towards right and y-axis is positive upward.

24. Two vectors of magnitude 10 each making angle 180° with each other. Find the magnitude of their resultant.

Ans.: We know that the sum of two vectors which are equal in magnitude and opposite in direction is zero.

Two vectors of magnitude 10 each making angle 180° with each other are in opposite direction. Therefore, the magnitude of their resultant will be equal to zero.

25. Define position vector and resultant vector.

Ans.: **Position vector:** A vector which describes the location of a point with respect to origin is called position vector.

Resultant vector: A single vector which would have the same effect as all the original vectors taken together.

26. Define null vector and component of a vector.

Ans: **Null vector** is a vector of zero magnitude and arbitrary direction.

A **component of a vector** is its effective vale in a given direction.

27. If $\vec{A} = 4\hat{i} - 4\hat{j}$, what is the orientation of $\vec{A}$.

Ans: As

$$\phi = \tan^{-1}\frac{A_y}{A_x}$$

$$= \tan^{-1}\left(\frac{4}{4}\right)$$

$$= 45^0$$

A_x is positive and A_y is negative, thus $\vec{A}$ lies in the fourth quadrant and its direction is

$$\theta = 360^0 - \phi$$

$$= 360^0 - 45$$

$$= 315^0$$

28. Define resultant vector and component of a vector.

Ans: The sum vector of two or more vectors is called **resultant vector.**
A **component of a vector** is its effective value in a given direction.

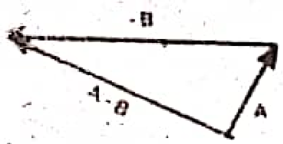
29. The magnitude of sum of two vectors is zero what are the conditions to get this?

Ans: The magnitude of sum of two vectors will only be zero, If they are equal in magnitude and opposite in direction.

30. How a vector is subtracted from another vector? Explain using diagram.

Ans: To subtract vector $\vec{B}$ from vector $\vec{A}$, reverse the direction of $\vec{B}$and add it to $\vec{A}$ by using Heat to Tail Rule.

$$\vec{A} - \vec{B} = \vec{A} + \left(-\vec{B}\right)$$



31. Find unit vector in the direction of the vector $\vec{A} = 12\hat{i} - 5\hat{j}$

Ans: we know that

$$A = \sqrt{A_x^{\,2} + A_y^{\,2}}$$

$$= \sqrt{(12)^2 + (-5)^2} = \sqrt{144 + 25} = \sqrt{169}$$

$$= 13$$

As $\hat{A} = \frac{\vec{A}}{A}$

so, $\hat{A} = \frac{12\hat{i} - 5\hat{j}}{13}$

32. Define component of a vector? What are rectangular components?

Ans: A component of a vector is its effective value in a given direction.
Components of a vector along mutually perpendicular directions are called rectangular components.

33. Find unit vectors in the direction of vector $\vec{A} = 8\hat{i} + 4\hat{j}$.

Ans: As $A = \sqrt{Ax^2 + Ay^2}$

$$= \sqrt{8^2 + 4^2} = \sqrt{64 + 16} = \sqrt{80}$$

$$A = 8.94$$

We know that $\hat{A} = \frac{\vec{A}}{A}$

$$\hat{A} = \frac{8\hat{i} + 4\hat{j}}{8.94}$$

34. Is it possible to add 5 in $2\hat{i}$? Explain.

Ans: No, 5 is a scalar and scalars cannot be added to vectors. Only the physical quantities of same nature can be added.

35. Define the null vector and give two examples.

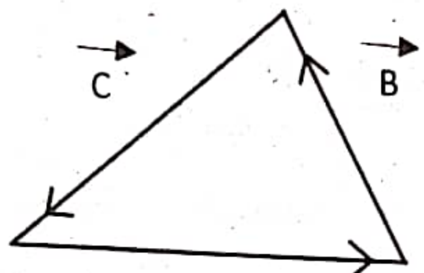
Ans: It is a vector of zero magnitude and arbitrary direction.
For example:

i. The sum of a vector and its negative vector is a null vector. $\vec{A}+(-\vec{A})=\vec{0}$

ii. The sum of two equal and opposite forces is a null vector $\vec{F}+(-\vec{F})=\vec{0}$

36. What is the orientation of three vectors to get their vector sum equal to zero magnitude?

Ans: If the three vectors added by head to tail rule make a triangle then their sum will be equal to zero magnitude.



$$\vec{R}=\vec{A}+\vec{B}+\vec{C}=\vec{0}$$

37. Is it possible to add $2\vec{A}$ into 6? Explain.

Ans: No, it is not possible.

6 is a scalar. $2\vec{A}$ and 6 are two different quantities by nature. Physical quantities of same nature can be added.

Topic II: Vector Addition by Rectangular Components:

38. Describe briefly, how we can obtain a vector when its rectangular components are given?

Ans: When the rectangular components of a vector are given, then vector will be

$$\vec{A}=A_x\hat{\imath}+A_y\hat{\jmath}$$

And its magnitude will be

$$A=\sqrt{A_x^{\,2}+A_y^{\,2}}$$

And direction will be

$$\tan\theta=\frac{A_y}{A_x}$$

$$\theta=\tan^{-1}\left(\frac{A_y}{A_x}\right)$$

39. If one of the rectangular components of a vector is not zero, can its magnitude be zero? Explain. **(7 Times)**

Ans: If one of the components is not zero, then the magnitude of vector can't be zero. If A_x and A_y are the rectangular components of vector $\vec{A}$, then its magnitude will be

$$A=\sqrt{A_x^{\,2}+A_y^{\,2}}$$

If $A_x=0$ then

$$A=\sqrt{0+A_y^{\,2}}=A_y$$

If $A_y=0$ then

$$A = \sqrt{A_x^2 + 0} = A_x$$

40. What are rectangular components of a vector? At what angle there components are equal?

Ans: The components of a vector which are perpendicular to each other are called rectangular components.

If a vector $\vec{A}$ makes an angle of 45^o with positive x-axis, then its rectangular components will be equal in magnitude.

$$A_x = A\cos 45^o = 0.707A$$
$$A_y = A\sin 45^o = 0.707A$$

41. Under what circumstances would a vector have components that are equal in magnitude? (6 Times)

Ans: If a vector $\vec{A}$ makes an angle of 45^o with positive x-axis, then its rectangular components will be equal in magnitude.

$$A_x = A\cos 45^o = 0.707A$$
$$A_y = A\sin 45^o = 0.707A$$

42. Vector $\vec{A}$ lies in xy –plane. For what orientation will both of its rectangular components be negative? (2 times)

Ans: For a vector $\vec{A}$ lies in xy –plane having both of its rectangular components negative, it will lie in third quadrant.

43. Write down the steps for addition of vectors by rectangular component method. (2 times)

Ans: The vector addition by rectangular components consists of the following steps.

(i) Find x and y components of all given vectors.

(ii) Find R_x by adding x-components of all the vectors.

(iii) Find R_y by adding y-components of all the vectors.

(iv) Find the magnitude of resultant vector $\vec{R}$ by using

$$R = \sqrt{R_x^2 + R_y^2}$$

(v) Find the direction of resultant vector $\vec{R}$ by using

$$\theta = \tan^{-1}\left(\frac{R_y}{R_x}\right)$$

44. A force of 10N makes an angle of 60^0 with X-axis. Find its X and Y components.

Ans: $F_x = F\cos\theta = 10\cos60^0 = 10 \times 0.5 = 5N$

$F_y = F\sin\theta = 10\sin60^0 = 10 \times 0.866 = 8.66N$

45. What are coplanar and concurrent forces?

Ans: All the forces lying in the same plane are called **coplanar forces.**

All the forces acting on the same point are called **concurrent forces.**

46. Vector $\vec{A}$ lies in xy plane. For what orientations will both of its rectangular components be negative and for what orientations, its rectangular components be positive.

Ans: Both of rectangular components of vector $\vec{A}$ will be negative when it lies in third quadrant and will be positive when it lies in first quadrant.

47. If a vector lies in $x - y$ plane. Is it possible, one of its rectangular components is zero? Explain.

Ans: No, a vector lying in xy plane have two rectangular components. If one of its rectangular component is zero, then the vector will be along any axis.

48. For what orientation of a vector its components have opposite signs, if vector lies in xy plane?

Ans: If a vector lies in second or fourth quadrent then its components will have opposite signs.

Topic III: Product of Two Vectors:

49. Prove that: $\vec{A}.\vec{B} = A_xB_x + A_yB_y + A_zB_z$ **(3 times)**

Ans: As $\vec{A}.\vec{B} = (A_x\hat{\imath} + A_y\hat{\jmath} + A_z\hat{k}).(B_x\hat{\imath} + B_y\hat{\jmath} + B_z\hat{k})$

Using $\hat{\imath}.\hat{\imath} = \hat{\jmath}.\hat{\jmath} = \hat{k}.\hat{k} = 1$ and $\hat{\imath}.\hat{\jmath} = \hat{\jmath}.\hat{k} = \hat{k}.\hat{\imath} = 0$

We get $\vec{A}.\vec{B} = A_xB_x + A_yB_y + A_zB_z$

50. Write any two characteristics of vector product.

Ans: Vector product is non-commutative.

$$\vec{A} \times \vec{B} \neq \vec{B} \times \vec{A}$$

The vector product of two parallel and anti-parallel vectors is a null vector.

$$\vec{A} \times \vec{B} = AB\sin 0^o = 0$$
$$\vec{A} \times \vec{B} = AB\sin 180^o = 0$$

51. If all the components of vector $\vec{A_1}$ and $\vec{A_2}$ were reserved, how would this alter $\vec{A_1} \times \vec{A_2}$? **(4 times)**

Ans: If all the components of vector $\vec{A_1}$ and $\vec{A_2}$ were reserved, then

$$-\vec{A_1} \times -\vec{A_2} = \vec{A_1} \times \vec{A_2}$$

Hence the vector product of two vectors will remain unchanged even when the components of the vectors are reversed.

52. Name the three different conditions that could make $\vec{A_1} \times \vec{A_2} = 0$. (16 Times)

Ans: The three conditions that could make $\vec{A_1} \times \vec{A_2} = 0$ are:

i. $\vec{A_1}$ is a null vector.

ii. $\vec{A_2}$ is a null vector.

iii. Both $\vec{A_1}$ & $\vec{A_2}$ are parallel or anti-parallel to each other.

53. Write two examples of vector product.

Ans: Two examples of vector product are,

i. The torque is a vector product of moment arm $\vec{r}$ and force $\vec{F}$. $\vec{\tau} = \vec{r} \times \vec{F}$

ii. The angular momentum is a vector product of position vector $\vec{r}$ and linear momentum $\vec{p}$. $\vec{L} = \vec{r} \times \vec{p}$

54. Find the dot product of unit vectors given.

Ans: A vector having the unit magnitude is called the unit vector. So the magnitude of unit vector is always unit i.e. 1.

$$\hat{\imath}.\hat{\imath} = \hat{\jmath}.\hat{\jmath} = \hat{k}.\hat{k} = 1$$
$$\hat{\imath}.\hat{\jmath} = \hat{\jmath}.\hat{k} = \hat{k}.\hat{\imath} = 0$$

55. What are different conditions that make $\vec{A} \times \vec{B} = 0$?

Ans: The different conditions that make $\vec{A} \times \vec{B} = 0$ are:

(i) $\vec{A}$ is a null vector. (ii) $\vec{B}$ is a null vector.

(iii) Both $\vec{A}$ & $\vec{B}$ are parallel or anti-parallel to each other.

56. Name the different conditions that could make $\vec{A}.\vec{B} = 0$

Ans: The different conditions that could make $\vec{A}.\vec{B} = 0$ are:

(i) $\vec{A}$ is a null vector. (ii) $\vec{B}$ is a null vector.

(iii) Both $\vec{A}$ & $\vec{B}$ are perpendicular to each other.

57. $\vec{A}$ *and* $\vec{B}$ are two vectors, $\vec{A} = 2\hat{\imath} + 5\hat{\jmath}$, $\vec{B} = 3\hat{\imath} + 7\hat{k}$. then find $\vec{A} \times \vec{B}$.

Ans: $\vec{A} \times \vec{B} = \begin{vmatrix} \hat{\imath} & \hat{\jmath} & \hat{k} \\ A_x & A_y & A_z \\ B_x & B_y & B_z \end{vmatrix} = \begin{vmatrix} \hat{\imath} & \hat{\jmath} & \hat{k} \\ 2 & 5 & 0 \\ 3 & 0 & 7 \end{vmatrix} = (5 \times 7 - 0)\hat{\imath} - (2 \times 7 - 3 \times 0)\hat{\jmath} +$

$(2 \times 0 - 5 \times 3)\hat{k}$

$= 35\hat{\imath} - 14\hat{\jmath} - 15\hat{k}$

58. Prove that dot product is commutative.

Ans: From definition $\vec{A}.\vec{B} = AB\cos\theta$

$$= BA\cos\theta$$
$$= \vec{B}.\vec{A}$$

Hence, proved that dot product is commutative.

59. Find the angle between $\vec{A}=2\hat{i}-2\hat{j}$ and $\vec{B}=2\hat{i}+2\hat{j}$

Ans:

$$\vec{A}.\vec{B}=(2\hat{i}-2\hat{j}).(2\hat{i}+2\hat{j})$$

$$(\because \quad \vec{A}.\vec{B}=A_xB_x+A_yB_y)$$

$$=2\times2+(-2)\times2$$

$$=4-4=0$$

As $\vec{A}.\vec{B}=AB\text{Cos}\theta$

Or $\text{Cos}\theta=\dfrac{\vec{A}.\vec{B}}{AB}$

$$\text{Cos}\theta=\frac{0}{AB}$$

$\text{Cos}\theta=0 \quad \Rightarrow \quad \theta=\text{Cos}^{-1}(0)=90^0$

60. State right hand rule for the cross product of two vectors.

Ans: Place together the tails of vectors $\vec{A}\,\&\,\vec{B}$. Rotate vector $\vec{A}$ into $\vec{B}$ through the smaller of the two possible angles with the curl of the fingers of the right hand, keeping the thumb erect. The direction of $\vec{A}\times\vec{B}$ will be along the erect thumb.

61. If $\vec{A}=\hat{i}-2\hat{j}+3\hat{k}$ and $\vec{B}=2\hat{i}-\hat{j}+\hat{k}$, then find $\vec{A}.\vec{B}$.

Ans: $\vec{A}.\vec{B}=(\hat{i}-2\hat{j}+3\hat{k}).(2\hat{i}-\hat{j}+\hat{k})$

$(\because A.B=A_xB_x+A_yB_y+A_zB_z)$

$\Rightarrow \vec{A}.\vec{B}=1\times2+(-2)(-1)+3\times1$

$=2+2+3$

$=7$ units

Topic IV: Torque:

62. Define torque. Write its unit and dimension. **(9 times)**

Ans: The turning effect of a force is called torque.

Or The cross product of moment arm $\vec{r}$ and force $\vec{F}$ is called torque $\vec{\tau}$.

$$\vec{\tau}=\vec{r}\times\vec{F}$$

Its unit is Nm or kgm^2s^{-2} and dimension is $[ML^2T^{-2}]$.

63. Can a body rotate about its center of gravity under the action of its weight? **(11 Times)**

Ans: No, a body cannot rotate about its center of gravity under the action of its weight. Because the whole weight of the body acts on its center of gravity. The moment arm is zero in this case i.e.

$$\vec{\tau}=\vec{r}\times\vec{F}$$
$$\tau=rF\sin\theta$$
$$\tau=(0)F\sin\theta$$
$$\tau=0$$

64. You are falling off the edge. What should you do to avoid falling? **(2 times)**

Ans: You should bend yourself backward to avoid falling off the edge. Because of this, your center of gravity will shift backward.

65. Why can a body not rotate about its centre of gravity under the action of its weight? **(5 Times)**

Ans.: As we know that the centre of gravity is that point at which the whole weight of the body acts.

In this case, the line of action of force (weight) passes through the pivot point (centre of gravity). Therefore, moment arm is zero. As a result torque is also zero.

As $$\vec{\tau}=\vec{r}\times\vec{F}$$
$$\tau=rF\sin\theta$$

$$\tau = (0)F\sin\theta$$
$$\tau = 0$$

66. What is the moment of a force about the point lying on the axis of rotation?

Ans: The moment of a force (or torque) about the point lying on the axis of rotation is given as

$$\vec{\tau} = \vec{r} \times \vec{F}$$
$$\tau = rF\sin\theta$$

If the force is acting at the point lying on the axis of rotation then the moment arm is zero. According to the equation, the torque will be zero.

67. Write down the condition for a body to be in complete equilibrium.

Ans: For a body to be in complete equilibrium both conditions should be satisfied i.e (i) $\sum F = 0$ (ii) $\sum \tau = 0$

68. Give two factors on which turning effect depends.

Ans: The turning effect of a force is called torque.

$$\vec{\tau} = \vec{r} \times \vec{F}$$

It depends upon moment arm and applied force.

Topic V: Equilibrium of Forces:

69. Give two conditions of equilibrium. (9 *times*)

Ans: **i)** The vector sum of all forces acting on any object must be zero.

$$\sum \vec{F} = 0$$

ii) The vector sum of all torques acting on any object about any arbitrary axis must be zero.

$$\sum \vec{\tau} = 0$$

70. Differentiate between static and dynamic equilibrium.

Ans: **Static equilibrium**: If a body is at rest, then it is said to be in static equilibrium.

Dynamic equilibrium: If the body is moving with uniform velocity, then it is said to be in dynamic equilibrium.

71. State condition of rotational equilibrium.

Ans: The vector sum of all torque acting on any object must be zero.

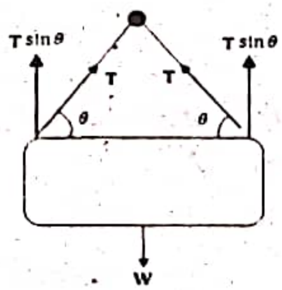
$$\sum \vec{\tau} = 0$$

When this condition of equilibrium is satisfied, there is no angular acceleration and body will be in rotational equilibrium.

Hence, a body cannot rotate about center of gravity under the action of its weight.

72. A picture is suspended on the wall by two strings. Show by diagram the configuration of the strings for which the tension in the string will be minimum? **(4 times)**

Ans: Consider a picture of weight W is suspended by two strings as shown in the figure.



It is clear from figure that $W = T\sin\theta + T\sin\theta$

$$W = 2T\sin\theta$$
$$T = \frac{W}{2\sin\theta}$$

Tension in the string will be minimum when $\theta = 90^o$, so

$$T = \frac{W}{2\sin 90^o}$$
$$T = 0.5\,W$$

73. When a body is in (i) Translational equilibrium (ii) Rotational equilibrium

Ans: **Rotational equilibrium**: The vector sum of all the torques acting on any object must be zero.

$$\sum \vec{\tau} = 0$$

When this condition of equilibrium is satisfied, there is no angular acceleration and body is said to be in rotational equilibrium.

Translational equilibrium: The vector sum of all the forces acting on a body must be zero.

$$\sum \vec{F} = 0$$

When the first condition of equilibrium is satisfied, the linear acceleration of a body is zero and body is said to be in translational equilibrium.

74. What is difference between moment arm and moment of force?

Ans.: **Moment arm:** The perpendicular distance from the line of action of force to the axis of rotation is called moment arm.

Moment of Force: The turning effect of a force about a fixed axis is called moment of force or torque.

S.I unit of moment arm is meter while moment of force is measured in Nm.

The dimensions of moment arm are $[L]$ while the dimensions of moment of force are $[MLT^{-2}]$.

2021

75. What is the vector product of two vectors. Give its two characteristics.

Ans: When two vectors are multiplied to give a vector quantity, then the product of vectors is called the vector or cross product. The vector product of two vectors $\vec{A}$ and $\vec{B}$ is written as $\vec{A}\times\vec{B}$ and is defined as:

$$\vec{A}\times\vec{B} = AB\sin\theta\hat{n}$$

Where A and B are the magnitudes of vector $\vec{A}$ and $\vec{B}$. θ is the angle between them and $\hat{n}$ is the unit vector perpendicular to the plane containing $\vec{A}$ and $\vec{B}$.

i. Vector product is non-commutative.

$$\vec{A}\times\vec{B} \neq \vec{B}\times\vec{A}$$

ii. The vector product of two parallel and anti-parallel vectors is a null vector.

$$\vec{A}\times\vec{B} = AB\sin 0^o = 0$$

$$\vec{A}\times\vec{B} = AB\sin 180^o = 0$$

76. If $\vec{A} = 2\hat{\imath} + 3\hat{\jmath} - \hat{k}$ and $\vec{B} = 3\hat{\imath} - 2\hat{k}$, Find $\vec{A}.\vec{B}$.

Ans:

Given that
$$\vec{A} = 2\hat{\imath} + 3\hat{\jmath} - \hat{k}$$
$$\vec{B} = 3\hat{\imath} - 2\hat{k}$$
$$\vec{A}.\vec{B} = AB\cos\theta = (2\hat{\imath} + 3\hat{\jmath} - \hat{k}).(3\hat{\imath} - 2\hat{k}) = 6 + 0 + 2 = 8$$

77. If $\vec{A} = 2\hat{\imath} - 2\hat{\jmath}$, then what will be the orientation of $\vec{A}$.

Ans: As

$$\varphi = \tan^{-1}\left[\frac{2}{2}\right] = \tan^{-1}(1) = 45^o$$

A_x is positive and A_y is negative, thus $\vec{A}$ lies in the fourth quadrant and its direction is:

$$\theta = 360^o - \varphi$$
$$\theta = 360^o - 45^o = 315^o$$

78. Prove that $\vec{A}.\vec{B} = \vec{B}.\vec{A}$.

Ans:

Consider two vectors $\vec{A}$ and $\vec{B}$. Place both vectors tail to tail. From fig (a).

$\vec{A}.\vec{B}$= (Magnitude of $\vec{A}$)(Component of $\vec{B}$ in the direction of $\vec{A}$)

$\vec{A}.\vec{B}$= (A)(B cosθ)= AB cosθ (1)

Similarly, from fig (b),

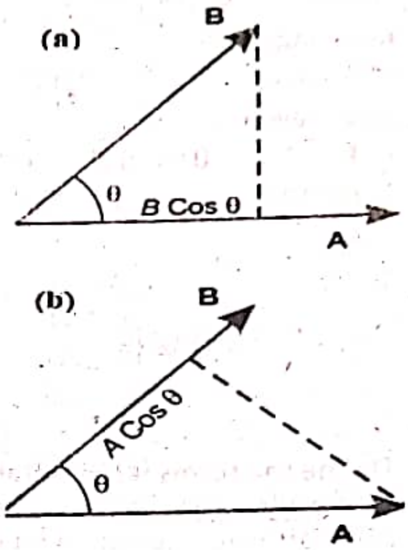
$\vec{B}.\vec{A}$= (Magnitude of $\vec{B}$)(Component of $\vec{A}$ in the direction of $\vec{B}$)

$\vec{B}.\vec{A}$= (B)(A cosθ)= BA cosθ = AB cosθ (2)

Thus, from eq. (1) and (2)

$$\vec{A}.\vec{B}=\vec{B}.\vec{A}$$

Hence, the scalar product is commutative.

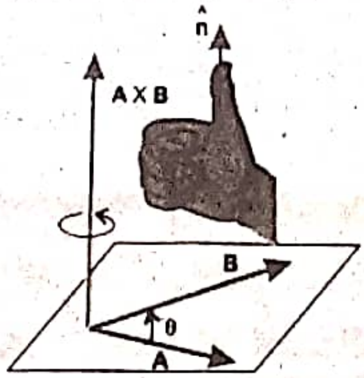


79. What is the method to find the direction of cross product of two vectors describe it. OR State and illustrate the "Right hand rule" of vector product.

Ans: According to right hand rule for the cross product of two vectors, the right hand is placed on the first vector and fingers are curled towards the second vector by keeping the thumb erect. The erected thumb will give the direction of vector product.

OR

Consider two vectors $\vec{A}$ and $\vec{B}$. Place the both vector $\vec{A}$ and $\vec{B}$ tail to tail to define the plane of $\vec{A}$ and $\vec{B}$ as shown in figure. Rotate the $\vec{A}$ vector towards $\vec{B}$ through smaller angle and curl your fingers in the direction of rotation. The erect thumb will give you the direction of $\vec{A}\times\vec{B}$ or $\hat{n}$.



80. Define Scalar product of two vectors.

Ans: When two vectors are multiplied to give a scalar quantity, then the product of vectors is called the scalar or dot product. The scalar product of two vectors $\vec{A}$ and $\vec{B}$ is written as $\vec{A}.\vec{B}$ and is defined as:

$$\vec{A}.\vec{B} = AB\cos\theta$$

Where A and B are the magnitudes of vector $\vec{A}$ and $\vec{B}$. θ is the angle between them.

81. Define Null vector. What is the difference between null and zero vector?

Ans: <u>**Null vector:**</u> A vector of zero magnitude and arbitrary direction is called null vector. Null vector is denoted as $\vec{O}$. The null vector also called zero vector.

82. Write down the position vector in one coordinate system, two coordinate system and three coordinate system.

Ans: A vector which describes the location of a point with respect to origin is called position vector. The position vector:

In one coordinate system $\vec{r} = a\hat{i}$

And magnitude $r = \sqrt{a^2} = a$

In two coordinate system $\vec{r} = a\hat{i} + b\hat{j}$

And magnitude $r = \sqrt{a^2 + b^2}$

In three coordinate system $\vec{r} = a\hat{i} + b\hat{j} + c\hat{k}$

And magnitude $r = \sqrt{a^2 + b^2 + c^2}$

83. **If $\vec{A} = 2\hat{i} - 10\hat{j}$ and $\vec{B} = 6\hat{k}$, Find $\vec{A} \times \vec{B}$ (Cross Product).**

Ans: Given that

$$\vec{A} = 2\hat{i} - 10\hat{j}$$
$$\vec{B} = 6\hat{k}$$

$$\vec{A} \times \vec{B} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 2 & -10 & 0 \\ 0 & 0 & 6 \end{vmatrix} = (-60 + 0)\hat{i} - (12 + 0)\hat{j} + (0 + 0)\hat{k}$$

$$\vec{A} \times \vec{B} = -60\hat{i} - 12\hat{j}$$

84. **Define the terms (a) Resultant vector (b) Subtraction of vector.**

Ans: (a) **Resultant vector:** A single vector which would have the same effect as all the original vectors taken together.

(b) **Subtraction of vector:** The vector which has the same magnitude as that of vector $\vec{A}$, but opposite in direction is called negative of vector $\vec{A}$. So, to subtract vector $\vec{B}$ from vector $\vec{A}$, reverse the direction of $\vec{B}$ and add it to $\vec{A}$ by head to tail rule.

$$\vec{A} - \vec{B} = \vec{A} + (-\vec{B})$$

85. **Find the unit vector of vector $\vec{A} = 4\hat{i} - 3\hat{j}$.**

Ans: Since

$$\hat{A} = \frac{\vec{A}}{A}$$

$$\hat{A} = \frac{4\hat{i} - 3\hat{j}}{\sqrt{(4)^2 + (-3)^2}}$$

$$\hat{A} = \frac{4\hat{i} - 3\hat{j}}{\sqrt{16 + 9}}$$

$$\hat{A} = \frac{4\hat{i} - 3\hat{j}}{\sqrt{25}}$$

$$\hat{A} = \frac{4\hat{i} - 3\hat{j}}{5}$$

LONG QUESTIONS OF CHAPTER-2 IN ALL PUNJAB BOARDS 2011-2021

Topic II: Vector Addition by Rectangular Components:

1. Explain the addition of vectors by rectangular components method. **(8 times)**
2. Explain the addition of vectors by rectangular components. Also write down the main steps for addition.
3. Define rectangular components of a vector. Find resultant of two vectors by their rectangular components.
4. Define rectangular components of a vector and explain addition of vectors by rectangular components. **(6 times)**

Topic III: Product of Two Vectors:

5. Define vector product of two vectors and also describe its characteristics. **(8 times)**
6. Explain cross product of two vectors. State right hand rule and give at least four characteristics.
7. Define and explain the Dot or Scalar product.
8. Define scalar product of two vectors. Also write any four characteristics of scalar product. **(5 times)**

Topic IV: Torque:

9. Define torque. Calculate torque due to force acting on a rigid body. **(4 times)**

NUMERICAL PROBLEMS OF CHAPTER-2 IN ALL PUNJAB BOARDS 2011-2021

Topic I: Basic Concepts of Vectors:

1. Give that $\vec{A}=2\hat{i}+3\hat{j}$ and $\vec{B}=3\hat{i}-4\hat{j}$. Find the magnitude and angle of $\vec{C}=\vec{A}+\vec{B}$.
(2 times)

Ans:

$\vec{A} = 2\hat{i} + 3\hat{j}$

$\vec{B} = 3\hat{i} - 4\hat{j}$

$\vec{C} = \vec{A} + \vec{B}$

$|\vec{C}| = ?$

$\theta = ?$

$\vec{C} = \vec{A} + \vec{B}$

$\vec{C} = (2\hat{i}+3\hat{j}) + (3\hat{i}-4\hat{j})$

$\vec{C} = 5\hat{i} - \hat{j}$

As $|\vec{C}| = \sqrt{c_x 2 + c_y 2}$

So, $|\vec{C}| = \sqrt{5^2 + (-1)^2} = \sqrt{25+1} = \sqrt{26} = 5.1$

Since $\theta = \tan^{-1}\left(\frac{C_y}{C_x}\right)$

$\theta = \tan^{-1}\left(\frac{1}{5}\right) = 11°$

The vector $\vec{C}$ has x – component positive and y – component negative. Thus it lies in 4[th] quadrant. And $\theta = 360° - \theta$

$\theta = 360° - 11° = 349°$

Topic II: Vector Addition by Rectangular Components:

2. Given that $\vec{A} = \hat{i} - 2\hat{j} + 3\hat{k}$ and $\vec{B} = 3\hat{i} - 4\hat{k}$, find the projection of $\vec{A}$ on $\vec{B}$.
(2 times)

Ans: Given that

$$\vec{A} = \hat{i} - 2\hat{j} + 3\hat{k}$$
$$\vec{B} = 3\hat{i} - 4\hat{k}$$
$$A\cos\theta = ?$$

Since

$$\vec{A}.\vec{B} = AB\cos\theta$$
$$A\cos\theta = \frac{\vec{A}.\vec{B}}{B}$$
$$A\cos\theta = \frac{(\hat{i} - 2\hat{j} + 3\hat{k}).(3\hat{i} - 4\hat{k})}{\sqrt{(3)^2 + (4)^2}}$$
$$A\cos\theta = \frac{(1)(3) - (2)(0) - (3)(4)}{\sqrt{9+16}}$$
$$A\cos\theta = \frac{3-0-12}{\sqrt{25}} \boxed{= \frac{-9}{5}}$$

3. Find projection of $\vec{A} = 2\hat{i} - 8\hat{j} + \hat{k}$ in direction of vector $\vec{B} = 3\hat{i} - 4\hat{j} + 12\hat{k}$.
(3 times)

Ans: Given that

$$\vec{A} = 2\hat{i} - 8\hat{j} + \hat{k}$$
$$\vec{B} = 3\hat{i} - 4\hat{j} + 12\hat{k}$$
$$A\cos\theta = ?$$

Since

$$\vec{A}.\vec{B} = AB\cos\theta$$

$$A\cos\theta = \frac{\vec{A}.\vec{B}}{B}$$

$$A\cos\theta = \frac{(2\hat{\imath} - 8\hat{\jmath} + \hat{k}).(3\hat{\imath} - 4\hat{\jmath} + 12\hat{k})}{\sqrt{(3)^2 + (-4)^2 + (12)^2}}$$

$$A\cos\theta = \frac{(2)(3) + (-8)(-4) + (1)(12)}{\sqrt{9 + 16 + 144}}$$

$$A\cos\theta = \frac{6 + 32 + 12}{\sqrt{169}} \boxed{= \frac{50}{13}}$$

4. Find the projection of $\vec{A} = 2\hat{\imath} + 8\hat{\jmath} + \hat{k}$ in the direction of vector $\vec{B} = 3\hat{\imath} - 4\hat{\jmath} - 2\hat{k}$.

(2 times)

Ans: Given that

$$\vec{A} = 2\hat{\imath} + 8\hat{\jmath} + \hat{k}$$

$$\vec{B} = 3\hat{\imath} - 4\hat{\jmath} - 12\hat{k}$$

$$A\cos\theta = ?$$

Since

$$\vec{A}.\vec{B} = AB\cos\theta$$

$$A\cos\theta = \frac{\vec{A}.\vec{B}}{B}$$

$$A\cos\theta = \frac{(2\hat{\imath} + 8\hat{\jmath} + \hat{k}).(3\hat{\imath} - 4\hat{\jmath} - 12\hat{k})}{\sqrt{(3)^2 + (-4)^2 + (12)^2}}$$

$$A\cos\theta = \frac{(2)(3) + (8)(-4) + (1)(-12)}{\sqrt{9 + 16 + 144}}$$

$$A\cos\theta = \frac{6 - 32 - 12}{\sqrt{169}} = -\frac{36}{13}$$

5. Two forces of magnitude of 10 N and 20 N acts on a body in directions making angle 30° and 60° respectively with x – axis. Find the resultant force and direction.

(4 times)

Sol

$$F_1 = 10N$$

$$F_2 = 20N$$

$$\theta_1 = 30^0$$

$$\theta_2 = 60^0$$

$$\vec{F} = ?$$

$$As\ \ F_{1X} = F_1 \cos\theta$$

$$10\cos 30^0 = 10 \times 0.866 = 8.66N$$

$$F_{2X} = F_2 \cos\theta_2$$

$$= 20x\cos 60^0 = 20 \times 0.5 = 10N$$

$$F_{1Y} = F_1 \sin\theta_1$$

$$= 10 \times \sin 30^0 = 10 \times 0.5 = 5N$$

$$F_{2Y} = F_2 \sin\theta_2$$

$$= 20 \times \sin 60^0 = 20 \times 0.866 = 17.32N$$

X – component of resultant force:

$$F_X = F_{1X} + F_{2X}$$

$$F_X = 8.66 + 10 = 18.66N$$

Y – component of resultant force:

$$Fy = F_{1y} + F_{2y}$$

$$Fy = 5 + 17.32 = 22.32N$$

Magnitude of resultant force:

$$F = \sqrt{F_x^2 + F_y^2}$$

$$F = \sqrt{(18.66)^2 + (22.32)^2}$$

$$F = \sqrt{348.2 + 498.2}$$

$$F = \sqrt{846.4}$$

$$F = 29N$$

Direction of resultant force

$$\theta = \tan^{-1}\left[\frac{F_y}{F_x}\right]$$

$$\theta = \tan^{-1}\left[\frac{22.32}{18.66}\right]$$

$$\theta = \tan^{-1}(1.196)$$

$$\theta = 50^0$$

6 Two particles are located at $\vec{r_1} = 3\hat{i} + 7\hat{j}$ and $\vec{r_2} = -2\hat{i} + 3\hat{j}$ respectively. Find both the magnitude of vector $(\vec{r_2} - \vec{r_1})$ and its orientation with respect to x-axis.

Sol: Given that $\vec{r_1} = 3\hat{i} + 7\hat{j}$

$$\vec{r_2} = -2\hat{i} + 3\hat{j}$$

$$|\vec{r_2} - \vec{r_1}| = ?$$

$$\theta = ?$$

$$\vec{r_2} - \vec{r_1} = (-2\hat{i} + 3\hat{j}) - (3\hat{i} + 7\hat{j})$$

$$= -2\hat{i} + 3\hat{j} - 3\hat{i} - 7\hat{j}$$

$$\vec{r_2} - \vec{r_1} = -5\hat{i} - 4\hat{j}$$

We know that $|\vec{R}| = \sqrt{R_x^2 + R_y^2}$

$$\Rightarrow |\vec{r_2} - \vec{r_1}| = \sqrt{(-5)^2 + (-4)^2}$$

$$= \sqrt{25+16} = \sqrt{49}$$

$$= 6.4$$

Since $\phi = \tan^{-1}\left(\frac{R_y}{R_x}\right)$

$$\Rightarrow \phi = \tan^{-1}\left(\frac{4}{5}\right)$$

$$\phi = 38.6^0$$

Both x and y components of $\vec{r_2} - \vec{r_1}$ are negative which shows that the vector lies in 3rd quadrant. So, the direction is given by

$$\theta = 180^0 + \phi$$

$$\theta = 180^0 + 38.6^0$$

$$\theta = 218.6^0$$

$\theta = 219^0$ Approx.

Topic III: Product of Two Vectors:

7. The magnitude of dot and cross product of two vectors are $6\sqrt{3}$ and 6 respectively. Find the angle between vectors. (5 Times)

Ans: It is given that

$$|\vec{A}.\vec{B}| = 6\sqrt{3}$$
$$|\vec{A}\times\vec{B}| = 6$$

Division yields

$$\frac{|\vec{A}\times\vec{B}|}{|\vec{A}.\vec{B}|} = \frac{6}{6\sqrt{3}}$$
$$\frac{AB\sin\theta}{AB\cos\theta} = \frac{1}{\sqrt{3}}$$
$$\tan\theta = \frac{1}{\sqrt{3}}$$
$$\theta = \tan^{-1}\frac{1}{\sqrt{3}} \boxed{= 30^o}$$

8. The position of two aero planes at any instant represented by points $A(2,3,4)$ and $B(5,6,7)$ from an origin in km. Calculate the distance between two aero planes.

Ans: The distance is given as

$$d = |\overrightarrow{AB}| = \sqrt{(x_2-x_1)^2+(y_2-y_1)^2+(z_2-z_1)^2}$$
$$d = \sqrt{(5-2)^2+(6-3)^2+(7-4)^2}$$
$$d = \sqrt{(3)^2+(3)^2+(3)^2}$$
$$d = \sqrt{9+9+9}$$
$$d = \sqrt{27}$$
$$d = \sqrt{9\times 3}$$
$$d = 3\sqrt{3} \boxed{= 5.2\ km}$$

9. Find the angle between two vectors $\vec{A} = 5\hat{\imath}+\hat{\jmath}$ and $\vec{B} = 2\hat{\imath}+4\hat{\jmath}$. (3 Times)

Ans: Given that

$$\vec{A} = 5\hat{\imath}+\hat{\jmath}$$
$$\vec{B} = 2\hat{\imath}+4\hat{\jmath}$$
$$\theta = ?$$

Since

$$\vec{A}.\vec{B} = AB\cos\theta$$
$$\cos\theta = \frac{\vec{A}.\vec{B}}{AB}$$
$$\cos\theta = \frac{(5\hat{\imath}+\hat{\jmath}).(2\hat{\imath}+4\hat{\jmath})}{\sqrt{(5)^2+(1)^2}\sqrt{(2)^2+(4)^2}}$$
$$\cos\theta = \frac{(5)(2)+(1)(4)}{\sqrt{25+1}\sqrt{4+16}}$$
$$\cos\theta = \frac{10+4}{\sqrt{26}\sqrt{20}}$$
$$\theta = \cos^{-1}\left(\frac{14}{\sqrt{26}\sqrt{20}}\right) = \cos^{-1}(0.61) \boxed{= 52^o}$$

10. Prove that the two vectors $\vec{A} = \hat{\imath}+\hat{\jmath}-\hat{k}$ and $\vec{B} = \widehat{4\imath}+\hat{\jmath}+\widehat{5k}$ are mutually perpendicular.

Ans: $\vec{A} = \hat{\imath}+\hat{\jmath}-\hat{k}$

$\vec{B} = 4\hat{\imath} + \hat{\jmath} + 5\hat{k}$

We have to show that $\hat{A}$ and $\hat{B}$ are mutually perpendicular.

$\hat{A}.\hat{B} \quad = (\hat{\imath} + \hat{\jmath} - \hat{k}) . (4\hat{\imath} + \hat{\jmath} + 5\hat{k})$

$= (1 \times 4) + (1 \times 1) + (-1 \times 5)$

$(\because \vec{A}.\vec{B} = A_xB_x + A_yB_y + A_zB_z)$

$= 4 + 1 - 5 = 0$

The scalar product of two vectors $\vec{A}$ and $\vec{B}$ will be equal to zero only if they are mutually perpendicular.
Hence proved.

11. Vectors $\vec{A}, \vec{B}$ and $\vec{C}$ are 4 units north, 3 units west and 8 units east respectively. Describe:

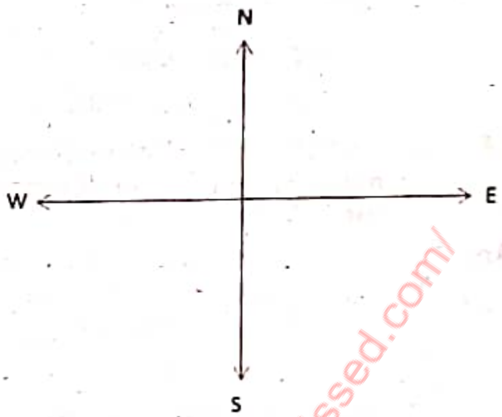
(i) $\vec{A} \times \vec{B}$ (ii) $\vec{B} \times \vec{C}$

Sol: $\vec{A}$ = 4 units north

$\vec{B}$ = 3 units west

$\vec{C}$ = 8 units east

(i) $\vec{A} \times \vec{B} = ?$ (ii) $\vec{B} \times \vec{C} = ?$



(i) $\vec{A} \times \vec{B} = AB\sin\theta\,\hat{n}$

As angle between $\vec{A}$ and $\vec{B}$ is 90^0

$\vec{A} \times \vec{B} = AB\sin 90^0\,\hat{n}$

$\vec{A} \times \vec{B} = 4 \times 3(1)\hat{n}$

$\vec{A} \times \vec{B} = 12\hat{n}$ =12 units vertically up

(ii) $\vec{B} \times \vec{C} = BC\sin\theta\,\hat{n}$

As angle between $\vec{B}$ and $\vec{C}$ is 180^0

$\vec{B} \times \vec{C} = 3 \times 8 \sin 180^0\,\hat{n}$

$\vec{B} \times \vec{C} = 3 \times 8 \sin(0)\hat{n}$

$\vec{B} \times \vec{C} = 0\hat{n}$

$\vec{B} \times \vec{C} = \vec{O}$

Topic IV: Torque:

12. The line of force $\vec{F} = \hat{\imath} - 2\hat{\jmath}$ passes through a point whose position vector is $-\hat{\imath} + \hat{k}$. Find the moment of $\vec{F}$ about the origin.

Ans: Given that

$\vec{F} = \hat{\imath} - 2\hat{\jmath}$

$\vec{r} = -\hat{\imath} + \hat{k}$

Since

$\vec{\tau} = \vec{r} \times \vec{F}$

$$\vec{\tau} = \begin{vmatrix} \hat{\imath} & \hat{\jmath} & \hat{k} \\ -1 & 0 & 1 \\ 1 & -2 & 0 \end{vmatrix}$$

$\vec{\tau} = (0 + 2)\hat{\imath} - (0 - 1)\hat{\jmath} + (2 - 0)\hat{k}$

$$\boxed{\vec{\tau} = 2\hat{\imath} + \hat{\jmath} + 2\hat{k}}$$

Topic V: Equilibrium of Forces:

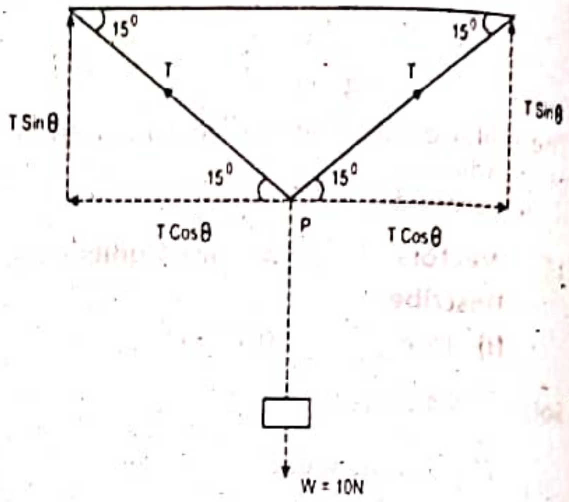
13. A load of 10.0 N is suspended from a clothes line. This distorts the line so that it makes and angle of 15° with the horizontal at each end. Find the tension in the clothes line. (3 times)

Ans: F = W = 10 N

$\theta = 15°$

Tension in the clothes line = T = ?

Applying 1st condition of equilibrium



$\sum F_x = 0$

i.e. $T\cos\theta - T\cos\theta = 0$

and

$\sum F_y = 0$

$T \sin 15° + T \sin 15° - W = 0$

$2T \sin 15° = W$

$T = \frac{W}{2 \sin 15°}$

Putting values we get,

$T = \frac{10}{2 \times 0.26} = 19.3N$

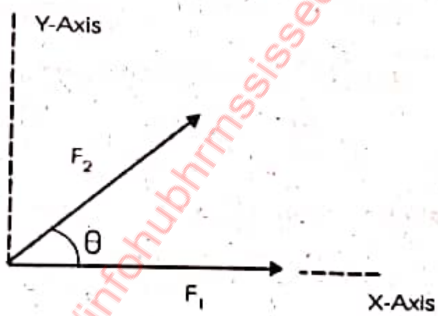
14. Find the angle between two forces of equal magnitude, when the magnitude of their resultant is also equal to the magnitude of either of these forces.

Ans: Let θ be the angle between two forces $\vec{F_1}$ and $\vec{F_2}$, where F_1 is along x – axis, then component their resultant is

$R_x = F_1 \cos 0° + F_2 \cos\theta$

$R_x = F_1 + F_2 \cos\theta$

and y – component of their resultant is



$R_y = R_1 \sin 0° + F_2 \sin\theta$

$R_y = 0 + F_2 \sin\theta$

$R_y = F_2 \sin\theta$

Now resultant

$R^2 = R_x^2 + R_y^2$

As

$R = F_1 = F_2 = F$ (Say)

Hence

$F^2 = (F + F\cos\theta)^2 + (F \sin\theta)^2$

$F^2 = F^2 + F^2\cos^2\theta + 2F.F\cos\theta + F^2\sin 2\theta$

$F^2 = F^2 + 2F^2\cos\theta + F^2(\sin^2\theta + \cos^2\theta)$

$F^2 = F^2 + 2F^2\cos\theta + F^2$ (1)

$0 = 2F^2\cos\theta + F^2$

$2F^2\cos\theta = -F^2$

$2\cos\theta = -1$

$\cos\theta = \frac{-1}{2}$

$\theta = \cos^{-1}(-\frac{1}{2}) = 120°$

15. A load is suspended by two cords as shown in figure. Determine the maximum load that can be suspended at "P" if maximum breaking stress of the cord used is 50 N.

Sol: $\theta_1 = 60^0$

$\theta_2 = 20^0$

Resolving T_1 and T_2 into rectangular components as shown in figure,

Applying 1[st] condition of equilibrium.

$\sum F_x = 0$

$T_2 \cos\theta_2 - T_1 \cos\theta_1 = 0$

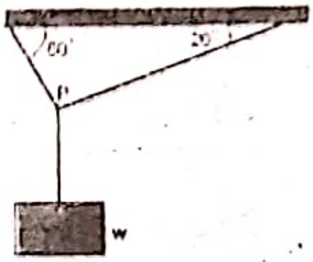
$T_2 \cos 20^0 - T_1 \cos 60^0 = 0$

$T_2 \times 0.94 - T_1 \times 0.5 = 0$

$0.94T_2 = 0.5T_1$

$T_1 = \frac{0.94}{0.5} T_2$

or $T_1 = 1.88T_2 \quad \rightarrow (i)$



thus $T_1 > T_2$

as $T_1 = 50N$, then from eq. (i)

$50 = 1.88T_2$

Or $T_2 = \frac{50}{1.88} = 26.6N$

Now $\sum F_y = 0$

$T_1 \sin\theta_1 + T_2 \sin\theta_2 - W = 0$

Or $W = T_1 \sin\theta_1 + T_2 \sin\theta_2$

$W = 50(Sin60^0) + 26.6(Sin20^0)$

$W = 43.3 + 9.04 = 52.34N$

16. A spherical ball of weight 50N is to be lifted over a step as shown in figure. Calculate the minimum force needed just to lift it above the floor.

Sol: $W = 50N$

$h = 5cm$

$r = 20cm$

$F = ?$

From diagram,

$OA = 20cm$

$OB = 15cm$

as $(OA)^2 = (AB)^2 + (OB)^2$

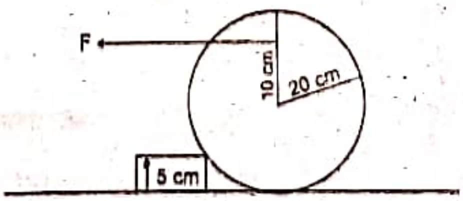
or $(AB)^2 = (OA)^2 - (OB)^2$

$AB = \sqrt{(OA)^2 - (OB)^2}$

$= \sqrt{(20)^2 - (15)^2}$

$= \sqrt{400 - 225} = \sqrt{175}$

$AB = 13.2cm$



In figure,

$CA = EO + OB$

$CA = 10 + 15$

$CA = 25 cm$

Taking the point A as an axis of rotation.

Applying 2nd condition of equilibrium.

$$\sum \tau = 0$$
$$F \times CA - W \times AB = 0$$
$$F \times 25 - 50 \times 13.2 = 0$$
$$25F - 660 = 0$$
$$25F = 660$$
$$F = \frac{660}{25} = 26.4N$$

or $F = 26N$

OBJECTIVES (MCQ'S) OF CHAPTER-3 IN ALL PUNJAB BOARDS 2011-2021

Topic I: Displacement:

1. The shortest distance between two points is called:
(A) Speed (B) Acceleration (C) Distance (D) Displacement

2. The distance covered by a body in time "t" starting from rest is:
(A) at^2 (B) v^2t (C) $a^2\frac{t}{2}$ (D) $\frac{at^2}{2}$

Topic II: Velocity:

3. When a body is moving with uniform velocity its?
(A) Speed Changes (B) Direction of motion changes
(C) Displacement from origin changes (D) Acceleration changes

4. When average velocity becomes equal to instantaneous then the body is called moving with.
(A) Instantaneous acceleration (B) Constant acceleration
(C) Constant velocity (D) Variable velocity

Topic III: Acceleration:

5. If the force acting on the body is doubled, then the acceleration becomes: (2 times)
(a) Double (b) Half (c) one-fourth (d) constant

6. The mass of an object is a quantitative measure of its:
(A) Momentum (B) Energy (C) Acceleration (D) Inertia

7. Motion of a body along y axis is:
(A) 1 dimensional (B) 2 dimensional (C) 3 dimensional (D) 4 dimensional

8. Nobody begins to move or comes to rest of itself was given by:
(A) Newton (B) Pascal (C) Bernoulli (D) Abu Ali Sena

9. If the mass of a body is doubled, the acceleration becomes.
(A) Double (B) half (C) one fourth (D) constant

10. A ball is allowed to fall freely from certain height. It covers a distance in first second equal to:
(a) 2 g (b) g (c) $\frac{g}{2}$ (d) gt^2

11. Kg ms^{-1} can also be written as:
(a) Nm (b) Ns (c) Ns^{-1} (d) Js

12. A man of mass 5 kg is falling freely, the force acting on it will be:
(a) 5 N (b) 9.8 N (c) 19.6 N (d) Zero

Topic IV: Velocity Time Graph:

13. The area between the velocity time graph and time axis is numerically equal to: (3 times)
(A) Velocity (B) Distance (C) Time (D) Acceleration

14 Slope of velocity time graph describes a physical quantity called: (3 Times)
(A) Displacement (B) Average velocity (C) Average acceleration (D) Momentum

15. The area between the velocity time graph is equal to: (2 times)
(A) Distance (B) Acceleration (C) Velocity (D) Speed

16. If the slope of a velocity time graph gradually decreases, then the body is said to be moving with:
(A) Positive acceleration (B) Negative acceleration (C) Uniform velocity (D) None

17. From velocity time graph we can calculate:
(A) Displacement (B) Force (C) Acceleration and distance (D) Speed

18. A body having uniform acceleration of $10ms^{-2}$ has velocity of 100 ms^{-1}. In what time its velocity will be doubled?
(A) 8 sec (B) 10 sec (C) 12 sec (D) 14 sec

19. When the body moves with constant acceleration, the velocity time graph is:
(a) Parabola (b) Hyperbola (c) Straight line (d) Curve

20. If velocity – time graph is parallel to time axis, then acceleration of moving body will be:
(A) Maximum (B) Positive (C) Zero (D) Negative

21. If the slope of the Velocity Time Graph remains constant then body is moving with:
(A) Uniform Velocity (B) Negative Variable Acceleration
(C) Variable Acceleration (D) Uniform Acceleration

Topic V: Newton's Law of Motion:

22. The area under the curve of force displacement graph represents:
(A) Force (B) Displacement (C) Work (D) Power

23. Laws of motion are not valid in a system which is:
(A) Moving with uniform velocity (B) At rest
(C) Isolated (D) Non-inertial

24. The equations of motion are not useful for objects moving with:
(A) Uniform velocity (B) Uniform acceleration (C) Variable velocity (D) Variable acceleration

25. The law of gravitation was introduced by:
(A) Huygens (B) Boyle (C) Newton (D) Pascal

26. Which formula is true:
(A) $m = \frac{a}{f}$ (B) $F = \frac{m}{a}$ (C) $a = \frac{F}{m}$ (D) $a = \frac{m}{F}$

27. Which theory is better about gravitation?
(a) Einstein (b) Plank (c) Newton (d) Michelson

Topic VI: Momentum:

28. Change in momentum is also called as: (2 times)
(A) Force (B) Acceleration (C) Torque (D) Impulse

29. SI unit of impulse is: (5 Times)
(A) Nkg (B) Ns (C) kgs (D) Nm

30. If a force of 10N acts on a body of mass 5kg for one second, then its change of momentum will be: (2 times)
(A) 10 $kgms^{-1}$ (B) 50 $kgms^{-1}$ (C) 2 $kgms^{-1}$ (D) 20 $kgms^{-1}$

31. Impulse can be defined as:
(A) $\vec{I} = \vec{F} \times \vec{d}$ (B) $\vec{I} = \vec{F} \times t$ (C) $\vec{I} = \vec{F} \times \vec{V}$ (D) $\vec{I} = \vec{F} / t$

32. The product of force and time is called:
(A) Impulse (B) Power (C) Torque (D) Velocity

33. SI unit of linear momentum is:
(A) kgm^2s^{-1} (B) kgm^2s^{-2} (C) $kgm^{-1}s^{-1}$ (D) $kgms^{-1}$

34. Rate of change of momentum is equal to: (6 times)
(A) Force (B) Momentum (C) Impulse (D) Torque

35. At what speed the momentum and kinetic energy of a body having the same value?
(A) 1 ms^{-1} (B) 2 ms^{-1} (C) 4 ms^{-1} (D) 8 ms^{-1}

36. A force of 10N acts on a body of mass 1 kg for 5 sec. to a distance of 10 m. The rate of change of momentum is:
(A) 50 N (B) 25 N (C) 20 N (D) 10 N

37. Unit of momentum in S.I. system is:

(a) N-m (b) $N-m^2$ (c) N^2-m (d) N-S

38. In the absence of external force, the change in momentum is:

(A) Zero (B) Constant (C) Decreasing (D) Increasing

Topic VII: Elastic and Inelastic Collision:

39. If a body of mass 2 kg moving with 15m/s collides with stationary body of same mass, then after elastic collision second body will move with velocity of:

(A) 15 m/s (B) 30 m/s (C) Zero m/s (D) None of these

Topic VIII: Force due to Water Flow:

40. The force due to water flow is: **(2 times)**

(A) F = mv (B) $F = \frac{mv}{t}$ (C) $F = \frac{ma}{t}$ (D) $F = \frac{mt}{V}$

Topic X: Rocket Propulsion:

41. For a rocket, the change in momentum per second of the ejecting gases is equal to: **(2 times)**

(A) Acceleration of the rocket (B) momentum of the rocket
(C) Velocity of the rocket (D) Thrust acting on rocket

42. A typical rocket consumes about 10000 Kgs^{-1} of fuel and ejects the burnt gases at speeds of over. **(2 times)**

(A) 2000 ms^{-1} (B) 3000 ms^{-1} (C) 4000 ms^{-1} (D) 5000 ms^{-1}

Topic XI: Projectile Motion:

43. Horizontal range is equal for the angles:

(a) 30° and 40° (b) 30° and 50° (c) 30° and 60° (d) 30° and 90°

44. A projectile is thrown upward with initial velocity "v_i" making an angle θ with the horizontal. The maximum horizontal range is given by:

(A) $\frac{v_i^2}{g}$ (B) $\frac{v_i^2}{2g}$ (C) $\frac{v_i^2}{g}\sin 2\theta$ (D) $\frac{v_i^2}{2g}\sin 2\theta$

45. Cricket ball is hit so that it travels straight up in air and it acquires 3 seconds to reach the maximum height. Its initial velocity is: **(2 times)**

(A) 10 ms^{-1} (B) 15 ms^{-1} (C) 29.4 ms^{-1} (D) 12.2 ms^{-1}

46. The range of projectile is directly proportional to:

(A) $\sin^2\theta$ (B) $\sin 2\theta$ (C) $\sin\theta$ (D) $2\sin\theta$

47. The horizontal range of projectile at 30° with horizontal is the same as that at an angle of: **(2 times)**

(A) 45° (B) 60° (C) 90° (D) 120°

48. What is the angle of projection for which its maximum height and horizontal range are equal? **(3 Times)**

(A) 46° (B) 56° (C) 66° (D) 76°

49. For an angle less than___ height reached by projectile and range both will be less:

(A) 15° (B) 30° (C) 45° (D) 60°

50. Rocket equation is given as:

(A) $a = \frac{M}{mv}$ (B) $a = \frac{Mv}{m}$ (C) $a = \frac{mv}{M}$ (D) $a = \frac{m}{Mv}$

51. The time of flight of a projectile is: **(2 times)**

(A) $\frac{v_i \sin\theta}{g}$ (B) $\frac{2v_i \sin\theta}{g}$ (C) $\frac{v_i \sin\theta}{2g}$ (D) $\frac{v_i^2 \sin\theta}{g}$

52. Motion of projectile is: **(3 Times)**

(A) 1 dimensional (B) 2 dimensional (C) 3 dimensional (D) 4 dimensional

53. For maximum range, the angle of projection must be: **(3 Times)**

(A) 0° (B) 90° (C) 45° (D) 180°

54. Horizontal components of velocity of projectile: **(4 Times)**

(A) Remains constant (B) Increase (C) Decrease (D) Zero

55. The ballistic missiles are useful only for: **(2 Times)**

(A) Long range (B) Short range (C) Intermediate range (D) Zero range

56. The velocity of projectile is maximum:
(A) At the highest point (B) at point of launching and just before striking the ground
(C) at half of the height (D) after striking the ground

57. The velocity of projectile at maximum height is:
(A) Vi Cosθ (B) Zero (C) Maximum (D) Vi Sinθ

58. For which pair of angles the range of projectile are equal:
(A) 20°, 30° (B) 70°, 20° (C) 60°, 40° (D) 50°, 10°

59. For a typical rocket, how much mass of rocket is in the form of fuel: (2 times)
(A) 60 % (B) 50 % (C) 80 % (D) 100 %

60. A ball is thrown up with 20ms^{-1} at an angle of 60° with x-axis the velocity of the ball at the top position is:
(A) 0 ms^{-1} (B) 10 ms^{-1} (C) 20 ms^{-1} (D) 16 ms^{-1}

61. The path followed by a projectile is known as its:
(A) Range (B) Trajectory (C) Cycle (D) Height

62. The trajectory of a projectile is:
(A) Circle (B) Parabola (C) Hyperbola (D) Straight line

63. Maximum height of projectile is: (2 times)
(a) $h = \frac{Vi^2 Sin^2\theta}{2g}$ (b) $h = \frac{Vi^2 Sin^2\theta}{g}$ (c) $v = \frac{Vi^2}{g}$ (d) $h = \frac{Vi^2}{g} Sin^2\theta$

64. The mass of fuel consumed by a typical rocket to overcome earth's gravity is: (5 times)
(a) 10000 KgS^{-1} (b) 1000 KgS^{-1} (c) 100 KgS^{-1} (d) 10 KgS^{-1}

65. The shape of trajectory of short range projectile is:
(a) Straight line (b) Circle (c) Elliptical (d) Parabolic

66. The range of projectile is same for:
(a) $0^0, 45^0$ (b) $35^0, 55^0$ (c) $15^0, 60^0$ (d) $30^0, 75^0$

67. The distance covered by freely falling body in two seconds is: (3 times)
(a) 9.8 m (b) 19.6 m (c) 44.4 m (d) 39.2 m

68. Veloicty of an oject dropped from a building at any instant 't' is given by:
(A) $\frac{1}{2}gt^2$ (B) $v_i t + \frac{1}{2}gt^2$ (C) at (D) gt

69. A paratrooper moves downward with:
(A) Zero acceleration (B) Constant acceleration
(C) Positive acceleration (D) Negative acceleration

70. The acceleration of a projectile along x – axis is. (2 times)
(A) Zero (B) increases (C) Decreases (D) Equal to 'g'

71. Height of projectile is maximum at an angle of:
(A) 45° (B) 60° (C) 30° (D) 90°

72. A ball is thrown up with 20 ms^{-1} at an angle of 60° with x – axis. The horizontal velocity of the ball at the top position is.
(A) 0 ms^{-1} (B) 10 ms^{-1} (C) 20 ms^{-1} (D) 16 ms^{-1}

2018

73. If the initial velocity of a projectile becomes doubled. The time of flight will become: (3 times)
(a) double (b) same (c) 3 times (d) 4 times

74. A mass of 5000 gm moves with an acceleration of 10 ms^{-2}, force acting on it is:
(a) 5 N (b) 500 N (c) 50 N (d) 5000 N

75. Before the launch of a rocket the mass of the fuel of the rocket approximately consists of:
(A) 20 % of rocket mass (B) 40 % of rocket mass
(C) 60 % of rocket mass (D) 80 % of rocket mass

76. The maximum range of a projectile is 100 km. Take g = 10 ms^{-2}. The initial velocity of the projectile will be:
(A) 1000 kms^{-1} (B) 1 kms^{-1} (C) 10 kms^{-1} (D) 100 kms^{-1}

2019

77. Rocket ejects the burnt gasses at a speed of over (consuming fuel at rate of 10000 kg/s): **(2 times)**
(A) 4000 m/s (B) 400 m/s (C) 4000 cm/s (D) 400 cm/s

78. Ballistic missiles are used for:
(A) short ranges (B) long ranges (C) very long ranges (D) any range

79. If maxium height of the projectile is equal to the range then angle of projection of projectile will be:
(A) 30° (B) 45° (C) 60° (D) 76°

80. If a shell explodes in mind air, its fragments fly off in different directions. The total momentum of the fragments. **(2 times)**
(A) decreases (B) increases (C) becomes zero (D) remains the same

81. Pull of earth on a mass of 10 Kg on the surface of the earth is:
(A) 95 N (B) 96 N (C) 97 N (D) 98 N

82. Distance travelled by free falling object in first second is:
(A) 4.9m (B) 9.8m (C) 19.6m (D) 10m

83. Impulse has same unit as that of: **(2 times)**
(A) Force (B) Energy (C) Mass (D) Linear momentum

84. The distance covered by a freely falling body in first 2 seconds, wihen its initial velocity was zero:
(A) 9.8m (B) 39.2m (C) 19.6m (D) 4.9m

2021

85. A 1500 kg has its velocity reduced from $20\,ms^{-1}$ to $15\,ms^{-1}$ in 3.0 sec. How large was the retarding force?
(A) 500 N (B) 2500 N (C) 1500 N (D) 1000 N

86. When a massive body of mass m_1 collides with lighter stationary body of mass m_2, the velocity of massive body after collision will be:
(A) $v_1' = 2v_1$ (B) $v_2' = v_1$ (C) $v_1' = v_1$ (D) $v_2' = 2v_2$

87. If a force of 20 N acts on a body for 5 seconds then the change in momentum will be .
(A) 5 Ns (B) 20 Ns (C) 50 Ns (D) 100 Ns

88. A typical rocket eject the burn gases speed of over
(A) 400 m/s (B) 4000 m/s (C) 8000 m/s (D) 10,000 m/s

89. The horizontal range of a projectile is:
(A) $\frac{2v_i \sin\theta}{g}$ (B) $\frac{v_i^2 \sin^2\theta}{2g}$ (C) $\frac{v_i^2 \sin 2\theta}{g}$ (D) $\frac{v_i \sin^2\theta}{2g}$

90. Height of projectile is maximum at an angle of projection of:
(A) 45° (B) 60° (C) 30° (D) 90°

91. When a shell explodes in mid-air, the total momentum of its fragments:
(A) Becomes zero (B) Decreases (C) Increases (D) Remains constant

92. An Un- powered and unguided missile is:
(A) Remote control (B) Long range (C) Powered (D) Ballistic

93. If the angle of projection is greater that 45^o, then the
(A) Height attained is more but range is less
(B) Height attained is less but is more
(C) Range and height attained is less
(D) Both height attained and range are more

94. A ball is thrown with an initial speed of 30 ms^{-1} in a direction 30^o above the Horizontal. Its vertical component velocity is
(A) 25.98 ms^{-1} (B) 30 ms^{-1} (C) 10 ms^{-1} (D) 15 ms^{-1}

95. A ball is dropped from a height of 4.2 meters. To what height it will rise if there loss after rebounding?
(A) 4.2 m (B) 8.4 m (C) 12.6 m (D) 2.4 m

96. Total time for which the projectile remain in air is called:
(A) Time of projectile
(B) Time of flight
(C) Time period
(D) Time constant

ANSWERS OF THE MULTIPLE CHOICE QUESTIONS

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
D	D	C	C	A	D	A	D	B	C	B	D	B	C	A
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
B	C	B	C	C	D	C	D	D	C	C	A	D	B	A
31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
B	A	D	A	B	D	D	A	A	B	D	C	C	A	C
46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
B	B	D	C	C	B	B	C	A	B	B	A	B	C	B
61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
B	B	A	A	D	B	B	D	B	A	D	B	A	C	D
76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
B	A	A	D	D	D	A	D	C	B	C	D	B	C	D
91	92	93	94	95	96									
D	D	A	D	A	B									

SHORT QUESTIONS OF CHAPTER-3 IN ALL PUNJAB BOARDS 2011-2021

Topic I: Displacement:

1. Differentiate between distance and displacement. (2 times)

Ans: **Displacement:** The change in position of a body from its initial position to final position is called displacement.

It is a vector quantity denoted by $\vec{d}$ which tells us how far and in which direction the body has displaced.

Its SI unit is meter.

Distance: The change in position of a body is called distance.

It is a scalar quantity denoted by S. A body may cover without having any displacement. Displacement coincides with distance when a body moves along a straight line. Its SI unit is also meter.

Topic II: Velocity:

2. What is the difference between average velocity and instantaneous velocity? Explain. (4 times)

Ans: **Average velocity:** The ratio between the total displacement and the total time taken by the body is called average velocity.

$$\overrightarrow{v_{av}} = \frac{\Delta \vec{d}}{\Delta t}$$

Instantaneous velocity: Velocity at any instant of time is called instantaneous velocity.

$$\overrightarrow{v_{ins}} = \lim_{\Delta t \to 0} \frac{\Delta \vec{d}}{\Delta t}$$

3. What is the difference between uniform and variable velocity? (5 Times)

Ans: **Uniform velocity:** A body is said to have a uniform velocity if it covers equal displacement in equal intervals of time.

Variable velocity: A body is said to have a variable velocity if it covers unequal displacements in equal intervals of time.

4. Can the velocity of an object reverse the direction when acceleration is constant? If so, give an example. (22 Times)

Ans: Yes, the velocity of a body can reverse its direction with constant acceleration. For example, when a body is thrown vertically upward under the action of gravity, the velocity of the object will go on decreasing because force of gravity is acting downward.

When the object reaches the maximum height, its velocity becomes zero, and then the object reverses its direction of motion and start moving vertically downward. During the whole process, the magnitude of the acceleration due to gravity remains constant.

5. Motion with constant velocity is a special case of motion with constant acceleration. Is this statement true? (8 *times*)

Ans: Yes, this statement is true. When a body moves with constant velocity in the straight line, its acceleration is zero. Hence, the acceleration of the body will always remain constant during such motion. As the zero is a constant quantity, therefore this is a special case of motion.

6. Under what condition, the instantaneous and average velocities of a moving object become equal? (2 times)

Ans: For a body moving with uniform velocity, its average and instantaneous velocities are equal.

Topic III: Acceleration:

7. Explain the circumstances in which the velocity $\vec{v}$ and acceleration $\vec{a}$ of a car are: i) Parallel ii) Anti-parallel (15 *times*)

Ans: <u>Parallel:</u> When the velocity of the car is increasing along a straight line then $\vec{v}$ and $\vec{a}$ of the car will be parallel to each other.

<u>Anti-Parallel:</u> When the velocity of the car is decreasing along a straight line then $\vec{v}$ and $\vec{a}$ of the car will be anti-parallel to each other.

8. An object is thrown vertically upward. Discuss the sign of acceleration due to gravity, relative to velocity, while the object is in air. (13 Times)

Ans: When the object is thrown vertically upward, it will move against the direction of gravity. The sign of acceleration due to gravity relative to velocity will be taken as negative. When the object is moving downward, the sign of acceleration due to gravity will be positive.

9. Explain circumstances in which acceleration $\vec{a}$ and $\vec{v}$ of a car:
a) $\vec{a}$ is zero but $\vec{v}$ is not zero b) $\vec{v}$ is zero but $\vec{a}$ is not zero (10 *times*)

Ans: <u>$\vec{a}$ is zero but $\vec{v}$ is not zero:</u> When the car is moving in straight line with uniform velocity, then $\vec{a}$ is zero but $\vec{v}$ is not zero.

<u>$\vec{v}$ is zero but $\vec{a}$ is not zero:</u> When the brake is applied on a moving car, it slows down and comes to rest due to negative acceleration in opposite direction. Then $\vec{v}$ is zero but $\vec{a}$ is not zero.

10. Explain the circumstances in which the velocity $\vec{v}$ and acceleration $\vec{a}$ of a car are perpendicular to one another. (12 *times*)

Ans: When the car moves along circular path, then $\vec{a}$ will be directed towards the center of the circle while its velocity will be along the tangent. Thus $\vec{v}$ and $\vec{a}$ of the car will be perpendicular to each other when it moves on a circular path.

11. Discuss the sign of acceleration due to gravity relative to velocity, while the object is in air?

Ans: When the object is thrown vertically upward, it will move against the direction of gravity. The sign of acceleration due to gravity relative to velocity will be taken as negative.

When the object is falling downward, it will move along the direction of gravity. The sign of acceleration due to gravity relative to velocity will be taken as positive.

12. What is meant by instantaneous acceleration? Write its formula.

Ans: The limiting value of $\frac{\Delta \vec{v}}{\Delta t}$ as the time interval Δt, following the time t, approaches to zero is called instantaneous acceleration. Mathematically,

$$\overrightarrow{a_{ins}} = \lim_{\Delta t \to 0} \frac{\Delta \vec{v}}{\Delta t}$$

13. Define inertial and non-inertial frame of references. (4 times)

Ans: <u>**Inertial frame of reference:**</u> The frame of reference in which Newton's first law holds is called inertial frame of reference. It is not an accelerated frame of reference. e.g., Earth is approximately an inertial frame of reference.

<u>**Non-inertial frame of reference:**</u> The frame of reference in which Newton's first law does not hold true is called non-inertial frame of reference. It is an accelerated frame of reference. e.g., Space ship etc.

14. Under what conditions a body can move with uniform acceleration?

Ans: If the velocity of the body is changing equally in equal intervals of time, the body is said to have uniform acceleration.

For a body moving with uniform acceleration, its average acceleration is equal to instantaneous acceleration.

15. Write any two properties of inertial frame of reference.

Ans: (i) A non-accelerated frame of reference is an inertial frame of reference.

(ii) Newton's 1st law of motion holds good in an inertial frame of reference.

16. What is difference between uniform velocity and uniform acceleration?

Ans: A body is said to have a uniform velocity if it covers equal displacement in equal intervals of time. It is measured in ms^{-1}. If the velocity of the body changes by equal amount in equal intervals of time, the body is said to have uniform acceleration. It is measured in ms^{-2}.

17. Explain the circumstance in which $\vec{v}$ and $\vec{a}$ are
(i) in parallel (ii) perpendicular.

Ans: i. When the velocity of the car is increasing along a straight line then $\vec{v}$ and $\vec{a}$ are parallel.

ii. When the car moves along circular path then $\vec{v}$ and $\vec{a}$ are perpendicular.

18. Define positive and negative acceleration along with their directions.

Ans: If velocity of object is increasing its acceleration will be positive. It will be along the motion. If velocity of object is decreasing its acceleration will be negative. It will be in opposite direction.

Topic IV: Velocity Time Graph:

19. How is the distance calculated from velocity time graph? (4 times)

Ans: Area under the velocity time graph line is equal to the distance covered by the body.

20. Show that the area between the velocity time graph and time axis is numerically equal to the distance covered by the object.

Ans:

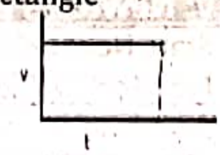
i. When the body moves with uniform velocity, graph is horizontal line and hence area is rectangular, so

distance covered by the object = Area of rectangle

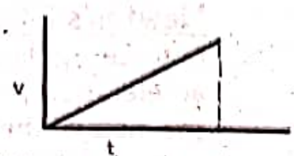
= (length)(width)

= vt

= S



ii. When the body moves with uniformly increasing velocity, graph is inclined straight line and hence area is triangular, so distance covered by the object = Area of triangle



$= \frac{1}{2}$(base)(height)

$= \frac{1}{2}vt \qquad \left(v_{av} = \frac{0+v}{2} = \frac{1}{2}v\right)$

$= v_{av}t$

$= S$

21. Name the quantities which can be calculated from velocity – time graph and

how these can be calculated? (2 times)

Ans: Distance moved by the body and its acceleration can be calculated by the velocity-time graph.

Area under the velocity time graph line is equal to the distance covered by the body. Slope of the tangent at any point gives the instantaneous acceleration at that point.

22. Write two objectives of velocity time graph.

Ans: Velocity time graph can be used to

(i) Calculate the distance covered by the body.

(ii) Find the instantaneous acceleration of the body.

23. Calculate the distance covered by a free falling body during 1[st] second of its motion.

Ans: Here a =g

t=1s

$v_{iy}=0$

distance covered h = ?

From 2[nd] equation of motion

$$h = V_{iy}t + \frac{1}{2}gt^2$$

$$h = (0)(1) + \frac{1}{2}(9.8)(1)^2 = \frac{9.8}{2} = 4.9m$$

24. What is velocity –time graph? What does its slope represent?

Ans: Graphs may be used to illustrate the variation of velocity of an object with time. Such graphs are called **velocity-time graphs.**

The average acceleration of the object during the interval t is given by the slope of its velocity-time graph.

25. What does the slope of velocity-time graph represent?

Ans: The slope of velocity – time graph at any instant represents the instantaneous acceleration at that time.

$$Slope = \frac{v}{t} = a$$

26. How the acceleration and distance are determined from velocity time graph?

Ans: Slope of the tangent at any point gives the instantaneous acceleration at that point.

Slope $= \frac{v}{t} = a$

Area under the velocity –time graph line is equal to the distance covered by the body.

Topic V: Newton's Law of Motion:

27. State Newton's first and second law of motion. **(5 times)**

Ans: <u>Newton's 1[st] law of motion</u>

A body at rest will remain at rest, and a body moving with uniform velocity will continue to do so, unless acted upon by some unbalanced external force.

<u>Newton's 2[nd] law of motion</u>

A force applied on a body produces acceleration in its own direction. The acceleration produced varies directly with the applied force and inversely with the mass of the body.

$$\vec{F} = m\vec{a}$$

28. Why Newton's first law of motion is known as law of inertia? **(2 times)**

Ans: Newton's first law of motion is

A body at rest will remain at rest and a body moving with uniform velocity will continue to do so unless acted upon by some unbalanced external force.

It is based on mass and inertia is the quantitative measure of an object's mass. So Newton's first law of motion is also known as law of inertia.

29. State Newton's third law of motion and give at least two examples. (2 times)

Ans: It states that every action has a reaction which is equal in magnitude but opposite in direction. An ideal elastic collision and propulsion of a rocket are two good examples of third law of motion.

30. State Newton's second law of motion and define the unit of force.

Ans: Newton's 2nd law of motion: Acceleration produced in a body is directly proportional to the applied force and inversely proportional to the mass of the body.

Mathematically,

$$\vec{F} = m\vec{a}$$

S.I unit of force: Force is measured in newton. If $1m/s^2$ acceleration is produced in a body of mass 1kg then the applied force will be 1N.

31. State law of Inertia.

Ans: Newton's 1st law of motion is called law of inertia

It states that a body at rest will remain at rest, and a body moving with uniform velocity will continue to do so, unless acted upon by some unbalanced external force.

Topic VI: Momentum:

32. Define momentum and write down its unit. (2 Times)

Ans: The product of mass and velocity of an object is called the linear momentum. It is a vector quantity.

The SI unit of momentum is kilogram metre per second ($kgms^{-1}$). It can also be expressed as newton second (Ns).

$$\vec{p} = m\vec{v}$$

33. Show that $\vec{F} = \frac{\Delta\vec{p}}{\Delta t}$ Or Show that the rate of change of momentum is equal to force. / Find the change in the momentum of an object subjected to a given force for a given time? (10 times)

Ans: Since acceleration is

$$\vec{a} = \frac{\vec{v}}{t} = \frac{\vec{v_f} - \vec{v_i}}{t}$$

And Newton's 2nd law of motion is

$$\vec{F} = m\vec{a}$$

$$\vec{a} = \frac{\vec{F}}{m}$$

Comparing gives

$$\frac{\vec{F}}{m} = \frac{\vec{v_f} - \vec{v_i}}{t}$$

$$\vec{F} = \frac{m(\vec{v_f} - \vec{v_i})}{t}$$

$$\vec{F} = \frac{m\vec{v_f} - m\vec{v_i}}{t}$$

$$\vec{F} = \frac{\vec{p_f} - \vec{p_i}}{t}$$

$$\vec{F} = \frac{\Delta\vec{p}}{\Delta t}$$

Hence proved.

34. State law of motion in terms of momentum. OR State only Newton's second law in term of linear momentum. (3 Times)

Ans: Law of motion in terms of momentum can be stated as

"The time rate of change of momentum of a body is equal to the applied force".

$$\vec{F} = \frac{\Delta\vec{p}}{\Delta t}$$

35. State the law of conversation of linear momentum. (3 times)

Ans: It states that
The total linear momentum of an isolated system remains constant.

$$\vec{p_i} = \vec{p_f}$$

36. Define impulse and show that how it is related to linear momentum. (20 times)

OR Define impulse and write its formula. (8 times)

Ans: When a force is acted on a body for a very short time Δt, the product of force and time is called impulse.

$$\vec{I} = \vec{F} \times \Delta t$$

According to the Newton's second law of motion, the rate of change of linear momentum is equal to the applied force.

$$\vec{F} = \frac{\Delta\vec{p}}{\Delta t}$$

$$\vec{F} \times \Delta t = \Delta\vec{p}$$

But

$$\vec{I} = \vec{F} \times \Delta t$$

So

$$\vec{I} = \Delta\vec{p}$$

Impulse is equal to the change in momentum of the body.

37. Define impulse and derive its dimensions.

Ans: When a force is acted on a body for a very short time Δt, the product of force and time is called impulse.

$$\vec{I} = \vec{F} \times \Delta t$$

<u>Dimensions</u>

$$[I] = [F][\Delta t]$$
$$[I] = [MLT^{-2}][T]$$
$$[I] = [MLT^{-2+1}]$$
$$[I] = [MLT^{-1}]$$

This dimension is same as that of momentum.

38 What is the effect on the speed of a fighter plane chasing another when it opens the fire? What happens to the speed of pursued plane when it returns the fire? (3 times)

Ans: When the fighter plane opens fire, its momentum will be in back direction due to reaction force in backwards direction and therefore its speed will decrease.
When the pursued plane opens fire in the backward direction, the momentum will act on the plane in forward direction due to reaction and therefore its speed will increase.

39. How would you find the momentum of an explosive force? Explain with one example.

Ans: One of the examples of explosive forces is the force experienced in firing a bullet of mass m from a rifle of mass M.

Initial momentum is zero, so momentum after fire, if $\vec{v'}$ is the recoil velocity of rifle then final momentum

$$\text{final momentum} = m\vec{v} + M\vec{v'}$$

According to law of conservation of momentum,

$$\text{Initial momentum} = \text{final momentum}$$
$$0 = M\vec{v'} + (-m\vec{v})$$
$$M\vec{v'} = -m\vec{v}$$
$$\vec{v'} = -\frac{m\vec{v}}{M}$$

It is the velocity of recoil of rifle, since mass of rifle is very large so recoil velocity is very small.

40. Does a moving object have impulse? (3 times)

Ans: No, when the body is moving with uniform or variable velocity then force is acting continuously; hence no impulse is produced because no force acts for short intervals of time.

$$\vec{I} = \vec{F} \times t$$

If the force is changing with time then the impulse will be produced.

41. A 20 g ball hits the wall of a squash court with a constant force of 50 N. If the time of impact of the force is 0.5 sec., find the impulse.

Ans:

$F = 50N$

$t = 0.5s$

Impulse is given as

$$I = F \times t$$

$$I = 50 \times 0.5 = 25\ Ns$$

42. Calculate the linear momentum of a ball of mas 100 gm which moves with 5 m/s along with a straight line.

Ans.

$m = 100gm = 100 \times 10^{-3}\ kg = 0.1\ kg$

$v = 5\ m/s$

we know that

$$P = mv$$

putting values, we get

$$P = 0.1 \times 5 = 0.5\ kg\ m/s$$

43. Which will be more effective in knocking down a bear and why?
(a) A rubber bullet (b) A lead bullet of same momentum.

Ans: It is given that, both the bullets have same momentum.

As $P = mv$

This shows that the speed of small mass will be greater than the other.

Therefore, rubber bullet will be more effective in knocking a bear down.

44. A rubber ball and lead ball of same size, are moving with same velocity. Which ball have greater momentum and why?

Ans: Lead ball have greater momentum.

As $\vec{P} = m\vec{v}$

Both the balls are moving with same velocity. Thus, lead ball being massive will have greater momentum.

45. A bullet is fired from a rifle. Derive the relation for velocity of rifle.

Ans: Consider a bullet of mass m is fired from a rifle of mass M with a velocity v. If v' is the velocity of the rifle then from law of conservation of linear momentum

Total momentum before fire = Total momentum after fire

$$mv + Mv' = 0 + 0$$

$$Mv' = -mv$$

$$v' = -\frac{mv}{M}$$

Negative sign shows that the rifle moves back.

46. Define Isolated System. Give its example.

Ans: It is a system on which no external agency exerts any force.

For example, the molecules of a gas enclosed in a glass vessel at constant temperature constitute an isolated system.

47. Define Impulse. Give its units.

Ans: When a force $\vec{F}$ is acted on a body for a very short time Δt, the product of force and time is called impulse.

$$\vec{I} = \vec{F} \times t$$

S.I units = Ns

48. State Law of Conservation of Momentum. What is its limitation?

Ans: The total linear momentum of an isolated system remains constant. The momentum of all bodies in a system add upto the same total momentum at all time. It is only applicable to isolated systems.

Topic VII: Elastic and Inelastic Collision:

49. What is the change in total energy during elastic or inelastic collisions?

Ans: The total energy of the system remains conserved during both type of collisions. But in an inelastic collision, some of the kinetic energy is lost.

50. Find the velocity of a heavy body when it elastically collides with a stationary light body.

Ans: In this case, initial velocity $v_2 = 0$ and $m_1 \gg m_2$. Under these conditions, m_2 can be neglected as compared to m_1.

$$v_1' = \frac{m_1 - m_2}{m_1 + m_2} v_1 + \frac{2m_2}{m_1 + m_2} v_2$$

$$v_1' = \frac{m_1 - 0}{m_1 + 0} v_1 + \frac{2(0)}{m_1 + 0}(0)$$

$$v_1' = v_1$$

Thus, there will be no change in the velocity of massive body, and the lighter body will move in forward direction with twice the velocity of incident body.

51. Find the value of v_1' and v_2' after elastic collision of light body with massive body at rest.

Ans: In this case, initial velocity $v_2 = 0$ and $m_2 \gg m_1$. Under these conditions, m_1 can be neglected as compared to m_2.

$$v_1' = \frac{m_1 - m_2}{m_1 + m_2} v_1 + \frac{2m_2}{m_1 + m_2} v_2$$

$$v_1' = \frac{0 - m_2}{0 + m_2} v_1 + \frac{2m_2}{0 + m_2}(0)$$

$$v_1' = -v_1$$

And

$$v_2' = \frac{2m_1}{m_1 + m_2} v_1 + \frac{m_2 - m_1}{m_1 + m_2} v_2$$

$$v_2' = \frac{2(0)}{0 + m_2} v_1 + \frac{m_2 - 0}{0 + m_2}(0)$$

$$v_2' = 0$$

52. Why a safety helmet of a motor cycle's is padded? **(3 Times)**

Ans: A motor cycle's safety helmet is padded so as to extend the time of collision to prevent serious injury.

53. Distinguish between elastic and inelastic collision. **(11 Times)**

OR **Explain the difference between elastic and inelastic collisions. Also give an example of each.** **(7 Times)**

OR **Explain the difference between Elastic and Inelastic Collisions. Explain how would a bouncing ball behave in each case?**

Ans: Difference between elastic and inelastic collision:

In case of elastic collision the K.E of the system is conserved while in case of inelastic collision the K.E is not conserved. But the total linear momentum and the total energy of the system remains constant in both types of collision.

Behaviour of a bouncing ball:

When a hard ball is dropped onto a marble floor, it rebounds to very nearly the initial height. It loses negligible amount of energy in the collision with the floor. Then such collision is approximately an elastic collision. But if the ball is not able to reach the initial height such as collision with the sand then there is a loss of kinetic energy and such collision is called inelastic collision.

54. Write solid reasons for the loss of kinetic energy in an inelastic collision.

Ans: In case of inelastic collision, the loss of kinetic energy is due to

i. friction of ball with floor ii. friction of ball with air iii. Sound

55. When a massive body collides elastically with light stationary body, what will be their final velocities? **(2 times)**

Ans: In this case $m_1 >> m_2$ and $v_2 = 0$ so m_2 can be neglected.
Final velocities of m_1 and m_2 will be

$$v_1' = \frac{m_1 - m_2}{m_1 + m_2} v_1 + \frac{2m_2}{m_1 + m_2} v_2 = \frac{m_1 - 0}{m_1 + 0} v_1 + \frac{2(0)}{m_1 + 0}(0) = \frac{m_1}{m_1} v_1 + 0 = v_1$$

$$v_2' = \frac{2m_1}{m_1 + m_2} v_1 + \frac{m_2 - m_1}{m_1 + m_2} v_2 = \frac{2m_1}{m_1 + 0} v_1 + \frac{0 - m_1}{m_1 + 0}(0) = \frac{2m_1}{m_1} v_1 + 0 = 2v_1$$

Thus after the collision, there is no change in velocity of massive body, but the lighter one gets twice the velocity of incident body.

Topic VIII: Force due to Water Flow:

56. What are the factors upon which force due to water flow depend?

Ans: Force due to water flow depends upon viscosity of the media and velocity of the fluid.

57. Find the relation for force due to water flow.

Ans: Force due to water flow depends upon viscosity of the media and velocity of the fluid.

$$\text{initial velocity} = \vec{v_i} = \vec{v}$$

$$\text{final velocity} = \vec{v_f} = 0$$

$$\text{change in velocity} = \Delta\vec{v} = \vec{v_f} - \vec{v_i} = 0 - \vec{v} = -\vec{v}$$

$$\text{mass hitting the wall in time t} = \text{m}$$

$$\text{change in momentum} = \Delta\vec{P} = m\Delta\vec{v} = -m\vec{v}$$

According to Newton's second law of motion,

$$\vec{F} = \frac{\text{change in momentum}}{\text{time}}$$

$$\vec{F} = \frac{-m\vec{v}}{t}$$

According to Newton's Third law of motion,

$$\vec{F} = -\left(\frac{-m\vec{v}}{t}\right)$$

$$\vec{F} = \frac{m\vec{v}}{t}$$

$$\vec{F} = \left(\frac{m}{t}\right)\vec{v}$$

Topic X: Rocket Propulsion:

58. What is the principle of rocket propulsion speed? **(3 times)**

Ans: Hot gases are expelled with extremely high velocity from the rocket engines. The gain in momentum of the gases equals the gain in momentum of the rocket. The gases and rocket move in opposite directions. Thus, the principle of rocket propulsion speed is law of conservation of momentum and Newton's 3rd law of motion.

Topic XI: Projectile Motion:

59. Define ballistics flight and ballistic trajectory. **(2 Times)**

Ans: The flight in which projectile is given an initial push and is then allowed to move freely due to inertia and under the action of gravity is called ballistic flight and the path followed by it is called ballistic trajectory.

60. At what point or points in its path does a projectile have its minimum speed, its maximum speed? **(26 times)**

Ans: The speed of the projectile is minimum at the maximum height of projectile. It is because of the reason that; at maximum height the vertical component of velocity becomes zero.

The speed of the projectile is maximum at the point of projection and also just before it strikes the ground because the vertical component of velocity is maximum at these points.

61. What is projectile motion? In what direction acceleration is zero in this motion? **(2 Times)**

Ans: It is the two dimensional motion in which the object moves under constant acceleration due to gravity.

- The acceleration in horizontal direction is zero in projectile motion.

62. An athlete wishes to generate a long jump. At what angle he should jump?
OR Show that the range of projectile maximum when projectile is thrown at an angle of 45° with the horizontal. **(16 Times)**

Ans: Range of the projectile is given by

$$R = \frac{v_i^2}{g}\sin 2\theta$$

The horizontal range will be maximum when the factor $\sin 2\theta$ is maximum. So

$$\sin 2\theta = 1$$
$$2\theta = \sin^{-1}(1)$$
$$2\theta = 90^o$$
$$\theta = 45^o.$$

Hence he should jump at 45^o.

63. A body is projected with the speed of $20\ ms^{-1}$ with an angle $\theta = 45^o$. Find the horizontal range?

Ans: The horizontal range is given as

$$R = \frac{v_i^2}{g}\sin 2\theta$$
$$R = \frac{(20)^2}{9.8}\sin 2(45)$$
$$R = 40.82\ metre$$

64. What is ballistic missile? Define ballistic trajectory. **(5 Times)**

Ans: The missile in which it is given an initial push and is then allowed to move freely due to inertia and under the action of gravity is called ballistic missile and the path followed by such a projectile is called ballistic trajectory.

65. What is meant by Projectile Motion? Derive an expression for time of flight? **(3 times)**

Ans: The two dimensional motion under the constant acceleration due to gravity and inertia is called projectile motion.

Examples:

A foot ball kicked by a player.
A missile fired from a launching pad.

Time of flight:

The time taken by a body to cover a distance from the place of projection to a place where it is just to hit the ground is called the time of flight.
Since the projectile covers no vertical distance after its total time of flight. So S = h = 0. If $v_i \sin\theta$ is the vertical component of initial velocity, Then

$$S = v_i t + \frac{1}{2}at^2$$
$$0 = (v_i \sin\theta)\,t - \frac{1}{2}gt^2$$
$$\frac{1}{2}gt^2 = (v_i \sin\theta)\,t$$
$$t = \frac{2v_i \sin\theta}{g}$$

66. Define and derive the formula of range of projectile. **(6 Times)**

Ans: **Range of the projectile:** Maximum distance which a projectile covers in the horizontal direction is called the range of projectile.
If $v_i \cos\theta$ is horizontal component of initial velocity then range of projectile R for the total time of flight t can be expressed as,

$$R = v_{ix} \times t$$

Putting values, we get

$$R = v_i \cos\theta \times \frac{2v_i \sin\theta}{g}$$
$$R = \frac{v_i^2.(2\sin\theta\cos\theta)}{g}$$

$$R = \frac{v_i^2 \sin 2\theta}{g} \qquad (2\sin\theta\cos\theta = \sin 2\theta)$$

67. Define time of flight and range of a projectile. Also, write their units. (5 times)

Ans: **Time of flight:** The time taken by a projectile to cover a distance from the place of projection to a place where it is just to hit the ground is called the time of flight. Time of flight can be expressed as,

$$t = \frac{2v_i \sin\theta}{g}$$

Its unit is second.

Range of the projectile:

Maximum distance which a projectile covers in the horizontal direction is called the range of projectile. Range of projectile R for the total time of flight can be expressed as,

$$R = \frac{v_i^2 \sin 2\theta}{g}$$

Its unit is meter.

68. Derive the relation for time to reach maximum height for a projectile. (3 times)

Ans: As body moves upward, so a = - g and from 1st equation of motion

$$v_{fy} = v_{iy} - gt$$

Since at maximum height the vertical component of final velocity "v_{fy}" will be zero. If $v_i\sin\theta$ is the vertical component of initial velocity, Then

$$0 = (v_i \sin\theta) - gt$$

$$gt = (v_i \sin\theta)$$

$$t = \frac{v_i \sin\theta}{g}$$

This is required time to reach the maximum height for a projectile.

69. Define projectile motion. Derive expression for maximum height.

Ans: The two dimensional motion under the constant acceleration due to gravity and inertia is called projectile motion.

From equations of motion

$$2aS = (v_{fy})^2 - (v_{iy})^2$$

As body moves upward, so a = - g, S=h, at maximum height the vertical component of velocity "v_{fy}" will be zero. If $v_i\sin\theta$ is the vertical component of initial velocity, Then

$$-2gh = 0 - (v_i \sin\theta)^2$$

$$-2gh = -v_i^2 \sin\theta^2$$

$$h = \frac{V_i^2 \sin\theta^2}{2g}$$

This is required maximum height for a projectile.

70. Why ballistic missiles are not useful for long ranges?

Ans: Ballistic missiles are unpowered and unguided missiles. For long ranges, air friction is not negligible and some times the force of air friction is more than gravity. It affects both horizontal as well as vertical motions of the missile.

71. A ball is dropped from a height of 490 m. How long does the ball take to reach the ground?

Ans: When ball is dropped

$$v_i = 0$$

$$h = 490\,m$$

$$g = 9.8\,ms^{-2}$$

$$t = ?$$

Using second equation of motion

$$h = v_i t + \frac{1}{2} g t^2$$

$$490 = (0)t + \frac{1}{2}(9.8)t^2$$

$$490 = (4.9)t^2$$

$$t^2 = \frac{490}{4.9} = 100$$

taking square root on both sides $t = 10s$

72. Is the range of projectile same for both angles of projection, 30° and 60°? If your answer is yes then prove it?

Ans: Yes, the range of projectile is same for both angles of projection.

We know that

$$R = \frac{v_i^2 \sin 2\theta}{g}$$

When $\theta = 30°$

$$R = \frac{v_i^2 \sin 2(30°)}{g} = \frac{v_i^2 \sin 60°}{g} = \frac{v_i^2 (0.866)}{g} = 0.866 \frac{v_i^2}{g}$$

When $\theta = 60°$

$$R = \frac{v_i^2 \sin 2(60°)}{g} = \frac{v_i^2 \sin 120°}{g} = \frac{v_i^2 (0.866)}{g} = 0.866 \frac{v_i^2}{g}$$

It is clear that the range of projectile is same for both angles of projection.

73. Define range of projectile. In which situations its value is maximum and minimum.

Ans: Maximum distance which a projectile covers in the horizontal direction is called the range of projectile. $R = \frac{V_i^2 \sin 2\theta}{g}$

Range of projectile will be maximum at $\theta = 45°$ and minimum at $\theta = 90°$

74. The horizontal range of projectile is four times of its maximum height. What is angle of projection?

Ans: Given that

$$R = 4H$$

$$\left(\frac{V_i^2 \sin 2\theta}{g}\right) = 4\left(\frac{V_i^2 \sin^2 \theta}{2g}\right)$$

$$\sin 2\theta = 2\sin^2 \theta$$

$$2\sin\theta\cos\theta = 2\sin^2\theta \qquad (\because \sin 2\theta = 2\sin\theta\cos\theta)$$

$$\frac{\sin\theta}{\cos\theta} = 1 \quad or \quad \tan\theta = 1$$

$$\Rightarrow \theta = \tan^{-1} 1 = 45°$$

75. Differentiate between ballistic and non-ballistic projectiles (missiles).

Ans: Ballistic missiles are un-powered and unguided. While non-ballilstic are remote control guided missiles Ballistic missiles are useful only for short ranges while for long ranges non-ballistic missiles are used. Non-ballistic missiles are used for greater precision.

76. Write briefly about Ballistic Missile.

Ans: The missile which is given an initial push and is then allowed to move freely due to inertia and under the action of gravity is called a ballistic missile. It is un-powered and un-guided. It is useful only for short ranges.

77. If angle of projection of a propertile is $90°$. Find its range.

Ans: Since range of projectile is given by

$$R = \frac{V_i^2 \ Sin2\theta}{g}$$

Put $\theta = 90°$

$$R = \frac{V_i^2 Sin2(90)^0}{g}$$

$$= \frac{V_i^2 Sin2180^0}{g} = \frac{V_i^2 (0)}{g}$$

$$R = 0$$

78. What is trajectory? Explain briefly.

Ans: The path followed by a projectile or any object is called its trajectory.
For short ranges, the trajectory of Ballistic Missile is parabolic.

79. Which quantity remains same at all points on the trajectory of a projectile; either velocity or acceleration? Explain.

Ans: X-component of velocity of projectile remains same at all points on the trajectory of a projectile because there is no force acting along X-axis.
X-component of acceleration remains zero because we neglect air resistance.

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80. Find the velocities of two elastically colliding bodies when m₁=m₂ after collision.

Ans: In this case $m_1 = m_2 = m$
Final velocities of m_1 and m_2 will be

$$v_1' = \frac{m_1-m_2}{m_1+m_2}v_1 + \frac{2m_2}{m_1+m_2}v_2 = \frac{m-m}{m+m}v_1 + \frac{2(m)}{m+m}v_2 = 0 + \frac{2m}{2m}v_2 = v_2$$

$$v_2' = \frac{2m_1}{m_1+m_2}v_1 + \frac{m_2-m_1}{m_1+m_2}v_2 = \frac{2m}{m+m}v_1 + \frac{m-m}{m+m}v_2 = \frac{2m}{2m}v_1 + 0 = v_1$$

Thus, after the collision, there velocities are interchanged.

81. State the law of conservation of linear momentum, pointing out the importance of isolated system. OR State the law of conservation of linear momentum and isolated system. (2 times)

Ans: It states that
The total linear momentum of an isolated system remains constant.

$$\vec{p_i} = \vec{p_f}$$

Total initial Momentum = Total final Momentum

$$m_1v_1 + m_2v_2 = m_1v_1' + m_2v_2'$$

Importance of isolated system:
A system on which no external agency exerts any force is called isolated system. Hence law of conservation of linear momentum holds for an isolated system.

82. Explain the difference between elastic and inelastic collision. Explain how would a bouncing ball behave in each case? Give the plausible reason for the fact that K.E is conserved in most cases?

Ans. A collision in which the K.E. of the system is conserved is called elastic collision. For the case of Elastic Collision, a ball dropped onto a floor will rebounds with the same velocity and will attain the same height.
A collision in which the K.E. of the system is not conserved is called inelastic collision. For the case of Elastic Collision, a ball dropped on floor doesn't attain the same height after the impact. It is because of the fact that some part of K.E is converted into heat and sound energies. Thus, the total energy of the system remains conserved.

83. A 100 g golf ball is moving towards right with a velocity of 20 ms^{-1}. It makes a head on collision with an 8 kg steel ball, initially at rest. Compute velocities of the ball after collision.

Sol: Given that

$$mass\ of\ first\ ball = m_1 = 100\ g = 0.1\ kg$$
$$velocity\ of\ first\ ball = v_1 = 20\ ms^{-1}$$
$$mass\ of\ second\ ball = m_2 = 8\ kg$$
$$v_2 = 0$$
$$velocties\ after\ collision = ?$$

We know that

$$v_1' = \frac{m_1 - m_2}{m_1 + m_2}v_1$$

$$v_1' = \left(\frac{0.1-8}{0.1+8}\right)20$$

$$v_1' = -19.5\ ms^{-1}$$

And
$$v_2' = \frac{2m_1}{m_1+m_2} v_1$$

$$v_2' = \left(\frac{2 \times 0.1}{0.1+8}\right) 20 = 0.5\ ms^{-1}$$

84. Water flow out from a pipe at 3 kgs^{-1} and its velocity changes from 5 ms^{-1} to zero on striking the wall, then find the force due to flow of this water. (2 Times)

Ans: The force due to water flow is given as:

$$\vec{F} = \frac{m}{t}\vec{v} = (3)\ (5\text{-}0) = (3)(5) = 15\ N$$

85. Define the range of projectile and show that the range of projectile maximum when projectile is thrown at an angle of 45^0 with the horizontal.

Ans: Maximum distance which a projectile covers in the horizontal direction is called the range of projectile. Range of the projectile is given by:

$$R = \frac{v_i^2}{g}\sin 2\theta$$

The horizontal range will be maximum when the factor $\sin 2\theta$ is maximum. So

$$\sin 2\theta = 1$$
$$2\theta = \sin^{-1}(1)$$
$$2\theta = 90^o$$
$$\theta = 45^o$$

86 Derive the formula for the vertical distance covered by the projectile when it is thrown from a certain height *h*.

Ans: As

$$S = v_i t + \frac{1}{2}at^2$$
$$y = v_{iy} t + \frac{1}{2}a_y t^2$$
$$y = (0)\,t + \frac{1}{2}(g)t^2$$
$$y = \frac{1}{2}gt^2$$

Hencs proved.

87. Write down three equations of motion.

Ans: The three equations of motions are:

i. $v_f = v_i + at$

ii. $S = v_i t + \frac{1}{2}at^2$

iii. $2aS = v_f^2 - v_i^2$

88. Define two-dimension motion.

Ans: The motion of an object in a plane is called two dimension motion. For example: Motion of Projectile is two dimension motion.

89. For what angle of projection, the range of projectile is half of its maximum possible value?

Ans: Given

$$R = \frac{R_{max}}{2}$$

$$\frac{v_i^2 \sin 2\theta}{g} = \frac{1}{2}\left(\frac{v_i^2}{g}\right)$$

$$\sin 2\theta = \frac{1}{2} \quad \text{or } 2\theta = \sin^{-1}(1/2) = 30^o$$

$$\theta = 15^o$$

LONG QUESTIONS OF CHAPTER-3 IN ALL PUNJAB BOARDS 2011-2021

Topic V: Newton's Law of Motion:

1. State Newton's second law of motion in terms of momentum and prove the law of conservation of momentum.

Topic VI: Momentum:

2. State and prove Law of conservation of linear momentum. **(9 Times)**

Topic VII: Elastic and Inelastic Collision:

3. Define Elastic Collision. Show that relative speed of approach is equal to relative speed of separation for one dimensional collision. **(4 times)**
4. What is Elastic collision? In case of elastic collision of two bodies in one dimension. Find their velocities after collision. **(2 times)**

Topic XI: Projectile Motion:

5. Define projectile motion. Derive formulas for **(5 times)**
   (i) Time of flight (ii) Horizontal range for projectile.
6. What is Projectile Motion? Derive relations for (i) Horizontal distance (ii) Vertical distance (iii) Instantaneous Velocity of Projectile during its motion
7. Define projectile motion. Derive mathematical formula for its height and time of flight. **(2 times)**
8. What is projectile motion, explain? Dervie the relation for maximum height and range of a projectile when it is projected with initial velocityd v_i? **(2 times)**

NUMERICAL PROBLEMS OF CHAPTER-3 IN ALL PUNJAB BOARDS 2011-2021

Topic V: Newton's Law of Motion:

1. A helicopter is ascending vertically at the rate of $19.6\ ms^{-1}$. When it is at a height of $156.8\ m$ above the ground, a stone is dropped. How long does this stone take to reach the ground?

Sol: If the direction of initial velocity is *positive* then the direction of other quantities like *distance* and *acceleration due to gravity* is negative because they are opposing the velocity. So

$$v_i = 19.6\,ms^{-1}$$
$$S = -156.8\,m$$
$$g = -9.8\,ms^{-2}$$

Using second equation of motion

$$S = v_i t + \frac{1}{2}gt^2$$
$$-156.8 = 19.6t - \frac{1}{2}(9.8)t^2$$
$$-156.8 = 19.6t - 4.9t^2$$

Dividing by 4.9 on both sides, we get

$$-32 = 4t - t^2$$
$$t^2 - 4t - 32 = 0$$
$$t^2 - 8t + 4t - 32 = 0$$
$$t(t-8) + 4(t-8) = 0$$
$$(t-8)(t+4) = 0$$
$$t - 8 = 0 \quad ; \quad t + 4 = 0$$

$$t = 8 \quad ; \quad t = -4$$

As time is always *positive*, so $\boxed{t = 8\ seconds}$

Topic VI: Momentum:

2. A 1500 kg car has its velocity reduced from 20 ms^{-1} to 15 ms^{-1} in 3.0 $seconds$. How large was the average retarding force? (6 Times)

Sol:

Since $mass\ of\ carr = m = 1500\ kg$

$$initial\ velocity = v_i = 20\ ms^{-1}$$
$$final\ velocity = v_f = 15\ ms^{-1}$$
$$time = t = 3\ seconds$$
$$force = F = ?$$

Since $F \times t = mv_f - mv_i$

$$F \times t = m(v_f - v_i)$$
$$F = \frac{m(v_f - v_i)}{t}$$
$$F = \frac{1500(15 - 20)}{3}$$
$$F = -2500\ N \boxed{= -2.5\ kN}$$

The *negative sign* indicates that the force is retarding one.

3. A truck weighing 2500 kg and moving with a velocity of 21 ms^{-1} collides with a stationary car weighing 1000 kg. The truck and the car moves together after the impact. Calculate their common velocity. (7 times)

Sol

$$m_1 = 2500\ kg$$
$$m_2 = 1000\ kg$$
$$v_1 = 21\ m/s$$
$$v_2 = 0$$

Common velocity = V = ?

By law of conservation of momentum

Total initial Momentum = Total final Momentum

$$m_1v_1 + m_2v_2 = m_1v_1' + m_2v_2'$$
$$m_1v_1 + m_2v_2 = m_1v + m_2v$$
$$m_1v_1 + m_2v_2 = (m_1 + m_2)v$$
$$v = \frac{m_1v_1 + m_2v_2}{m_1 + m_2}$$
$$v = \frac{2500 \times 21 + 1000 \times 0}{2500 + 1000} = \frac{2500 \times 21 + 0}{3500}$$
$$v = 15\ m/s$$

4. Two blocks of masses 2 kg and 0.5 kg are attached at the two ends of compressed spring. The elastic potential energy stored in the spring is 10 J. Find the velocities of blocks if the spring delivers its energy to the blocks when released.

Sol: Given that $mass\ of\ the\ first\ block = m_1 = 0.5\ kg$

$$mass\ of\ the\ second\ block = m_2 = 2\ kg$$
$$elastic\ P.E. stored\ in\ the\ spring = 10\ J$$
$$velocity\ of\ the\ first\ block = v_1 = ?$$

$$velocity\ of\ the\ second\ block = v_2 = ?$$

By law of conservation of momentum

$$final\ momentum = initial\ momentum$$
$$0 + 0 = m_1v_1 + m_2v_2$$
$$0 = 0.5v_1 + 2v_2$$
$$0.5v_1 = -2v_2$$
$$v_1 = -4v_2$$

And by law of conservation of energy.

$$energy\ gained\ by\ blocks = energy\ lost\ by\ spring$$
$$\frac{1}{2}m_1{v_1}^2 + \frac{1}{2}m_2{v_2}^2 = 10$$
$$m_1{v_1}^2 + m_2{v_2}^2 = 20$$
$$0.5{v_1}^2 + 2{v_2}^2 = 20$$
$${v_1}^2 + 4{v_2}^2 = 40$$

Putting $v_1 = -4v_2$, we get

$$(-4)^2{v_2}^2 + 4{v_2}^2 = 40$$
$$16{v_2}^2 + 4{v_2}^2 = 40$$
$$20{v_2}^2 = 40$$
$${v_2}^2 = 2 \boxed{= 1.41\ ms^{-1}}$$

Thus $v_1 = -4v_2$

$$v_1 = -4(1.41) \boxed{= -5.64\ ms^{-1}}$$

The negative sign shows that both the blocks move in opposite directions.

5. **A boy places a fire cracker of negligible mass in an empty can of 40g mass. He plugs the end with a wooden block of mass 200g. After igmiting the fire cracker, he throws the can straight up. It explodes at the top of its path. If the block shoots out with a speed of 3 m/s, how fast will the can be going?**

Sol: Mass of can $m_1 = 40g = 0.04kg$

Mass of wooden block $m_2 = 200g = 0.2kg$

Final speed of wooden block $v_2 = 3m/s$

Final speed of can $v_1 = ?$

Both the can and wooden block are initially at rest. Therefore, their initial momentum is zero. According to law of conservation of momentum.

Total initial momentum = Total final momentum

$$0 + 0 = m_1v_1 + m_2v_2$$
$$m_1v_1 = -m_2v_2$$

or

$$v_1 = -\frac{m_2}{m_1}v_2$$

Putting values,

$$v_1 = \frac{0.2}{0.04} \times 3$$
$$v_1 = -15\ m/s$$

The negative sign shows that the can will shoot in the opposite direction to that of wooden block.

Topic VII: Elastic and Inelastic Collision:

6. A 100 g golf ball is moving towards right with a velocity of 20 ms^{-1}. It makes a head on collision with an 8 kg steel ball, initially at rest. Compute velocities of the ball after collision. (4 Times)

Sol: Given that

$$mass\ of\ first\ ball = m_1 = 100\ g = 0.1\ kg$$
$$velocity\ of\ first\ ball = v_1 = 20\ ms^{-1}$$
$$mass\ of\ second\ ball = m_2 = 8\ kg$$
$$v_2 = 0$$
$$velocties\ after\ collision = ?$$

We know that

$$v_1' = \frac{m_1 - m_2}{m_1 + m_2} v_1$$
$$v_1' = \left(\frac{0.1 - 8}{0.1 + 8}\right) 20$$
$$v_1' = -19.5\ ms^{-1}$$

And

$$v_2' = \frac{2m_1}{m_1 + m_2} v_1$$
$$v_2' = \left(\frac{2 \times 0.1}{0.1 + 8}\right) 20 \boxed{= 0.5\ ms^{-1}}$$

7. A proton moving with a speed of 1.0×10^7 m/s passes through a 0.02 cm thick sheet of paper and emerges with a speed of 2.0×10^6 m/s. Assuming the uniform deceleration, find retardation and time taken to pass through the paper. (2 times)

Sol:

$v_i = 1.0 \times 10^7$ m/s

$v_f = 2.0 \times 10^6$ m/s

Thickness of paper sheet = S = 0.02 cm

S = 0.02×10^{-2} m

Retardation = $\vec{a}$ = ? , t = ?

Since $2as = v_f^2 - v_i^2$

$$a = \frac{v_f^2 - v_i^2}{2s}$$
$$a = \frac{(2.0 \times 10^6)^2 - (1.0 \times 10^{-7})^2}{2 \times 0.02 \times 10^{-2}}$$
$$a = 2.4 \times 10^{17}\ m/s^2$$

As $v_f = v_i + at$

So,

$$t = \frac{v_f - v_i}{a}$$
$$t = \frac{2 \times 10^6 - 1 \times 10^7}{-2.4 \times 10^{17}} = \frac{-8}{-2.4} \times 10^{-11} = \mathbf{3.33 \times 10^{-11}\ s}$$

8. An electron ($m = 9.1 \times 10^{-31}$ Kg) travelling at $2.0 \times 10^7\ ms^{-1}$ undergoes a head on collision with a hydrogen atom ($m = 1.67 \times 10^{-27}$ kg) which is initially at rest. Assuming the collision to be perfectly elastic and a motion to be along a straight line, find the velocity of hydrogen atom.

Sol:

$m_1 = 9.1 \times 10^{-31}$kg

$v_1 = 2.0 \times 10^7\ ms^{-1}$

$m_2 = 1.67 \times 10^{-27}$ kg

$v_2 = 0$

Velocity of Hydrogen atom after collision = v_2' =?

We know that

$$v_2' = \frac{2m_1}{[m_1 + m_2]} v_1 + \frac{[m_2 - m_1]}{[m_1 + m_2]} v_2$$

$$v_2' = \frac{2\times 9.1\times 10^{-31}\times 2\times 10^{7}}{9.1\times 10^{-31}+1.67\times 10^{-27}}+0$$

$$v_2' = \frac{36.4\times 10^{-24}}{1.67\times 10^{-27}}$$

$$v_2' = 2.178\times 10^{4} = 2.2\times 10^{4}\ m/s$$

Topic XI: Projectile Motion:

9. A football is thrown at an angle of 30° with respect to horizontal. To throw 40 m pass, what must be the initial speed of the ball? (8 Times)

Sol:

It is given that

$$angle = \theta = 30^o$$
$$range = R = 40\ m$$
$$initial\ speed = v_i = ?$$

The horizontal range is given as

$$R = \frac{v_i^2}{g}\sin 2\theta$$

$$v_i^2 = \frac{gR}{\sin 2\theta}$$

$$v_i^2 = \frac{(9.8)(40)}{\sin 2(30)}$$

$$v_i^2 = \frac{392}{\sin 60}$$

$$v_i^2 = \frac{392}{0.866}$$

$$v_i^2 = 452.6$$

$$v_i = 21.28\ ms^{-1} \boxed{\approx 21\ ms^{-1}}$$

10. A ball is thrown with a speed of 30 ms^{-1} in a direction 30° above the horizon. Determine the time of flight.

Sol:

Given that

$$speed = v_i = 30\ ms^{-1}$$
$$angle = \theta = 30^o$$
$$time\ of\ flight = t = ?$$

Since

$$t = \frac{2v_i}{g}\sin\theta$$

$$t = \frac{2(30)}{9.8}\sin 30^o \boxed{= 3.1\ s}$$

11. A bomber dropped a bomb at a height of 490 m when its velocity along the horizontal was 300 km hr[-1]. At what distance from the point vertically below the bomber at the instant the bomb was dropped, did it strike the ground. (4 times)

Sol:

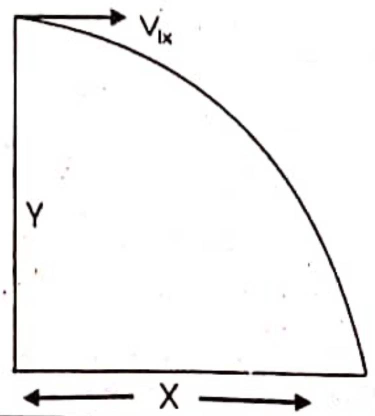
$Y = h = 490\ m$

$v_{ix} = 300\ km/h = \frac{300\times 1000}{60\times 60}\ m/s = 83.3\ m/s$

$v_{iy} = 0$

$g = 9.8\ m/s^2$

$x = ?$



By using the equ.

$Y = v_{iy}\ t + \frac{1}{2} g\ t^2$

$490 = 0 + \frac{1}{2}(9.8)\ t^2$

$490 = 4.9\ t^2$

$t^2 = \frac{490}{4.9} = 100$

Taking square root

$t = \sqrt{100} = 10s$

Since $x = v_{ix}\ t$

$x = 83.3 \times 10 = \mathbf{833\ m}$

12. Find the angle of projection of projectile for which maximum height and horizontal range are equal. (6 Times)

Sol: Angle of projection = θ = ?

Maximum height of projectile = $h = \frac{vi^2 Sin^2\theta}{2g}$

Horizontal Range = $R = \frac{vi^2 Sin 2\theta}{g}$

Given that, $h = R$

$$\frac{vi^2 Sin^2\theta}{2g} = \frac{vi^2 Sin\ 2\theta}{g}$$

$$\frac{sin^2\theta}{2} = \sin 2\theta$$

$$\sin^2\theta = 2 \sin 2\theta$$

$$\sin^2\theta = 2 \times 2 \sin\theta \cos\theta$$

$$\frac{sin\theta}{cos.\theta} = 4$$

$$\tan\theta = 4$$

$$\theta = \tan^{-1}4 = \mathbf{76^\circ}$$

13. A ball is thrown horizontally from a height of 10m with a velocity of 21ms⁻¹. How far off it hit the ground and with what speed? (5 times)

Sol:

$v_{ix} = 21\ m/s$

$v_{iy} = 0$

$y = h = 10m$

$g = 9.8\ m/s^2$

$x = ?$

$v = ?$

As $y = v_{iy}\ t + \frac{1}{2} g t^2$

$10 = 0 + \frac{1}{2}(9.8)\ t^2$

$10 = 4.9\ t^2$

$t^2 = \frac{10}{4.9} = 2.04$

$t = \sqrt{2.04} = 1.42\ s$

Now $x = v_{ix} \times t$

$x = 21 \times 1.42$

$\mathbf{x = 30m}$

Horizontal component of velocity remains constant. Therefore,

$v_{ix} = v_{fx} = 21m/s$

$v_{fy} = v_{iy} + gt$

$= 0 + (9.8)(1.42)$

$v_{fy} = 14\ m/s$

Resultant velocity

$$v = \sqrt{V_{fx}^2 + V_{fy}^2}$$

$$v = \sqrt{(21)^2 + (14)^2}$$

$$= \sqrt{441 + 196}$$

$$v = \sqrt{637}$$

$$\mathbf{v = 25.2\ m/s}$$

14. A ball is thrown with a speed of 30 m/s in a direction 60° with horizontal. Calculate the range of the ball.

Sol: $v_i = 30\ m/s$

$\theta = 60^\circ$

$R = ?$

We know that

$$R = \frac{V_i^2 Sin2\theta}{g}$$

$$= \frac{(30)^2 Sin2(60)^0}{9.8}$$

$$= \frac{900 \times Sin120^0}{9.8}$$

$R = 79.53\ m$

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15. Two spherical balls of 2.0 kg and 3.0 kg masses are moving towards each other with velocities of 6 ms^{-1} and 4 ms^{-1} respectively. What must be the velocity of the smaller ball after collision, if the velocity of the bigger ball is 3 ms^{-1}.

Sol: Given that

$$m_1 = 2\ kg$$
$$m_2 = 3\ kg$$
$$v_1 = 6\ ms^{-1}$$
$$v_2 = 4\ ms^{-1}$$
$$v_2' = 3\ ms^{-1}$$
$$m_1v_1 + m_2v_2 = m_1v_1' + m_2v_2'$$
$$(2)(6) + (3)(-4) = (2)(v_1') + (3)(-3)$$
$$12 - 12 = (2)(v_1') - 9$$
$$2v_1' = 9$$
$$v_1' = 4.5\ ms^{-1}$$

OBJECTIVES (MCQ'S) OF CHAPTER-4 IN ALL PUNJAB BOARD 2011-2021

Topic I: Work done by Constant Force:

1. Work done is maximum when the angle between force and displacement is: **(2 Times)**

(A) 0° (B) 45° (C) 90° (D) 180°

2. Work is negative when angle between $\vec{F}$ and $\vec{d}$ is: **(4 Times)**

(A) 0° (B) 90° (C) 45° (D) 180°

3. Kilowatt hour is the unit of: **(4 times)**

(A) Power (B) Work (C) Force (D) Momentum

4. Which one is conservative force: **(2 times)**

(A) Electric force (B) Tension is string
(C) Propulsion force of motor (D) Normal force

5. Nm is equal as:

(A) Pascal (B) Newton (C) Henry (D) Joule

6. Work has same dimension as that of: **(2 times)**

(A) Torque (B) Power (C) Momentum (D) Force

7. S.I unit of work is:

(A) Newton (B) Watt (C) Pascal (D) Joule

Topic II: Work done by a Variable Force:

8. The force which can do no work on the body on which it acts is: (2 times)
(A) Elastic force (B) Frictional force (C) Centripetal force (D)Gravitational force

9. If direction of a force is perpendicular to the direction of motion of body, then work done is:
(A) Minimum (B) Maximum (C) Zero (D) Infinity

10. As we move up a body above the surface of earth, the change in potential energy will always be:
(A) Negative (B) Positive (C) Zero (D) Infinity

11. If a body of mass 5kg is raised vertically through a distance of 1m, then work done is:
(A) 49J (B) 4.9 J (C) 490 J (D) 0.49 J

12. Work done will be minimum when the angle between force and displacement is.
(A) 0° (B) 90° (C) 120° (D) 180°

Topic III: Work done by gravitational Field:

13. Which one is a conservative force?
(A) Elastic Spring Force (B) Frictional Force (C) Air Resistance (D) Tension in the string

Topic IV: Power:

14. Power can be defined as the product of:
(A) Force and displacement (B) force and velocity
(C) force and time (D) force and mass

15. kWm^{-2} is the unit of: (3 Times)
(A) Power (B) Intensity (C) Energy (D) Energy per unit area

16. The scalar product of force and velocity is: (3 times)
(A) Work (B) Power (C) Momentum (D) Energy

17. kWh is equal to:
(A) 10^4 watt (B) 36×10^6 joule (C) 36×10^6 watt (D) 3.6×10^6 joule

18. 3 joules of work is done in 3 seconds, then power is:
(a) 6 watt (b) 3 watt (c) 18 watt (d) 1 watt

19. The power needed to lift a mass of 5000g to height of 1 m in 2 second is:
(A) 2.45 watt (B) 24.5 watt (C) 245 watt (D) 2.45 k watt

20. The dimensions of power are: (2 times)
(A) $[MLT^{-1}]$ (B) $[ML^2T^{-2}]$ (C) $[ML^2T^{-1}]$ (D) $[ML^2T^{-3}]$

Topic V: Energy:

21. Which is called internal energy of ideal gas:
(A) Potential energy (B) Translational kinetic energy
(C) Vonratopma: lometoc energy (D) Vibrational kinetic energy

22.1 kWh equals: (2 times)
(A) 0.36 MJ (B) 3.6 MJ (C) 36 MJ (D) 360 MJ

23. Commercial unit of electrical energy is: (3 times)
(A) Kilowatt (B) Kilowatt hour (C) Joule (D) Watt

24. The dimensions of kinetic energy are:
(A) $[ML^2T^2]$ (B) $[ML^2T^{-2}]$ (C) $[ML^2T^{-1}]$ (D) $[ML^2T^{-2}]^{1/2}$

25. The disc used by a women athlete has a mass of 1 kg, its weight in Newton is:
(A) 98 N (B) 100 N (C) 80 N (D) 9.8 N

26. Energy stored in spring is:-
(a) Elastic P.E. (b) Gravitational P.E. (c) K.E. (d) Chemical P.E

27. The K.E. of bullet of mass 500 gm moving at a speed of 200 ms^{-1} is:
(a) 250 J (b) 125 J (c) 2500 J (d) 10,000 J

Topic VI: Interconversion of Potential Energy and Kinetic Energy:

28. A stone is thrown up from the surface of earth when it reaches at maximum height, its K.E is equal to:

(A) mgh (B) $\frac{1}{2}mv^2$ (C) Zero (D) 2mgh

Topic VII: Conservation of Energy:

29. Absolute P.E of an object at infinite height w.r.t earth is taken as:

(A) Negative (B) Zero (C) Minimum (D) Virtual

Topic VIII: Non-Conventional Energy Sources:

30. A solar cell converts light energy into:

(A) Heat energy (B) Chemical energy (C) Electrical energy (D) Atomic energy

31. Which one is renewable source of energy:

(A) Coal (B) Natural gas (C) Sun light (D) Uranium

32. The original source of tidal energy is: **(2 times)**

(A) Moon (B) Earth (C) Sun (D) Sea

33. Which one is biofuel:

(A) Water (B) Petrol (C) Ethanol (D) Oil

34. Biomass is a potential source of:

(A) Renewable energy (B) Non-renewable energy (C) Both (A) and(B) (D) Tidal energy

35. An example of non-conservational force is: **(4 Times)**

(A) Electric force (B) Gravitational force (C) Frictional force (D) Magnetic force

36. Solar energy at normal incidence outside the earth atmosphere is about:

(A) 1.4 kWm^{-2} (B) 1 kWm^{-2} (C) 4.1 kWm^{-2} (D) 4 kWm^{-2}

37. Value of solar constant is:

(A) 1.4 kW m^{-2} (B) 1.0 kW m^{-2} (C) 4.1 kW m^{-2} (D) 0.1 kW m^{-2}

38. Original source of energy for biomass is: **(2 times)**

(a) Earth (b) Moon (c) Sun (d) Star

39. Earth receives large amount of energy directly from:

(a) Wind (b) Water (c) Sun (d) Moon

40. Which one is renewable source of energy?

(A) Coal (B) Uranium (C) Biomass (D) Natural Gas

41. Biomass is converted into fuel by

(A) Evaporation (B) Fermentation (C) Reflection (D) Scattering

42. Which one is non-renewable source of energy?

(A) Hydroelectric (B) Biomass (C) Tides (D) oil

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43. For freely falling body, in the presence of force of friction the:

(a) Loss in P.E = gain in K.E (b) Loss in P.E < gain in K.E.

(c) Loss in P.E > gain if K.E. (d) Loss in P.E. = 0

44. A body has P.E = mgh when it is at height "h" from the ground. At the point at a distance "x" below from the top its P.E. will be:

(a) mgx (b) mgh (c) mg (x+h) (d) mg (h-x)

45. The tides give rise in sea due to gravitational pull of:

(A) Moon (B) Mars (C) Venus (D) Satum

46. Identify the non-conservative force among the following:

(A) Air resistance (B) Gravitationa force (C) Elastic spring force (D) Electric force

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47. Power of an electric heater is (approximate power):
(A) 1 kW (B) 2 kW (C) 3 kW (D) 4 kW

48. If 50 kg crate is pushed through 2 m across the floor with a force of 50 N, the work done will be:
(A) 245 J (B) 150 J (C) 200 J (D) 100 J

49. When the finite force is parallel to the direction of motion of the body the work done is:
(A) Minimum (B) Maximum (C) Infinity (D) Varies

50. Tidal energy is due to the gravitational pull of:
(A) Sun (B) Moon (C) Earth (D) Mars

51. The maximum velocity required of an object to go out from the gravitational field in heavenly body is:
(A) moon (B) mercury (C) mars (D) earth

52. ______ is non-conservative force. **(2 times)**
(A) electric force (B) magnetic force (C) gravitational force (D) frictional force

53. If the velocity of an object is doubled then its K.E becomes: **(3 times)**
(A) double (B) constant (C) four times (D) sixteen times

54. Choice of zero potential energy level is:
(A) Surface of the Earth (B) at infinity
(C) Just above the surface of Earth (D) arbitrary

55. One watt Hour is equal to:
(A) 3.6 MJ (B) 3.6 KJ (C) 36 KJ (D) 36 MJ

56. Consumption of Energy by a 60 Watt Electirc Bulb in 2 Seconds is:
(A) 120 J (B) 60 J (C) 30 J (D) 0.5 J

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57. Which one the following in non-conservative force
(A) Gravitational force (B) Electric force
(C) Elastic spring force (D) Frictional force

58. The K.E of an object of mass "m" is "E" its momentum will be:
(A) 2 Em (B) $\sqrt{\frac{2E}{m}}$ (C) $\sqrt{\frac{1}{2}Em}$ (D) $\sqrt{2mE}$

59. If velocity and mass of a moving object are doubled then K.E becomes:
(A) Double (B) 4 times (C) 6 times (D) 8 times

60. In work-Energy principle work done on a body is equal to
(A) Kinetic energy (B) Potential energy
(C) Elastic potential energy (D) Change in Energy

61. The escape velocity is maximum for
(A) Moon (B) Mercury (C) Earth (D) Jupiter

62. Gravity performs zero work when body moves:
(A) Vertically (B) Horizontally
(C) at 60^{o} with vertical (D) at 60^{o} with horizontal

ANSWERS OF THE MULTIPLE CHOICE QUESTIONS

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
A	D	B	A	D	A	D	C	C	B	A	B	A	B	B
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
B	D	D	B	D	B	B	B	B	D	A	D	C	B	C
31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
C	A	C	A	C	A	A	C	C	C	B	D	C	D	A
46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
A	B	D	B	B	D	D	C	D	B	A	D	D	D	D
61	62													
D	B													

SHORT QUESTIONS OF CHAPTER-4 IN ALL PUNJAB BOARDS 2011-2021

Topic I: Work done by Constant Force:

1. Define work and its SI unit.

Ans: The product of magnitude of displacement and the component of the force in the direction of the displacement is called work./The dot product of force and displacement is called work. $W = \vec{F}.\vec{d}$

It is a scalar quantity and its SI unit is joule.

Joule: If a force of $1\ N$ acts on a body and displaces it to $1\ m$, then the amount of work done is one joule. $1\,J = 1\,N \times 1\,m$

2. What four conclusions can you draw from the definition of work? OR In what situation work done by a force is positive, negative and zero? (3 times)

Ans:
(i) If $\theta < 90^o$, work is said to be positive.
(ii) If $\theta > 90^o$, work is said to be negative.
(iii) If $\theta = 90^o$, no work is done.
(iv) Its unit is Nm, also called $joule\ (J)$.

3. Define joule and watt. (2 times)

Ans: **Joule:** If a force of $1\ N$ acts on a body and displaces it to $1\ m$, then the amount of work done is one joule. $1\,J = 1\,N \times 1\,m$

Watt: If $1\ J$ of work is done in $1\ s$, then power is one watt.

$$1\,W = 1\frac{J}{s}$$

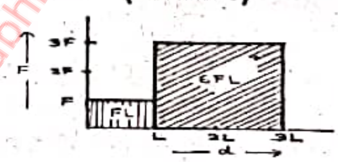
4. A person holds a bag of groceries while standing still. A car is stationary with its engine running. How are the two situations similar from the point of view of work? (2 times)

Ans: In both the above two cases, since there is no displacement, therefore the work done will be zero. Hence in this respect, the two situations are similar.

5. A force F acts through a distance L. The force is the increased to 3F and then acts through a further distance of 2L. Draw the work diagram to scale. (3 Times)

Ans: Take displacement along x-axis and force along y-axis. The area under the displacement – force graph is equal to amount of work done. So

Total work done = 1FL+6FL = 7FL (units)



6. Differentiate between positive and negative work.
OR
Under what conditions work done will be positive and negative.

Ans: The dot product of force and displacement is called work.

$$W = \vec{F}.\vec{d} = Fd\ cos\theta$$

If $\theta < 90^o$, work is said to be positive.

If $\theta > 90^o$, work is said to be negative.

7. State work energy principle, give its one example. (3 times)

Ans: It states that "Work done on the body equals the change in its kinetic energy".

$$W = \Delta(K.E.)$$

Whenever work is done on a body, it increases its energy.

Examples:
(i) If force accelerates a body then work done is equal to change in its kinetic energy.
(ii) If a body is raised up from the Earth's surface then work done is equal to change in its gravitational potential energy.
(iii) If a spring is compressed then work done is equal to change in its elastic potential energy.

8. A car is moving along a circle of radius r. It completes four revolutions and terminates its journey at starting point. How much work is done by the car? Explain.

Ans: Work done by the car is zero. Work done is defined as

$$W = \vec{F}.\vec{d}$$

Here no displacement is covered by the car i.e, d = 0

And $W = \vec{F}.(0)$

$= 0$

9. Define Joule using formula for the work done.

Ans: Work done is defined as

$$W = Fd$$

If a force of 1N acting on a body displaces it to 1m, then the amount of work done is 1 joule. $1J = 1N \times 1m$

10. An object has 2 Joule potential energy. Explain what does it mean?

Ans: An object has 2 joule of potential energy means that the work done in lifting the body through a distance is 2 joule. Which is stored in the form of potential energy.

OR The body has a capacity to do 2 joules of work.

Topic II: Work done by a Variable Force:

11. What do you mean by variable force? Give its two examples? (2 times)

Ans: The force which is not constant but varies in magnitude and direction or in both is called a variable force. For example,

- Force of gravity acting on a rocket moving away from earth.
- Force exerted by the spring increases by the amount of stretch.

Topic III: Work done by gravitational Field:

12. Differentiate between conservative and non-conservative force. Give Example. (3 times)

Ans: Conservative force: The force by which work done along a closed path is zero is called conservative force. For example, gravitational force, electric force and magnetic force.

Non-conservative force: The force by which work done along a closed path is not zero is called non-conservative force. For example, frictional force, air resistance and normal force.

13. Define conservative and non-conservative fields. (2 times)

Ans: Conservative field: The field in which work done along a closed path is zero is called conservative field. For example, Earth's gravitational field

Non-conservative fields: The field in which work done along a closed path is not zero is called non-conservative field. For example, field of frictional force.

14. What are the essential conditions for conservative field?

Ans: For a field to be conservative, energy should be conserved and work should be independent of the path followed. As in case of work done along a path in the gravitational field of Earth.

15. Name the four non conservative forces.

Ans: i. Frictional force ii. Air resistance iii. Normal force iv. Tension in a string

Topic IV: Power:

16. Define power. Write its SI unit. (2 Times)

Ans: The rate at which the work is being done is called power.

$$P = \frac{W}{t}$$

It is a scalar quantity and its SI unit is $watt\ (W)$.

17. Prove that $P = \vec{F}.\vec{v}$ (10 times)

OR Prove that power is the dot product of force and velocity. (2 times)

OR Write power in temr of foce and velocityt.

OR Drive and define power in term of velocity.

Ans: If the work ΔW is done in time interval Δt, then the instantaneous power P is defined as:

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$$P = \lim_{\Delta t \to 0} \frac{\Delta W}{\Delta t}$$

Since $\Delta W = \vec{F}.\Delta\vec{d}$, so

$$P = \lim_{\Delta t \to 0} \frac{\vec{F}.\Delta\vec{d}}{\Delta t}$$

$$P = \vec{F}.\lim_{\Delta t \to 0} \frac{\Delta\vec{d}}{\Delta t}$$

$$P = \vec{F}.\vec{v}$$

This is the required result.

18. Define kilowatt hour (kWh). **(3 Times)**

Ans: Kilowatt hour is the work done in one hour by an agency whose power is one kilowatt.

$$1\ kWh = 3.6 \times 10^6\ J$$

19. Show that 1 $kWh = 3.6 \times 10^6\ J$ **(9 Times)**

Ans: As

$$1\ kWh = 1000\ W \times 3600\ s$$

$$1\ kWh = 3600000\ J$$

$$1\ kWh = 3.6 \times 10^6\ J$$

20. What is dimension of power, also define power.

Ans: The rate at which the work is being done is called power. Mathematically,

$$P = \frac{W}{t}$$

Its SI unit is $watt$ (W) which is Js or kgm^{2}s^{-3} and dimensions are $[ML^2T^{-3}]$

21. Define power and also define its unit.

Ans: Power:The rate at which the work is being done is called power.
Mathematically,

$$P = \frac{W}{t}$$

Watt: If 1 J of work is done in 1 s, then power is one watt.

$$1W = 1\frac{J}{s}$$

22. A 70 kg man runs up a long flight of stairs in 9.8 sec. The vertical height of the stairs is 5 m. Calculate his power in kW.

Ans: Work done = mgh

Power = $\frac{mgh}{t} = \frac{70 \times 9.8 \times 5}{9.8}$ =350 W

P= 0.35 x 10^{3}W

P = 0.35 kW

23. Convert 1.4kw into joule/sec.

Ans: $1.4\ kW = 1.4 \times 1000W$

$= 1400\ W \quad \left(\because 1W = \frac{1J}{1s}\right)$

$= 1400\ Joule/\sec$

Topic V: Energy:

24. State work energy relation and write down its equation. **(5 Times)**

Ans: It states that "Work done on the body equals the change in its kinetic energy".

$$Fd = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$$

$$W = \Delta(K.E.)$$

25. What is geothermal energy? How is it generated?

Ans: The heat energy extracted from Inside the Earth in the form of steam or hot water is called geothermal energy.
It can be generated by the following processes:
i. Radioactive Decay ii. Residual Heat of Earth iii. Compression of Material

26. What sort of energy Is in the following?
i. A moving car ii) A compressed spring **(10 Times)**

Ans: A moving car has kinetic energy.
A compressed spring has elastic potential energy.

27. When a rocket reenters the atmosphere, its nose cone becomes very hot. Where does this heat energy come from? **(20 Times)**

Ans: The atmosphere of earth contains a large number of dust particles, gases and water vapours. So when a rocket enters into the atmosphere and passes through these particles, due to the force of friction, the kinetic energy of the rocket is lost in the form of heat. That's why its nose cone becomes very hot.

28. In which case is more work done when a 50 kg bag of books is lifted through 50 cm or when a 50 kg crate is pushed through 2 m, across the floor with the force of 50 N? **(13 Times)**

Ans: Case I

$$mass = m = 50\ kg$$
$$h = height = 50\ cm = 0.5\ m$$
$$work = W = ?$$
Since
$$W = mgh$$
$$W = (50)(9.8)(0.5)$$
$$W = 245\ J$$

Case II

$$mass = m = 50\ kg$$
$$distance = d = 2\ m$$
$$work = W = ?$$
$$W = Fd$$
$$W = (50)(2)$$
$$W = 100\ J$$

Hence in 1st case, more work is done.

29. Calculate the work done in Kilo joules when 10 kg crate is pushed through 4 m across the floor with a force of 50 N? **(2 times)**

Ans: Since
$$mass = m = 10\ kg$$
$$distance = d = 4\ m$$
$$force = F = 50\ N$$
$$work = W = ?$$
$$W = Fd$$
$$W = (50)(4)$$
$$W = 200\ J = 0.2\times10^3\ J = 0.2kJ$$

30. A ball of mass m is held at a height h_1 above a table. The table top is at a height h_2 above the floor. One student says that its P.E is mgh_1, and other says that P.E is $mg(h_1 + h_2)$. Who is correct?

Ans: Both of these statements are correct.
As P.E is always with respect to some reference point or relative position, so we can say that the first student has measured P.E with respect to table top i.e. mgh_1, and the second student measured P.E with respect to floor i.e. $mg(h_1+h_2)$.

31. What sort of energy is in the following? **(3 Times)**
(a) Compressed spring (b) Water in a high dam

Ans: a) A compressed spring has Elastic Potential Energy stored in it.
b) Water in a high dam has Gravitational potential Energy in it.

32. Define absolute potential energy and write only its formula. Give its unit. **(2 times)**

Ans: It is defined as the work done by the gravitational force in displacing the object from that position to infinity where the force of gravity becomes zero.
Mathematically,

$$U_g = -\frac{GMm}{R}$$

The negative sign shows that the earth's gravitational field for mass m is attractive.
Its unit is joule.

33. What does negative sign show in the expression $U_g = -\frac{GMm}{R}$

Ans: The negative sign shows that the Earth's gravitational field for mass m is attractive.

34. Write only formula for escape velocity and find its value on earth.

Ans: Formula for escape velocity is given as

$$V_{esc} = \sqrt{2gR}$$

Where g is acceleration due to gravity and R is the radius of earth.

$$V_{esc} = \sqrt{2(9.8)(6.4 \times 10^6)} \approx 11km/s$$

35. Derive work-energy principle. (2 times)

Ans: It states that work on the body equals change in its kinetic energy.
Consider a body of mass m is moving with velocity v_i. A force F acting through a distance d increases the velocity to v_f, then from equation of motion.

$$2ad = v_f^2 - v_i^2$$

$$d = \frac{1}{2a}\left(v_f^2 - v_i^2\right) \_\_\_\_ (i)$$

From 2nd law of motion F = ma ______ (ii)
Multiplying eq (i) & (ii)

$$Fd = \frac{1}{2}m\left(v_f^2 - v_i^2\right)$$

$$Fd = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$$

$$W = \Delta(K.E)$$

Topic VI: Interconversion of Potential Energy and Kinetic Energy:

36. Explain interconversion of P.E and K.E.

Ans: The law of conservation of energy states that energy cannot be destroyed but can only be transformed from one form into another.
So potential energy and kinetic energy are interchanged continuously.

$$Loss\ in\ P.E. = Gain\ in\ K.E.$$

In the presence of frictional force

$$Loss\ in\ P.E. = Gain\ in\ K.E. + Work\ done\ against\ friction$$

$$mgh = \frac{1}{2}mv^2 + fh$$

37. A boy uses a catapult to throw a stone which accidentally smashes a greenhouse window. What energy changes are involved? (13 Times)

Ans: Initially, the catapult had elastic P.E. when the stone is thrown, its P.E. is converted into K.E. On striking the window, this energy is converted into sound energy, heat energy work done in breaking the window into pieces and kinetic energy of pieces.

38. Calculate the work done in kilo joules in lifting a mass of 10 kg (at a steady velocity) through a vertical height of 10 m. (10 Times)

OR Calculate the work done in joules and in kilo joules in lifting a mass of 10kg at a steady velocity through a vertical height of 10 meter. (4 times)

Ans: Since

$$W = mgh$$

$$W = (10)(9.8)(10)$$

$$W = 980\,J$$
$$W = 0.98\,kJ$$

39. A girl drops a cup from a certain height which breaks into pieces. What energy changes are involved? $(17\ times)$

Ans: When the cup was in the hands of girl, it had gravitational P.E. When the cup is dropped, its P.E. is converted into the K.E. On striking the ground, this energy is converted into sound energy, heat energy, work done in breaking the cup into pieces and kinetic energy of pieces.

40. An object has one joule of potential energy. Explain what it means. (17 times)

Ans: It means that work has been done on the body by the force of 1 N which has lifted the body through a distance of 1 m. This work has been stored in the body in the form of P.E. which is 1 J.

41. Define law of conservation of energy.

Ans: Energy cannot be destroyed. It can be transformed from one kind into another, but the total amount of energy remains constant.

Topic VIII: Non-Conventional Energy Sources:

42. How sunlight is directly converted into electricity by solar cells?

Ans: By using semiconductor devices, the solar cell also called photo voltaic cell, sunlight can be directly converted in to electricity. These solar cells are made of silicon wafers. Electron in the silicon gain energy from sunlight to create a voltage. Voltage can be increased by increasing the number of solar cells.

43. How can we gain energy from tides? (3 times)

OR What is tidal energy?

OR How energy can be obtained from sea tides? Explain briefly.

Ans: The tides raise the water in the sea roughly twice a day. If the water at the high tide is trapped in a basin by constructing a dam, then it is possible to use this as a source of energy. The dam is filled at high tide and water is released in a controlled way at low tide to drive the turbines and generate electricity.

44. How you can get energy from the waves?

Ans: The tides and winds blow across the surface of ocean due to which strong water waves are produced. Professor Salter invented a device called Salter's duck. It has two parts; duck float and balance float. The wave energy produces the movement in duck float relative to balance float. The relative motion of duck float can be used to run electricity generators.

45. What are non-conventional energy sources? Describe briefly. OR Nmae some non conventional energy sources.

Ans: The energy sources which are not very common these days are called non-conventional energy sources. Some of the non-conventional energy sources are:

i. Energy from tides ii. Energy from waves iii. Energy from biomass
iv. Energy from waste products v. Solar energy vi. Geothermal energy

46. Explain briefly about residual heat of the earth.

Ans: Hot igneous rocks within 10km of earth's surface are present in molten form. They conduct heat energy from interior part of the earth. The temperature of these rocks is 200°C or more.

47. How electrical energy can be obtained from sunlight by indirect conversion method?

Ans: By using semiconductor devices, the solar cell also called photo voltaic cell; sunlight can be directly converted into electricity. These solar cells are made of silicon wafers. Electron in the silicon gain energy from sunlight to create a voltage. Voltage can be increased by increasing the number of solar cells.

48. Write down two sources of energy which are renewable.

Ans: The renewable sources of energy are:

i. Hydroelectric Energy ii. Wind Energy iii. Tides Energy
iv. Biomass Energy v. Sunlight Energy

49. Describe four uses of solar cells.

Ans: Solar cells are used

(i) To power satellites.

(ii) In remote ground based weather stations.
(iii) In rain forest communication systems.
(iv) In solar calculators.

50. How can we obtain energy from Biomass? (2 times)
OR How energy is obtained form direct combustion and fermentiaon?
OR How many common methods used for the conversion of bio mass into fuel. Write their names.

Ans: There are two most common methods to obtain energy from biomass:

(i) Direct combustion: Waste products like wood waste, crop residue, and municipal solid waste is burnt in a confined container. Heat produced is directly used in the boiler to produce steam that can run turbine generator.

(ii) Fermentation: Biofuel is obtained by fermentation of biomass using enzymes and by decomposition through bacterial action in the absence of air.
The rotting of biomass in a closed tank called digester produces Biogas which can be piped out to use for cooking and heating.

51. How heat is generated within the Earth?
Ans: Heat within the earth is generated by the following processes.
(i) Radioactive decay
(ii) Residual heat of the earth (usually within 10 km of earth's surface).
(iii) Compression of material deep inside the earth.

52. Name at least two renewable and two non-renewable energy sources.
Ans: The renewable sources of energy are
(i) Wind (ii) Tides (iii) Biomass (iv) Sunlight
The non-renewable sources of energy are
(i) Coal (ii) Natural gas (iii) Oil (iv) Uranium

53. What is "Aquifer" ? (2 times)
Ans: Aquifer is a layer of rock holding water that allows water to percolate through it with pressure.

54. What is Salter's duck? (3 times)
Ans: Salter's duck is a device which can be used to utilize the water waves energy and to generate electricity. It consists of two parts (i) Duck float (ii) Balance float.
The wave energy makes duck float move relative to the balance float. The relative motion of the duck float is then used to run electricity generators.

55. Differentiate between geyser and aquifer. (2 times)
Ans: Geyser is a hot spring that discharges steam and hot water, intermittently releasing an explosive column into the air.
Aquifer is a layer of rock holding water that allows water to percolate through it with pressure.

56. Write some methods to obtain solar energy.
Ans: solar energy can be used directly to heat water using large solar reflectors (mirrors) and thermal absorbers.
Semi-conductor devices called solar cells are used to convert sunlight into electricity. Solar cells are thin wafers made from silicon.
For cloudy days or nights, electric energy can be saved in Nickel cadmium batteries by connecting them to solar panels.

57. What is solar constant? What is its value?
Ans: Solar energy at normal incidence outside the Earth's atmosphere is about 1.4 kW m^{-2} which is referred as solar constant.

58. What are renewable & non-renewable energy sources? Give example of each.
Ans: Renewable energy is derived from natural processes that are replenished constantly. Such as wind, tides etc.
Non-renewable energy source is a source that does not renew itself. Such as coal, natural gas etc.

59. How energy can be obtained from waste products?

Ans: Waste products like wood waste, crop residue, and municipal solid waste is burnt in a confined container. Heat produced in this way is directly utilized in the boiler to produce steam that can run turbine generator.

60. How energy is obtained by water waves and what is the source of this energy?

Ans: To obtain energy by water waves large floats are used which move up and down with the waves. One such device is known as Salter's duck. It consists of two parts (i) Duck float (ii) Balance float.
The motion of the duck float relative to the balance float is used to run electricity generators. The tidal movement and the winds blowing across the surface of the ocean produce strong water waves.

61. How can air pollution be reduced?

Ans: Air pollution can be reduced by following these points
- i. planting trees
- ii. Keeping all heat engines used for transportation and for power generation in good repaired condition.
- iii. Stopping the burning of garbage.

62. What is the biomass? Write the names of two methods to obtain energy from biomass.

Ans: Biomass is a potential source of renewable energy. This includes all the organic materials such as crop residue, natural vegetation, trees, animal drug and sewage.
Two most common methods to obtain energy from biomass are
- i. Direct combustion.
- ii. Fermentation.

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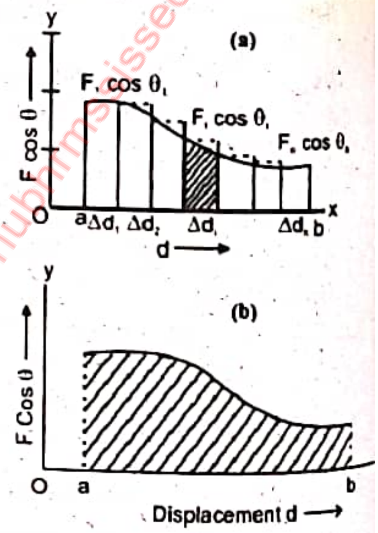
63. How can you find the work done by variable force by graphical method?

Ans: The work done by variable force determined graphically by plotting F cos θ verses d as shown in Figure(a). The displacement d has been subdivided into "n" equal intervals. The value of F cos θ at the beginning of each interval is indicated in the figure by horizontal lines.
Now the ith shaded rectangle has an area $F_i \cos \theta_i \Delta d$, which is the work done during the ith interval. Thus, the work done by given equation (ii) equals the sum of the areas of all the rectangles. If we subdivide the distance into a large number of intervals so that each Δd becomes very small, the work done given by equation (ii) becomes more accurate. If we let each Δd to approach zero then we obtain an exact result for the work done, such as



$$W_{total} = \lim_{\Delta d \to 0} \sum_{i=1}^{n} F_i cos\theta_i \Delta d_i$$

In this limit Ad approaches to zero, the total area of the rectangles approaches the area between the F cos θ curve and d-axis from a to b as show in figure shaded. Thus, the work done by a variable force in moving a particle between two points is equal to the area under the F cos θ verses d curve between the two points a and b as shown in figure (b).

64. What will be the velocity of the particle if its momentum and kinetic energy are equal in magnitude?

Ans: Given that kinetic energy = momentum

$$\frac{1}{2}mv^2 = mv$$
$$v^2 = 2v$$
$$(v^2 - 2v) = 0$$
$$v(v-2) = 0$$
$$v = 0\ ms^{-1}\ and\ (v-2) = 0\ or\ v = 2\ ms^{-1}$$

65. Define (a) Gravitational field (b) Conservative field.

Ans: (a) <u>Gravitational field:</u> The space around the Earth in which its gravitational force acts on a body, is called the gravitational field.

(b) <u>Conservative field:</u> The field in which work done along a closed path is zero is called conservative field. For example, Earth's gravitational field

66. A force of 400 N is required to overcome friction and air resistance propelling an automobile at 22.22 ms^{-1}. What power (kW) must the engine develop?

Sol:

It is given that

$$force = F = 400\ N$$
$$\text{velocity} = v = 22.22\ {}^{m}/_{s}$$
$$power = P = ?$$
$$P = \vec{F}.\vec{v} = Fv\cos 0^o$$
$$P = Fv$$
$$P = (400)(22.22)$$
$$P = 8888\ W$$
$$P = 8.9 \times 10^3\ W = 8.9\ kW$$

67. Give two names of conservative force and non-conservative forces.

Ans: <u>Conservative force:</u> i) Elastic spring force ii) Electric force iii) Gravitational force

<u>Non-conservative forces:</u> i) Frictional force ii) Air resistance iii) Tension in string

68. Derive the mathematical expression for escape velocity.

Ans: We know that work done in lifting a body from Earth's surface to an infinite distance is equal to increase (change) in its potential energy. i.e.,

$$\text{Increase in P.E.} = 0 - \left(-\frac{GMm}{R}\right) = \frac{GMm}{R}$$

The body will escape out of the gravitational field if the initial K.E. absolute P.E.

$$\frac{1}{2}mv_{esc}^2 = \frac{GMm}{R}$$
$$v_{esc}^2 = \frac{2GM}{R}$$
$$v_{esc} = \sqrt{\frac{2GM}{R}} \quad (1)$$

As F = w = mg and F = GMm/R^2. By comparing mg = GMm/R^2 or g R^2 = GM put in eq. (1), we get

$$v_{esc} = \sqrt{\frac{2gR^2}{R}} = \sqrt{2gR}$$

LONG QUESTIONS OF CHAPTER-4 IN ALL PUNJAB BOARDS 2011-2021

Topic III: Work done by gravitational Field:

1. Define conservative field and prove that work done is independent of the path followed by the body in gravitational field. **(5 times)**
2. Explain work done in gravitational field. Also define conservative field. **(2 times)**
3. Prove that work done by gravitational field is independent of the path followed. And what you conclude from this? **(2 times)**

4. Define gravitational field. Prove that work done in the earth's gravitational field is independent of the path followed. **(7 times)**

Topic V: Energy:

5. Define energy. Prove that $K.E = \frac{1}{2}mv^2$. Also derive work energy relation.
6. Define absolute potential energy. Derive its mathematical expression. **(9 Times)**

Topic VI: Interconversion of Potential Energy and Kinetic Energy:

7. A body is falling from height "h". Discuss inter-conversion of potential energy into kinetic energy at different positions.

NUMERICAL PROBLEMS OF CHAPTER-4 IN ALL PUNJAB BOARDS 2011-2021

Topic I: Work done by Constant Force:

1. **Ten bricks each 6 cm thick and mass 1.5 kg lie flat on a table. How much work is required to stack them one on the top of other? (6 Times)**

Sol: Given that

$$mass\ of\ each\ brick = m = 1.5\ kg$$
$$height\ of\ each\ brick = h = 6\ cm = 0.06\ m$$
$$work = W = ?$$

There is no work done for the first brick because that is already lying on the surface of table. So

$$W = 0\,mgh + 1\,mgh + 2\,mgh + 3\,mgh + 4\,mgh + 5\,mgh + 6\,mgh + 7\,mgh + 8\,mgh + 9\,mgh$$
$$W = 45\,mgh$$
$$W = 45(1.5)(9.8)(0.06)$$
$$W = 39.69\,J \boxed{= 40\,J}$$

2. **A car of mass 800 kg travelling at 54 kmh^{-1} is brought to rest in 60 meters. Find the average retarding force on the car. What has happened to original kinetic energy? (6 times)**

Sol:

m = 800 kg

$v_i = 54\ km/h = \frac{54 \times 1000}{60 \times 60} = 15\ m/s$

$v_f = 0$

d = 60 m

Retarding force = ?

What happened to original K.E. =?

According to work – energy principle

$Fd = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$

$Fd = \frac{1}{2}m(v_f^2 - v_i^2)$

Putting values, we get

$F(60) = \frac{1}{2} \times 800\,(0 - 15^2)$

$60F = 400 \times (-225)$

$F = -400 \times 225/60$

$F = -1500\ N$

(i) Negative sigh shows that it is retarding force.

(ii) As the velocity of the car is decreasing, so its K.E also decreasres and becomes zero due to frictional force.

Topic IV: Power:

3. A force (thrust) of 400 N is required to overcome friction and air resistance propelling an automobile at 80 $km/_{hr}$, What power (kW) must the engine develop? (4 Times)

Sol:

It is given that

$$force = F = 400\ N$$

$$velocity = v = 80\ km/_{hr} = \frac{80 \times 1000}{60 \times 60} m/_s$$

$$v = 22.22\ m/_s$$

$$power = P = ?$$

$$P = \vec{F}.\vec{v} = Fv\cos 0^o$$

$$P = Fv$$

$$P = (400)(22.22)$$

$$P = 8888\ W$$

$$P = 8.9 \times 10^3\ W \boxed{= 8.9\ kW}$$

4. A 70 kg mas runs up a long flight of stairs in 4.0 $seconds$. The vertical height of stairs is 4.5 m. Calculate his power output in watts. (3 Times)

Sol: It is given that

$$m = 70\ kg$$

$$t = 4\ s$$

$$h = 4.5\ m$$

$$P. = ?$$

Since Work done = mgh

And $Power = \frac{work\ done}{time}$

$$P = \frac{mgh}{t}$$

$$P = \frac{(70)(9.8)(4.5)}{4} \boxed{= 7.7 \times 10^2\ W}$$

5. If 100 m^3 of water is pumped from a reservoir into a tank 10 m higher than the reservoir in 20 $minutes$. If the density of water 1000 kgm^{-3}. Find the power delivered by the pump. (3 Times)

Sol: Given that

$$voulme\ of\ water = V = 100\ m^3$$

$$height\ of\ the\ tank = h = 10\ m$$

$$time = t = 20\ min = 20 \times 60 = 1200\ s$$

$$density\ of\ water = \rho = 1000\ kgm^{-3}$$

$$power = P = ?$$

Now

$$\rho = \frac{m}{V}$$

$$m = \rho V$$

$$m = (1000)(100)$$

$$m = 10^5\ kg$$

So

$$P.E. = mgh$$

$$P.E. = (10^5)(9.8)(10)$$

$$P.E. = 9.8 \times 10^6\ J$$

Thus

$$P = \frac{P.E.}{t}$$

$$P = \frac{9.8 \times 10^6}{1200}$$

$$P = 8166.6\ W$$

$$P = 8.167 \times 10^3\ W \boxed{= 8.2\ kW}$$

Topic V: Energy:

6. **How a large force is required to accelerate an electron ($m = 9.1 \times 10^{-31}\ kg$) from rest to a speed of $2.0 \times 10^{7}\ ms^{-1}$ through a distance of $5.0\ cm$? (4 times)**

Sol: Given that

$$mass\ of\ electron = m = 9.1 \times 10^{-31}\ kg$$
$$initial\ velocity\ of\ electron = v_i = 0$$
$$final\ velocity\ of\ electron = v_f = 2.0 \times 10^{7}\ ms^{-1}$$
$$distance = d = 5\ cm = 0.05\ m$$
$$force = F = ?$$

Using work-energy principle

$$Fd = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$$
$$F(0.05) = \frac{1}{2}(9.1 \times 10^{-31})(2.0 \times 10^{7})^2 - \frac{1}{2}(9.1 \times 10^{-31})(0)^2$$
$$F = \frac{9.1 \times 4 \times 10^{-31} \times 10^{14} - 0}{2(0.05)}$$
$$F = 364 \times 10^{-17}\ N \boxed{= 3.64 \times 10^{-15}\ N}$$

7. **An object of mass 6 kg is travelling at a velocity of 5 ms^{-1}. What is its kinetic energy? What is its kinetic energy if velocity is doubled? (3 Times)**

Sol:

$$mass = m = 6\ kg$$
$$velocity = v = 5\ ms^{-1}$$
$$kinetic\ energy = K.E. = ?$$

So

$$K.E. = \frac{1}{2}mv^2$$
$$K.E. = \frac{1}{2}(6)(5)^2$$
$$K.E. = \frac{1}{2}(6)(25) \boxed{= 75\ J}$$

And If velocity is doubled

$$K.E. = \frac{1}{2}m(2v)^2$$
$$K.E. = 4\frac{1}{2}mv^2$$
$$K.E. = 2mv^2$$
$$K.E. = 2(6)(5)^2$$
$$K.E. = 12(25) \boxed{= 300\ J}$$

8. **A child starts from rest at the top of a slide of height 4m.**
i) What is his speed at the bottom if the slide is frictionless?
ii) If he reaches the bottom with a speed of 6m/s, what percentage of his total energy at the top of the slide is lost as a result of friction?

Sol: (i) Given that

$$height\ of\ the\ slide = h = 4\ m$$
$$speed\ at\ the\ bottom = v = ?$$

Since

$$Loss\ of\ P.E. = Gain\ in\ K.E.$$
$$mgh = \frac{1}{2}mv^2$$
$$gh = \frac{1}{2}v^2$$
$$v^2 = 2gh$$
$$v = \sqrt{2gh}$$
$$v = \sqrt{2 \times 9.8 \times 4}$$
$$\boxed{v = 8.8\ ms^{-1}}$$

(ii) % age loss of K.E. = ?

$$v' = 6\ m/s$$
$$v = 8.8\ m/s$$

$$\%\ age\ loss\ of\ K.E. = \frac{\frac{1}{2}mv^2 - \frac{1}{2}mv'^2}{\frac{1}{2}mv^2} \times 100\%$$

$$= \frac{\frac{1}{2}m(v^2 - v'^2)}{\frac{1}{2}mv^2} \times 100\%$$

$$= \frac{(v^2 - v'^2)}{v^2} \times 100\%$$

$$= \frac{(8.8^2 - 6^2)}{8.8^2} \times 100\%$$

% age loss of K.E. = 53.5 % = 54 % approximately

9. An electron strikes the screen of a cathode-ray tube with a velocity of $1.0 \times 10^7\ ms^{-1}$. Calculate its kinetic energy. The mass of an electron is 9.1×10^{-31} kg.

Sol:

$$m = 9.1 \times 10^{-31}\ kg$$
$$v = 1.0 \times 10^7\ ms^{-1}$$
$$K.E = \frac{1}{2}mv^2$$
$$K.E = \frac{1}{2}(9.1 \times 10^{-31})(1.0 \times 10^7)^2$$
$$K.E = \frac{1}{2} \times 9.1 \times 10^{-17}$$
$$K.E = 4.55 \times 10^{-17}\ J$$

Topic VI: Interconversion of Potential Energy and Kinetic Energy:

10. A child starts from rest at the top of the slide of height $4.0\ m$. What is his speed at the bottom if the slide is frictionless?

Sol: Given that

$$height\ of\ the\ slide = h = 4\ m$$
$$speed\ at\ the\ bottom = v = ?$$

Since

$$Loss\ of\ P.E. = Gain\ in\ K.E.$$
$$mgh = \frac{1}{2}mv^2$$
$$gh = \frac{1}{2}v^2$$
$$v^2 = 2gh$$
$$v = \sqrt{2gh}$$
$$v = \sqrt{2 \times 9.8 \times 4} \boxed{= 8.8\ ms^{-1}}$$

11. A 1000 kg automobile at the top of an incline 10 m high and 100 m long is released and rolls down the hill. What is its speed at the bottom of the incline if the average retarding force due to friction is 480 N? (2 Times)

Sol: Given that

$$mass = m = 1000\ kg$$
$$average\ retarding\ force = f = 480\ N$$
$$height = h = 10\ m$$
$$length = d = 100\ m$$
$$speed = v = ?$$

Since

$$Loss\ in\ P.E. = Gain\ in\ K.E. + Work\ done\ against\ friction$$
$$mgh = \frac{1}{2}mv^2 + fd$$
$$\frac{1}{2}mv^2 = mgh - fd$$
$$\frac{1}{2}(1000)v^2 = (1000)(9.8)(10) - (480)(100)$$

$$500v^2 = 5000$$
$$v^2 = 100 \boxed{= 10\ ms^{-1}}$$

12. A brick of mass 2kg is dropped from a rest position 5 m above the ground. What is its velocity at a height of 3m above the ground? (2 times)

Sol: m = 2.0 kg

$h = h_1 - h_2 = 5m - 3m = 2m$

at rest position $v_1 = 0$ and $v_2 = v = ?$

As $mg(h_1 - h_2) = \frac{1}{2} m.(v^2 - 0^2)$

$mgh = \frac{1}{2} mv^2$

$v^2 = 2gh$

Or $v = \sqrt{2gh} = \sqrt{2 \times 9.8 \times 2} = 6.3$ m/s

OBJECTIVES (MCQ'S) OF CHAPTER-5 IN ALL PUNJAB BOARD 2011-2021

Topic I: Angular Displacement:

1. When a body moves in circle, the angle between its linear velocity $\vec{v}$ and angular velocity $\vec{\omega}$ is: **(5 Times)**
(A) 180° (B) 90° (C) 0° (D) 45°

2. SI unit for angular displacement is: **(6 Times)**
(A) Metre (B) Degree (C) Revolution (D) Radian

3. The angular displacement of one revolution is equal to: **(2 times)**
(A) 1 radian (B) $\pi/2$radian (C) π radian (D) 2π radian

4. When a wheel turns though an angle of 180° it lays out a tangential distance S is equal to:
(A) $2\pi r$ (B) π r (C) 2 r (D) πr^2

5. 6.36^0 is equal to:
(a) $\frac{\pi}{8}$ (b) $\frac{\pi}{6}$ (c) $\frac{\pi}{5}$ (d) $\frac{\pi}{12}$

6. 2 Radian = ________:
(A) 114.6° (B) 57.3° (C) 75.3° (D) 37.5°

Topic II: Angular Velocity:

7. The direction of angular velocity is along the:
(A) Radius of the circle towards the center (B) Radius of circle away from center
(C) Tangent at the point (D) Axis of rotation

8. The direction of angular velocity is determined by: **(2 Times)**
(A) Left hand rule (B) Head to tail rule (C) Right hand rule (D)General rule

9. If angular velocity of a particle rotating in a circle is doubled then its moment of inertia: **(2 Times)**
(A) Remains the same (B) Become half (C) Become doubled (D) Become 4 times

10. S.I unit of angular velocity is:
(A) Radian/sec (B) Metre sec^{-1} (C) Degree/sec^{-1} (D) Revolution/sec

11. Angular speed of daily rotation of earth is:
(A) 2π (B) π (C) 4π (D) 7.3×10^{-5} Red/sec

12. A wheel of radius 5.0 cm having an angular speed of 20 $rad\ s^{-1}$ have linear speed:
(A) 1.5 ms^{-1} (B) 1.0 ms^{-1} (C) 0.5 ms^{-1} (D) 2.5 ms^{-1}

13. Revolution per minute is unit for:
(A) Angular displacement (B) Angular velocity
(C) angular acceleration (D) Time

14. Speed of moon around the earth is:
(A) 1200 m/s (B) 1100 m/s (C) 1000 m/s (D) 900 m/s

15. The dimensions of angular velocity is
(A) T^{-1} (B) LT^{-1} (C) LT^{-2} (D) L^{-1}

16. A wheel of diameter 1 m makes 60 rev/min. The linear speed of a point on its rim in ms^{-1} is:
(A) π (B) 2π (C) $\frac{\pi}{2}$ (D) 3π

17. The rate of change of regular velocity is called:
(A) Angular velocity (B) Angular acceleration
(C) Angular displacement (D) Angular speed

18. A wheel radius 2 m turns through an angle of 57.3°. It lays out a tangential distance:
(A) 2m (B) 4m (C) 57.3 m (D) 114.6m

19. 1 rev/min is equal to: **(2 Times)**
(a) $\frac{\pi}{6} rads^{-1}$ (b) $\frac{\pi}{15} rads^{-1}$ (c) $\frac{\pi}{20} rads^{-1}$ (d) $\frac{\pi}{30} rads^{-1}$

20. The angular velocity of the minute hand of a clock is:
(A) $2\pi rad\ s^{-1}$ (B) $\pi rad\ s^{-1}$ (C) $\frac{\pi}{60} rad\ s^{-1}$ (D) $\frac{\pi}{1800} rad\ s^{-1}$

Topic III: Angular Acceleration:

21. The SI unit of angular acceleration is:
(A) $\frac{rad}{sec^2}$ (B) $\frac{rad}{sec}$ (C) $\frac{rav}{sec^2}$ (D) $\frac{rev}{sec}$

22. The weight of a man in an elevator descending with an acceleration of $4.9 ms^{-2}$ will become:
(A) Twice (B) Half (C) Zero (D) Unchanged

23. The dimension of angular acceleration is: **(2 Times)**
(A) $[T^{-1}]$ (B) $[T^{-2}]$ (C) $[LT^{-2}]$ (D) $[LT^{-3}]$

24. Time rate of change of angular velocity is called:
(A) Angular momentum (B) Angular acceleration (C) Angular displacement (D) Angular distance

25. Which one of the following is correct?
(a) $\omega = vr$ (b) $v = \frac{r}{\omega}$ (c) $v = r\omega$ (d) $\omega = \frac{r}{v}$

26. A body starting from rest attains Angular Acceleration of 5 rad s^{-2} in 2 second. Velocity will be:
(A) 10 $rads^{-1}$ (B) 7 rad s^{-1} (C) 3 rad s^{-1} (D) 2 rad s^{-1}

27. Direction of angular acceleration is always along:
(A) x – axis (B) y axis (C) z-axis (D) The axis of rotation

Topic IV: Centripetal Force:

28. A body is moving in a circle under centripetal force F. If its linear velocity and radius both are made twice; the centripetal force will be:
(A) F_c (B) $F_c/2$ (C) $2F_c$ (D) $4F_c$

29. π radian equal: **(2 times)**
(A) 60° (B) 90° (C) 180° (D) 360°

30. A body of mass 7kg moves along a circle of radius 4m with constant speed of $8 ms^{-1}$, the centripetal force on the body is:
(A) 48 N (B) 8 N (C) 112 N (D) 72 N

31. The angular version of F = ma is:
(A) $L = I\omega$ (B) $\tau = I\alpha$ (C) $L = \tau\alpha$ (D) $F = \frac{mv}{t}$

32. The magnitude of centripetal force on mass 'm' moving with angular speed 'w' in a circle of radius 'r' is:
(A) $mr^2\omega$ (B) $\frac{m\omega^2}{r}$ (C) $mr\omega^2$ (D) $mr^2\omega^2$

33. Centripetal force performs:
(A) Minimum work (B) No work (C) Maximum work (D) Negative work

34. The pull of earth on a mass of 20kg at the centre of earth is:
(A) 392N (B) 196N (C) 9.8N (D) zero

35. Which one of the following is not directed along the axis of rotation? (2 times)
(A) Angular acceleration (B) Angular momentum
(C) Centripetal acceleration (D) Angular displacement

36. The centripetal force is always directed: (2 times)
(a) Away from the centre along the radius (b) along the direction of motion
(c) opposite to the motion of the body (d) towards the centre along the radius

37. Centripetal acceleration is also called:
(a) Tangential (b) radial (c) angular (d) rotational

38. If a body revolves under centripetal force, its Angular Acceleration is:
(A) Non Zero (B) Variable (C) Increasing (D) Zero

39. If linear velocity and radius are both made to half of a body moving around a circle.
(A) F_c (B) $\frac{F_c}{2}$ (C) $\frac{F_c}{4}$ (D) $2F_c$

Topic V: Moment of Inertia:

40. Moment of inertia is equal to:
(A) m^2r (B) m^2r^2 (C) mr (D) mr^2

41. Moment of inertia is measured in: (4 Times)
(A) kgm^2 (B) kgm^{-2} (C) $rad\ s^{-1}$ (D) Js

42. Moment of inertia of ring or hoop is: (2 Times)
(A) mr^2 (B) $\frac{2}{5}mr^2$ (C) $\frac{1}{2}mr^2$ (D) $\frac{1}{12}mr^2$

43. Moment of inertia of a sphere is:
(A) $\frac{1}{2}$ m r^2 (B) $\frac{2}{5}$ m r^2 (C) $\frac{2}{5}$ m r^3 (D) $\frac{1}{3}$ m r^2

44. The ratio of the momentum of inertia of disc and hoop is: (3 times)
(a) 1/4 (b) 1/2 (c) 3/4 (d) 3/2

45. The diver spins faster when moment of inertia becomes: (2 times)
(a) Smaller (b) greater (c) constant (d) equal

46. Choose the quantity which plays the same role in angular motion as mass in linear motion. (3 times)
(A) Angular acceleration (B) Torque
(C) Moment of inertia (D) Angular momentum

47. The product of rotational inertia "I" and angular velocity "ω" is equal to:
(A) Torque (B) Linear momentum (C) angular momentum (D) Force

Topic VI: Angular Momentum:

48. The angular momentum $\vec{L}$ is given by: (2 Times)
(A) $m\vec{w}$ (B) $\vec{w}\times\vec{r}$ (C) $\vec{r}\times\vec{F}$ (D) $\vec{r}\times\vec{P}$

49. The direction of angular momentum of a body moving in a circle is: (2 times)
(A) Along the tangent (B) perpendicular to the plane of the circle
(C) Radially outward (D) Radially inward

50. Angular momentum of a rigid body is given by: (2 times)
(A) $I^2\omega$ (B) $I\omega^2$ (C) $I^2\omega^2$ (D) $I\omega$

51. For angular momentum of system to remain constant, external torque should be:
(A) Small (B) Large (C) Zero (D) None

52. The value of angular momentum is maximum when θ is:
(A) 90° (B) 60° (C) 45° (D) 0°

53. The unit of angular momentum is: (2 times)
(A) Ns (B) Js (C) ms (D) $Kgms^{-1}$

Topic VIII: Rotational K.E:

54. The linear velocity of disc moving do in inclined plane is: (3 Times)

(A) $\sqrt{gh}$ (B) $\sqrt{\frac{4}{3}gh}$ (C) $\sqrt{\frac{2}{3}gh}$ (D) $\sqrt{\frac{1}{3}gh}$

55. Which is larger for a hoop of mass M and radius R that is rolling without slipping? Its translational or rotational kinetic energy?

(A) Transactional kinetic energy (B) Rotational kinetic energy
(C) Both are the same (D) Answer depend upon the radius

56. Moment of inertia of thin rod is given by relation: (2 times)

(A) $\frac{1}{12}mL^2$ (B) $\frac{2}{5}mR^2$ (C) $12mL^2$ (D) $\frac{5}{7}mR^2$

57. If the body is at rest or rotating with uniform angular velocity, then torque will be:

(A) Maximum (B) Negative (C) Zero (D) Positive

58. Rotational inertia of two equal masses cylinders, but one has larger diameter will be:

(A) Lesser (B) Larger (C) Same (D) Infinity

59. Rotational K.E of the disc is: (3 times)

(A) $\frac{1}{4}mv^2$ (B) $\frac{1}{2}mv^2$ (C) $\frac{1}{2}mr^2$ (D) $\frac{1}{4}mr^2$

60. The speed of a hoop at the bottom of inclined plane can be given by: (3 Times)

(A) $V=\sqrt{gh}$ (B) $V=\sqrt{2gh}$ (C) $V=\sqrt{\frac{4gh}{3}}$ (D) $V=\sqrt{\frac{3}{4}gh}$

61. The rotational K.E of a body is given by:

(A) $\frac{1}{2}I\omega^3$ (B) $\frac{1}{2}I\omega^2$ (C) ω^2 (D) $\frac{1}{2}I$

62. The ratio of velocity of disc to velocity of hoop is: (3 times)

(A) $\frac{2}{\sqrt{3}}$ (B) $\frac{4}{\sqrt{3}}$ (C) $\frac{2}{3}$ (D) $\frac{4}{3}$

63. In rotational motion, the torque is equal to rate of change of.

(A) Angular velocity (B) Linear momentum (C) Angular Momentum (D) Angular acceleration

64. The rotational K.E of a Hoop of mass "m" moving down frictionless inclined plane with velocity "v" will be.

(A) $\frac{1}{4}mv^2$ (B) $\frac{1}{2}mv^2$ (C) $\frac{3}{4}mv^2$ (D) mv^2

65. The unit of rotational k.E is.

(A) Rad/sec (B) JS (C) J (D) Kg m^2

66. A body rotating with angular vel0ocity of 2 radian /s and linear velocity is also $2ms^{-1}$, then radius of circle is:

(A) 1 m (B) 0.5 m (C) 4 m (D) 2 m

Topic IX: Artificial Satellites:

67. A satellite moving around the earth constitutes:

(A) Inertial frame of reference (B) Non-inertial frame of reference
(C) Neither inertial nor non-inertial (D) Both inertial and non-inertial

68. The minimum velocity necessary to put a satellite into orbit is:

(A) 7.1 kms^{-1} (B) 7.3 kms^{-1} (C) 7.9 kms^{-1} (D) 8.9 kms^{-1}

69. The value of a time period of a low flying satellite is:

(A) 1 year (B) 84 minutes (C) 28 hours (D) 2.8 hours

70. Satellites are the objects that orbit around the:

(A) Moon (B) Sun (C) Earth (D) Star

71. The frequency of rotation of a spaceship about its own axis to create artificial gravity like that on earth is:

(a) $f = 2\pi\sqrt{g/R}$ (b) $f = \frac{1}{2\pi}\sqrt{g/R}$

(c) $f = \frac{1}{2\pi}\sqrt{g/R^2}$ (d) $f = \frac{1}{2\pi}\sqrt{R/g}$

72. The expression for the time period of low flying satellite put into the orbit is:

(A) $T = \frac{2\pi R}{g}$ (B) $T = \frac{2\pi R}{G}$ (C) $T = \frac{2\pi V}{R}$ (D) $T = \frac{2\pi R}{V}$

Topic X: Real and Apparent Weight:

73. The apparent weight of man in a lift moving down with an acceleration of $9.8\ ms^{-2}$ is:

(A) Zero (B)9.8N (C) 19.6N (D) infinity

74. The weight of the body at the centre of Earth is: **(2 times)**

(A) Maximum (B) Minimum (C) Zero (D) Infinite

75. If a rocket is accelerating upward with an acceleration of 2 g, an astronaut of weight Mg in the rocket shows apparent weight:

(A) Zero (B) Mg (C) 2 Mg (D) 3 Mg

76. A mass of 1 kg is freely falling. The force of gravity is:-

(a) 1 N (b) 9.8 N (c) 0.5 N (d) zero

77. An elevator is moving up with an acceleration equal to "g". An apparent weight of the body in an elevator is.

(A) Zero (B) Equal to real weight (C) 2 mg (D) 3 mg

78. Apparent Weight of a man in upward accelerated lift will:

(A) Increase (B) Decrease (C) Remain Same (D) Increase then Decrease

Topic XI: Weightlessness in Satellites and Gravity Free System:

79. If by some means the diameter of earth increase to 4 times, the escape velocity will become:

(A) Same (B) Double (C) Half (D) One fourth

80. The escape velocity can be determined by relation:

(A) $v_{esc} = gR$ (B) $v_{esc} = 2gR$ (C) $v_{esc} = \sqrt{gR}$ (D) $v_{esc} = \sqrt{2gR}$

81. The escape velocity is maximum for:

(A) Moon (B) Mercury (C) Earth (D) Jupiter

Topic XII: Orbital Velocity:

82. The ratio between orbital and escape velocities are **(6 Times)**

(A) 1 (B) 2 (C) $\sqrt{2}$ (D) $\frac{1}{\sqrt{2}}$

83. Orbital speed of satellite can be determined by: **(3 Times)**

(A) $V = \frac{2\pi r}{t}$ (B) $V = \sqrt{\frac{GM}{r}}$ (C) $V = \sqrt{gR}$ (D) $V = \sqrt{\frac{2GM}{R}}$

84. Relation between escape velocity v_{esc} and orbital velocity v_o is:

(A) $v_{esc} = \frac{1}{2}v_o$ (B) $v_{esc} = \sqrt{2}v_o$ (C) $v_{esc} = v_o$ (D) $v_{esc} = 2v_o$

85. If the radius of earth is doubled then the value of critical velocity becomes:

(A) $\frac{1}{\sqrt{2}} v_o$ (B) $\frac{1}{2} v_o$ (C) $\sqrt{2} v_o$ (D) $\frac{1}{4} v_o$

86. Orbital velocity near surface of earth is given by:-

(a) $\sqrt{2gR}$ (b) $\sqrt{gR}$ (c) $\sqrt{\frac{2g}{R}}$ (d) $\sqrt{\frac{g}{R}}$

87. The value of Escape Velocity is:

(A) $11.6 \times 10^3\ ms^{-1}$ (B) $11 \times 10^3\ ms^{-1}$ (C) $11.5 \times 10^3\ ms^{-1}$ (D) $12 \times 10^3\ ms^{-1}$

88. Escape velocity of a body of mass 1000 kg is 11 kms^{-1}. If the mass of the body is doubled then its escape velocity will be:
(A) 5.5 kms^{-1} (B) 11 kms^{-1} (C) 22 kms^{-1} (D) 44 kms^{-1}

89. Escape velocity on the surface of earth is 11.2 KmS^{-1} the escape velocity on the surface of another planet of same mass as that of earth but of $\frac{1}{4}$ times of the radius of earth is:
(a) 5.6 KmS^{-1} (b) 11.2 KmS^{-1} (c) 22.4 KmS^{-1} (d) 5.6 mS^{-1}

90. The escape velocity can be determined by relation:
(a) $V_{esc} = gR$ (b) $V_{esc} = 2gR$ (c) $V_{esc} = \sqrt{gR}$ (d) $V_{esc} = \sqrt{2gR}$

91. The value of escape velocity for earth is:
(A) 11km/h (B) 11 kms^{-1} (C) 1.1km/h (D) 1.1 ms^{-1}

Topic XIV: Geostationary Orbits:

92. The period of revolution of geo-stationary satellite is equal to:
(A) 1 hour (B) 84 min. approximately (C) 1 day (D) 1 month

93. A geo stationary satellite covers a longitude of:
(A) 90° (B) 100° (C) 120° (D) 150°

94. Minimum number of geostationary satellites required to cover whole the populated world:
(A) 1 (B) 3 (C) 126 (D) 130

95. Height of geo-stationary orbit of the satellite above the earth is:
(A) 300 km (B) 250 km (C) 400 km (D) None of these

Topic XV: Communication Satellites:

96. The largest satellite system is managed by the countries:
(A) 126 (B) 136 (C) 120 (D) 3

97. INTELSAT VI satellite operates at microwave frequencies of:
(a) 2, 4, 6, 10 GHZ (b) 4, 6, 12 and 14 MHZ (c) 4, 6, 11 and 14 GHZ (d) 4, 6, 11 and 14 MHZ

98. Close orbiting satellites orbit the earth at a height of about: **(2 Times)**
(A) 400km (B) 4000km (C) 400cm (D) 4000cm

99. A communication satellite is used to reflect the signal of.
(A) Microwaves (B) Radiowaves (C) λ - rays (D) x – rays

100. Microwaves frequencies use in satellite for communication are.
(A) 4 Ghz (B) 6 Ghz (C) 11 Ghz (D) 4, 6, 11, 14 Ghz

2018

101. Einstein's theory gives us a physical picture of how the:
(a) body moves (b) gravity works
(c) moment of inertia produced (d) weightlessness creates

102. The ratio of moment of inertia of hoop to the moment of inertia of disc (if their masses and radii are same) is equal to:
(a) 2 (b) $\frac{1}{2}$ (c) 4 (d) $\frac{1}{4}$

103. One degree is equal to:
(a) $\frac{2\pi}{260} rad.$ (b) $\frac{2\pi}{180} rad.$ (c) $\frac{\pi}{180} rad.$ (d) $\frac{\pi}{360} rad$

104. The Apparent weight of object of mass "m" when the lift in moving upward with acceleration equal to "g" (acceleration due to gravity) is given as:
(a) mg (b) 2 mg (c) zero (d) $\frac{1}{2}$ mg

105. The ratio of moment of inertia of a disc and sphere of same radius is:
(A) $\frac{2}{5}$ (B) $\frac{5}{4}$ (C) $\frac{1}{2}$ (D) $\frac{5}{2}$

106. If a body is moving in the counter clockwise direction then the direction of angular velocity will be:
(A) Towards the centre (B) Away from the centre
(C) Along the linear velocity (D) Prependicular to both radius and linear velocity

107. The moment of inertia of 10kg hoop about the axis of rotation perpendicular to the plane having radius 5 m is :
(A) 50 Kgm^2 (B) 100 Kgm^2 (C) 150 Kgm^2 (D) 250 Kgm^2

108. The apparent weight of a pilot diving down with an acceleration $9.8mS^{-2}$ will become:
(A) Half (B) Zero (C) Double (D) Increaese to four times

109. The dimensions of centripetal force are:
(A) $[MLT^{-1}]$ (B) $[ML^2T^{-1}]$ (C) $[MLT^{-2}]$ (D) $[ML^2T^{-2}]$

110. If a body of mass 1kg is allowed to fall freely then its weight becomes:
(A) 1 N (B) 9.8 N (C) 980 N (D) zero

111. If a body of mass 10kg is falling freely, its apparent weight is: **(2 Times)**
(A) Zero (B) 98N (C) 10N (D) 980N

112. Time period of geostationary satellite of radius "R" is:
(A) 6 hours (B) 12 hours (C) 18 hours (D) 1 day

113. Angular Momentum has the same unit as:
(A) Impulse x Distance (B) Power x time
(C) Linear Momentum x time (D) Work x frequency

114. The number of Satellite which form the Global Positioning System close to earth are:
(A) 22 (B) 24 (C) 30 (D) 34

115. The weight of an object in an elevator moving down with an acceleration of 9.8 m/s^2 will become
(A) Half (B) Double (C) Unchanged (D) Zero

116. Artificial gravity can be created in the spaceship by :
(A) Revolving around the earth (B) Spinning around its own axis
(C) Increasing its velocity (D) Decreasing its velocity

117. $\omega = 60$ rev min^{-1} is equal to:
(A) π rad s^{-1} (B) 2π rad s^{-1} (C) $\frac{1}{\pi}$ rad s^{-1} (D) $\frac{2}{\pi}$ rad s^{-1}

118. Height of geostationary satellite from the earth's surface is:
(A) 42300 km (B) 900 km (C) 36000 km (D) 400 km

2019

119. One radian is equal to: **(4 Times)**
(A) 77.3° (B) 67.3° (C) 57.3° (D) 47.3°

120. A man in a lift moving upward with constant velocity will conclude that his weight has:
(A) Increased (B) Decreased (C) Reduced to zero (D) Not changed

121. The number of satellites in global positioning system is:
(A) 3 (B) 12 (C) 24 (D) 36

122. In rotational motion analogous of force is:
(A) Torque (B) Rotational inertia (C) Mass (D) Momentum

123. IF orbital velocity of a satellite is 7.9 Km/s and 'R' is the radius of Earth, time required to complete one rotation will be:
(A) 84 min (B) 84 sec (C) 6050 sec (D) 24 hours

124. A body rotates with a constant angular velocity of 100 rad/sec about a vertical axis the required torque to sustain his motion will be.
(A) zero Nm (B) 100 Nm (C) 200 Nm (D) 300 Nm

125. Moment of inertia of 100 kg sphere having radius 50 cm will be.
(A) 10 Kg m^2 (B) 5 Kg m^2 (C) 500 Kg m^2 (D) 2.5 Kg m^2

126. 20 N centripetal Force revolving a body along a circular path of radious 1m, the wrok done by the centripetal Force is.
(A) 20 Joule (B) 40 Joule (C) 10 Joule (D) Zero Joule

127. Moment of inertia for a particle is given by:
(A) m^2r^2 (B) mr^2 (C) m^2r (D) mr^{-2}

128. S.I unit of angular momentum is:
(A) Kg m^2s^{-1} (B) Kg $m^{-2}s^{-2}$ (C) Kg $m^{-1}s$ (D) Kg m^2s^{-2}

129. When a body moves in a circular path, the angle between its linear velocity and angular velocity is.
(A) 180° (B) zero degree (C) 90° (D) 45°

130. 2° is equal to:
(A) 0.035 rad (B) 0.30 rad (C) 0.35 rad (D) 0.0035 rad

131. In rotational motion analogous of force is:
(A) Torque (B) Inertia (C) Velocity (D) Momentum

132. Orbital velocity of a satellite of mass "m_s" orbiting around earth of mass "M" is:
(A) $\sqrt{\frac{GM}{r}}$ (B) $\sqrt{\frac{GM_s}{r}}$ (C) $\frac{GM}{r}$ (D) $\sqrt{gR}$

133. Everything in the vastness of space is in a state of:
(A) Rest (B) Restillinear Motion (C) Prepetual Motion (D) Projectile Motion

134. If External Torque on a body is zero, then which of these quantities is constant:
(A) Force (B) Linear Momentum (C) Liner Velocity (D) Angular Momentum

135. The correct S.I. unit of Angular Momentum is:
(A) $Kgs\ m^{-2}$ (B) $Kg\ ms^{-1}$ (C) Kgm^2s^{-1} (D) $Kg\ m^2s^{-2}$

136. Relation between the speed of disc and hoop at the bottom of an incline is:
(A) $V_{disc} = \sqrt{\frac{3}{4}}V_{hoop}$ (B) $V_{disc} = \sqrt{\frac{4}{3}}V_{hoop}$
(C) $V_{disc} = \sqrt{\frac{2}{5}}V_{hoop}$ (D) $V_{disc} = 2V_{hoop}$

137. 2 revolutions are equal to:
(A) π rad (B) $\frac{3\pi}{2}$ rad (C) 2π rad (D) 4π rad

138. The expression for centripetal force is given by:
(A) $\frac{mv^2}{r^2}$ (B) $\frac{m^2v^2}{r}$ (C) $\frac{m^2v^2}{r^2}$ (D) $mr\omega^2$

2021

139. A hope is rolled down on an inclined plane having height of 10 m. Its velocity at the bottom will be:
(A) 4.91 m/sec (B) 9.89 m/ sec (C) 28.31 m/sec (D) 31.31 m/sec

140. Apparent weight of an object in a lift moving down with acceleration a=g is:
(A) T=w+ma (B) T=0 (C) T=w (D) T = Infinity

141. The moment of inertia of solid disc or cylinder is
(A) mr^2 (B) $\frac{1}{2}mr^2$ (C) $\frac{1}{4}mr^2$ (D) $\frac{1}{2}m^2r$

142. If a body of mass 10 kg is allowed to fall freely, its apparent weight becomes:
(A) Zero (B) 89 N (C) 9.8 N (D) 10 N

143. The angular displacement per second is called angular:
(A) Acceleration (B) Rotation (C) Velocity (D) Speed

144. The rotational K.E of solid sphere is:
(A) $\frac{2}{5}mr^2\omega^2$ (B) $\frac{1}{5}mr^2\omega^2$ (C) $\frac{2}{3}mr^2\omega^2$ (D) $\frac{1}{5}I\omega^2$

145. If a body is moving counter clockwise, then angular displacement is:
(A) Minimum (B) Zero (C) Negative (D) Positive

146. The direction of angular momentum $\vec{L} = \vec{r} \times \vec{p}$ is:
(A) Along the direction of $\vec{p}$
(B) Along the direction of $\vec{r}$
(C) Parallel to the plane containing $\vec{r}$ and $\vec{p}$
(D) Perpendicular to the plane containing $\vec{r}$ and $\vec{p}$

147. A body of mass 10 kg in free falling lift has weight
(A) 10 N (B) 98 N (C) zero N (D) 980 N

148. In one Revolution. the angular displacement covered is
(A) 60^o (B) 360^o (C) 90^o (D) 180^o

149. When a body moves in a circular path it's linear velocity:
(A) remains constant (B) becomes zero
(C) changes (D) increases

150. Pull of the Earth on 20kg body on surface of Earth is:
(A) 20 N (B) 196 N (C) 19.6 N (D) 1960 N

ANSWERS OF THE MULTIPLE CHOICE QUESTIONS

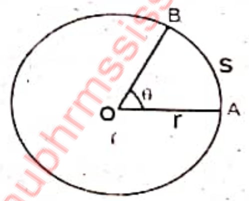
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
B	D	D	B	C	A	D	C	A	A	D	B	B	C	A
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
A	B	A	D	D	A	B	B	B	C	A	D	C	C	C
31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
B	C	B	D	C	D	B	D	B	D	A	A	B	B	A
46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
C	C	D	B	D	C	A	B	B	C	A	C	B	A	A
61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
B	A	C	B	C	A	A	C	B	C	B	D	A	C	D
76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
B	C	A	B	D	D	D	B	B	C	B	B	B	C	D
91	92	93	94	95	96	97	98	99	100	101	102	103	104	105
B	C	C	B	D	A	C	A	A	D	B	A	C	B	B
106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
D	D	B	C	B	A	D	A	B	D	B	B	C	C	D
121	122	123	124	125	126	127	128	129	130	131	132	133	134	135
C	A	A	A	A	D	B	A	C	A	A	A	C	D	C
136	137	138	139	140	141	142	143	144	145	146	147	148	149	150
B	D	D	D	B	B	A	C	B	D	D	B	B	C	B

SHORT QUESTIONS OF CHAPTER-5 IN ALL PUNJAB BOARDS 2011-2021

Topic I: Angular Displacement:

1. Show that $s = r\theta$ **(7 Times)**

Ans: Consider the diagram



Since

$$\theta = \frac{arc\ length}{radius} rad$$

$$\theta = \frac{S}{r} rad$$

$$S = r\theta$$

where θ is in radians.

2. Show that: $1\ radian = 57.3^o$ **(4 times)**

Ans: We know that

$$1\ revolution = 360^0$$

$$2\pi\ radian = 360^0$$

$$1\ radian = \frac{360^0}{2\pi}$$

$$1\ radian = 57.3^o$$

Hence proved.

3. State the right hand rule to find the direction of angular displacement. (2 Times)

Ans: It states that

"Grasp the axis of rotation in right hand with the fingers curling in the direction of rotation, then the erect thumb will give the direction of angular velocity and angular momentum."

4. Define angular displacement and write its S.I unit.

Ans: The angle, through which a particle moves in a certain interval of time, while moving in a circle, is called its angular displacement.

$$\theta = \frac{s}{r}$$

Its SI unit is radian.

5. **Define radian and degree and what relation between them is.**

Ans: The angle between two radii of a circle which cut off on the circumference an arc, equal in length to the radius is one radian.

$\frac{1}{360}$ th part of angle subtended at the centre of circle is equal to one degree.

1 radian = 57.3°

6. **How many radians are there in 2 degree?**

Ans: $\because \ 1rad = 57.3^{o}$

$$1^{o} = \frac{1}{57.3^{o}} \ rad$$

Multiplying by 2

$$2^{o} = \frac{2}{57.3} \ rad$$

$$2^{o} = 0.035 \ rad$$

Topic II: Angular Velocity:

7. **Explain the difference between tangential velocity and angular velocity.** (8 *times*)

OR **Explain the difference between tangential velocity and angular velocity. Write the formula which relates them.**

Ans: The linear velocity of a particle moving along a curve or circle is called **tangential velocity**. Its direction is always along the tangent to the circle.

While

The rate of change of angular displacement is called **angular velocity**. The direction of angular velocity is along the axis of rotation of the body by right-hand rule.

$$v = r\omega$$

8. **Derive the relation between linear and angular velocity. OR Show that $v = r\omega$** (7 *times*)

Ans: Since $\quad s = r\theta$

For small changes $\quad \Delta s = r\Delta\theta$

Dividing both sides by Δt $\quad \frac{\Delta s}{\Delta t} = r\frac{\Delta\theta}{\Delta t}$

$$v = r\omega$$

It is the required relation between linear velocity and angular velocity.

9. **Define angular velocity; give its units and dimensions.** **(2 Times)**

Ans: The rate of change of angular displacement is called angular velocity. The direction of angular velocity is along the axis of rotation of the body.

S.I unit of angular velocity = rad/s

Dimensions of angular velocity = $[T^{-1}]$

10. **Define angular velocity, How its direction is determined?** **(2 Times)**

Ans: The rate of change of angular displacement is called angular velocity. The direction of angular velocity is along the axis of rotation and can be determined by right hand rule:

"Grasp the axis of rotation in right hand with the figures curling in the direction of rotation then the erect thumb will give the direction of angular velocity."

11. **State Right Hand Rule. How would apply it to find the direction of angular velocity.**

Ans: Grasp the axis of rotation in your right hand with fingers curling in the direction of rotation, the thumb points in the direction of angular velocity. The direction of angular velocity is along the axis of rotation.

12. **Define angular velocity and give its formula.** **(2 Times)**

Ans: The rate at which the angular displacement is changing with time is called angular velocity.

$$\omega = \frac{\Delta\theta}{\Delta t}$$

Topic III: Angular Acceleration:

13. Prove that $a = r\alpha$. / Derive the relation between linear-and angular acceleration. (2 Times)

Ans: As we know that

$$V = r\omega$$

or

$$\Delta V = r\Delta\omega$$

Dividing by Δt on both sides and taking limit $\Delta t \to 0$, *we get*

$$\lim_{\Delta t\to 0} \frac{\Delta V}{\Delta t} = \lim_{\Delta t\to 0} r\frac{\Delta\omega}{\Delta t}$$

$$\lim_{\Delta t\to 0} \frac{\Delta V}{\Delta t} = r\lim_{\Delta t\to 0} \frac{\Delta\omega}{\Delta t}$$

or

$$a = r\alpha.$$

14. Define angular acceleration. Write its unit and formula. (2 Times)

Ans: The rate of change of angular velocity is called angular acceleration.

$$\alpha = \frac{\Delta w}{\Delta t}$$

S.I units = rad s^{-2}

Topic IV: Centripetal Force:

15. What is meant by centripetal force? Write down its formula and unit. (3 Times)

Ans: The force which keeps the body to move in the circular path and always directed towards the center of the circle is called the centripetal force.

$$F_C = \frac{mv^2}{r}$$

Its S.I unit is Newton.

16. Why banked tracks are needed for turns?

Ans: Banked tracks are needed because friction alone cannot provide energy for centripetal force.

If the road is banked, so that the outer edge is above the inner edge, then a portion of the normal force from the road on the tyre points towards the center of the track; this fraction of the normal force can provide enough centripetal force to keep the car moving in a circle.

17. Explain what is meant by centripetal force. How is it converted in terms of angular velocity?

Ans: The force which keeps the body to move in the circular path and always directed towards the center of the circle is called the centripetal force.

$$F_C = \frac{mv^2}{r}$$

Since

$$v = r\omega$$

So

$$F_C = \frac{m(r\omega)^2}{r} = \frac{mr^2\omega^2}{r} = mr\omega^2$$

This is the required expression of centripetal force in terms of angular velocity.

18. When mud flies off the tyre of a moving bicycle, in what direction does it fly? Explain. (18 Times)

Ans: Adhesive force between mud and tire is weak. When the mud flies off the tyre of a moving bicycle, it always flies along the tangent to the tyre. Because linear velocity is always tangent to the circle.

19. Explain what is meant by centripetal force and why it must be furnished to an object if the object is to follow a circular path. (4 Times)

Ans: The force which keeps the body to move in the circular path and always directed towards the center of the circle is called the centripetal force.

$$F_C = \frac{mv^2}{r}$$

In order to move an object in a circular path, its direction needs to be changed at every point. So, to change the direction of motion continuously a continuous perpendicular force is required which is known as centripetal force. It is directed along the radius towards the centre of the circle.

20. Define centripetal force and centripetal acceleration.

Ans: The force needed to bend the normally straight path of the particle into a circular path is called the centripetal force.

The instantaneous acceleration of an object traveling with uniform speed in a circle is directed towards the centre of the circle and is called centripetal acceleration.

21. What are Banked tracks? Explain.

Ans: A banked track is one that slopes upward towards the outer edge of a curve. Banked tracks are needed for turns that are taken so quickly that friction alone cannot provide energy for centripetal force.

22. Define centripetal force and centripetal acceleration. Also write their relations. (do not derive)

Ans: The force needed to bend the normally straight path of the object into a circular path is called centripetal force.

$$F_c = \frac{mv^2}{r}$$

The acceleration of an object moving along a circular path is directed towards the centre of the circle and is known as centripetal acceleration

$$\alpha_c = \frac{v^2}{r}$$

Topic V: Moment of Inertia:

23. On what factors moment of inertia depends?

Ans: The moment of inertia is $I = mr^2$

So it depends upon the mass of the body and its distance from the axis of rotation.

24. Define moment of inertia, how it is related to torque.

Ans: The property of the body to resist any change in its state of rest or uniform angular velocity is called moment of inertia. For a point mass 'm' situated at a distance 'r' from the axis of rotation, the moment of inertia 'I' is given by:

$$I = mr^2$$

Moment of inertia is related to torque and angular acceleration as

$$\tau = I\alpha$$

25. Define Moment of Inertia. Write its formula. **(21 Times)**

OR What is movement of inertia? Explain it significance. **(5 Times)**

Ans: The property of the body to resist any change in its state of rest or uniform angular velocity is called moment of inertia. For a point mass 'm' situated at a distance 'r' from the axis of rotation, the moment of inertia 'I' is given by: $I=mr^2$

Significance:

Moment of inertia plays the same role in angular motion as that of mass plays in linear motion. It is also called measure of rotational inertia in angular motion. Moment of inertia determines the angular acceleration while mass determines the linear acceleration.

Topic VI: Angular Momentum:

26. State the direction of the following vectors in simple situation:

i. Angular momentum ii. Angular velocity **(8 *times*)**

Ans: The directions of angular momentum and angular velocity can be determined by right hand rule:

"Grasp the axis of rotation in right hand with the figures curling in the direction of rotation, then the erect thumb will give the direction of angular velocity and angular momentum."

27. Show that orbital angular momentum $L_o = mvr$. **(18 Times)**

Ans: Angular momentum is

$$\vec{L} = \vec{r} \times \vec{p}$$
$$L = rp\sin\theta$$
$$L = r(mv)\sin\theta$$

In circular motion, since r and v are perpendicular to each other, so

$$L_o = mvr\sin 90^o$$
$$L_o = mvr(1)$$
$$L_o = mvr$$

Hence the result.

28. Why you wear seat belts?

Ans: During collision, the passengers move forward towards the windscreen due to inertia. The seat belt prevents the passengers from moving forward. And lessened the chances of injury.

29. Define angular momentum and give its dimensions and unit. (6 Times)

Ans: The cross product of position vector and linear momentum of an object is known as angular momentum. $\vec{L} = \vec{r} \times \vec{p}$

The SI unit of angular momentum is kgm^2s^{-1} and dimensions are $[ML^2T^{-1}]$

30. What is meant by angular momentum? State the law of conservation of angular momentum. (6 Times)

Ans: **Angular Momentum:**

Cross product of position vector $\vec{r}$ with respect to axis of rotation and linear momentum $\vec{p}$ is called angular momentum. It is denoted by $\vec{L}$.

$$\vec{L} = \vec{r} \times \vec{p}$$

Or $L = rp\sin\theta$

Where 'θ' is the angle between r and p,

As p = mv, so $L = mvr\sin\theta$

Law of conservation of angular momentum:

Total angular momentum of a system remains constant when no external torque acts on it. Mathematically: $L_{total} = L_1 + L_2 + L_3 + \ldots\ldots = I\,\omega = \text{Constant}$

Topic VII: Law of Conservation of Angular Momentum:

31. State the law of conversation of angular momentum. (2 Times)

Ans: It states that

If no external torque acts on a system, the total angular momentum of the system remains constant. $\vec{L}_{total} = \text{constant}$

32. Why does a diver change his body position before and after diving in the pool? (22 Times)

Ans: By law of conservation of angular momentum $I_1\omega_1 = I_2\omega_2 = constant$

When the diver jumps from the diving board, his legs and arms are fully extended. The diver has large moment of inertia I_1 but the angular velocity ω_1 is small. When the diver curls his body, the moment of inertia reduces to I_2 .In order to conserve the angular momentum, the value of angular velocity increases to ω_2. Hence, the diver must spin faster and can take extra somersaults.

33. Explain conservation of direction of angular momentum.

Ans: The direction of angular momentum along the axis of rotation remains fixed. This is due to the fact that the axis of rotation of an object will not change its orientation unless an external torque causes it to do so.

34. Prove that orbital angular momentum depends upon the radius of the orbit.

Ans: Angular momentum is defined as

$$\vec{L} = \vec{r} \times \vec{p}$$

Or $L = rpsin\theta$

For orbital motion $\theta = 90^0$

$L_0 = rpsin90^0 = rmv(1) = rmv$

Hence, it is proved that orbital angular momentum depends upon radius of orbit.

Topic VIII: Rotational K.E:

35. A disc and a hoop start moving down from the top of an inclined plane at the same time. Which one will be moving faster on reaching the bottom? (9 Times)

Ans: Since, speed of dics and hoop on reaching the bottom is given by

$$v_{disc} = \sqrt{\frac{4gh}{3}} = \sqrt{\frac{4}{3}}\sqrt{gh} = 1.16\sqrt{gh}$$

And

$$v_{hoop} = \sqrt{gh}$$

So it is clear from the above relations that the disc will be moving with greater speed on reaching the bottom.

36. You have a disk and a hoop of same mass and size. Which of the two has greater moment of inertia and why?

Ans: Since

$$I_{hoop} = mr^2$$

$$I_{disc} = \frac{1}{2}mr^2$$

It is because for a solid disc, the mass is equally distributed in the space between the center and the circumference of the circle and for a ring, all the mass is in the space occupied by the ring, which is located at a specific distance, radius, from the center of circle.

37. Find the rotational kinetic energy of a Disc. (4 Times)

Ans: As we know

$$(K.E)_{rot} = \frac{1}{2}I\omega^2$$

Moment of inertia of a disc is

$$I = \frac{1}{2}mr^2$$

So,

$$(K.E)_{rot} = \frac{1}{2}\left(\frac{1}{2}mr^2\right)\omega^2$$

$$(K.E)_{rot} = \frac{1}{4}mr^2\omega^2$$

As we know $v = r\omega$, so $r^2\omega^2 = v^2$, hence

$$(K.E)_{rot} = \frac{1}{4}mv^2$$

38. A disc is rolling down on an inclined. Find a relation for the speed of disc at its bottom.

Ans: A disc rolling down on an inclined plane has both translational and rotational kinetic energy. If no energy is lost against friction, the total kinetic energy of the disc on reaching the bottom of the incline must be equal to its potential energy at the top.

$$P.E = K.E_{tran} + K.E_{rot}$$

As we know that for a disc

$$(K.E)_{rot} = \frac{1}{2}I\omega^2 = \frac{1}{4}mv^2$$

Thus

$$mgh = \frac{1}{2}mv^2 + \frac{1}{4}mv^2$$

or

$$v_{disc} = \sqrt{\frac{4gh}{3}}$$

39. Why is the axis of rotation of Earth remains fixed in one direction with respect to the universe around it?

Ans: The major force acting on Earth is the pull of the Sun and no other sizeable torque is experienced by it. The Earth's axis of rotation, therefore, remains fixed in one direction with reference to the universe around us.

40. What types of energies are possessed by a hoop moving down frictionless inclined plane?

Ans: A hoop rolling down on an inclined plane has both translational and rotational kinetic energy. If no energy is lost against friction, the total kinetic energy of the disc on reaching the bottom of the incline must be equal to its potential energy at the top.

$$P.E = K.E_{tran} + k.E_{rot}$$

41. Show that velocity of hoop rolling down on an inclined plane is $v = \sqrt{gh}$. (2 Times)

Ans: For a hoop $I = mr^2$

Thus $K.E_{rot} = \frac{1}{2} I\omega^2$

$= \frac{1}{2} mr^2\omega^2 = \frac{1}{2} m(r\omega)^2$

$K.E_{rot} = \frac{1}{2} mv^2$

For a hoop rolling down on an inclined plane total K.E on reaching the bottom must be equal to its P.E at the top $P.E = K.E_{Trans} + K.E_{rot}$

$mgh = \frac{1}{2} mv^2 + \frac{1}{2} mv^2$

$\cancel{m} gh = \cancel{m} v^2$

$v^2 = gh \quad \Rightarrow v = \sqrt{gh}$

42. Give one practical application of the rotational kinetic energy.

Ans: Rotational kinetic energy is put to practical use by fly wheels, which are essential parts of many engines.

A fly wheel stores energy between powers stokes of the pistons and distribute over the full revolution of crankshaft to make the rotation smooth.

Topic IX: Artificial Satellites:

43. What are satellites and how they move around the earth?

Ans: Satellites are the objects that orbit around the earth. They are put into orbit by rockets and are held in orbits by the gravitational pull of the earth.

44. What are Artificial Satellites?

Ans: Artificial Satellites are the man-made objects that orbit around the Earth.

Topic X: Real and Apparent Weight:

45. Differentiate between apparent weight and real weight. (5 Times)

Ans: Apparent weight: The weight of the object which is measured by spring balance is called apparent weight.

Real weight: The real weight on the earth is the gravitational pull of the earth on the object.

46. A body of mass "m" is suspended from the ceiling of an elevator. If the elevator is ascending with acceleration "a", what would be the value of "T" acting on the body?

Ans: when the elevator is moving upward with acceleration a, then

$$T - W = ma$$

or

$$T = W + ma$$

The object will then weigh more than its real weight by an amount ma.

Topic XI: Weightlessness in Satellites and Gravity Free System:

47. What is escape velocity?

Ans: The initial velocity of an object with which it goes out of the earth's gravitational field is called escape velocity. $v_{esc} = \sqrt{2gR} = 11\ kms^{-1}$

48. An object orbiting around the earth in said to be a freely falling body. Why?

Ans: An object in orbit is said to be freely falling, because the trajectory of its fall has the same curvature as Earth's surface. In fact, the object is falling towards the center of earth but because of spherical shape of earth, it never reaches the surface of earth.

49. Explain why earth's satellite despite of being freely falling object does not reach the earth. *(2 times)*

Ans: To orbit the planet and not come crashing down, a spacecraft has to travel forward (tangential to Earth) fast enough that it compensates for the fall downwards. The trajectory of its fall has the same curvature as earth's surface. So it will never reach the earth.

50. Define weightlessness and Gravity free system. **(2 Times)**

OR Explain weightlessness in satellites.

Ans: <u>Weightlessness</u>: When the object is thrown horizontally fast enough from a certain height, so that the curvature of its path will match with the curvature of the Earth then the object simply revolve around the Earth. Hence motion of the object under the constant acceleration is only under the action of gravitational force so that the object is said to be in state of weightlessness.

<u>Gravity free system:</u> A satellite is a freely falling body and all the objects inside it are weightless. No force is required to hold an object in the frame of reference of the space satellites. Such a system is called gravity free system .

51. Explain why an object, orbiting the earth is said to be freely falling. Use your explanation to point.

out why objects appear weightless under certain circumstances.

Ans: In fact, the spaceship is falling towards the center of the earth at because of spherical shape of earth, it never reaches the surface of the earth. The curvature of its path will match the curvature of the earth.

Since the spaceship is in free fall, all the objects within it appear to be weightless. Thus no force is required to hold an object falling in the frame of reference of the space craft or satellite. Such a system is called gravity free system.

Topic XII: Orbital Velocity:

52. What do you mean by orbital velocity and artificial gravity? **(2 times)**

Ans: <u>Orbital velocity:</u> The tangential velocity to put a satellite into orbit around the earth is called orbital velocity. $V = \sqrt{\frac{GM}{r}}$

<u>Artificial gravity:</u> Artificial gravity is the gravity like effect produced in an orbiting spaceship to overcome weightlessness by spinning the spaceship about its own axis.

53. Describe what should be the minimum velocity for a satellite, to orbit close to the earth around it. *(6 Times)*

OR What is critical velocity. Find its value. **(2 Times)**

Ans: We know that

$$v = \sqrt{gR}$$

$$v = \sqrt{9.8 \times 6.4 \times 10^6}$$

$$v = 7.9\ kms^{-1}$$

This is the minimum velocity necessary to put a satellite into the orbit and is called critical velocity.

54. What will be the effect on moment of inertia of a cylinder about its axis if its diameter is doubled?

Ans: Moment of inertia of a cylinder about its axis is given as

$$I = \tfrac{1}{2} m r^2$$

Or

$$I = \tfrac{1}{2} m (d/2)^2$$

If diameter is doubled i.e $d' = 2d$ then,

$$I' = \tfrac{1}{2} m (d'/2)^2$$

$$I' = \tfrac{1}{2} m (2d/2)^2$$

$$I' = 4 \{\tfrac{1}{2} m (d/2)^2\}$$

$$I' = 4 I$$

Thus, moment of inertia will be four times.

Topic XIII: Artificial Gravity:

55. How is artificial gravity created? **(4 Times)**

Ans: Artificial gravity is the gravity like effect produced in an orbiting spaceship to overcome weightlessness. To create artificial gravity the spaceship is set into rotation around its own axis. The astronaut then is pressed towards the outer rim and exerts a force on the floor of the spaceship in much the same way as on the earth.

Topic XIV: Geostationary Orbits:

56. Explain how many minimum number of geo-stationary satellites are required for global coverage of T.V transmission. (11 Times)

Ans: A geostationary satellite covers 120^0 of longitude. So the whole earth can be covered by three correctly positioned geostationary satellites.

57. What are geostationary orbit and geostationary satellites?

Ans: Geostationary orbit: An orbit in which the time period of satellite is equal to the time period of spin motion of the earth is called geostationary orbit.

Geostationary satellites: A satellite whose orbital motion is stationary along the earth is called geostationary satellite.

58. What is geo-stationary satellite? How many minimum number of geo stationary satellites are required for global coverage of T.V transmission?

Ans: A satellite whose orbital motion is stationary along the earth is called geostationary satellite. The time period of satellite is equal to the time period of spin motion of the earth.

A geostationary satellite covers $120^0$of longitude. So the whole earth can be covered by three correctly positioned geostationary satellites.

59. Define geo-synchronous satellite and what is the height of such satellite above the earth?

Ans: A satellite whose orbital motion is synchronized with the rotation of the earth is called geo-synchronous or geostationary satellite.

Its height above the equator is about 36000 km.

60. Define the terms (a) Gravitation, and (b) Geodesics.

Ans: According to Newton, the gravitation is the intrinsic property of matter that every particle of matter attracts every other particle with a force that is directly perportional to the product of their masses and is inversely proportional to the square of distance between them.

Geodesic is a curve representing in some sense the shortest path between two points in a surface.

Geodesics are equivalent to straight lines in plane geometry.

Topic XV: Communication Satellites:

61. Why the microwaves are used in satellite communication? (3 Times)

Ans: Micro waves are used in satellite communication because they travel in a narrow beam, in a straight line and pass easily through the atmosphere of the earth.

62. Write down applications of communication satellites. (2 Times)

Ans: A satellite communication system consists of three geo-stationary satellites. There are over 200 Earth stations which can transmit and receive signals. INTELSAT-VI operates at microwave frequencies 4, 6, 11 and 14 GHz and has a capacity of 30,000 two way telephone circuits plus three TV channels.

Geo-stationary satellites are very useful for worldwide communication, weather observations, navigation, and other military uses.

63. What is meant by INTEL SAT? At what frequencies the INELSAT-VI operates? (2 Times)

Ans: The largest satellite system managed by 126 countries is International Telecommunication Satellite Organization (INTELSAT).

The INELSAT-VI operates at microwaves frequencies of 4, 6, 11 and 14 GHz.

Topic XVI: Newton's and Einstein's Views of Gravitation:

64. Why Einstein views of gravitation are preferred than Newton's views of gravitation? Explain briefly. (2 times)

Ans: Newton discovered the inverse square law of gravity. Einstein's theory also says that gravity follows an inverse square law (except in strong gravitational fields), but it gives us a physical picture of how gravity works. The bending of star light caused by the gravity of the Sun was measured during a solar eclipse in 1919, it was found to match Einstein's prediction rather than Newton's.

65. What is main difference between Newton's & Eintstein's views of gravitation? (2 Times)

Ans: According to Newton, the gravitation is the intrinsic property of matter. He offered no explanation of why gravity should follow an inverse square law.
According to Einstein's theory, space time is curved, especially near massive bodies. Gives us a physical picture of how gravity works.
The deflection of light by gravity is predicted to be exactly twice as great as it is according to Newton's theory. Einstein's theory is better than Newton's.

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66. Define the terms (a) Rotational Kinetic Energy (b) Orbital velocity.

Ans: (a) **Rotational Kinetic Energy:** The kinetic energy of a body moving in a circular path is called rotational kinetic energy.

(b) **Orbital velocity:** The tangential velocity to put a satellite into orbit around the earth is called orbital velocity.

67. Find the rotational kinetic energy of hoop.

Ans: As we know

$$(K.E)_{rot} = \frac{1}{2} I\omega^2$$

Moment of inertia of a hoop is

$$I = mr^2$$

So,

$$(K.E)_{rot} = \frac{1}{2}(mr^2)\omega^2$$

$$(K.E)_{rot} = \frac{1}{2}mr^2\omega^2$$

As we know $v = r\omega$, so $r^2\omega^2 = v^2$, hence

$$(K.E)_{rot} = \frac{1}{2}mv^2$$

68: Define angular displacement. How its direction can be found.

Ans: The angle, through which a particle moves in a certain interval of time, while moving in a circle, is called its angular displacement.

$$\theta = \frac{s}{r}$$

Its SI unit is radian. The direction of angular displacement is determined by right hand rule: Grasp the axis of rotation in right hand with curling in the direction of rotation; the thumb points in the direction of angular displacement.

69. What do you mean by orbital velocity? Write down its formula.

Ans: The tangential velocity to put a satellite into orbit around the earth is called orbital velocity. $v = \sqrt{\frac{GM}{r}}$

70. State the law of angular conservation of linear momentum. Explain its importance.

Ans: The law of conservation of angular momentum states that if no external torque acts on a system, the total angular momentum of the system remains constant.

$$L_1 + L_2 + L_3 + \ldots\ldots\ldots\ldots = \text{constant}$$

This fact is of great importance for the Earth as it moves around the Sun. No other sizeable torque is experienced by the Earth, because the major force acting on it is the pull of the Sun. The Earth's axis of rotation, therefore, remains fixed in one direction with reference to the universe around us.

71. A 1000 kg car travelling with a speed of 40 ms^{-1} around a curve of radius 100 m. Find the necessary centripetal force.

Sol:

$$mass \Rightarrow m = 1000\ kg$$
$$velocty = v = 40\ ms^{-1}$$
$$radius = r = 100\ m$$
$$centripetal\ force = F_c = ?$$

Since, centripetal force is $F_c = \frac{mv^2}{r}$

$$F_c = \frac{(1000)(40)^2}{100}$$
$$F_c = 16000\ N = 1.6 \times 10^4\ N$$

LONG QUESTIONS OF CHAPTER-5 IN ALL PUNJAB BOARDS 2011-2021

Topic IV: Centripetal Force:

1. Define Centripetal Acceleration and drive its relation. **(2 Times)**
2. Define centripetal force and derive its formula $F_c = \frac{mv^2}{r}$. **(2 Times)**
3. What is meant by centripetal force? Derive relations for centripetal force and centripetal acceleration. **(3 Times)**
4. What is meant by centripetal force? Show by mathematical proof that $a_c = v^2/r$ (2 times)

Topic VI: Angular Momentum:

5. Describe Angular Momentum and discuss the Law of Conservation of Angular Momentum with one example.

Topic VIII: Rotational K.E:

6. Define rotational kinetic energy. Also derive an expression for rotational K.E of a disc and a hoop. **(4 Times)**
7. What is meant by rotational kinetic energy? Using this find velocity of disc and hoop at the bottom of an inclined plane.
8. Explain rotational kinetic energy. Prove that velocity of disc is greater than hoop if both are rolling down from the same height.

Topic IX: Artificial Satellites:

9. What are artificial satellites? Find the expression for velocity and period to put a satellite into the orbit?

Topic XIV: Geostationary Orbits:

10. What are geostationary orbits and geostationary satellite? Derive a relation for geostationary orbit.
11. What are Geostationary Satellites? Derive the relation for radius of Geostationary Orbit. **(7 Times)**

NUMERICAL PROBLEMS OF CHAPTER-5 IN ALL PUNJAB BOARDS 2011-2021

Topic III: Angular Acceleration:

1. A gramophone record turntable accelerates from rest to an angular velocity of 45.0 rev min^{-1} in 1.60s. What is its average angular acceleration? (4 times)

Sol
$\omega_i = 0$

$\omega_f = 45.0$ rev/min $= \frac{45\times 2\pi}{60}$ rad/s $= \frac{45\times 2\,(3.14)}{60}$ rad/s $= 4.7$ rad/s

$t = 1.60$ s

$\alpha_{av} = ?$

Since $\alpha_{av} = \frac{(\omega_f-\omega_i)}{t} = \frac{4.7-0}{1.60} = 2.95$ rad s^{-2}

Topic IV: Centripetal Force:

2. A 1000 kg car travelling with a speed of 144 kmh^{-1} around a curve of radius 100 m. Find the necessary centripetal force. (4 times)

Sol:

$$mass = m = 1000\ kg$$
$$velocty = v = 144\ kmh^{-1} = \frac{144\times 1000}{60\times 60}\ ms^{-1} = 40\ ms^{-1}$$
$$radius = r = 100\ m$$
$$centripetal\ force = F_c = ?$$

Since, centripetal force is $F_c = \frac{mv^2}{r}$

$$F_c = \frac{(1000)(40)^2}{100}$$
$$F_c = 16000\ N \boxed{= 1.6\times 10^4\ N}$$

3. A 1000 kg car in turning around a corner at 10 ms^{-1} as it travels along an arc of a circle. If the radius of the circular path is 10 m. How large a force must be exerted by the pavement on the tyres to hold the car in the circular path?

Sol:

$$mass = m = 1000\ kg$$
$$velocty = v = 10\ ms^{-1}$$
$$radius = r = 10\ m$$
$$centripetal\ force = F_c = ?$$

Since, centripetal force is $F_c = \frac{mv^2}{r}$

$$F_c = \frac{(1000)(10)^2}{10}$$
$$F_c = 10000\ N \boxed{= 1\times 10^4\ N}$$

4. What is the least speed at which an aeroplane can execute a vertical loop of 1.0 km radius, so that there will be no tendency for the pilot to fall down at the highest point? (3 Times)

Sol:

$$radius = r = 1\ km = 1000\ m$$
$$acceleration\ due\ to\ gravity = g = 9.8\ ms^{-2}$$
$$speed = v = ?$$

At the highest point, weight should be balanced by centrifugal force

Thus $mg = \frac{mv^2}{r}$

$$g = \frac{v^2}{r}$$

$$v = \sqrt{gr}$$

$$v = \sqrt{(9.8)(1000)}$$

$$v = 98.99\ ms^{-1}\ \boxed{= 99\ ms^{-1}}$$

5. A 1000 kg car is travelling with a speed of 144 kmh^{-1} around a curve of radius 100m. Find the necessary centripetal force.

Sol: m = 1000 kg

r = 100 m

$v = 144\ kmh^{-1} = \frac{144 \times 1000}{60 \times 60}$ m/s = 40 m/s

$F_c = ?$

Since, $F_c = \frac{1000 \times (40)^2}{100}$

$F_c = 1.60 \times 10^4$ N

6. What is the least speed at which an aeroplane can execute a vertical loop of 1km radius so that there will be no tendency for the pilot to fall down at the highest point?

Sol: r = 1.0 km = 1000 m

$g = 9.8\ ms^{-2}$, $v = ?$

At the highest point, weight should be equal to the centrifugal force So that the pilot will not fall down

Thus $\frac{mv^2}{r} = mg$

$g = \frac{v^2}{r}$

$v^2 = gr$

$v^2 = 9.8 \times 100 = 9800$

Taking square root $v = \sqrt{9800} = 99\ ms^{-1}$

Topic V: Moment of Inertia:

7. A body of moment of inertia $I = 0.80\ kgm^2$ about a fixed axis rotates with constant angular velocity of $100\ rad\ s^{-1}$. Calculate its angular momentum and torque to sustain this motion. (5 times)

Sol:

$$moment\ of\ inertia = I = 0.80\ kgm^2$$

$$constant\ angular\ velocity = \omega = 100\ rad\ s^{-1}$$

$$angular\ momentum = L = ?$$

$$torque = \tau = ?$$

Since $L = I\omega$

$$L = (0.80)(100)\ \boxed{= 80\ Js}$$

As the body is rotating with constant angular velocity. Therefore, its angular acceleration $\alpha = 0$

Since $\tau = I\alpha$

$$\tau = (80)(0)\ \boxed{= 0}$$

8. The earth rotates on its axis once a day. Suppose by some process the earth contracts so that its radius is only half as large as at present. How fast will it be rotating then? (For sphere $I = \frac{2}{5}MR^2$). (2 times)

Sol:

Before contraction: Mass of earth = M

Radius of earth = R

Angular velocity = ω_1

Period of rotation of earth = T_1 = 24h

After contraction: Radius of earth = $R' = \frac{R}{2}$

Angular velocity = ω_2

Period of rotation = T'

For sphere, $I = \frac{2}{5}MR^2$

According to law of conservation of momentum

$L_1 = L_2$

$$I_1 \omega_1 = I_2 \omega_2$$
$$\frac{2}{5} MR^2\omega_1 = \frac{2}{5} MR'^2 \omega_2$$
$$R^2\omega_1 = \left(\frac{R}{2}\right)^2 \omega_2$$
$$R^2\omega_1 = \frac{R^2\omega_2}{4}$$
$$\omega_1 = \frac{\omega_2}{4} \qquad (\because \omega = \frac{2\pi}{T})$$
$$\frac{2\pi}{T} = \left(\frac{2\pi}{T'}\right)\frac{1}{4}$$
$$T' = \frac{T}{4}$$

Putting the value we get $T' = \frac{24\,h}{4} = 6$ hours

9. Calculate the angular momentum of a star of mass $2\times10^{30}\ kg$ and radius $7.0\times10^5\ km$. If it makes one complete rotation about its axis once in 20 days.

(2 Times)

Sol: Mass of star $M = 2.0\times10^{30}\ kg$

Radius of star $R = 7.0\times10^5\ kg$

Or $R = 7.0\times10^8\ m$

Time period of star $T = 20\ days$

Or $T = 20\times24\times60\times60\ s$

$T = 1728000s$

$L = ?$

For star (i.e sphere)

$$I = \frac{2}{5}MR^2$$

And $\omega = \frac{2\pi}{T}$

We know that

$L = I\omega$

Thus $L = \frac{2}{5}MR^2 \times \frac{2\pi}{T}$

Putting value, we get

$$L = \frac{2}{5}\times2.0\times10^{30}\times\left(7.0\times10^8\right)^2\times\frac{2(3.14)}{172800}$$

$L = 0.00014\times10^{46}$

Or $L = 1.4\times10^{42}\ Js$

Topic VIII: Rotational K.E:

10. A disc without slipping rolls down a hill of height 10 m. If the disc starts from rest at the top of the hill, what is its speed at the bottom? (3 Times)

Sol:

$height = h = 10\ m$

$speed = v = ?$

Since $v = \sqrt{\frac{4gh}{3}}$

$$v = \sqrt{\frac{4(9.8)(10)}{3}} \boxed{= 11.4\ ms^{-1}}$$

11. **An electric fan rotating at 3.0 rev/s is switched off, it comes to rest in 18 sec. Assuming decleration to be uniform, find its value. How many revolutions did it turn before coming to rest?** **(2 Times)**

Sol

$$\omega_i = 3.0 revs^{-1}$$

$$\omega_f = 0$$

$$t = 18.0 sec.$$

$$a = ?$$

$$\theta = ?$$

$$a = \frac{\omega_f - \omega_i}{t}$$

$$a = \frac{0-3}{18}$$

$$a = -\frac{3}{18}$$

$$a = -0.167 revs^{-2}$$

As

(i) $$\theta = \omega_i t + \frac{1}{2}at^2$$

$$\theta = 3\times18 + \frac{1}{2}(-0.167)\times(18)^2$$

$$\theta = 54 + (-0.083)(324)$$

$$\theta = 54 - 26.4$$

$$\theta = 27 rev (Approx)$$

Topic XII: Orbital Velocity:

12. **What should be the orbital speed to launch a satellite in a circular orbit 900 km above the surface of the earth?** **(6 Times)**

Sol:

$$mass\ of\ earth = M = 6.0\times10^{24}\ kg$$

$$radius\ of\ the\ earth = R = 6400\ km$$

$$height\ of\ the\ satellite = h = 900\ km$$

$$total\ radius = r = R + h = 6400 + 900 = 7300\ km$$

$$= 7300\times10^3 m$$

$$orbital\ speed = v = ?$$

Since $$v = \sqrt{\frac{GM}{r}}$$

$$v = \sqrt{\frac{6.67\times10^{-11}\times6.0\times10^{24}}{7300\times10^3}}$$

$$v = 7.4\times10^3\ ms^{-1} \boxed{= 7.4\ km/s}$$

OBJECTIVES (MCQ'S) OF CHAPTER-6 IN ALL PUNJAB BOARD 2011-2021

Topic I: Viscous Drag and Stokes Law:

1. **The maximum drag force on falling sphere is 9.8 N. its weight is:**
(A) 1 N (B) 9.8 N (C) 19.8 N (D) 4.9 N
2. **Which of the following has maximum viscosity?**
(A) Air (B) Water (C) Acetone (D) Glycerin
3. **SI unit of coefficient of viscosity is:** **(5 Times)**
(A) $kgm^{-1}s^{-1}$ (B) $kgm^{-1}s$ (C) $kgms^{-1}$ (D) None of these
4. **The drag force F on a sphere of radius r moving slowly with speed v through a fluid of viscosity ηis:**
(A) $6\pi\eta r^2 v$ (B) $6\pi\eta rv$ (C) $6\pi\eta r^3 v$ (D) $6\pi\eta rv^2$
5. **An object moving through a fluid experience a retarding force is called:**
(A) Drag force (B) Gravitational force (C) Terminating force (D) Frictional force
6. **The word FLUID means:**
(A) To rise (B) To fall (C) To flow (D) To oppose

Topic II: Terminal Velocity:

7. **When a body is falling under the action of gravity with terminal velocity, its acceleration is:** **(2 Times)**
(A) Constant (B) Zero (C) Variable (D) $9.8 m/s^2$
8. **If the radius of droplet becomes half, then its terminal velocity will be: (4 Times)**
(A) Double (B) Half (C) One fourth (D) Four time
9. **The terminal velocity of a drop is proportional to the square of its:**
(A) Radius (B) Density (C) Volume (D) Mass
10. **A fog droplet falls vertically through air with an acceleration:**
(A) Equal to "g" (B) Less than "g" (C) Zero (D) Greater than "g"
11. **A mass of 1 Kg is freely falling. The force of gravity is:**
(A) 1 N (B) 9.8 N (C) 0.5 N (D) Zero

Topic III: Fluid Flow:

12. **The device used for the measurement of liquid flow is:** **(2 Times)**
(A) manometre (B) barometre (C) hydrometre (D) venturimeter
13. **A horizontal pipe narrows from a diameter of 10cm to 5cm. For a fluid flowing from larger diameter to smaller:**
(A) The velocity and pressure both increase
(A) The velocity increase and pressure decrease
(B) The velocity decrease and pressure increase
(C) The velocity and pressure both decrease
14. **The friction effect between difference layers of moving fluid is called:**
(A) Fluidity (B) Density (C) Viscosity (D) Flow rate
15. **____ has minimum viscosity:**
(A) Air (B) Water (C) Glycerin (D) Acetone
16. **If the Stream lines of fluid are forced closer together then:**
(A) Speed of the Fluid Increases (B) Speed of the Fluid Decrease
(C) Pressure of the Fluid Increases (D) Speed of the Fluid Remains Same

Topic IV: Equation of Continuity:

17. **The pressure will be low where the speed of fluid is:** **(4 Times)**
(A) High (B) Low (C) Zero (D) Constant
18. **The SI unit of flow rate of fluid is:** **(6 Times)**
(A) $m^3 \sec^{-1}$ (B) $m^2 \sec^{-1}$ (C) $m^2 \sec^{-2}$ (D) $m^3 \sec^{-3}$

Topic V: Bernoulli's Equation:

19.The term $\frac{1}{2}\rho v^2$ in Bernoulli's equation has same unit as: **(3 times)**

(A) Work (B) Volume (C) Pressure (D) Force

20.Bernoulli's theorem is applicable to:

(A) Solids (B) Plasma state (C) Fluids (D) Liquids

21.A 6 m high tank is full of water. A hole appears at its mid. What is the speed of efflux? **(2 times)**

(A) 7.66 ms^{-1} (B) 5.66 ms^{-1} (C) 6.66 ms^{-1} (D) 8.66 ms^{-1}

22.The unit of ρgh is same as that of: **(3 times)**

(A) Pressure (B) Energy (C) Power (D) Force

Topic VI: Applications of Bernoulli's Equation:

23.Blood vessels are not rigid, so they can:

(A) Remain blocked (B) stretch (C) be tight (D) None of the above

24.The mathematical relation, $v_2 = \sqrt{2g(h_1 - h_2)}$ is known as:

(A) Equation of continuity (B) Bernoulli's equation

(C) Torricelli's theorem (D) venturi relation

25.The venture metre is used to find: **(7 Times)**

(A) Speed of the fluid (B) Density of the fluid

(C) Pressure of the fluid (D) Viscosity of the fluid

26.Where the blood pressure is large:

(A) In the neck (B) In the hand (C) In the foot (D) In the leg

27.Venturi relation is given as: **(3 times)**

(A) $P = \frac{1}{2}\rho v^2$ (B) $P_1 - P_2 = \frac{1}{2}\rho v_2^2$

(C) $P_1 - P_2 = \frac{1}{2}\rho v_1^2 - \frac{1}{2}\rho v_2^2$ (D) $v_2 = \sqrt{2g(h_1 - h_2)}$

28.The density of blood is nearly equal to: **(3 Times)**

(A) Air (B) Water (C) Milk (D) Honey

29.The velocity of efflux is measured by relation:

(A) $\sqrt{gh}$ (B) $\sqrt{gh/2}$ (C) $\sqrt{2gh}$ (D) $\sqrt{4/3gh}$

30.SI unit of blood pressure is:

(A) Watt (B) Nm^{-2} (C) Torr (D) Bar

31.The systolic pressure of normal healthy person is: **(4 Times)**

(A) 120 torr (B) 130 torr (C) 115 torr (D) 110 torr

32.High concentration of red blood cells increases viscosity of blood from

(A) 2-3 times that of water (B) 3-4 times that of water

(C) 3-5 times that of water (D) 4-5 times that of water

33.1 torr in Nm^{-2} is expressed as: **(5 times)**

(a) 130.5 Nm^{-2} (b) 133.3 Nm^{-2} (c) 135.3 Nm^{-2} (d) 140.5 Nm^{-2}

34. Bunsen burner works on the principle of:

(A) Venturi effect (B) Terricilli's effect

(C) Bernoull's effect (D) None of these

35. Opted unit to measure blood pressure is:

(A) N/m^2 (B) Pascal (C) mm of Hg (D) $N.m^2$

36. The instrument which detects the instant at which the external pressure becomes equal to the systolic pressure is called.

(A) Monometer (B) Sphygmomanometer (C) Barmometer (D) Stethoscope

37. The concentration of red blood cells in the blood is nearly.

(A) 40% (B) 60% (C) 50% (D) 25%

38. On the average for normal healthy person diastolic pressure is.

(A) 120 torr (B) 110 torr (C) 100 torr (D) 75 – 80 torr

39. Density of blood is nearly equal to that of:

(A) Water (B) Iron (C) Milk (D) Glycerin

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40. The dimensions of potential energy per unit volume are same as that of:
(a) Work (b) Pressure (c) Speed (d) Density

41. The diastolic pressure of a normal healthy person is:
(A) 70 to 75 torr (B) 75 to 80 torr (C) 80 to 85 torr (D) 70 to 80 torr

42. Pressure of fluid will be low where speed of fluid is:
(A) Low (B) High (C) Zero (D) Constant

43. Let A = Area of crossection of pipe V = speed of fluid then 'AV' is caled:
(A) Volume flow rate (B) Energyy flow rate(C) Mass flow rate (D) Pressure flow rate

2019

44. The systolic pressure for a normal healthy person is:
(A) 75 – 80 torr (B) 100 torr (C) 120 torr (D) 140 torr

45. Drag force is given by:
(A) Stoke's law (B) Bernoulli's equation (C) Continuity equation (D) Newton's law

46. If V_1= 0.20m/s and V_2= 2m/s and S= 1000 Kg/m³, then $P_1 – P_2$ will be:
(A) 1980 N/m² (B) 1970 N/m² (C) 1960 N/m² (D) 1990 N/m²

47. Laminar flow occurs at:
(A) High speed (B) Low speed (C) Zero speed (D) very high speed

48. Stoke's Law hold for bodies when they have: **(2 Times)**
(A) Spherical shape (B) Curved shape (C) Rectangular shape (D) Oblong shape

49. One Torr is equal to.
(A) 120 Pascals (B) 100 Pascals (C) 133.3 Pascals (D) 80 Pascals

50. Fluid dynamics is the study of the behavior of:
(A) Fluid at rest (B) Liquids at rest
(C) Liquids in motion (D) Liquids and gases in motion

51. The speed of efflux is equal to the velocity gained by the falling fluid under the action of gravity through a certain height is called:
(A) Torricelli's theorem (B) Bernoulli's theorem (C) Stoke's theorem (D) Venturi's theorem

52. Formula of racing cars have a:
(A) steamlined design (B) turbulented design (C) rectangular design (D) elliptical design

53. As the speed of object moving through a fluid increases then the drag force experienced by it:
(A) increases (B) decreases (C) remains constant (D) becomes zero

54. When the temperature increases, the viscosity of the gases:
(A) decreases (B) remains constant (C) increases (D) none of these

55. One the average for normal healthy person diastolic pressure is:
(A) 120 torr (B) 110 torr (C) 100 torr (D) 75 - 80 torr

56. Terminal velocity of a particle in the fluid depends on:
(A) Nature of fluid (B) Acceleration of particle
(C) Force of particle (D) Angular velocity of particle

57. Equation of continuity gives conservation of:
(A) Energy (B) Power (C) Mass (D) Density

58. Product of area of cross section, velocity and time gives:
(A) Volume (B) Density (C) Mass (D) Weight

59. Bernoulli's Equation based upon Law of Conservation of:
(A) Mass (B) Linear Momentum(C) Angular Momentum (D) Energy

60. A 20 meter high tank is full of water. A hole appears at its middle. The speed of efflux will be:
(A) 10 ms⁻¹ (B) 14 ms⁻¹ (C) 11.5 ms⁻¹ (D) 9.8 ms⁻¹

61. A 10 meter high tank is full of water. A hole appears at its middle. The speed of efflux will be: **(2 Times)**
(A) 5 ms⁻¹ (B) 10 ms⁻¹ (C) 100 ms⁻¹ (D) 5.11 ms⁻¹

62. Terminal velocity V_t is related with redius r of spherical objects as:
(A) $V_t \propto r^2$ (B) $V_t \propto r$ (C) $V_t \propto \frac{1}{r}$ (D) $V_t \propto \frac{1}{r^2}$

63. Equation or continuity gives the conservation of the:
(A) Mass (B) Energy (C) Speed (D) Volume

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64. When droplet of water has terminal velocity the acceleration is
(A) Maximum (B) Minimum (C) Zero (D) Constant

65. A ten meter high tank is full of water. A hole appears at its middle. The speed of efflux be:
(A) $5\,ms^{-1}$ (B) $9.9ms^{-1}$ (C) $8.9ms^{-1}$ (D) $5.11ms^{-1}$

66. The term $\frac{1}{2}\rho v^2$ in equation represents:
(A) K.E of fluid (B) Pressure energy (C) K.E per unit volume(D) P.E of fluid

67. A chimney works best when it is:
(A) Tall (B) Wide (C) Short (D) Narrow

68. Bernoulli's equation is based upon law of conservation of:
(A) Momentum (B) Energy (C) Mass (D) Charge

ANSWERS OF MULTIPLE CHOICE QUESTIONS

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
B	D	A	B	A	C	D	C	A	A	B	D	A	C	A
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
A	A	A	C	C	A	A	B	C	A	D	B	B	C	B
31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
A	C	B	C	C	D	C	D	A	B	B	B	A	C	A
46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
A	B	A	C	D	A	A	A	C	D	A	C	A	D	B
61	62	63	64	65	66	67	68							
B	A	A	D	B	C	A	B							

SHORT QUESTIONS OF CHAPTER-6 IN ALL PUNJAB BOARDS 2011-2021

Topic I: Viscous Drag and Stokes Law:

1. Explain what you understand by term Viscosity? **(7 times)**
OR Define Viscosity.

Ans: The frictional effect between the layers of the flowing fluid is called viscosity. Viscosity measures, how much force is required to slide one layer of liquid over another layer.
It is denoted by Greek letter η.
Thick tar and honey have large coefficients of viscosity than water.

2. Briefly explain "viscous drag". OR Define drag force. **(2 Times)**

Ans: An object moving through a fluid experience a retarding force called the drag force. The drag force depends upon the velocity of object in a fluid and is given by Stoke's law.

$$F_D = 6\pi\eta r v$$

$$\text{OR} \quad \vec{F_D} \propto \vec{v}$$

At high speeds the force is no longer simply proportional to speed.

3. What do you mean by drag force and Venturi effect?

Ans: An object moving through a fluid experience a retarding force called the **drag force**. The drag force depends upon the velocity of object in a fluid.

$$\vec{F_D} \propto \vec{v}$$

While
The Venturi effect is that where the speed of fluid is high, pressure will be low.

4. What you know about viscosity and what is its effect on drag force?

Ans: The frictional effect between different layers of a flowing fluid is called viscosity. Viscosity measures, how much force is required to slide one layer of the liquid over another layer. Substances that have large viscosity causes a large drag force.

5. What is drag force? On what factors does it depend?

Ans: An object moving through a fluid experiences a retarding force called a drag force.

The drag force increases as the speed of the object increases.

By Stoke's law $F = 6\pi\eta r v$

The drag force "F" acting on a sphere depends upon:

(i) Radius of sphere (ii) speed of sphere "v" and (iii) viscosity of the medium "η"

6. State Stoke's law and what are the limitation of this law?

Ans: A sphere of radius r moving with speed v through a fluid of viscosity η experiences a viscous drag force $\vec{F}$ give by Stoke's law.

$F = 6\pi\eta r v$

At high speeds the force is no longer simply proportional to speed.

Topic II: Terminal Velocity:

7. Define terminal velocity. **(3 times)**

Ans: The maximum and constant velocity of an object falling vertically downward is called terminal velocity.

$$v_t = \frac{2gr^2\rho}{9\eta}$$

8. Why fog droplets appear to be suspended in air? **(16 Times)**

Ans: When the drag force on the fog droplet becomes equal to its weight, the net force acting on it is zero. And the droplet starts falling with a constant velocity called terminal velocity.

$$v_t = \frac{mg}{6\pi\eta r}$$

$$\text{Or} \quad v_t \propto m$$

As mass of the fog droplet is very small. So, its terminal velocity is very small and it appears to be suspended in air.

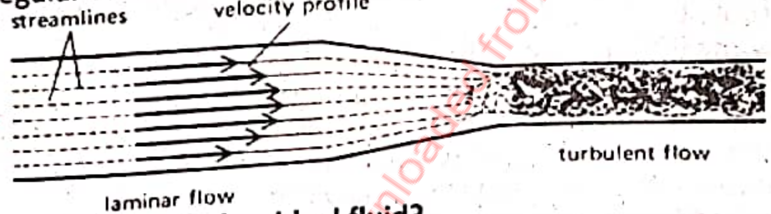
Topic III: Fluid Flow:

9. Differentiate between streamline flow and turbulent flow. **(6 Times)**

Ans: The flow is said to be steady or laminar or streamline flow if each particle of the fluid follows a smooth path.

While

The irregular or unsteady flow of the fluid is called turbulent flow.



10. What are conditions of an ideal fluid?

Ans: For an ideal fluid, the conditions are:

i. The fluid is non-viscous.

ii. The fluid is incompressible.

iii. The fluid motion is steady.

Topic IV: Equation of Continuity:

11. State equation of continuity.

Ans: For the steady flow of incompressible fluid, the equation of continuity states that "The product of the cross-sectional area of the pipe and the fluid speed at any point along the pipe is a constant". i.e $A_1v_1 = A_2v_2$

Topic V: Bernoulli's Equation:

12. Describe any application of Bernoulli's equation. (2 times)

Ans: When the cricket ball is thrown in such a way that is spins as well as moves forward, the velocity of the air on one side of the ball increases due to the spin and hence the pressure decreases. So the swing is produced in a fast moving cricket ball.
And it is just in accordance with Bernoulli's equation.

13. State Bernoulli's equation for liquid in motion. Give its mathematical form. (2 Times)

Ans: If the fluid is incompressible, non viscous and flows in a steady state manner through the pipe then Bernoulli's equation states that the sum of pressure, kinetic energy per unit volume and potential energy per unit volume remains constant.
Mathematically,

$$P + \frac{1}{2}\rho v^2 + \rho g h = \text{constant}$$

Topic VI: Applications of Bernoulli's Equation:

14. State Torricelli's theorem. Write the formula for the speed of efflux. (3 times)

Ans: It states that
The speed of efflux is equal to the velocity gained by the fluid in falling through a distance $(h_1 - h_2)$ under the action of gravity. $v_2 = \sqrt{2g(h_1 - h_2)}$

15. A person is standing near a fast moving train, is there any danger that he will fall towards it? (12 Times)

Ans: According to Bernoulli's equation, where the speed is high, pressure will be low. So the pressure between the person and train will be low as compared to the pressure of side way. So there is a danger that he may fall towards the train.

16. Explain how the swing is produced in a fast moving cricket ball. (18 Times)

Ans: When the cricket ball is thrown in such a way that it spins as well as moves forward, the velocity of the air on one side of the ball increases due to the spin and hence the pressure decreases. So the swing is produced in a fast moving cricket ball.

17. Considering Bernoulli's principle, explain the working of a carburetor of a motor car. (6 Times)

Ans: The carburetor of a car engine uses a Venturi duct to feed the correct mix of air and petrol to the cylinders. The air through the duct moves very fast, creating low pressure in the duct, which draws petrol vapour into the air stream and enters the cylinder of the engine, where combustion occurs.

18. Two boats moving parallel in the same direction are pulled toward each other. Explain. (7 Times)

Ans: According to Bernoulli's equation, where the speed is high, pressure will be low. So the pressure between the two boats decreases as compared to the pressure of sideway. So the side way high pressure pushes the two boats towards each other.

19. How an aeroplane is lifted up?

OR Explain how the lift is produced in an aeroplane?

Ans: The wing of the aero plane is designed to deflect the air so that the streamlines are closer together above the wing than below it. Thus, air is travelling faster on the upper side of the wing than on the lower. As the result, the pressure will be lower at the top of the wing, and the wing will be forced upward.

20. What is the function of a Venturi duct in the carburetor of a car?

Ans: In the carburetor of a car, Venturi duct to give correct mixture of air and petrol to the engine. Air is drawn through the duct and along a pipe to the cylinders. The low pressure in the duct draws petrol vapour into the air stream.

21. Write few lines on blood flow.

Ans: Blood is an incompressible fluid having density nearly equal to that of water. A high concentration of red blood cells increases its viscosity from three to five times. Blood vessels are not rigid. They stretched like rubber hose. There is tension in the walls of the blood vessels.

22 Describe the method of measuring human blood pressure.

Ans: The blood pressure of a person is measured using a device called sphygmomanometer.

A stethoscope detects the instant at which the external pressure becomes equal to the systolic pressure. At this point, the blood flow through the vessel with very high speed. As a result, the flow is initially turbulent.

As the pressure drops, the external pressure eventually equals the diastolic pressure. The flow of the blood switches from turbulent to laminar, and gurgle in the stethoscope disappears. This is the signal to record the diastolic pressure.

23. Why should Chimney be tall for its better working?

Ans: A Chimney works best when it is tall and exposed to air currents, which reduces the pressure at the top and force the upward flow of smoke.

24. Explain the term systolic and diastolic pressure.

Ans: The pressure varies from a high to a low value between beats in normal, healthy person.

The high pressure is called systolic pressure. Its value is 120 torr. The low pressure is called diastolic pressure. Its value is 75 – 80 torr. The numbers tend to increase with age.

25. How does a chimney work?

Ans: A chimney works best when it is tall and exposed to air currents, which reduces the pressure at the top and force the upward flow of smoke.

26. Define venturi effect. Also write its relation.

Ans: The effect of the decrease in pressure with the increase in speed of the fluid in a horizontal pipe is known as venturi effect.

$$P_1 - P_2 = \frac{1}{2}\rho v_2^2$$

This is known as Venturi relation.

27. What is Venturi Relation? Explain briefly.

Ans: Venturi relation is given as

$$P_1 - P_2 = \frac{1}{2}\rho v_2^2$$

This is used in venturi-meter, a device used to measure speed of liquid flow.

28. Derive the relation between speed and pressure of the fluid.

Ans: Suppose that water flows through a pipe as shown in figure. It is clear that water will flow faster at B than it does at A or C.

Let us assume $v_A = 0.20 ms^{-1}$, $v_S = 2.0\ ms^{-1}$ & $\rho = 1000\, kg\, m^{-3}$ Applying Bernoulli's equation

$$P_A + \frac{1}{2}\rho v_A^2 = P_B + \frac{1}{2}\rho v_B^2 \quad \Rightarrow P_A - P_B = 1980\ Nm^{-2}$$

This shows that

"Where the speed is high, the pressure will be low".

29. Derive Venturi Relation.

Ans: If one of the pipes has a much smaller diameter than the other as shown in figure.

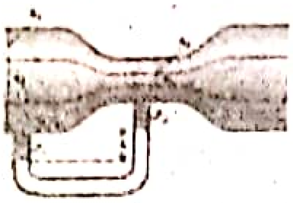
Bernoulli's equation can be written as

$$P_1 - P_2 = \frac{1}{2}\rho v_2^2 - \frac{1}{2}\rho v_1^2$$

As $A_2 << A_1$, using equation of continuity $(A_1 v_1 = A_2 v_2)$ we get $v_1 << v_2$. Thus $v_1 \approx 0$

Hence $p_1 - p_2 = \frac{1}{2}\rho v_2^2$

This is known as Venturi relation.



30. In an orbiting space station, would the blood pressure in major arteries in the legs ever be greater than the blood pressure in major arteries in the neck?

Ans: No, as in an orbiting space station, everything is in state of weightlessness. So, pressure will be same in major arteries of both in neck and legs.

31. State Bermoulli's relation for a liquid in motion and describe some of its applications.

Ans: For an ideal solution the sum of pressure, kinetic energy per unit volume, and potential energy per unit volume at any point along the pipe always remains constant.

$$P + \frac{1}{2}\rho v^2 + \rho gh = \text{constant}$$

Applications:

i. The swing of ball

ii. Lift on an aeroplane

iii. Working of carburetor in a car

2021

32. Explain the difference between laminar and turbulent flow. (2 Times)

Ans: **Laminar flow:** The flow is said to be streamline or laminar if every particle that passes a particular point, moves along exactly the same path as followed by particles which passed that points earlier.

Turbulent flow: The irregular or unsteady flow of the fluid is called turbulent flow.

LONG QUESTIONS OF CHAPTER-6 IN ALL PUNJAB BOARDS 2011-2021

Topic I: Viscous Drag and Stokes Law:

1. Define stoke's law and show that the terminal velocity is directly propeotional to square of radius of the object.

Topic II: Terminal Velocity:

2. Define terminal velocity. Show that terminal velocity is directly proportional to the square of radius. **(6 times)**

Topic IV: Equation of Continuity:

3. Stat and derive equation of continuity $A_1V_1 = A_2V_2$.
4. State and prove Equation of Continuity. **(3 Times)**
5. What is Equation of Continuity? Derive a relation for it. Also discuss flow rate.

Topic V: Bernoulli's Equation:

6. Derive Bernoulli's equation. **(4 times)**
7. State and prove Bernoulli's equation. **(7 Times)**
8. State and prove the Bernoulli's equation in dynamic fluid that relates pressure to fluid speed and height.
9. Establish a relation between pressure and speed of fluid and explain it with two examples.

NUMERICAL PROBLEMS OF CHAPTER-6 IN ALL PUNJAB BOARDS 2011-2021

Topic II: Terminal Velocity:

1. **Certain globular protein particle has a density of 1246 kgm^{-3}. It falls through pure water ($\eta = 8.0 \times 10^{-4}$ Nms^{-2}) with a terminal speed of 3.0 cmh^{-1}. Find radius of particle.**

Sol: Density of particle = ρ = 1246 kgm^{-3}

Viscosity of water = $\eta = 8.0 \times 10^{-4}$ Nms^{-2}

$g = 9.8\ ms^{-2}$

$v_t = 3.0\ cmh^{-1} = \frac{3.0}{100} \times \frac{1}{3600} ms^{-1} = 8.3 \times 10^{-6}\ ms^{-1}$

Radius of particle = r = ?

As terminal velocity $v_t = \frac{2\rho g r^2}{9\eta}$

$$r^2 = \frac{9\eta v_t}{2\rho g}$$

$$r^2 = \frac{9 \times 8.0 \times 10^{-4} \times 8.3 \times 10^{-6}}{2 \times 1246 \times 9.8} = 2.46 \times 10^{-12} = \sqrt{2.46 \times 10^{-12}}$$

$r = 1.56 \times 10^{-6}$ m

2. **A tiny water droplet of raidus 0.01 cm descends through air from a high building. Calculate its terminal velocity. Given that η for air = 19×10^{-6} $kgm^{-1}s^{-1}$ and density of water $\sigma = 1000 kgm^{-3}$.** **(3 times)**

Sol: $r = 0.010cm = 1.0 \times 10^{-4}m$

$\rho = 1000kgm^{-3}$

$N = 19 \times 10^{-6}kgm^{-1}s^{-1}$

$v_t = ?$

As $v_t = \frac{2gr^2\rho}{9n}$

Putting values, we get

$$v_t = \frac{2\times 9.8 \times (1.0\times10^{-4})^2 \times 1000}{9\times19\times10^{-6}}$$

$$= \frac{2\times 9.8 \times 10^{-8} \times 10^3}{9\times19\times10^{-6}}$$

$$= \frac{19.6\times10^{-5}}{171\times10^{-6}}$$

$$= 0.11 \times 10 ms^{-1}$$

$$v_t = 1.1 m/\sec$$

Topic IV: Equation of Continuity:

3. **Water flows through a hose whose internal diametre is 1 cm, at a speed 1 ms^{-1}. What should be the diametre of the nozzle if the water is to emerge at 21 ms^{-1}?** **(5 Times)**

Sol:

Given that internal diameter $= d_1 = 1\ cm = 0.01\ m$

diameter of the nozzle $= d_2 = ?$

$$speed\ of\ water\ flow = v_1 = 1\ ms^{-1}$$
$$speed\ of\ water\ emergence = v_2 = 21\ ms^{-1}$$

According to equation of continuity

$$A_1v_1 = A_2v_2$$

Since $A = \pi r^2 = \pi\left(\frac{d}{2}\right)^2 = \frac{\pi d^2}{4}$

So $\frac{\pi d_1^{\ 2}}{4}v_1 = \frac{\pi d_2^{\ 2}}{4}v_2$

$$d_1^{\ 2}v_1 = d_2^{\ 2}v_2$$
$$d_2^{\ 2} = \frac{d_1^{\ 2}v_1}{v_2}$$
$$d_2 = \sqrt{\frac{d_1^{\ 2}v_1}{v_2}} = \sqrt{\frac{(0.01)^2(1)}{21}} = 0.002\ m\ \boxed{= 0.2\ cm}$$

4. How large must a heating duct be if air moving with $3.0\ ms^{-1}$ along it can replenish the air in a room of $300\ m^3$ volume every 15 minutes? Assume the air density remains constant. (7 Times)

Sol:

Given that

$$speed\ of\ air = v = 3.0\ ms^{-1}$$
$$volume\ of\ air = V = 300\ m^3$$
$$time = t = 15\ min = 15 \times 60 = 900\ s$$
$$size\ of\ duct = r = ?$$

According to equation of continuity

$$Av = volume\ flow\ rate$$
$$Av = \frac{V}{t}$$
$$\pi r^2 v = \frac{V}{t},\quad r^2 = \frac{V}{\pi v t}$$
$$r = \sqrt{\frac{V}{\pi v t}} = \sqrt{\frac{300}{3.14 \times 3 \times 900}} = 0.19\ m\ \boxed{= 19\ cm}$$

5. A water hose with an internal diametre of $20\ mm$ at the outlet discharges $30\ kg$ of water in $60\ seconds$. Calculate the water speed at the outlet. Assume the density of water is $1000\ {kg}/{m^3}$ and its flow is steady. (3 times)

Sol:

Given that

$$diameter = d = 20\ mm = 20\times10^{-3}m$$
$$mass\ of\ water = 30\ kg$$
$$time = 60\ s$$
$$radius = r = \frac{d}{2} = 10 \times 10^{-3}\ m$$
$$density = \rho = 1000\ kgm^{-3}$$
$$v = ?$$

mass flow per second = 30 / 60 = 0.5 kg/s

Cross sectional area = $A = \pi r^2 = 3.14\times(10\times10^{-3})^2$

$= 3.143.14\times10^{-4}m^2$

The mass of water discharging per second through area (A) is

$$\rho \quad \frac{\text{mass}}{\text{second}}$$

$$v = \frac{\text{mass / second}}{\rho A} \quad v = \frac{0.5}{1000 \times 3.14 \times 10^{-4}}$$

$$\boxed{= 1.6\ ms^{-1}}$$

6. **How large must a heating duct be if air moving $300\,ms^{-1}$ along it can replenish the air in a room of $300\,m^3$ volume every 15 minutes? Assume air's density remains constant.**

Sol: Speed of air $v = 3.0\,m/s$

Volume of air $v = 300\,m^3$

Time $t = 15\min = 15 \times 60 = 900s$

Size of the duct $r = ?$

As Rate of flow$= \frac{V}{t} = Av$

Or $\frac{v}{t} = \pi r^2 v$

Or $r^2 = \frac{v}{t\pi v}$

Putting values, we get

$$r^2 = \frac{300}{900 \times 3.14 \times 3}$$

$$r^2 = 0.0354$$

Taking square root,

$$r = 0.188\,m$$

Or $r = 18.8\ cm$

$$r \approx 19\ cm$$

Topic V: Bernoulli's Equation:

7. **What gauge pressure is required in city mains for a stream from a fire hose connected to the mains to reach vertical height of $15.0\ m$?** (7 times)

Sol: It is given that $h_2 - h_1 = h = 15\ m$

$$g = 9.8\ ms^{-2}$$

$$density\ of\ water = \rho = 1000\ kgm^{-3}$$

$$\Delta P = ?$$

According to Bernoulli's equation

$$P_1 + \frac{1}{2}\rho v_1^2 + \rho g h_1 = P_2 + \frac{1}{2}\rho v_2^2 + \rho g h_2$$

$$P_1 - P_2 = \rho g(h_2 - h_1) + \frac{1}{2}\rho(v_2{}^2 - v_1{}^2)$$

As speed of water throughout the flow does not change i.e. $v_2 = v_1$

It gives $p_1 - p_2 = \rho g(h_2 - h_1) + 0$

Thus $\Delta P = \rho g h$

$$\Delta P = (1000)(9.8)(15) \boxed{= \mathbf{1.47 \times 10^5\ Pa}}$$

Topic VI: Applications of Bernoulli's Equation:

8. **The pipe near the lower end of large water storage tank develops a small leak and stream of water shoots from it. The top of the water in tank is 15 m above the point of leak. With what speed does the water rush from the hole? (2 times)**

Sol: Given that $height\ of\ water = h_1 - h_2 = 15\ m$

$speed\ of\ water\ emergence = v = ?$

According to Torricelli's theorem

$$v = \sqrt{2g(h_1 - h_2)} = \sqrt{2(9.8)(15)} \boxed{= \mathbf{17.14\ ms^{-1}}}$$

9. **An Airplane wing is designed so that when the speed of air across the top of the wing is 450ms^{-1}, the speed of air below the wing is 410ms^{-1}. What is the pressure difference between top and bottom wing? Density of air = 1.29 kgm^{-3}.**

Sol: $V_1 = 450$ m/s , $V_2 = 410$ m/s , $\rho = 1.29$ kg/m^3 , $P_2 - P_1 = ?$

According to venture relation $P_1 + \frac{1}{2}\rho v_1^2 = P_2 + \frac{1}{2}\rho v_2^2$

$$P_2 - P_1 = \frac{1}{2}\rho v_1^2 - \frac{1}{2}\rho v_2^2$$

$$P_2 - P_1 = \frac{1}{2}\rho\,(v_1^2 - v_2^2)$$

Putting the values $P_2 - P_1 = \frac{1}{2}(1.29)\,[(450)^2 - (410)^2]$

$$= \frac{1}{2} \times 1.29\,(202500 - 168100) = \frac{1}{2} \times 1.29\,(34400) = 22188\ \text{Pa}$$

$$P_2 - P_1 = 22.19 \times 10^3\ \text{Pa}$$

$$P_2 - P_1 = 22.19\ \text{kPa}$$

$$\mathbf{P_2 - P_1 \approx 22\ kpa}$$

10. **Calculate the angular momentum of a star of mass 2 x 10^{30} Kg and radius 7 x 10^5 Km. If it completes one complete rotation about its axis once in 20 days.**

Ans: $m = 2 \times 10^{30}$ Kg

$r = 7.0 \times 10^5$ km $= 7.0 \times 10^8$ m

$T = 20$ days $= 20 \times 20 \times 60 \times 60$ s $= 1728000$s

$L = ?$

$$\omega = \frac{\theta}{T} = \frac{2\pi\ rad}{T} = \frac{2(3.14)}{1728000} = 3.64 \times 10^{-6}\ rads^{-1}$$

$$L = I\omega$$

$$= \frac{2}{5} m r^2 \omega$$

$$L = \frac{2}{5} \times 2 \times 10^{30} \times (7.0 \times 10^8)^2 \times 3.6 \times 10^{-6}$$

$$L = 1.4 \times 10^{42}\ Js$$

OBJECTIVES (MCQ'S) OF CHAPTER-7 IN ALL PUNJAB BOARD 2011-2021

Topic I: Simple Harmonic Motion:

1.On increasing the tension, frequency of vibration of a string: **(2 Times)**
(A) Increase (B) Decrease
(C) Remains constant (D) First increase and then decrease

2.The product of time period and frequency is: **(4 Times)**
(A) Zero (B) 1 (C) π (D) 2

3.A body is executing SHM. What fraction of its total energy will be kinetic energy when its displacement from the mean position is half of its displacement?
(A) $\frac{1}{2}$ (B) $\frac{3}{2}$ (C) $\frac{3}{4}$ (D) $\frac{1}{4}$

4.Distance covered during one vibration of an oscillating body in terms of amplitude 'A' is: **(2 times)**
(A) A/2 (B) A (C) 2 A (D) 4 A

5.Acceleration of projection of a particle moving around a circle is given by relation:
(A) $a = -\frac{gx}{l}$ (B) $a = -\omega^2 x$ (C) $a = \frac{-k}{m}x$ (D) $a = -g\sin\theta$

6.At mean position during SHM:
(A) PE is maximum and KE is minimum (B)PE is minimum and KE is maximum
(C) Both KE and PE are maximum (D) Both KE and PE are minimum

7.The wave form of SHM is:
(A) Cosine wave (B) Sine wave (C) Square wave (D) Pulse wave

8.The time required to complete one vibration is called:
(A) Time period (B) Frequency (C) Vibration (D) Amplitude

9.If stretching force "T" of a wire is increased, then its frequency:
(A) Decrease (B) Increase (C) Remains same (D) One half

10..The acceleration of a body having SHM, depends upon its:
(A) Time period (B) Amplitude
(C) Frequency (D) Displacement from mean position

11.In simple harmonic motion the velocity of a particle is maximum at:
(A) Extreme position (B) Mean position
(C) In between extreme and mean position (D) None of them

12. When quarter of the cycle is completed of circular motion in SHM. The phase will be.
(A) 2π (B) $3\pi/2$ (C) π (D) $\pi/2$

13. The profile of periodic waves generated by a source executing S.H.M is represented by a:
(A) Circle (B) Sine Curve (C) Tangent curve (D) Cosine curve

Topic III: Horizontal Mass Spring System:

14. The S.I units of spring constant are: **(2 Times)**
(A) m^{-1} (B) Nm^{-1} (C) Nm^{-2} (D) Nm^2

15. If a string of length ℓ vibrates in n loops, the wavelength of stationary wave produced will be:
(A) $\frac{2\ell}{n}$ (B) $\frac{n\ell}{2}$ (C) $\frac{\ell}{2n}$ (D) $\frac{n\ell}{2}$

16. 10cm extension is produced in a spring due to a force of 20 N. The spring constant is:
(A) 2 Nm^{-1} (B) 20 Nm^{-1} (C) 200 Nm^{-1} (D) 2000 Nm^{-1}

17. The mathematical expression for the restoring force is:
(A) F = kx (B) F = ma (C) F = dp/dt (D) F = -kx

18. The dimension of spring constant "K" are:
(A) $[MLT^{-1}]$ (B) $[MT^{-2}]$ (C) $[MLT^{-2}]$ (D) $[MT^{-1}]$