1 UNITS & MEASUREMENTS

1 OMQ + 1 VSAQ [1 M + 2M = 3 M]

I.MULTIPLE CHOICE Q'S(MCQ)

OMQ'S

1×1= 1 Mark

1. **Pascal is the unit of** [2]
   1) power **2) pressure** 3) potential energy 4) pressure gradient

2. **When the number 0.046508 is reduced to four significant figures then it becomes [BMP2]** [1]
   1) 0.04651 2) 4650 3) 4.651 4) 4.650

3. **Which of the following physical quantity has no dimensions? [MAR-26]** [3]
   1) Angular Velocity 2) Angular Acceleration
   3) Angular Displacement 4) Stress

4. **Mention same dimensions in the dimensional formula of torque and angular momentum**
   1) mass, time 2) time, length **3) mass, length** 4) mass [3]

5. **The velocity of an object varies with time as $V = At^2 + B\,t + C$, then the dimensions of C are** [1]
   1) LT^{-1} 2) LT^{-2} 3) LT^{-3} 4) LT^{-4}

6. **Which of the following equation is dimensionally correct?** [1]
   1) $\frac{1}{2}mv^2 = mgh$ 2) $V = ut + at$ 3) $s = ut + at^3$ 4) $t = s + uv$

7. **The velocity (V) of sound in air pressure (P) and density (d) of air are related as $V \propto P^x d^y$. The value of x and y are** [3]
   1) 1, 1/2 2) –1/2, 1/2 **3) 1/2, –1/2** 4) 1/2, 1/2

8. **The velocity of a body is given by $V = A\,t^2 + B\,t + C$. If V and t are expressed in SI units, then unit of A is** [3]
   1) m/s 2) m/s^2 **3) m/s^3** 4) ms

9. **The dimensional formula for product of two physical quantities P and Q is ML^2T^{-2} and dimensional formula of P/Q is MT^{-2} then P is** [1]
   1) force 2) displacement 3) acceleration 4) velocity

10. **E, M, L and G denote energy, mass angular momentum and gravitational constant respectively. Then the dimension of $EL^2M^{-5}G^{-2}$ is** [1]
    1) angle 2) length 3) mass 4) time

(☞ Answers for MCQ are kept in **bold font)**

II. FILL IN THE BLANKS(FIB)

1. Plane angle is the ratio of length of arc to **radius**.
2. The unit of plane angle is **radian.**
3. The SI unit of luminous intensity is **Candela.**
4. The dimensional formula for the coefficient of viscosity is [$ML^{-1}T^{-1}$]
5. The number of significant figures in 0.02308 is **4**
6. If F, M and T are the force, mass and time, then $FM^{-1}T^2$ denotes **length**
7. A number 2.735 is rounded off to three significant figures is **2.74**
8. Plank's constant and **angular momentum** have same dimensions.
9. The dimensional formula of angular impulse is [ML^2T^{-1}] **[BMP1]**
10. A force is represented by $F = Ax^2 + Bt^2$, where x= distance and t = time then the dimensions of 'A' is [$ML^{-1}T^{-2}$]

III. ONE WORD ANSWER Q'S

1. What is fundamental physical quantity?

A: **Fundamental quantities** are the physical quantities which are **independent of other physical quantities. Ex:** Length, Mass, Time.

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2. What is derived physical quantity?

A: **Derived quantities** are the physical quantities which can be **derived from other physical quantities. Ex:** Velocity, Acceleration, Force.

---

3. What is the SI unit of solid angle?

A: SI unit of solid angle is **steradian.** Its symbol is **sr.**

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4. Write any one physical constant that is having dimensions.

A: **Planck's constant (h):** $[ML^2T^{-1}]$
Gravitational constant (G): $[M^{-1}L^3T^{-2}]$

---

5. Which physical quantity has negative dimensions in mass?

A: **Universal Gravitational constant** has negative dimensions in mass.

---

6. Which physical quantity is represented by $\sqrt{gR}$, where R is the radius of the Earth?

A: $\sqrt{gR}$ represents the **Orbital velocity** of a satellite.

---

7. Which physical quantity is represented by PV, where P is pressure and V is volume?

A: PV represents **Work.**

---

8. Name atleast one physical quantity whose SI unit is Nm^{-2}.

A: **Pressure, stress** have SI units Nm^{-2}

HINTS FOR HARD MCQ & FIB

MULTIPLE CHOICE QUESTIONS [MCQ]

1. **(2)** **Pascal in unit of pressure** $\left[\because P_a = \frac{kg}{ms^2} = \frac{N}{m^2} = \text{Unit of pressure}\right]$

2. **(1)** 0.046508 = 0.04651[8 is above 5 rule hence it is rounded to 1 & zero before non-zero after decimal is not significant.]

3. **(3)** Angular displacement $= \theta = \frac{l}{r} = \text{ratio of same entities (units)}$

4. **(3)** Dimension of torque = $[M^1L^2T^{-2}]$;Dimension of angular momentum = $[M^1L^2T^{-1}]$
So Mass, length have same dimensions.

5. **(1)** According to the principle of homogeneity Dimensions of C = Dimensions of velocity V = $[LT^{-1}]$

6. **(1)** $\frac{1}{2}mv^2 = K.E,\ mgh = P.E$

7. **(3)** $V = [L^1T^{-1}]$; $P = [M^1L^{-1}T^{-2}]$; $d = [M^1L^{-3}]$
$V \propto P^x\, d^y \Rightarrow [V] \propto [P^x\, d^y] \Rightarrow [LT^{-1}] = [M^1L^{-1}T^{-2}]^x\,[M^1L^{-3}]^y$
$\Rightarrow [M^0L^1T^{-1}] = [M^{(x+y)}\, L^{(-x-3y)}\ T^{-2x}]$
$\Rightarrow x + y = 0;\ -x - 3y = 1;\ -2x = -1 \Rightarrow x = 1/2;\ y = -1/2$

8. **(3)** From the principle of Homogeneity $[LT^{-1}] = A\,[T^2] \Rightarrow A = \frac{[LT^{-1}]}{[T^2]} = \left[\frac{L}{T^3}\right]$. So, units m/s^3

9. **(1)** $PQ = [M^1L^2T^{-2}]$ .....(1); $\frac{P}{Q} = [M^1L^0T^{-2}]$ .....(2)
$(1)\times(2 \Rightarrow P\cancel{Q} \times \frac{P}{\cancel{Q}} = [M^2L^2T^{-4}] \Rightarrow P^2 = [M^2L^2T^{-4}] \Rightarrow P = [M^1L^1T^{-2}] = \text{Force}$

10. **(1)** $EL^2M^{-5}G^{-2} = \frac{[M^1L^2T^{-2}][M^2L^4T^{-2}]}{[M^5][M^{-2}L^6T^{-4}]} = [M^0L^0T^0] = \text{Angle has no dimensions.}$

FILL IN THE BLANKS [FIB]

4. Coefficient of Viscosity $\eta = \frac{F}{A\left(\frac{dv}{dx}\right)} = \frac{[M^1L^1T^{-2}]}{[L^2]\left[\frac{L^1T^{-1}}{L^1}\right]} = \frac{\left[M^1L^{-1}T^{-2}\right]}{[L^2T^{-1}]} = \left[M^1L^{-1}T^{-1}\right]$

5. **4** [The zeros before the first non zero digit are not significant.]

6. $FM^{-1}T^2 = [M^1L^1T^{-2}]\,[M^{-1}T^2] = [M^0L^1T^0] = L = \text{Length}$

7. **2.74** (If the number to **be not** is exactly 5 then the digit before is odd then increase it by 1]

9. Angular Impulse = change in angular momentum
[Angular impulse] = [Angular momentum] = $[M^1L^2T^{-1}]$

10. According to principle of homogeneity $[F] = [Ax^2]$

$[M^1L^1T^{-2}] = A[L^2] \Rightarrow [A] = \frac{[MLT^{-1}]}{[L^2]} = [M^1L^{-1}T^{-2}]$

2 MOTION IN A STRAIGHT LINE

1 OMQ + 1 VSAQ + 1 SAQ [1 M + 2M + 4M = 7 M]

I.MULTIPLE CHOICE Q'S(MCQ)

OMQ'S

1×1= 1 Mark

1. Pascal is the unit of

1. The velocity of a body depends on time according to the equation $V = 10 + 2t^2$. The body is undergoing [3]

1) uniform acceleration 2) uniform retardation
3) non-uniform acceleration 4) zero acceleration

2. Which of the following is true? [4]

1) Speed is always equal to magnitude of velocity.
2) Speed is always greater than the magnitude of velocity.
3) velocity is always greater than speed
4) Speed in general is either equal to or greater than the magnitude of velocity.

3. A bullet is dropped from a certain height, at the same time another bullet is fired horizontally from the same height. Both bullets will hit the ground [2]

1) one after the other **2) simultaneously**
3) depends on the observer 4) depends on the velocity of the fired bullet

4. If a car is moving with a uniform velocity of 60 km/h. Then its acceleration is [1]

1) 0 km/h^2 2) 10 km/h 3) 20 km/h^2 4) 30 km/h^2 **[BMP2]**

5. A ball is thrown vertically upward with an initial velocity of 50 m/s. Its maximum height is (take g = 10m/s^2) [1]

1) 125m 2) 250 m 3) 500 m 4) 1000m

6. A particle moves in a straight line with an initial velocity of 10 m/s and a constant acceleration of 2 m/s^2. Its displacement after 5 seconds will be: [2]

1) 50 m **2) 75 m** 3) 150 m 4) 200 m

7. A body starts from rest and moves with a uniform acceleration of 2 m/s^2. Its velocity after 10 seconds will be [4]

1) 5 m/s 2) 10 m/s 3) 15 m/s **4) 20 m/s**

8. For the motion with uniform velocity, the slope of the velocity- time graph is equal to [2]

1) 1 m/s **2) zero** 3) initial velocity 4) final velocity

9. If a cyclist takes two minutes to complete half revolution on a circular path of 120 m radius, what is the average speed? [3]

1) 1 m/s 2) 2 m/s **3) 3.14 m/s** 4) 4.14 m/s

10. In a particular time, the net displacement travelled by the body is equal to [3]

1) the area which v - t graph encloses with displacement axis
2) the area which x - t graph encloses with the time axis
3) the area which v - t graph encloses with time axis
4) the area which a - t graph encloses with axis

11. A particle moves along a straight line. At a time t, the distance x of the particle from the origin is given by $x = 20 + 12t - t^3$, where x is in meters and t in sec, the time taken for the particle for coming to rest is [2]

1) 1 sec **2) 2 sec** 3) 4 sec 4) 6 sec

12. A car travels half of the distance with speed v and the remaining distance with speed 2v. Its average speed is [1]

1) $\frac{4v}{3}$ 2) $\frac{3v}{4}$ 3) $\frac{v}{3}$ 4) $\frac{2v}{3}$

13. A car runs at constant speed on a circular track of radius 100m, taking 62.8 seconds for every circular lap. The average velocity and average speed of each circular lap respectively is [3]

1) 10 m/s, 0 m/s 2) 0 m/s, 0 m/s **3) 0 m/s, 10 m/s** 4) 10 m/s, 10 m/s.

14. The motion of the particle is given by the equation $S = (2t^3 + 5t^2 + 16t + 8)$ m. The value of acceleration of the particle at t = 1 sec is [2]

1) 20 m/s^2 **2) 22 m/s^2** 3) 24 m/s^2 4) 26 m/s^2

15. The ratio of distances travelled by a freely falling body in the 1st 2nd, 3rd, 4th second [3]

1) 1 : 2 : 3 : 4 2) 1 : 4 : 9 : 16 **3) 1 : 3 : 5 : 7** 4) 1 : 1 : 1 : 1

16. A stone falls freely under gravity. It covers distances h_1, h_2 and h_3 in the first 5 seconds, the next 5 seconds and the next 5 seconds respectively. The relation between h_1,h_2 and h_3 is [4]

1) $h_2 = 3\,h_1$ and $h_3 = 3h_2$ 2) $h_1 = h_2 = h_3$

3) $h_1 = 2h_2 = 3h_3$ **4)** $\mathbf{h_1 = \frac{h_2}{3} = \frac{h_3}{5}}$

II. FILL IN THE BLANKS(FIB)

1. **Kinematics** deals with the study of motion of objects without taking into account, the factors which cause the motion.
2. The shortest path travelled by a moving object in a given time from initial to final position is called **displacement.**
3. The distance covered by a body along a semicircular path of radius r is **πr**
4. The slope of velocity time graph gives **acceleration.**
5. The slope of displacement time graph gives **velocity.**
6. The area under acceleration -time graph gives **change in velocity.** **[BMP1]**
7. The acceleration of a body moving with uniform velocity is **zero.**
8. The velocity of a body at any instant of time is called **instantaneous velocity**
9. The value of an acceleration of a freely falling body is **g= 9.8 m/s^2** **[MAR-26]**
10. The ratio of distances travelled by a freely falling body from the rest in the first three seconds is **1:3:5**

III. ONE WORD ANSWER Q'S

1. What is uniform motion?

A: A body is said to be in uniform motion if it covers **equal distances in equal intervals of time**.

---

2. What is acceleration?

A: **Acceleration** is the **rate of change of velocity** of the body with **time**.

---

3. What is average speed?

A: **Average speed** is the **ratio of total distance (Δx) to the total time(Δt).**

---

4. What is instantaneous velocity?

A: **Instantaneous velocity** of a body is the **velocity** of the body at a particular instant of its motion .

$\left[\because \mathbf{v} = \lim_{\Delta t \to 0} \frac{\Delta x}{\Delta t} = \frac{dx}{dt}\right]$

---

6. What represents the area under the curve of velocity-time graph?

A: The area represents **Displacement** in v-t graph.

---

7. Mention one similarity between speed and velocity.

A: Speed and velocity have the **same units (m/s)**. (or)
They both measure the rate of change of position of a body.

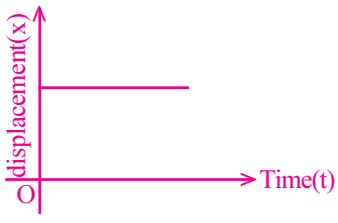
---

9. What is the time taken by the body, when it is freely dropped from a height "h"?

A: For a freely falling body, Time $t = \sqrt{\frac{2h}{g}}$, $g = 9.8 m/s^2$ $\left(\because h = \frac{1}{2}gt^2\right)$

5. Draw position-time graph for an object at rest.

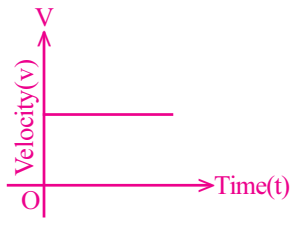
A:



Body is at rest (Slope=0)

8. Draw velocity-time graph for a particle moving with uniform velocity.

A:



Uniform velocity

HINTS FOR HARD MCQ & FIB

MULTIPLE CHOICE QUESTIONS [MCQ]

1. **(3)** $a=\frac{dv}{dt}=\frac{d}{dt}(10+2t^2)=4t$. a = 4t. Hence a varies with time. Hence a is non-uniform. This indicates that the acceleration depends on time t.

2. **(4)** |speed| ≥ |velocity| [∵ Path length or distance ≥ displacement (Shortest distance)]

3. **(2)** In both cases, the initial velocity in the vertically downward direction is zero. So they hit the ground simultaneously.

4. **(1)** As the velocity of the car is a constant, its acceleration is zero.

5. **(1)** $H_{max.}=\frac{U^2}{2g}=\frac{50\times50}{2\times10}=125m$ 6. **(2)** $S=ut+\frac{1}{2}at^2=10\times5+\frac{1}{2}\times2\times(5)^2=75m$

7. **(4)** V = u + at = 0 + 2(10) = 20 m/s

8. **(2)** Slope of velocity - time graph is acceleration, for uniform velocity, acceleration is zero.

9. **(3)** $\text{Avg speed}=\frac{\text{total distance}}{\text{total time}}=\frac{\pi R}{t}=\frac{3.14\times120}{120}=3.14\ m/s$

10. **(3)** Displacement = Area enclosed by v-t graph.

11. **(2)** $x=20+12+-t^3\Rightarrow V=\frac{dx}{dt}=12-3t^2$ Body comes to rest when v=0
$\Rightarrow 12-3t^2=0\Rightarrow 3t^2=12\Rightarrow t^2=4\Rightarrow t=2s.$

12. **(1)** Avg. speed = $\frac{2V_1V_2}{V_1+V_2}=\frac{2\times v\times 2v}{v+2v}=\frac{4v^2}{3v}=\frac{4v}{3}$

13. **(3)** In a circular track, in a lap the car comes to the same starting point. Hence its displacement is zero. Hence its velocity is zero.
But total path length = circumference =2πR. Total time = 62.8

$\text{Avg. velocity}=\frac{\text{Total displacement}}{\text{Total time}}=\frac{0}{62.8}=0\ m/s$.

$\text{Avg speed}=\frac{\text{Total distance}}{\text{Total time}}=\frac{2\pi R}{62.8}=\frac{2\times3.14\times100}{62.8}=10m/s$.

14. **(2)** $S=2t^3+5t^2+16t+8\ \Rightarrow V=\frac{dS}{dt}=6t^2+10t+16\Rightarrow a=\frac{dv}{dt}=12t+10$.

At t = 1s, $a=12(1)+10=22m/s^2$

15. **(3)** $S_n=U+\frac{a}{2}(2n-1)$ [Here a is a constant] $S_n=0+\frac{a}{2}(2n-1)$ [$\therefore S_n\propto(2n-1)$]
$S_1:S_2:S_3:S_4=2(1)-1:2(2)-1:2(3)-1:2(4)-1=1:3:5:7$

16. **(4)** $h_1=\frac{1}{2}gt^2=\frac{1}{2}\times10\times5^2=125;\quad h_2=\frac{1}{2}\times10\times10^2-\frac{1}{2}\times10\times5^2=500-125=375$

$h_3=\frac{1}{2}\times10\times15^2-\frac{1}{2}\times10\times10^2=625\qquad\therefore h_1=\frac{h_2}{3}-\frac{h_3}{5}$

3 MOTION IN A PLANE

1 OMQ + 1 VSAQ + 1 SAQ [1 M + 2M + 4M = 7 M]

I.MULTIPLE CHOICE Q'S(MCQ)

OMQ'S

1×1= 1 Mark

1. A particle moving with uniform speed in a circular path maintains [4]

1) constant velocity
2) constant acceleration
3) constant velocity but varying acceleration
4) varying velocity and varying acceleration

2. The projection or component of the vector $3\hat{i}+4\hat{k}$ on y-axis is [4]

1) 7 2) 5 3) 4 **4) 0**

3. The angle made by the vector $\hat{A}=\hat{i}+\hat{j}$ with x-axis is [3]

1) 22.5º 2) 30º **3) 45º** 4) 90º

4. A body is projected into air from the ground at an angle 90^0 to the horizontal on reaching the highest point above the ground [1]

1) its velocity is zero, acceleration is not zero
2) ts acceleration is zero, velocity is not zero
3) both the velocity and acceleration are not equal to zero
4) both the velocity and acceleration are equal to zero.

5. Two balls are projected from the same point in directions 30^0 and 60^0 with respect to the horizontal. What is the ratio of their initial velocities if they attain the same height? [1]

1) $\sqrt{3}:1$ 2) $1:\sqrt{3}$ 3) 1 : 1 4) 3 : 1

6. An aeroplane is dropping a bomb while moving horizontally at a constant speed. When air resistance is taken into consideration, then the bomb. [2]

1) falls alongside the plane.
2) falls on earth behind the plane
3) fall on earth ahead of the plane
4) fall on earth exactly below the plane.

7. Which of the following is the vector quantity? [3]

1) Distance 2) Speed **3) Acceleration** 4) Temperature

8. Which of the following is a scalar quantity? [2]

1) Momentum **2) Mass** 3) Velocity 4) Force

9. Which of the following is not a vector quantity? **[BMP1]** [4]

1) Weight 2) Torque 3) Momentum **4) Potential energy**

10. Which of the following physical quantity can be negative? [3]

1) Speed 2) Mass **3) Velocity** 4) Distance

11. Vector addition obeys [3]

1) commutative law only 2) associative law only

3) both commutative and associative laws 4) neither commutative nor associative laws

12. The relation between the time of flight of projection T_f and the time to reach the maximum height t_m is [2]

1) $T_f = t_m$ **2) $T_f = 2t_m$** 3) $T_f = t_m/2$ 4) $T_f = \sqrt{2}t_m$

13. Which the following is not a projectile motion [4]

1) A stone thrown horizontally from a building

2) A bullet fried from a gun at angle 45° w.r.t. ground

3) The jump of a frog **4) A car moving in a straight line**

14. A missile is fired for a maximum range with an initial velocity of 30m/s. If g = 10m/s^2, then the range of the missile will be [2]

1) 100m **2) 90m** 3) 80m 4) 70m

15. The horizontal range and the maximum height of a projectile are equal. The angle of projection of the projectile is [3]

1) $\theta = 45^0$ 2) $\theta = \tan^{-1}(1/4)$ **3) $\theta = \tan^{-1}(4)$** 4) $\theta = \tan^{-1}(2)$

(☞ Answers for MCQ are kept in **bold font)**

II. FILL IN THE BLANKS(FIB)

1. The dimensional formula for centripetal acceleration in a circular motion is **$M^0L^1T^{-2}$**
2. If θ is the angle of projection, g is the acceleration due to gravity, then maximum height of projectile is **$U^2\sin^2\theta/2g$**
3. The equation for the trajectory of a projectile motion is **$y = ax - bx^2$**
4. The path of the projectile with respect to ground is **parabola.** **[BMP2]**
5. The resultant of multiplying the scalar with a vector is a **vector**
6. The time required by a projectile to reach its highest point in terms of u and g is **$u\sin\theta/g$**
7. The position of a particle is $r = 3.0ti + 2.0t^2j + 5.0k$ where t is in seconds, the coefficients have the proper units r to be in metres, then v(t) = **$3\hat{i} + 4t\hat{j}$**
8. The angle between two vectors A and B with magnitudes $\sqrt{3}$ and 4 respectively and $\overline{A}.\overline{B}=2\sqrt{3}$ is **$\pi/3$**

III. ONE WORD ANSWER Q'S

1. When are the two vectors said to be equal vectors? **[MAR-26]**

A: Two vectors are said to be equal if they have the **same magnitude & direction.**

---

2. Can a vector of zero magnitude have non-zero components?

A: **No.** A vector of magnitude zero cannot have non-zero components.

Let $\bar{a} = a_x \bar{i} + a_y \bar{j} + a_z \bar{k}$ be such that its magnitude is zero.

$\Rightarrow |\bar{a}| = 0 \Rightarrow |\bar{a}^2| = 0 \Rightarrow a_x^2 + a_y^2 + a_z^2 = 0$ which is true only when $a_x = 0, a_y = 0, a_z = 0$. $(\because x^2 \geq 0)$

$\therefore \bar{a}$ has all zero components.

---

3. When will the magnitude of sum of two vectors be maximum and minimum?

A: i) $|\bar{P} + \bar{Q}|$ is maximum when $\theta = \mathbf{0^0}$(parallel in the same direction)

ii) $|\bar{P} + \bar{Q}|$ is minimum when $\theta = \mathbf{180^0}$(parallel in the opposite direction)

---

4. At what angle of projection of body with respect to ground, its range is maximum?

A: At $\theta = \mathbf{45^o}$, the projectile will have maximum range.

---

5. What is the acceleration of a projectile at the top of its trajectory? **[AP 25]**

A: At the top of the trajectory, acceleration of a projectile is $\mathbf{9.8 ms^{-2}}$ in downward direction.

---

6. What is the direction of velocity at any point on the path of a circularly moving object?

A: **Tangential** to the circular path at that point.

---

7. What is the angle between the direction of velocity and acceleration at the highest point of projectile path?

A: $\mathbf{90^o}$

HINTS FOR HARD MCQ & FIB

MULTIPLE CHOICE QUESTIONS [MCQ]

1. **(4)** In uniform circular motion, direction of velocity and acceleration keeps changing.

2. **(4)** As the vector has no $\hat{j}$ component, the projection of the vector on the Y-axis is zero.

3. **(3)** $\cos\theta = \frac{A_x}{|A|} = \frac{1}{1^2+1^2} = \frac{1}{2} \Rightarrow \theta = 45^0$

4. **(1)** The velocity of body is zero but it has non-zero acceleration due to gravity.

5. **(1)** $H = \frac{u^2 \sin^2\theta}{2g}$ H, g are constant. $\therefore \frac{u_1}{u_2} = \frac{\sin\theta_2}{\sin\theta_1} = \frac{\sqrt{3}}{1} = \frac{\sin 60^o}{\sin 30^o} = \frac{\sqrt{3}/2}{1/2}$

6. **(2)** Air resistance acts as a drag force, so it will fall behind the plane.

7. **(3)** Acceleration has both magnitude & direction hence a vector.

8. **(2)** Mass has only magnitude but no direction. Hence a scalar.

9. **(4)** Potential energy has only magnitude but no direction. Hence a scalar.

10. **(3)** Velocity can be either positive or negative.

11. **(3)** Vector addition obeys both commutative law and associative law.

12. **(2)** $T_f = t_m + t_m = 2t_m$

13. **(4)** A car moving on a straight line

14. **(2)** $R_{max} = \frac{u^2}{g} = \frac{(30)^2}{10} = \frac{900}{10} = 90m$

15. **(3)** $R = H \Rightarrow \frac{u^2 \sin 2\theta}{g} = \frac{u^2 \sin^2\theta}{2g} \Rightarrow 2\sin\theta\cos\theta = \frac{(\sin\theta)(\sin\theta)}{2} \Rightarrow \tan\theta = 4 \Rightarrow \theta = \text{Tan}^{-1}(4)$

FILL IN THE BLANKS[FIB]

1. $M^0L^1T^{-2}$ $a_c = \frac{V^2}{r} = \frac{[L^1T^{-1}]^2}{L^1} = \frac{L^2T^{-2}}{L^1} = L^1T^{-2}$

7. $r = 3t\hat{i} + 2t\hat{j} + 5\hat{k} \Rightarrow v(t) = \frac{dr}{dt} = 3\hat{i} + 4t\hat{j}$

8. $\cos\theta = \frac{\bar{A}.\bar{B}}{|A||B|} = \frac{2\sqrt{3}}{\sqrt{3}.4} = \frac{1}{2} = \cos\frac{\pi}{3} \Rightarrow \theta = \frac{\pi}{3}$

4 LAWS OF MOTION

1 OMQ + 1 VSAQ + 1 SAQ [1 M + 2M + 4M = 7 M]

I.MULTIPLE CHOICE Q'S(MCQ)

OMQ'S

1×1= 1 Mark

1. When a bus starts suddenly, the passengers are pushed back. This is an example for [1]
   1) Newton's First Law 2) Newton's Second Law
   3) Newton's Third Law 4) Newton's law of gravitation

2. Which of the following is an example of centripetal force? [3]
   1) Pushing door 2) Mud flying off tire
   3) Planets orbiting the sun 4) Churning of butter in butter milk

3. A non zero net force exerted on a body does not change its [4]
   1) direction of motion 2) momentum
   3) acceleration **4) inertia**

4. The rate of change of momentum is proportional to **[BMP2]** [3]
   1) acceleration 2) velocity **3) force** 4) displacement

5. The net force (F) experienced by a body of mass (m) whose displacement is $y = ut + \frac{1}{2}gt^2$ is [2]
   1) F = ma **2) F = mg** 3) F = 0 4) F ≠ 0

6. The linear momentum of a particle as a function of time t is given by P = a + bt. The force acting on the particle is [2]
   1) a **2) b** 3) a/b 4) b/a

7. The inertia of a moving object depends on [4]
   1) momentum of the object 2) speed of the object
   3) shape of the object **4) mass of the object**

8. A force accelerates a lighter vehicle more easily than a heavier vehicle. Guess the law behind this. [2]
   1) Newton's First Law of motion **2) Newton's Second Law of motion**
   3) Newton's Third Law of motion 4) Newton's Law of gravitation

9. Calculate the time needed for a net force of 5N to change the velocity of a 10 kg mass by 2 m/s [3]
   1) 2sec 2) 6sec **3) 4sec** 4) 3sec

II. FILL IN THE BLANKS(FIB)

1. Friction opposes the **relative motion** between the surfaces in contact with each other.
2. **Non zero net force** is required to keep a body in accelerated motion.
3. Kinetic friction produces **heat** energy.
4. Powder is sprinkled on a carom board to **reduce** friction between the striker and the board surface.
5. To every action there is always an equal and **opposite** reaction.
6. Impulse is the product of force and time which equals **change in momentum.**
7. **Mass** gives the measure of inertia.
8. The area under F-t graph represents **impulse.**
9. The Newton's Second Law is consistent with the first law only if **F = 0**
10. Sliding friction **less** than the limiting value of static friction.

III. ONE WORD ANSWER Q'S

1. State Newton's First Law.

A: Newton's First Law: 'Every body continues to be in its state of rest or uniform motion, in a straight line, unless compelled by some external force to change that state'.

---

2. State Newton's Third Law.

A: Newton's Third Law: 'To every action, there is always an equal and opposite reaction'.

---

3. Write the mathematical equation of Newton's Second Law. **[MAR-26]**

A: F = ma is the mathematical equation of Newton's Second Law.

---

4. State the SI unit of force.

A: SI unit of force is **Newton.**

---

5. Define centripetal force. **[BMP1]**

A: Centripetal force (CPF) is the force required to maintain a body in a circular path. It is directed along the radius and **towards** the centre.

---

6. According to Newton's Third Law every force is accompanied by an equal and opposite force. Then how can a movement ever take place?

A: Action and reaction always take place on **two different bodies**. Hence, they never cancel each other. So movement of bodies is possible.

---

7. Why does a heavy rifle not recoil as strongly as light rifle using the same cartridges?

A: Recoil of the rifle $V = \frac{mu}{M}$. Here, mass M of rifle .

For a heavy rifle, mass M is more which is in the denominator. Hence, its recoil velocity V is less.

HINTS FOR HARD MCQ & FIB

MULTIPLE CHOICE QUESTIONS [MCQ]

1. **(1)** Inertia of rest - Newton's first law

2. **(3)** Planets orbiting the Sun - Centripetal force

3. **(4)** Inertia (mass does not change & mass is a measure of inertia)

4. **(3)** $F \propto \frac{dp}{dt}$ ($\because$ Newton's II Law)

5. **(2)** F = mg

6. **(2)** $F = \frac{dp}{dt} = \frac{d}{dt}(a + bt) = 0 + b = b$

7. **(4)** Mass is a measure of inertia

8. **(2)** Newton's II law of motion. $F = ma \Rightarrow a \propto \frac{1}{m}$

9. **(3)** $F = ma = m\left(\frac{v-u}{t}\right) \Rightarrow t = \frac{m(v-u)}{F} = \frac{10 \times 2}{5} = 4s$

7 GRAVITATION

1 OMQ + 1 VSAQ + 1 SAQ [1 M + 2M + 4M = 7 M]

I.MULTIPLE CHOICE Q'S(MCQ)

OMQ'S

1 × 1 = 1 Mark

1. A planet moves around the sun in an elliptical orbit at a given point P, it is closest from the sun at a distance d_1 and has a speed v_1. At another point Q, when it is farthest from the sun at a distance d_2, its speed v_2 will be. [3]

1) $\frac{d_1^2 v_2}{d_2^2}$ 2) $\frac{d_2 v_2}{d_1}$ **3) $\frac{d_1 v_1}{d_2}$** 4) $\frac{d_2^2 v_2}{d_1^2}$

2. According to Kepler, the period of revolution (T) of a planet and its mean distance (r) from the sun are related by the equation [2]

1) $T^3 r^3$ = constant **2) $T^2 r^{-3}$ = constant**
3) Tr^3 = constant 4) $T^2 r$ = constant

3. A satellite revolves around the earth in an elliptical orbit. Its speed [2]

1) is the same at all points in the orbit
2) is greatest when it is closest to the earth
3) is greatest when it is farthest from the earth
4) goes on increasing or decreasing continuously depending upon the mass of the satellite

4. The force of gravitation is [3]

1) repulsive force 2) electrostatic force
3) conservative force 4) non-conservative force

5. If the distance between two masses is doubled, the gravitational attraction between them [4]

1) is doubled 2) becomes four times
3) is reduced to half **4) is reduced to a quarter**

6. If the earth losses its gravity, then for a body [1]

1) weight becomes zero, but not the mass
2) mass becomes zero, but not the weight
3) both mass and weight become zero
4) neither mass nor weight become zero

7. The first experimental value of G is given by [1]

1) Cavendish 2) Copernicus 3) Brook Teylor 4) None of these

8. The acceleration due to gravity is 'g' at a point distant 'r' from the centre of earth of radius R. If r < R. Then [1]

1) $g \propto r$ 2) $g \propto r^2$ 3) $g \propto r^{-1}$ 4) $g \propto r^{-2}$

9. Four particles each of mass M, are located at the vertices of a square with side. The gravitational potential due to this at the centre of the square is [1]

1) $-\sqrt{32}\frac{GM}{L}$ 2) $-\sqrt{64}\frac{GM}{L^2}$ 3) Zero 4) $\sqrt{32}\frac{GM}{L}$

10. The escape velocity of a sphere of mass m from the surface of earth having mass M and radius is given by [1]

1) $\sqrt{\frac{2GM}{R}}$ 2) $2\sqrt{\frac{GM}{R}}$ 3) $\sqrt{\frac{2GMm}{R}}$ 4) $\sqrt{\frac{GM}{R}}$

11. For a satellite moving in an orbit around the earth, the ratio of of its kinetic energy to potential energy is [2]

1) 2 : 1 **2) 1 : 2** 3) $1:\sqrt{2}$ 4) $\sqrt{2}:1$

12. When a satellite going round the earth in a circular orbit of radius r with speed v loses some of its energy, then r and v changes as [3]

1) r and v both will increase 2) r and v both will decrease
3) r will decrease and v will increase 4) r will decrease and v will decrease

13. If r represents the radius of the orbit of a satellite of mass m moving around a planet of mass M, the square of orbital velocity (v_0) of the satellite is given by [4]

1) $v_0^2 = g\frac{M}{r}$ 2) $v_0^2 = \frac{GMm}{r}$ 3) $v_0^2 = \frac{Gr}{M}$ **4) $v_0^2 = \frac{GM}{r}$**

14. The period of a satellite in a circular orbit around a planet is independent of [3]

1) the mass of the planet 2) the radius of the planet
3) the mass of the satellite 4) the radius of the satellite

II. FILL IN THE BLANKS(FIB)

1. Kepler's second law regarding constancy of areal velocity of a planet is a consequence of the law of conservation of **angular momentum.**
2. If M is the mass of the earth and R is its radius, the ratio of the acceleration due to gravity on the surface of earth and the universal gravitational constant is $\frac{M}{R^2}$
3. If R is the radius of the earth and g is the acceleration due to gravity on the earth's surface, then the mean density of the earth is $\frac{3g}{4\pi RG}$
4. The intensity of gravitational field at the centre of the spherical shell is **zero.** **[BMP2]**
5. The force of attraction due to a hollow spherical shell of uniform density, on a point mass situated inside it is **zero.**
6. The acceleration due to gravity on the surface of earth is 'g'. Its value at a height equal to double the radius of the earth is $\frac{g}{9}$
7. As we go from the equator to the poles, the value of g **increases.**
8. The escape velocity of a projectile from the earth's surface is **11.2 km/s** (approximately).

9. A missile is launched with a velocity less than the escape velocity. The sign of sum of its kinetic and potential energy is **negative**

10. The time period of satellite in an orbit very close to the surface of earth is **85 minutes.** (approximately)

11. If V_e is the escape velocity and V_0 is the orbital velocity of a satellite for an orbit close to the earth's surface, then V_e is $\sqrt{2}$ times of V_0

III. ONE WORD ANSWER Q'S

1. State Kepler's law of orbits.

A: Law of orbits: All planets move in **elliptical orbits** with the **sun** situated at one of the **foci**.

---

2. State Kepler's law of areas. **[MAR-26]**

A: Law of areas: The line that joins any planet to the sun sweeps **equal areas in equal intervals of time.**

---

3. What is the value of universal gravitational constant (G)? **[BMP1]**

A: Universal gravitational constant $\mathbf{G = 6.67 \times 10^{-11}\ Nm^2\ kg^{-2}}$

---

4. What is the weight of a body at the centre of the earth?

A: Zero.

---

5. What is the gravitational potential energy of two point masses m_1 and m_2, which are kept at infinite distance from each other?

A: Gravitational PE is $U = \frac{-Gm_1m_2}{r} = \frac{-Gm_1m_2}{\infty} = 0$

---

6. Does the escape velocity of the projected body depend upon its mass?

A: No. [$\because$ Escape velocity $v_e = \sqrt{\frac{2GM}{R}}$, which is independent of mass of projected body]

---

7. What is the sign of kinetic energy of a satellite revolving around the earth?

A: Positive.

---

8. Does the orbital velocity of a satellite depend upon its mass?

A: No. [$\because$ Orbital velocity $v_0 = \sqrt{\frac{GM}{R}}$, which is independent of mass of revolving body]

---

9. What is the time period of the moon revolving in an orbit around the earth approximately?

A: 27.3 days is time period of the moon revolving in an orbit around the earth.

HINTS FOR HARD MCQ & FIB

MULTIPLE CHOICE QUESTIONS [MCQ]

1. **(3)** $L_P = L_Q \Rightarrow \cancel{m} V_1 d_1 = \cancel{m} V_2 d_2 \Rightarrow V_1 d_1 = V_2 d_2 \Rightarrow V_2 = \frac{d_1 V_1}{d_2}$ [☛ Given textual answer $\frac{d_1 V_2}{d_2}$ is a mistake]

2. **(2)** $T^2 \propto r^3 \Rightarrow T^2 = Kr^3 \Rightarrow T^2 r^{-3} = K$, K is a constant.

3. **(2)** Speed is greatest when it is closest to the earth.

4. **(3)** Force of gravitation is a conservative force.

5. **(4)** $F \propto \frac{1}{d^2} \Rightarrow \frac{F_2}{F_1} = \left(\frac{d_1}{d_2}\right)^2 = \left(\frac{d}{2d}\right)^2 = \frac{1}{4} \Rightarrow F_2 = \frac{F_1}{4}$ reduces to a quarter.

6. **(1)** W = mg, if g = 0 then W = 0 but $m \neq 0$. 7.**(1)** Cavendish

8. **(1)** Inside the earth $g = \left(\frac{4}{3}\right)\pi G r \Rightarrow g^1 \propto r \Rightarrow g \propto r$.

9. **(1)** $OA = OB = OC = OD = \frac{1}{\sqrt{2}}$

Potential at centre O due to given mass configuration is

$$V = \left(\frac{-GM}{OA}\right) + \left(\frac{-GM}{OB}\right) + \left(\frac{-GM}{OC}\right) + \left(\frac{-GM}{OD}\right) = \frac{-4GM}{L/\sqrt{2}} = -4\sqrt{2}\frac{GM}{L} = -\sqrt{32}\frac{GM}{L}$$

10. **(1)** $\frac{1}{2}\cancel{m}v_e^2 = \frac{GM\cancel{m}}{r} \Rightarrow V_e^2 = \frac{2GM}{r} \Rightarrow V_e = \sqrt{\frac{2GM}{r}}$

11. **(2)** $\frac{KE}{PE} = \frac{\frac{1}{2}mv^2}{-\frac{GMm}{r}} = \frac{\frac{1}{2}m\left(\frac{2GM}{r}\right)}{-\frac{GMm}{r}} = \frac{-1}{2}$ $\left[V = \sqrt{\frac{2GM}{r}} \Rightarrow V^2 = \frac{2GM}{r}\right]$

12. **(3)** Its orbital radius decreases and its speed increases.

13. **(4)** $V_0 = \sqrt{\frac{GM}{r}} \Rightarrow V_0^2 = \frac{GM}{r}$

14. **(3)** T is independent of the mass of the satellite. $T = 2\pi\sqrt{\frac{(R+h)^3}{GM}}$.

FILL IN THE BLANKS [FIB]

2. $\frac{g}{G} = \frac{\cancel{G}M/R^2}{\cancel{G}} = \frac{M}{R^2}$

3. $g = \frac{GM}{R^2} \Rightarrow M = \frac{gR^2}{G}$ density $\rho = \frac{M}{V} = \frac{gR^2/G}{\frac{4}{3}\pi R^3} = \frac{3g}{4\pi RG}$

6. $g^1 = \frac{g}{\left(1+\frac{h}{R}\right)^2} = \frac{g}{\left(1+\frac{2R}{R}\right)^2} = \frac{g}{3^2} = \frac{g}{9}$ $(\because h = 2R)$

8. 11.2 Km/s $\left[\because V_e = \sqrt{2gR} = \sqrt{2\times 9.8\times 6.4\times 10^6} = 11.2 \text{ Km/s}\right]$

11. $V_0 = \sqrt{gR}$; $V_e = \sqrt{2gR}$; $V_e = \sqrt{2}V_0$

8 MECHANICAL PROPERTIES OF SOLIDS

1 OMQ + 1 VSAQ + 1 SAQ [1 M + 2M + 4M = 7 M]

I.MULTIPLE CHOICE Q'S(MCQ)

OMQ'S

1 × 1 = 1 Mark

1. Among the following, the material with highest elasticity is [MAR-26] [4]

1) Copper 2) Aluminium 3) Brass **4) Steel**

2. The type of stress which acts tangentially to a body's surface is [2]

1) Hydraulic stress **2) Shearing stress**

3) Compressive stress 4) Tensile stress

3. If the length of a wire is stretched to twice its original length, the strain in the wire is [2]

1) 2 **2) 1** 3) 1/2 4) 1/4

4. Two metal wires of the same material have lengths in the ratio 1 : 2 and radii in the ratio 2 : 1. The ratio of their elongations under the same applied force is [2]

1) 1 : 2 **2) 1 : 8** 3) 1 : 4 4) 4 : 1

5. Determine the volume contraction of a solid copper cube with a volume of 10^{-3} m^3 when subjected to a hydraulic pressure of 7×10^6 Pa. (Bulk modulus of copper K = 140×10^9 Nm^{-2}) [2]

1) 5×10^{-7} m^3 **2) 5×10^{-8} m^3** 3) 0.5×10^{-8} m^3 4) 5×10^{-5} m^3

6. Poisson's ratio depends only on [3]

1) stress 2) strain **3) nature of the material** 4) force

7. The maximum stress that a material can withstand without breaking is [2]

1) Yield strength **2) Ultimate tensile strength**

3) Elastic limit 4) Breaking stress

8. Steel is more elastic than rubber, because [2]

1) Young's modulus of rubber is greater than that of steel.

2) Young's modulus of steel is greater than that of rubber.

3) For the same applied force, the elongation of steel is more.

4) For the same applied force, the elongation of rubber is less.

9. A force of 30 kN is applied along its length on a steel rod of cross-sectional area 3 cm^3. The stress on the rod is [3]

1) 10^2 Nm^{-2} 2) 10^4 Nm^{-2} **3) 10^8 Nm^{-2}** 4) 10^6 Nm^{-2}

II. FILL IN THE BLANKS(FIB)

1. The property of a body to regain its original shape after deformation is called **elasticity**.
2. The SI unit of Young's modulus is **pascal or N/m^2**.

3. Materials that can undergo large strains are called **elastomers**.
4. An example of elastomer is **Rubber or Tissue of aorta**.
5. The typical value of Poisson's ratio for steel is **0.28 to 0.30**.
6. When a wire is stretched, it shows an increase in length and a decrease in **diameter**.
7. The strain produced by hydraulic pressure is called **volume strain**.
8. The strain perpendicular to the applied force is called **lateral strain**.
9. The reciprocal of the Bulk modulus is called **compressibility** **[BMP2]**
10. The ratio of shearing stress to shearing strain is called **shear modulus**.

III. ONE WORD ANSWER Q'S

1. What is the proportionality constant in Hooke's law?
A: **Modulus of Elasticity** is the proportionality constant in Hooke's law.

---

2. What is the term for the energy stored in a stretched wire?
A: **Elastic potential energy** is the energy stored in a stretched wire.

---

3. In the stress-strain curve, what is the point beyond which permanent deformation occurs?
A: Yield point.

---

4. What is the dimensional formula of stress?
A: DF of stress = $[M^1L^{-1}T^{-2}]$

---

5. Which modulus measures resistance to compression?
A: **Bulk modulus** measures resistance to compression.

---

6. What is the equation for elastic potential energy stored in a stretched wire? **[BMP1]**
A: Elastic P.E in a stretched wire is $U = \frac{1}{2} \times \text{Stress} \times \text{Strain} \times \text{Volume}$

---

7. What is Poisson's ratio?
A: **Poisson's ratio(σ)** is the ratio of lateral contractional strain to the longitudinal elongational strain.
Formula: $\sigma = \frac{\Delta d / d}{\Delta l / l}$

---

8. What is the SI unit of strain?
A: Strain has no units. It's a dimensionless quantity.

---

9. What is the maximum possible height of a mountain on earth?
A: Elastic limit for a typical rock is $\rho gh = 30\times10^7 N/m^2$.

$\therefore \rho gh = 30\times10^7 \Rightarrow h = \frac{30\times10^7}{3\times10^3\times10} = 10km$

$\therefore$ Maximum possible height of a mountain on earth=10km

---

10. What is the property of a material that resists a change in shape?
A: Rigidity.

HINTS FOR HARD MCQ & FIB

MULTIPLE CHOICE QUESTIONS [MCQ]

1. **(4)** Elasticity of Steel > Copper > Brass > Aluminium

   [∵ 200Gpa > 130 Gpa > 125 Gpa > 69 Gpa]

2. **(2)** Shearing stress

3. **(2)** $\text{Strain} = \frac{\text{Charge in length}}{\text{Original length}} = \frac{L_2 - L_0}{L_0} = \frac{2L_0 - L_0}{L_0} = \frac{L_0}{L_0} = 1$

4. **(2)** Youngs modulus $y = \frac{fl}{a\Delta l} \Rightarrow \Delta l = \frac{fl}{ay}$ (f, y are constants, $a = \pi r^2$); $l_1 : l_2 = 1:2$; $r_1 : r_2 = 2:1$

   $\frac{\Delta l_1}{\Delta l_2} = \frac{l_1}{l_2}\left(\frac{r_2}{r_1}\right)^2 = \frac{1}{2}\left(\frac{1}{2}\right)^2 = \frac{1}{2}\times\frac{1}{4} = \frac{1}{8} = \mathbf{1:8}$ [☛ Given textual answer 2:1 is a mistake]

5. **(2)** $\Delta V = -\left(\frac{PV}{K}\right) = -\left(\frac{7\times10^6\times10^{-3}}{140\times10^9}\right) = -5\times10^{-8}\,m^3$

6. **(3)** Nature of material

7. **(2)** Ultimate tensile strength

8. **(2)** $Y_{steel} > Y_{rubber}$

9. **(3)** $\text{Stress} = \frac{30\times10^3}{3\times(10^{-2})^2} = 10^8\,N/m^2$

9 MECHANICAL PROPERTIES OF FLUIDS

1 OMQ + 1 VSAQ + 1 SAQ [1 M + 2M + 4M = 7 M]

I.MULTIPLE CHOICE Q'S(MCQ)

OMQ'S

$1 \times 1 = 1$ Mark

1. The rise of a liquid in a capillary tube does not depend on [3]

1) angle of contact 2) density

3) outer radius of the capillary tube 4) surface tension

2. The type of flow is characterized by parallel layers of fluid moving with out mixing is [1]

1) Streamline flow 2) Turbulent flow

3) Circular flow 4) Rotational flow

3. The angle of contact between pure water and clean glass is [2]

1) 90° **2) 0°** 3) 135° 4) 180°

4. Bernoulli's principle is based on the conservation of [3]

1) Momentum 2) Angular momentum **3) Energy** 4) Volume

5. Among the following, the wrong statement about pressure is [1]

1) It is a vector quantity 2) It is a scalar quantity.

3) Pressure at sea level is 1.013×10^5 Pa 4) Dimensions of pressure are $[M\ L^{-1}\ T^{-2}]$

6. The gauge pressure at a depth of 10 m in a lake is [2]

1) 10^6 Pa **2) 10^5 Pa** 3) 10^4 Pa 4) Zero

7. Surface tension arises due to **[BMP1]** [4]

1) gravitational forces 2) pressure differences

3) viscosity **4) cohesive forces**

8. Bernoulli's principle states that an increase in the speed of a fluid occurs simultaneously with decrease in [3]

1) temperature 2) viscosity **3) pressure** 4) flow rate

9. The terminal velocity of a sphere of radius R falling in a viscous fluid is proportional to [4]

1) R 2) R^3 3) $\sqrt{R}$ **4) R^2**

10. 1 torr is equal to [3]

1) 1.013×10^5 Pa 2) 760 Pa

3) 133 Pa 4) 1013 Pa

II. FILL IN THE BLANKS(FIB)

1. The difference between absolute pressure (P) and atmospheric pressure (P_a) at a depth h is called **Gauge pressure.**
2. 1 bar is equal to 10^5 Pa.
3. Hydraulic lift and hydraulic brakes are based on **Pascal's** law. **[MAR-26]**
4. The study of fluids in motion is known as **fluid dynamics.**
5. The path taken by a fluid particle under a steady flow is called a **streamline.**
6. The Bernoulli's equation in general can be written as $P + \frac{1}{2}\rho v^2 + \rho gh = \text{constant}$
7. The maximum velocity acquired by a falling sphere in a viscous fluid is called **terminal velocity.**
8. The SI unit of surface tension is **N/m**
9. The spherical shape of raindrops is due to **surface tension**
10. The aerodynamic lift experienced by a spinning ball moving in air is called **magnus effect.**

III. ONE WORD ANSWER Q'S

1. What is relative density?

A: Relative density is the ratio of density of a material to the density of water at 4°C.

---

2. Name the device used to measure atmospheric pressure. **[BMP2]**

A: **Barometer** is used to measure atmospheric pressure.

---

3. Write the equation of continuity.

A: Equation of continuity is $A_1V_1 = A_2V_2$

---

4. Mention the speed limit, beyond which steady flow of liquid becomes turbulent?

A: It is the critical speed. The Critical Reynolds number is above 3000

---

5. What is the speed of efflux from a hole at the bottom of a tank filled with water to a height h, which is open at the top?

A: Speed of efflux is $V = \sqrt{2gh}$

6. What is the property of a fluid to resist relative motion between its layers?

A: **Viscosity** resists relative motion between its layers.

---

7. Which principle is involved in the dynamic lift of an airplane?

A: **Bernoullis principle** is involved in the dynamic lift of an airplane.

---

8. What happens to the viscosity of liquids with increase in temperature?

A: Viscosity of liquids **decreases** with increase in temperature.

---

9. What is the SI unit of the coefficient of viscosity?

A: SI unit of the coefficient of viscosity is **Poiseiulle(μ) (or) Pa.S (or) NSm^{-2} (or) $kgm^{-1}s^{-1}$**

---

10. What is surface tension?

A: **Surface Tension** is a force per unit length acting in the plane of the interface between the plane of the liquid and any other substance.

HINTS FOR HARD MCQ & FIB

MULTIPLE CHOICE QUESTIONS [MCQ]

1. **(3)** Outer radius of the capillary tube

2. **(1)** Streamline flow

3. **(2)** 0°

4. **(3)** Energy

5. **(1)** Pressure is a scalar quantity

6. **(2)** $\rho_{gauge} = \rho gh = 10^3 \times 10 \times 10 = 10^5 \rho cv$

7. **(4)** Cohesive forces

   [the property of molecules adhering to one another due to mutual attraction]

8. **(3)** Speed of fluid is inversely proportional to pressure.

9. **(4)** $V_t = \frac{2R^2(\rho - \sigma)}{9\eta} \Rightarrow V_t \propto R^2$

10. **(3)** $1 \text{ torr} = \frac{1}{760}(\text{atm}) = \frac{1}{760} \times 101325 \text{ pa} = 133\text{pa}$

12 KINETIC THEORY

1 OMQ + 1 VSAQ + 1 SAQ [1 M + 2M + 4M = 7 M]

I.MULTIPLE CHOICE Q'S(MCQ)

OMQ'S

$1 \times 1 = 1$ Mark

1. To decrease the volume of a gas by 5% at constant temperature, the pressure should be [2]

1) Decreased by 5.26% **2) Increased by 5.26%**
3) Decreased by 11% 4) Increased by 11%

2. At NTP, sample of equal volume of Chlorine and Oxygen is taken. Now ratio of number of molecules is [1]

1) 1 : 1 2) 32 : 27 3) 2 : 1 4) 16 : 14

3. If pressure of a gas contained in a closed vessel is increased by 0.4% when heated by 1 °C the initial temperature must be [1]

1) 250 K 2) 250 °C 3) 2500 K 4) 25 °C

4. A perfect gas at 27°C is heated at constant pressure to 327°C. If original volume of gas at 27°C is V then its volume at 327 °C is [3]

1) V 2) 3V **3) 2V** 4) V/2

5. Under which of the following conditions is the law PV = RT obeyed most closely by a real gas [3]

1) High pressure and high temperature 2) Low pressure and low temperature
3) Low pressure and high temperature 4) High pressure and low temperature

6. The equation of state for 5g of oxygen at a pressure P and temperature T, when occupying a volume V, will be [1]

1) PV = (5/32)RT 2)PV = (5/8) R T 3) PV = (5/2) RT 4) PV = (5/16) RT

7. A sample of gas is at 0°c. The temperature to which it must be raised in order to double the r.m.s speed of the molecule is [2]

1) 270 °C **2) 819 °C** 3) 1090 °C 4) 100 °C

8. The r.m.s speed of gas molecules is given by [2]

1) $1.414\sqrt{\frac{RT}{M}}$ **2)** $\mathbf{1.732\sqrt{\frac{RT}{M}}}$ 3) $1.414\sqrt{\frac{M}{RT}}$ 4) $1.732\sqrt{\frac{M}{RT}}$

9. The relation between the gas pressure P and average kinetic energy per unit volume E is [4]

1) $P = \frac{1}{2}E$ 2) $P = E$ 3) $P = \frac{3}{2}E$ **4)** $\mathbf{P = \frac{2}{3}E}$

10. In kinetic theory of gases, a molecule of mass m of an ideal gas collides with a wall of vessel with velocity V. The change in the linear momentum of the molecule is [1]

1) 2 mV 2) mV 3) –mV 4) zero

11. Pressure of an ideal gas is increased by keeping the temperature constant. The effect of kinetic energy of molecules is [3]

1) Increase 2) Decrease **3) No change** 4) Can't be determined

12. Energy of all molecules of a monatomic gas having a volume V and pressure P is $\frac{3}{2}PV$. The total translational kinetic energy of all molecules of a diatomic gas as the same volume and pressure is [2]

1) $\frac{1}{2}PV$ **2) $\frac{3}{2}PV$** 3) $\frac{5}{2}PV$ 4) 3 PV

13. If the degrees of freedom of a gas are f, then the ratio of two specific heats $\frac{C_P}{C_V}$ is given by

1) $\frac{2}{f}+1$ 2) $1-\frac{2}{f}$ 3) $1+\frac{1}{f}$ 4) $1-\frac{1}{f}$ [1]

14. The relation between the molar specific heat at constant pressure and at constant volume of an ideal gas is [2]

1) $C_P + C_V = R$ **2) $C_P - C_V = R$** 3) $C_P / C_V = R$ 4) $C_V / C_P = R$

II. FILL IN THE BLANKS(FIB)

1. If the molecular weights of two gases are M_1 and M_2 at a given temperature, then the ratio of their root mean square velocities will be $\sqrt{\frac{M_2}{M_1}}$

2. A gas is allowed to expand isothermally. Then the root mean square velocity of the molecules will **remain unchanged**.

3. The pressure is exerted by the gas on the walls of the container because **on collision with walls there is a change in momentum**.

4. The ratio of mean kinetic energy of hydrogen and oxygen gas molecules at a given temperature is **1:1**

5. The mean kinetic energy per degree of freedom of gas molecule is $\frac{1}{2}KT$

6. The kinetic energy of one gm-mole of a gas at normal temperature and pressure nearly is 3.4×10^3 J (R = 8.31 J/Mole-K)

7. A monoatomic gas molecule has **three** degrees of freedom. **[MAR-26]**

8. The number of translational degrees of freedom for a diatomic gas is **three**. **[BMP1]**

9. The value of C_v for one mole of neon gas is $\frac{3}{2}R$

10. If the mean free path of the molecules is doubled then the pressure of the gas will become **half**.

III. ONE WORD ANSWER Q'S

1. What is an ideal gas?

A: Gases which obey, all gas laws at all temperatures and pressures are called Ideal gases.

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2. Write the ideal gas equation. **[BMP2]**

A: Ideal gas equation : $PV = nRT \Leftrightarrow \frac{PV}{T} = k \Rightarrow \frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$.

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3. What is the nature of curve obtained when pressure versus reciprocal of volume is plotted for an ideal gas at constant temperature?

A: Straight line.

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4. What is the nature of curve obtained when volume of an ideal gas is plotted against its absolute temperature at constant pressure?

A: A straight line that passes through the origin.

---

5. What is the value of universal gas constant?

A: Universal gas constant is $\mathbf{R = 8.314\ J\ mol^{-1}\ K^{-1}}$.

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6. What is the value of Boltzmann constant?

A: Boltzmann constant is $k = \frac{R}{N_A} = 1.38 \times 10^{-23}\ JK^{-1}$

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7. What is the average speed of five molecules of a gas having speeds V_1,V_2, V_3,V_4 and V_5?

A: Average speed $V_{avg} = \frac{V_1 + V_2 + V_3 + V_4 + V_5}{5}$

---

8. What is the RMS speed of five molecules of a gas having speeds V_1,V_2, V_3,V_4 and V_5

A: RMS speed $V_{rms} = \sqrt{\frac{V_1^2 + V_2^2 + V_3^2 + V_4^2 + V_5^2}{5}}$

HINTS FOR HARD MCQ & FIB

MULTIPLE CHOICE QUESTIONS [MCQ]

1. **(2)** $p_1v_1 = p_2v_2$. Volume is decreased by 5% $\Rightarrow v_2 = v_1 - \frac{5}{100}v_1 = \left(1-\frac{5}{100}\right)v_1 \Rightarrow v_2 = \frac{95}{100}v_1$

Now $p_1 \cancel{v_1} = p_2\left(\frac{95}{100}\right)\cancel{v_1} \Rightarrow p_1 = p_2\left(\frac{95}{100}\right) \Rightarrow \frac{p_2}{p_1} = \frac{100}{95} \Rightarrow \frac{p_2}{p_1} - 1 = \frac{100}{95} - 1 \Rightarrow \frac{p_2 - p_1}{p_1} = \frac{5}{95} = \frac{1}{19}$

$\therefore \frac{\Delta p}{p_1} \times 100 = \frac{p_2 - p_1}{p_1} \times 100 = \frac{1}{19} \times 100 = 5.26\%$

2. **(1)** At NTP (273.15K, 1 atm), any ideal gas contains equal number of molecules.So if we take equal volumes of C*l* and O at NTP, the number of molecules in each gas will be the same.

$\therefore \frac{N_{Cl_2}}{N_{O_2}} = 1$

3. **(1)** $\frac{p_1}{T_1} = \frac{p_2}{T_2} \Rightarrow \frac{p_1}{T_1} = \frac{p_1 + 0.004p_1}{T_1 + 1} = \frac{1.004p_1}{T_1 + 1}$

$T_1 + 1 = 1.004T_1 \Rightarrow T_1(0.004) = 1 \Rightarrow T_1 = \frac{1}{0.004} = 250K$

4. **(3)** $\frac{v_2}{v_1} = \frac{T_2}{T_1} \Rightarrow \frac{v_2}{v} = \frac{2(27+273)}{(27+273)} = \frac{600}{300} = 2 \Rightarrow v_2 = 2v$

5. **(3)** Low pressure and high temperature

6. **(1)** $n = \frac{m}{M} = \frac{5}{32}$. Now $pv = nRT \Rightarrow pv = \frac{5}{32}RT$

7. **(2)** $V_{rms} = \sqrt{\frac{3RT}{M}}$; $V_{rms} \propto \sqrt{T}$

$\frac{T_2}{T_1} = \left(\frac{V_{rms2}}{V_{rms1}}\right)^2 \Rightarrow \frac{T_2}{0+273} = \left(\frac{2\cancel{V}}{\cancel{V}}\right)^2 \Rightarrow \frac{T_2}{273} = 4 \Rightarrow T_2 = 1092K$; T_2 °C= 1092 – 273= 819 °C

8. **(2)** $V_{rms} = \sqrt{\frac{3RT}{M}} = \sqrt{3}\sqrt{\frac{RT}{M}} = 1.732\sqrt{\frac{RT}{M}}$

9. **(4)** $KE = \frac{3}{2}nRT = \frac{3}{2}(pv) \Rightarrow 3pv = 2KE \Rightarrow p = \frac{2}{3}\frac{KE}{v} = \frac{2}{3}E$

10. **(1)** $\Delta p = mv - (-mv) = 2mv$

11. **(3)** Kinetic energy of ideal gas depends only on its temperature.

Hence, it remains constant whether its pressure is increased or decreased.

12. **(2)** Given that $KE_{monoatomic} = \frac{3}{2}pv$ ($\because$ 3 degrees of freedom) ; Also $KE_{traslational} = \frac{3}{2}pv$

$KE_{diatomic} = \frac{f}{2}pv$ here f = 5 $\therefore KE_{diatomic} = \frac{5}{2}pv$

13. **(1)** $C_v = \frac{f}{2}R ; C_p = C_v + R \Rightarrow C_p = \frac{f}{2}R + R \Rightarrow C_p = \left(\frac{f}{2}+1\right)R$

$$r = \frac{C_p}{C_v} = \frac{\left(\frac{f}{2}+1\right)\cancel{R}}{\frac{f}{2}\cancel{R}} = \frac{\frac{f}{2}+1}{\frac{f}{2}} = 1 + \frac{1}{\left(\frac{f}{2}\right)} = 1 + \frac{2}{f}$$

14. **(2)** $C_p - C_v = R$

FILL IN THE BLANKS [FIB]

1. $V = \sqrt{\frac{3RT}{M}} \Rightarrow V \propto \frac{1}{\sqrt{M}} \Rightarrow \frac{V_1}{V_2} = \sqrt{\frac{M_2}{M_1}}$

2. remain unchanged.

3. on collision with walls there is a change in momentum.

4. $\frac{\overline{KE}_{H_2}}{\overline{KE}_{O_2}} = \frac{\frac{3}{2}KT}{\frac{3}{2}KT} = \frac{1}{1} = 1:1$

5. $\mathbf{\frac{1}{2}KT}$

6. $KE = \frac{3}{2}RT = \frac{3}{2} \times 8.3 \times 273 = 3.4 \times 10^3 J$

7. three

8. three

9. $C_v = \frac{3}{2}R$

10. Mean freepath is inversely proportional to the pressure.

14 WAVES

1 OMQ+1 VSAQ + 1 SAQ [1M+2M + 4M = 7M]

I.MULTIPLE CHOICE Q'S(MCQ)

OMQ'S

$1 \times 1 = 1$ Mark

1. Which one of the following statements is true? [BMP1] [2]

1) Both light and sound waves in air are longitudinal
2) The sound waves in air are longitudinal while the light waves are transverse
3) Both light and sound waves in air are transverse
4) Both light and sound waves can travel in vacuum.

2. The waves described by y = 3 sin(10πx – 2πt), where x and y are in meters and t is in the seconds, is a wave travelling along the [4]

1) +ve x direction with frequency 3 Hz and wavelength λ = 0.2m
2) –ve x direction with amplitude 3 m and wavelength λ = 0.2m
3) –ve x direction with frequency 1 Hz and wavelength λ = 0.2m
4) +ve x direction with frequency 1 Hz and wavelength λ = 0.2m

3. Two waves are represented by the equations y_1 = a sin(ωt + kx + 0.57) m and y_2 = a cos(ωt + kx)m, where x is in meter and t in sec. The phase difference between them is [1]

1) 1.0 rad 2) 1.25 rad 3) 1.57 rad 4) 0.57 rad

4. A transverse harmonic wave on a string is described by y = 3sin(36t + 0.018x + π/4) where x and y are in cm and t in sec. Which of the following is wrong? [2]

1) Amplitude is 0.03 m **2) frequency is 36 Hz**
3) speed of the wave is 20 m/s 4) It is travelling in-ve X-direction

5. If the tension in the string is doubled and the linear density is halved, then the ratio of initial and final speeds of a transverse wave along the string is [4]

1) $1:\sqrt{2}$ 2) $\sqrt{2}:1$ 3) 2 : 1 **4) 1 : 2**

6. The stationary wave is represented by $y(x,t) = 0.06\sin\left(\frac{2\pi}{3}x\right)\cos(120\pi t)$ where x and y are in 'm' and 't' in sec. Then the speed of wave [2]

1) 160 m/s **2) 180 m/s** 3) 200 m/s 4) 360 m/s

7. Match the following an elastic wave to its mathematical equation [1]

e) Stationary Wave — i) $y = 2\sqrt{x - vt}$
f) travelling harmonic wave — ii) y = 2cos3x sin 10t
g) Neither travelling nor stationary waves — iii) y = 3sin(5x – 0.5t) + 4cos(5x – 0.5t)
h) Superposing of two stationary waves — iv) y = cos x sin t + cos 2x sin 2t

1) e-ii, f-iii, g-i, h-iv 2) e-i, f-ii, g-iii, h-iv
3) e-i, f-ii, g-iii, h-iv 4) e-iv, f-iii, g-ii, h-i

8. A stone is dropped from the top of a tower of height h into a pond of water near the base of the tower. When the splash heard at the top, given that the speed of sound in air is V

1) $\sqrt{2gh}+\frac{h}{V}$ 2) $\sqrt{2gh}+hV$ **3)** $\sqrt{\frac{2h}{g}}+\frac{h}{V}$ 4) $\sqrt{\frac{2g}{h}}+\frac{h}{V}$ **[3]**

9. The velocity of sound in air is given by $V=\sqrt{\frac{\gamma p}{d}}$. Then which of the following is correct about the velocity of sound in air? **[3]**

i) dependent on pressure ii) Increases with temperature
iii) Increases with humidity

1) i & ii 2) i & iii **3) ii & iii** 4) i, ii & iii

10. Why gases cannot support the propagation of transverse wave? [MAR-26] **[2]**

1) gases are incompressibles **2) gases have no shearing stress**
3) density of gas is less 4) gases can flow

11. A pipe 20cm long is closed at one end. Which harmonic mode of the pipe is resonantly excited by 1275 Hz source? (Speed of sound in air is 340m s^{-1}) **[1]**

1) 3rd 2) 5th 3) 7th 4) 9th

12. Two vibrating tuning forks produce waves given by y_1= 5 sin 500πt and y_2 = 3 sin 506πt. The number of beats produced per sec are **[2]**

1) 2 **2) 3** 3) 4 4) 6

II. FILL IN THE BLANKS(FIB)

1. Mechanical waves, like sound waves require **medium** for propagation.
2. If the constituents of the medium oscillate perpendicular to the direction of wave propagation, then we call that wave a **Transverse wave**
3. The waves produced by a motor boat sailing in water are **both Transverse and Longitudinal**
4. The distance between two successive points in a wave having same phase is called **Wavelength.**
5. The SI unit of angular frequency (ω) is **rad/sec.**
6. In a **Longitudinal** wave, the displacement of an element of the medium is parallel to the direction of propagation of the wave.
7. The pressure variations in the propagation of sound waves are **Adiabatic** processes.
8. A travelling wave suffers a phase change of **π** on reflection at a rigid boundary.
9. The equation y = 2a sinkx cosωt represents a stationary wave. The amplitude of the stationary wave is **2a sinkx**
10. In a stationary wave, the points at which the amplitude is the largest are called **antinodes.**
11. The lowest possible natural frequency of an oscillating system is called its **fundamental frequency or First Harmonic.**
12. **Beat** phenomenon is used in tuning musical instruments by musicians.

III. ONE WORD ANSWER Q'S

1. What does a wave represent?

A: A wave represents a disturbance that moves in a medium or space.

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2. Why sound wave requires a medium for its propagation? **[BMP2]**

A: Sound waves are mechanical waves. So they require a physical substance to propagate. They are carried from one point to another by the molecules of solids, liquids and gases.

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3. What is a longitudinal wave?

A: Waves in which the particles of the medium vibrate along the direction of wave propagation are called **longitudinal waves.**

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4. What is a transverse wave?

A: Waves in which the particles of the medium vibrate in perpendicular to the direction of wave propagation are called **transverse waves.**

---

5. What is the phase difference between the incident and reflected waves, when the wave is reflected by a rigid boundary?

A: 180^{o} or π radians.

---

6. What is the velocity of progressive wave, in terms of angular frequency (ω) and angular wave number (k)?

A: Velocity of progressive is $V=\frac{\omega}{k}$

---

7. What is the SI unit of angular wave number or propagation constant (k)?

A: SI unit of angular wave number is **rad/m.**

---

8. What is the fundamental mode or the first harmonic of an oscillatory system?

A: Fundamental mode is the simplest and lowest natural frequency at which an oscillatory system can vibrate.

---

9. A string is stretched between two rigid supports. What is the ratio of frequencies of vibration in such a string?

A: 1:2:3:4

---

10. What is the ratio of harmonics produced by an air column in a long tube, closed at one end?

A: 1:3:5:7

---

11. What is the ratio of harmonics produced by an air column in a long tube, open at both ends?

A: 1:2:3:4

---

12. What is the distance between node and immediate antinode in a stationary wave?

A: $\lambda/4$ (one quarter of the wavelength)

HINTS FOR HARD MCQ & FIB

MULTIPLE CHOICE QUESTIONS [MCQ]

1. **(2)** Sound waves are Longitudinal Light waves are Transverse

2. **(4)** $y = 3\sin(10\pi x - 2\pi t)$; comparing with $y = A\sin(Kx - \omega t)$ we get $K = 10\pi$, $\omega = 2\pi$

   We know $K = \frac{2\pi}{\lambda} \Rightarrow \lambda = \frac{2\pi}{K} = \frac{2\pi}{10\pi} = 0.2m$

   Now $\omega = \frac{2\pi}{T} = 2\pi \Rightarrow T = 1\ s \Rightarrow f = 1Hz$

3. **(1)** $y_1 = a\sin(\omega t + kx + 0.57) \Rightarrow \phi_1 = 0.57; y_2 = a\cos(\omega t + kx) = a\sin\left(\omega t + Kx + \frac{\pi}{2}\right) \Rightarrow \phi_2 = \frac{\pi}{2}$

   $\Delta\phi = \frac{\pi}{2} - 0.57 = \frac{3.14}{2} - 0.57 = 1.57 - 0.57 = 1$

4. **(2)** $y = 3\sin\left(36t + 0.018dx + \frac{\pi}{4}\right) = A\sin(\omega t + Kx + \phi)$ Now $\omega = 36$ $2\pi n = 36 \Rightarrow n = \frac{36}{2\pi} Hz$

5. **(4)** $V = \sqrt{\frac{T}{M}}$ $\frac{V_1}{V_2} = \sqrt{\frac{T_1}{T_2} \times \frac{M_2}{M_1}} = \sqrt{\frac{T}{2T} \times \frac{(M/2)}{\mu}} = \sqrt{\frac{1}{4}} = \frac{1}{2}$

6. **(2)** $y(x_1 t) = 0.06\sin\left(\frac{2\pi}{3}x\right)\cos(120\pi t)$. Comparing with $A\sin Kx\cos\omega t$ we get $k = \frac{2\pi}{3}, \omega = 120\pi$

   $\therefore V = \frac{\omega}{K} = \frac{120\pi}{\left(\frac{2\pi}{3}\right)} = 180m/s$

7. **(1)** For Stationary wave $y = 2\cos 3x \sin 10t$

   For travelling harmonic wave $y = 3\sin(5x - 0.5t) + 4\cos(5x - 0.5t)$

   For neither travelling nor stationary waves $y = 2\sqrt{x - vt}$

   For superposing of two stationary waves $y = \cos x \sin t + \cos 2x \sin 2t$

8. **(3)** $T = t_1 + t_2 = \sqrt{\frac{2h}{g}} + \frac{h}{v}$

9. **(3)** Velocity increases with temperature & humidity

10. **(2)** Gases have no shearing stress

11. **(1)** $f = \frac{nv}{4l} \Rightarrow 1275 = \frac{n(340)}{4 \times 20 \times 10^{-2}} \Rightarrow n = 3$

12. **(2)** $f_1 = \frac{500\pi}{2\pi} = 250Hz; f_2 = \frac{506\pi}{2\pi} = 253Hz$

    $\Delta f = |f_2 - f_1| = |253 - 250| = 3Hz$