
तत् त्वं पूषन् अपावृणु
केन्द्रीय विद्यालय संगठन
KENDRIYA VIDYALAYA SANGATHAN
ZIET MYSORE
3 DAYS WORKSHOP FOR PGT PHYSICS
ON COMPETENCY BASED ASSESSMENT
&
PREPARATION OF TEST ITEM
24 - 26 SEPTEMBER 2024
"From Concepts to Competence:
Elevating Assessment
Standards in Physics"
CLASS XI
SUBJECT PHYSICS

DIRECTOR'S MESSAGE……

It is with profound delight and utmost pride that we present the Competency Based Assessment question bank for **CLASS XI** which was prepared by PGT(Physics) of the feeder regions during the 03 – day workshop on "**Competency Based Assessment in Physics: Design of test items**" It's my firm belief that access to quality education should know no boundaries, transcending social and economic constraints. Our collective vision is to empower all students and teachers with the tools for success and intellectual growth.

With their steadfast dedication, the PGT(Physics) from the feeder Regions namely Bangalore, Chennai, Ernakulam and Hyderabad have invested their knowledge and expertise in preparation of the CBA test items.

It is with pleasure that I place on record my commendation for the commitment and dedication of the team of PGT(Physics) from the four Regions, Shri. Mathew Abraham, Principal KV Konni, Ernakulam Region & Associate Course Director, the Resource person Mr Randheer Vannery PGT(Physics)KV No. 1 Palakkad and Mr. Dinesh Kumar, Training Associate (Physics) from ZIET Mysore who has been the Coordinator of this assignment.
Wishing you all the very best in your academic journey!

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CHAPTER–2: UNIT AND MEASUREMENT

SYLLABUS: Units and Measurements Need for measurement: Units of measurement; systems of units; SI units, fundamental and derived units. significant figures. Dimensions of physical quantities, dimensional analysis and its applications.

ASSERTION & REASON

SL NO	QUESTION	MARKS
1	**Assertion(A):** Force cannot be added to energy. **Reason(R):** The dimension of force and energy are different.	1
2	**Assertion(A):** Linear Momentum is a derived physical quantity. **Reason(R):** Linear Momentum cannot be derived from fundamental physical quantities.	1
3	**Assertion(A):** For the measurement of any physical quantity, we choose a constant quantity as a standard **Reason(R):** We compare this standard quantity with given physical quantity to find number which expresses how many times a standard quantity is contained in the physical quantity.	1
4	**Assertion(A):** Number of significant figures in 0.005 is one that in 0.500 is three. **Reason(R):** This is because zeros are not significant.	1
5	**Assertion(A):** When we change the unit of measurement of a quantity, its numerical value changes. **Reason(R):** Smaller the unit of measurement larger is its numerical value.	1
6	**Assertion(A):** All constants are dimensionless **Reason(R):** All physical quantities necessarily have dimensions.	1
7	**Assertion(A):** All derived quantities may be represented dimensionally in the terms of base quantities. **Reason(R):** The dimensions of base quantity in other base quantities is zero	1
8	**Assertion(A):** Method of dimensions cannot be used for deriving formulas containing trigonometric ratios. **Reason(R):** This is because trigonometric ratios do not have dimensions.	1
9	**Assertion(A):** the equation y = 2x – t cannot be true if x and y are distance t is time. **Reason(R):** Quantities with different dimensions cannot be added.	1
10	**Assertion(A):** Pressure has the dimensions of energy density **Reason(R):** energy density = energy/Volume = $[ML^{-1}T^{-2}]$= Pressure	1

Answer Key AR

Q1. A Q2. C Q3. A Q4. C Q5. A

Q6. D Q7. B Q8. A Q9. A Q10. A

CH: 2, UNIT AND MEASUREMENT

CASE BASED QUESTIONS

SL NO	QUESTION	MARKS
1	Dimensions are customarily used as a preliminary test of the consistency of an equation, when there is some doubt about the correctness of the equation. However, the dimensional consistency does not guarantee correct equations. It is uncertain to the extent of dimensionless quantities or functions. The arguments of special functions, such as the trigonometric, logarithmic and exponential functions must be dimensionless. if an equation fails this consistency test, it is proved wrong, but if it passes, it is not proved right. Thus, a dimensionally correct equation need not be actually an exact (correct) equation, but a dimensionally wrong (incorrect) or inconsistent equation must be wrong.	
i)	If α kilogram, β meter, and ϒ second are the fundamental units, 1 cal can be expressed in the new units as [1 cal = 4.2 J] (a) $[\alpha^{-1}\ \beta^{2}\ \Upsilon]$ (b) $[\alpha^{-1}\ \beta^{-2}\ \Upsilon]$ (c) $4.2\ [\alpha^{-1}\ \beta^{2}]$ (d) $4.2\ [\alpha^{-1}\ \beta^{2}\ \Upsilon^{2}]$	**1**
ii)	The energy of SHM is dependent on mass m, frequency f, and amplitude A of oscillation. The relation is (a) $[m\ f\ A^{2}]$ (b) $[m\ f\ A^{-2}]$ (c) $[m\ f^{2}\ A^{-2}]$ (d) $[m\ f^{2}\ A^{-2}]$	**1**
iii)	Given T stands for the time period and *l* stands for the of length of simple pendulum. If g is the acceleration due to gravity then which of the following statements about the relation $T^2 = l/g$ is correct? (a) It is correct both dimensionally as well as numerically. (b) It is neither dimensionally correct nor numerically. (c) It is dimensionally correct but not numerically. (d) It is numerically correct but not dimensionally	**1**
iv)	A student when discussing the properties of the medium (except vacuum) writes Speed of light in vacuum = speed of light in medium This formula is (a) Dimensionally correct (b) Dimensionally incorrect (c) Numerically incorrect (d) Both a and c **OR** Which of the following pair has the same dimensions? (a) Torque and linear momentum (b) Angular momentum and Planck’s constant (c) Energy and Young’s modulus. (d) Frequency and wavelength	**1**
2	Every measurement involves errors. Thus, the result of measurement should be reported in a way that indicates the precision of measurement. Normally, the reported result of measurement is a number that includes all digits in the number that are known reliably plus the first digit that is uncertain. The reliable digits plus the first uncertain digit are known as significant digits or significant figures.	

i)	If the length and breadth are measured as 4.234 and 1.05 m, the area of the rectangle is (a) 4.4457 m^2 (b) 4.45 m^2 (c) 4.446 m^2 (d) 0.4446 m^2	**1**
ii)	Which of the following has least significant figures? (a) 0.80760 (b) 0.80200 (c) 0.08076 (d) 80.267	**1**
iii)	How many significant figures does 190909090? (a) 8 (b) 7 (c) 9 (d) 5	**1**
iv)	Express the final answer up to proper significant digits: 101.2 + 18.702 =? (a) 119.902 (b) 119.9 (c) 119.90 (d) 119.91 **OR** How many significant figures are in measurement 0.0082 L? **(a)** 2 (b) 4 (c) 5 (d) 3	**1**
3	Physical measurements are usually expressed for small and large quantities in scientific notation, with powers of 10. Scientific notation and the prefixes are used to simplify measurement notation and numerical computation, giving indication to the precision of the numbers**.**	
i)	The order of magnitude of 499 is 2. Then the order of magnitude of 501 will be: (a) 4 (b) 2 (c) 1 (d) 3	**1**
ii)	The order of magnitude of 0.005 is: (a) -2 (b) -3 (c) 2 (d) 1	**1**
iii)	The order of magnitude of 379 is (a) 2 (b)1 (c) 3 (d) 4	**1**
iv)	The order of magnitude of 14759 is: (a) 1 (b) 2 (c) 3 (d) 4 **OR** The order of magnitude of 8245 is: (a) 1 (b) 2 (c) 3 (d) 4	**1**
4	Physics is a quantitative science, based on measurement of physical quantities. Certain physical quantities have been chosen as fundamental or base quantities (such as length, mass, time, electric current, thermodynamic temperature, amount of substance, and luminous intensity). Each base quantity is defined in terms of a certain basic, arbitrarily chosen but properly standardised reference standard called unit (such as metre, kilogram, second, ampere, kelvin, mole and candela). The units for the fundamental or base quantities are called fundamental or base units. Other physical quantities, derived from the base quantities, can be expressed as a combination of the base units and are called derived units. A complete set of units, both fundamental and derived, is called a system of units. The International System of Units (SI) based on seven base units is at present internationally accepted unit system and is widely used throughout the world. The SI units are used in all physical measurements, for both the base quantities and the derived quantities obtained from them. Certain derived units are expressed by means of SI units with special names (such as joule, newton, watt, etc). The SI units have well defined and internationally accepted unit symbols (such as m for metre, kg for kilogram, s for second, A for ampere, N for newton etc.).	
i)	The equation of the stationary wave is $y = 2A\sin\left(\frac{2\pi ct}{\lambda}\right)\cos\left(\frac{2\pi x}{\lambda}\right)$	**1**

	(a) The unit of ct is same as that of λ (b) The unit of x is same as that of λ (c) The unit of 2πc/ λ is same as that of 2πx/ λt. (d) The unit of c/ λ is same as that of x/ λ	
ii)	Given that: $y = A\sin[\left(\frac{2\pi}{\lambda}\right)(ct - x)]$, where y and x are measured in unit of length . Which of the following statements are true (a) The unit of λ is same as that of x and A (b) The unit of λ is same as that of x but may not be same as that of A (c) The unit of c is same as that of 2π/ λ (d) The unit of (ct-x) is same as that of 2π/ λ.	**1**
iii)	The unit of angular acceleration in the SI System is (a) N/Kg (b) m/s^2 (c) rad/s^2 (d) $m\ kg^{-1}K$	**1**
iv)	Newton-sec is the unit of (a) Velocity (b) Angular Momentum (c) Momentum (d) Energy **OR** Which of the following is not represented in correct unit (a) Stress/Strain = N/m^2 (b) Surface Tension = N/m (c) Energy = Kg-m/sec (d) Pressure = N/m^2	**1**

ANSWER KEY CASE BASED QUESTIONS

Q1. (i) d (ii) b (iii) c (iv) d OR b

Q2. (i) b (ii) b (iii) a (iv) b or a

Q3. (i) b (ii) b (iii) a (iv) d or c

Q4. (i) d (ii) b (iii) c (iv) c or c

CHAPTER 3: MOTION IN STRAIGHT LINE

1	Assertion (A): For a moving particle distance can never be negative or zero. Reason(R): Distance is a scalar quantity and never decreases with time for moving object.	1
2	Assertion (A): It is not possible to have constant velocity and variable acceleration. Reason(R): Accelerated body cannot have constant velocity.	1
3	Assertion (A): In the presence of air resistance, if the ball is thrown vertically upward then time of ascent is less than the time of descent. Reason(R): Force due to air friction always acts opposite to the motion of body.	1
4	Assertion (A): An object can have constant speed but variable velocity. Reason(R): Speed is a s calar but velocity is a vector quantity	1
5	Assertion (A): A body hav ing a non zero acceleration can have constant velocity. Reason(R): Acceleration is the rate of change of velocity	1
6	Assertion (A): The area under acceleration-time graph is equal to velocity of object. Reason(R): For an object moving with constant acceleration position-time graph is a straight line.	1
7	Assertion (A): An object can have constant speed but variable velocity. Reason(R): Speed is a scalar but velocity is a vector quantity	1
8	Assertion (A): A body moving with decreasing speed may have increased acceleration. Reason(R): The speed of body decreases when acceleration of body is opposite to velocity	1
9	Assertion (A): Retardation is directly opposite to the velocity. Reason(R): Retardation is equal to the time rate of decrease of speed.	1
10	Assertion (A): A body can have acceleration even if its velocity is zero at that instant. Reason(R): The body will momentarily at rest when it reverses its direction of motion	1

ANSWERS:

1	A
2	A
3	A
4	A
5	C
6	D
7	A
8	B
9	B
10	A

CASE BASED QUESTIONS

1	The acceleration of an object is said to be uniform acceleration if its velocity changes by equal amount in equal interval of time, however small these time intervals may be. A particle is moving with uniform acceleration in x-direction, the displacement x of particle varies with time t as $x = 4t^2-15t+25$ m	
i)	(i) The position of particle at t = 0 (a) 14 m. (b) 18 m (c) 20 m (d) 25 m	1
ii)	(ii) Velocity of particle at t = 2 s (a) -15 m/s (b) 1 m/s (c) 3 m/s (d) 31 m/s	1
iii)	(iii) Acceleration of particle at t = 2 s (a) 0 ms^{-2} (b) 8 ms^{-2} (c) 10 ms^{-2} (d) 20 ms^{-2}	1
iv)	(v) The particle has a uniform acceleration 'a 'when (a) acceleration does not depend on time t (b) acceleration depends on time t (c) velocity changes by unequal amount in equal interval of time (d) None of these OR (iv) The velocity of particle will become zero at time t equal to (a) 2.975 s (b) 1.875 s (c) 2 s (d) 1 s	1
2	Average Speed and Average Velocity When an object is in motion, its position changes with time. So, the quantity that describes how fast is the position changing w.r.t. time and in what direction is given by average velocity. It is defined as the change in position or displacement (Δx) divided by the time interval (Δt) in which that displacement occurs. However, the quantity used to describe the rate of motion over the actual path, is average speed. It defined as the total distance travelled by the object divided by the total time taken.	
i)	A 250 m long train is moving with a uniform velocity of 45 km/h. The time taken by the train to cross a bridge of length 750 m is A) 56 s B) 68 s C) 80 s D) 92 s	1
ii)	A truck requires 3 hr to complete a journey of 150 km. What is average speed? (a) 50 km/h (b) 25 km/h (c) 15 km/h (d) 10 km/h	1
iii)	Average speed of a car between points A and B is 20 m/s, between B and C is 15 m/s and between C and D is 10 m/s. What is the average speed between A and D, if the time taken in the mentioned sections is 20s, 10s and 5s, respectively? (a) 17.14 m/s (b) 15 m/s (c) 10 m/s (d) 45 m/s	1
iv)	A cyclist is moving on a circular track of radius 40 m completes half a revolution in 40 s. Its average velocity (in m/s) is (a) zero (b) 2 (c) 4π (d) 8	1
3	If you tossed an object either up or down and could somehow eliminate the effects of air on its flight you would find that the object accelerates downward at a certain constant rate. The rate is called the free fall acceleration and its magnitude is represented by g. The acceleration is independent of the objects characteristics such as mass density or shape it is the same for all objects.	
i)	The time of ascent of a body thrown vertically upward with initial velocity u is a) t = u/2g b) t= u/g c) t= u/4g d) t= u/3g	1
ii)	The time of descent of a body thrown vertically upward with initial velocity u is a)t = u/4g b) t= u/g c)t= u/2g d) t= u/3g	1

iii)	The total time of flight to come back to the point of projection of a body thrown vertically upward with initial velocity u is (a) t= 2u/3g (b) t= u/2g (c) t= 2u/g (d) t= u	1
iv)	Velocity of fall at the point of projection of a body thrown vertically upward with initial velocity u is a) v = u b) v = 2u c)v = 3u d) v = 4u	1
4	When an object moves along a straight line with uniform acceleration, it is possible to relate its velocity, acceleration during motion and the distance covered by it in a certain time interval by a set of equations known as the equations of motion. For convenience, a set of three such equations are given below: v = u + at s = ut + ½ at2 $2a\ s = v^2 – u^2$ Where u is the initial velocity of the object which moves with uniform acceleration a for Time t, v is the final velocity and s is the distance travelled by the object in time t.	
i)	Equations of motion are applicable to motion with A) uniform acceleration B) non uniform acceleration C)constant velocity D) none of these	1
ii)	2. Consider a body moving with an acceleration of 2 m/s^2. After t seconds its velocity is 10 m/s. Find 't'. A) 4 s B) 20 s C) 5 s D) 8	1
iii)	The brakes applied to a car produce an acceleration of 10 ms^{-2} in the opposite direction to the motion. If the car takes 1 s to stop after the application of brakes, calculate the distance covered during this time by car. A) 5m B) 2.5m C)25m D) 10m	1
iv)	An object is dropped from a tower falls with a constant acceleration of 10 m/s^2. Find its speed 10 s after it was dropped. A)110m/s B)100m/s C)120m/s D) -120m/s **OR** A bullet hits a Sand box with a velocity of 10 m/s and penetrates it up to a distance of 5 cm. Find the deceleration of the bullet in the sand box A) − 10m⁄s B) 20m⁄s C) $-9m/s^2$ D)$-18m/s^2$	1

1			**3**	
i)	**D**		i)	**B**
ii)	**B**		ii)	**B**
iii)	**B**		iii)	**C**
iv)	**B or A**		iv)	**A**
2			**4**	
i)	**C**		i)	**A**
ii)	**A**		ii)	**C**
iii)	**C**		iii)	**A**
IV)	**A**		IV)	**B OR A**

CHAPTER–4: MOTION IN A PLANE

SYLLABUS: Motion in a Plane Scalar and vector quantities; position and displacement vectors, general vectors and their notations; equality of vectors, multiplication of vectors by a real number; addition and subtraction of vectors, Unit vector; resolution of a vector in a plane, rectangular components, Scalar and Vector product of vectors. Motion in a plane, cases of uniform velocity and uniform acceleration- projectile motion, uniform circular motion.

ASSERTION & REASON

SL NO	QUESTION	MARKS
1	**Assertion (A):** A projectile is projected at an angle θ and then at an angle $(90° - \theta)$, keeping the initial velocity same. In both the cases, the range will be same. **Reason (R):** Range of a projectile R $=u^2\sin^2\theta$	1
2	**Assertion:** The scalar product of two vectors can be zero. **Reason:** If two vectors are perpendicular to each other, their scalar product will be zero.	1
3	**Assertion:** A body of mass 1 kg is making 1 rps in a circle of radius 4 m. Centripetal acceleration of the body is $16\pi^2$ m/s^2. **Reason:** Centripetal acceleration is given by$\frac{v^2}{r}$**.**	1
4	**Assertion (A):** For uniform circular motion, the displacement and acceleration are directed towards the centre along the radius. **Reason (R):** Centripetal acceleration is represented as $\frac{v^2}{r}$	1
5	**Assertion:** Minimum number of non-equal vectors (in magnitude) in a plane required to give zero resultant is three**.** **REASON:** If $\boldsymbol{P}+\boldsymbol{Q}+\boldsymbol{R} = \mathbf{0}$**,** then they must lie in one plane.	1
6	**Assertion**: Multiplying a vector **A** with a positive number λ gives a vector whose magnitude is changed by the factor λ but the direction is the same as that of **A.** **Reason: λ** is a scalar quantity so scalar multiplied with a vector gives scalar	1
7	**Assertion:** When a 30-dyne force is inclined to y-axis at an angle 60°, the vertical and horizontal components of the force are 15 dyne and 15√3 dyne respectively. **Reason:** When a vector A is inclined to y-axis at an angle θ, the vertical and horizontal components of the vector are A cosθ and A sin θ respectively.	1
8	**Assertion:** If there were no gravitational force, the path of the projected body always is a straight line. **Reason:** Gravitational force act along line joining centres of bodies.	1
9	**Assertion:** Torque is an axial vector. **Reason:** Force is a polar vector.	1
10	**Assertion:** Unit vector has magnitude equal to one. **Reason:** Unit vector is used to represent direction of vector only.	1

ANSWERKEY

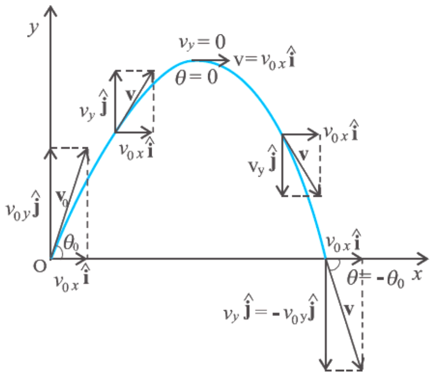
1.C	**6.C**
2.A	**7.A**
3.A	**8.B**
4.C	**9.B**
5.A	**10.A**

CHAPTER–4: MOTION IN A PLANE

SYLLABUS: Motion in a Plane Scalar and vector quantities; position and displacement vectors, general vectors and their notations; equality of vectors, multiplication of vectors by a real number; addition and subtraction of vectors, Unit vector; resolution of a vector in a plane, rectangular components, Scalar and Vector product of vectors. Motion in a plane, cases of uniform velocity and uniform acceleration- projectile motion, uniform circular motion.

CASE BASED QUESTIONS

SL NO	QUESTION	MARKS
CASE 1	An object that is in flight after being thrown or projected is called a projectile. Such a projectile might be a football, a cricket ball, a baseball or any other object. The motion of a projectile may be thought of as the result of two separate, simultaneously occurring components of motions. One component is along a horizontal direction without any acceleration and the other along the vertical direction with constant acceleration due to the force of gravity. It was Galileo who first stated this independency of the horizontal and the vertical components of projectile motion in his Dialogue on the great world systems (1632). In our discussion, we shall assume that the air resistance has negligible effect on the motion of the projectile. Suppose that the projectile is launched with velocity vo that makes an angle θo with the x-axis as shown in Fig. After the object has been projected, the acceleration acting on it is that due to gravity which is directed vertically downward:	



SL NO	QUESTION	MARKS
Q.1	Out of which of the following cases which can be called a projectile motion?	1
i)	A child takes a turn on the ground	
ii)	A player throws a ball above a wall	
iii)	A block slides on floor	
iv)	A car got a collision with other car	
Q.2	At which point of the path it's angle of velocity from the horizontal becomes 0^o?	1
i)	At point O	
ii)	At top point	
iii)	1 sec after projection	
iv)	2 sec after projection	
Q.3	If the velocity of projection of a projectile is 2i + 3j then the velocity with which it strikes the ground is	1
i)	-2i + 3j	
ii)	-2i - 3j	

iii)	2i - 3j	
iv)	2i + 3j	
Q.4	The horizontal component of velocity	
i)	goes on decreasing	
ii)	goes on increasing	
iii)	cannot be predicted	
iv)	remains constant	
	OR	
Q.4	On increasing angle from the horizontal	
i)	Vertical component of velocity increases	
ii)	horizontal component of velocity increases	
iii)	No change occurs in components of velocity	
vi)	Vertical component of velocity decreases	

SL NO	**QUESTION**	**MARKS**
CASE 2 Q.1	The following are the properties of vector quantities:- (a) Two vectors A and B are said to be equal if, and only if, they have the same magnitude and the same direction. b) Multiplying a vector A with a positive number λ gives a vector whose magnitude is changed by the factor λ but the direction is the same as that of A : $\lvert\lambda A\rvert = \lambda\lvert A\rvert$ c) The null vector also results when we multiply a vector A by the number zero. Properties of 0 are $A + 0 = A$ $\lambda 0 = 0$ $0 A = 0$ d) Subtraction of vectors can be defined in terms of addition of vectors. We define the difference of two vectors A and B as the sum of two vectors A and –B $A – B = A + (–B).$ Two vectors A and B are said to be equal if	1
i)	they have the same magnitude	
ii)	they have the same direction	
iii)	they have the same magnitude and the same direction	
iv)	None of these	
Q.2	Multiplying vector, A with a positive number will results in	1
i)	Change in magnitude	
ii)	Change in direction	
iii)	Change in both magnitude and the same direction	
iv)	None of these	
Q.3	If a vector is multiplied by a scalar then	1
i)	Only magnitude is changed	
ii)	Only direction is changed	
iii)	Both may be changed	
iv)	None of the above	
Q.4	$A – B = \lvert A\rvert - \lvert B\rvert$	
i)	Always true	1
ii)	Never true	
iii)	True under some special condition	
iv)	Cannot be predicted	
	OR	

Q.4	We can make the direction of a vector opposite by multiplying it with	
i)	A positive scalar	
ii)	A negative scalar	
iii)	A vector	
iv)	None of the above	

CASE BASED QUESTIONS

SL NO	QUESTION	MARKS
CASE 3	Rectangular components of vectors: The quantities *Ax* and *Ay* are called *x*, and *y* components of the vector A. Note that A_x is itself not a vector, but A_xi is a vector, and so is A_yj. Using simple trigonometry, we can express A_x and A_y in terms of the magnitude of A and the angle θ it makes with the *x*-axis : $A_x = A\cos\theta$……..(1) $A_y = A\ \sin\theta$…..(2) As is clear from above, a component of a vector can be positive, negative or zero depending on the value of θ. Now, we have two ways to specify a vector A in a plane. It can be specified by : (i) its magnitude *A* and the direction θ it makes with the *x*-axis; or (ii) its components A_x and A_y If A and θ are given, A_x and A_y can be obtained using Eq. (1)and (2). If A_x and A_y are given, *A* and θ can be obtained as follows : A = $\sqrt{Ax^2 + Ay^2}$ And tan θ = $\frac{Ay}{Ax}$	
Q.1	Horizontal component of A is	1
i)	$A\cos\theta$	
ii)	$A\ \sin\theta$	
iii)	$A\ \sin\theta$ or $A\cos\theta$ depending upon the angle made with horizontal of vertical	
iv)	None of these	
Q.2	If A_x and A_y are given then θ will be given by	1
i)	tan($\frac{Ay}{Ax}$)	
ii)	$\tan^{-1}$($\frac{Ay}{Ax}$)	
iii)	sin($\frac{Ay}{Ax}$)	
iv)	$\sin^{-1}$($\frac{Ay}{Ax}$)	
Q.3	If a vector is given by 3i + 4j then its magnitude is	1
i)	7	
ii)	-7	
iii)	-5	
iv)	5	
Q.4	In the above question angle made by A from x axis is	1
i)	$\sin^{-1}(1)$	
ii)	$\tan^{-1}(4/3)$	
iii)	$\tan^{-1}(3/4)$	
iv)	$\cos^{-1}(1)$	
	OR	

Q.4	If we increase the angle from vertical	
i)	Vertical component of vector increases	
ii)	horizontal component of vector decreases	
iii)	No change occurs in components of vector	
iv)	Vertical component of vector decreases	

SL NO	QUESTION	MARKS
CASE 4	When the football travels through the air, it always follows a parabolic path because the movement of the ball in the vertical direction is influenced by the force of gravity. As the ball travels up, gravity slows it down until it stops for a moment at its peak height; the ball then comes down and gravity accelerates it until it hits the ground. When a footballer kicks a ball he has to consider 3 factors: • The velocity at which the ball leaves his feet • The angle of kick • The rotation of the ball The rotation of the ball determines how the ball will slow down in flight. The velocity of the ball and the angle of the kick are the major factors those determine: • How long the ball will remain in air (hangtime) • How high the ball will go • How far will the ball go When the ball leaves the footballer's foot, it moves in two directions - horizontally and vertically. If the ball is kicked at a steep angle, then it will have more velocity in the vertical direction than in the horizontal direction - the ball will go high, have a long hang-time, but travel a short distance. If the ball is kicked at a shallow angle, it will have more velocity in the horizontal direction than in the vertical direction - the ball will not go very high, will have a short hang-time, but will travel a long distance. The footballer decides on the best angle in view of his field position.	
Q1	A footballer kicks a ball with velocity 60 m/s at an angle a. For which of the following values of a, the hang-time will be highest?	
i)	15°	
ii)	30°	
iii)	45°	
iv)	60°	
Q2	A player can impart a maximum speed 40 m/s to a football. At which angle he should kick the ball to pass it on to another player of his team standing a distance 80m.($g = 10m/s^2$)	1
i)	15°	
ii)	30°	
iii)	45°	
iv)	60°	
Q.3	At the topmost point of its path what will be the acceleration	1
i)	Less than g	
ii)	Equal to g	
iii)	Greater than g	
iv)	Zero	

Q.4	Ball A is kicked at an angle 30° and ball B is kicked at an angle 60° with same velocity	
i)	Maximum height of ball A will be greater than B	
ii)	Maximum height of ball B will be greater than A	
iii)	Both the balls will achieve same maximum height	
iv)	Cannot be predicted	
	OR	
Q.4	For smaller angle of projection, time of flight will be	
i)	smaller	
ii)	larger	
iii)	It does not depend on angle of projection	
iv)	None of these	

ANSWER KEY

CASE 1	CASE 2	CASE 3	CASE 4
1(ii)	1(iii)	1(iii)	1(iv)
2(ii)	2(i)	2(ii)	2(i)
3(iii)	3(iii)	3(iv)	3(ii)
4(iv)	4(iii)	4(iii)	4(ii)
Or	Or	Or	or
(i)	4(ii)	4(iv)	4(i)

CHAPTER–5: LAWS OF MOTION

Concept of force, Inertia, Newton's first law of motion; momentum and Newton's second law of motion; impulse; Newton's third law of motion. Law of conservation of linear momentum and its applications. Equilibrium of concurrent forces, Static and kinetic friction, laws of friction, rolling friction, lubrication. Dynamics of uniform circular motion: Centripetal force, examples of circular motion (vehicle on a level circular road, vehicle on a banked road).

ASSERTION AND REASONING – LAWS OF MOTION

SL NO	QUESTION	MARKS
1	**A:** On a banked curved track, horizontal component of normal reaction provides the necessary centripetal force R: centripetal force is not always required for turning.	1
2	**A:** Two bodies having mass m_1 and m_2 collide elastically the net momentum of the system conserves whereas the individual momentums of the particles changes. R: During elastic collision, by Newton's third law of motion force on m_1 is exactly equal and opposite to force on m_2.	1
3	**A:** Angle of repose is 30^0. Coefficient of friction between object and a surface is $1/\sqrt{3}$. **R:** Coefficient of friction is equal to tan (angle of repose).	1
4	**A:** In uniform circular motion the speed of the object doesn't change. **R:** Centripetal force is responsible for changing the direction and magnitude of the speed.	1
5	**A**: Friction between the tyres and the road produces considerable wear and tear. To avoid friction the curved road is given an inclination **R**: When the road is banked the horizontal component of the normal reaction provides the necessary centripetal force.	1
6	**A:** when we jump on to a Cushion we get less hurt. **R:** when change in momentum of an object takes place in more time it experiences less force.	1
7	**A**: In uniform circular motion the speed of the object remains constant. **R**: In uniform circular motion object accelerates.	1
8	**A:** - In uniform circular motion velocity is not constant **R:** In uniform circular motion object experiences centripetal force.	1
9	**A:** when an object is placed on a surface the frictional force between the surface and the object is more if the mass of the object is heavy. **R:** static friction is directly proportional to normal reaction.	1
10	**A**: In a perfectly inelastic collision kinetic energy of the system is not conserved. **R**: In a perfectly in elastic collision momentum of the system is conserved.	1

ANSWER KEY

1	C		6	A
2	A		7	B
3	A		8	A
4	C		9	A
5	A		10	B

CASE-BASED QUESTIONS

SL NO	QUESTION	MARKS
1	When a car negotiates a curved road, the force of friction between the road and the tyres provides the centripetal force required to keep the car in motion around the curve. A large amount of friction between the tyres and the road produces considerable wear and tear on the tyres. To avoid dependence on friction, the curved road is given an inclination sloping upwards towards the outer circumference. This reduces the wearing of the tyres because the horizontal component of the normal reaction provides the necessary centripetal force. The system of raising the outer edge of a curved road above the inner edge is called the banking of the curved road. When a vehicle negotiates a circular turn of radius r and is banked at an angle θ, the maximum safe velocity is given by $v_{max} = rg\ tan\theta$ the absence of frictional forces $v_{max} = \sqrt{}rg\ (\mu S\ +\ tan\ \theta)\ /(\ 1 -\ \mu S\ tan\ \ \theta),$ in the presence of frictional forces.	
i)	If the radii of circular paths of two particles of the same masses are in the ratio of 16:25 then to have a constant centripetal force, their velocities should be in a ratio of A)3:2 B) 4:1. C) 4:5. D) 2:3	1
ii)	The maximum speed with which a car can be driven round a curve of radius 16m without skidding (when g= 10m/s^2 and the coefficient of friction between rubber tyres and the roadway is 0.4) A)8m/s. B) 10m/s C) 6m/s D) 4m/ s.	1
iii)	A body moves along a circular path of radius 1m and the coefficient of friction is 0.25. what should be its angular speed in rad/ s if it is not to slip from the surface(take g= 10m / s^2). A) 1.5 rad/ s. B) 0.5 rad/ s C) 3.5 rad /s D) 2 .0 rad/s.	1
iv)	The force which is acting as a centripetal force when a vehicle takes a circular turn on a level road A) normal reaction B) Frictional force C) components of normal force D) none of the above.	1
v)	For a car not to turn safely on a curved road (A) speed is slow (B) distance between tyres is large (C) center of gravity for car is low (D) low friction force	1
2	Consider an isolated system of n interacting particles. The mutual forces between pairs of particles in the system cause changes in momenta of the individual particles. By third law, the mutual forces between any pair of particles are equal and opposite. By second law, the change in momenta for any pair of particles are Ft and -Ft. Thus, the momentum changes cancel in pairs and total momentum of the system remains constant. This leads to a fundamental principle of physics called the law of conservation of linear momentum. This law states that the total linear momentum of an isolated system of interacting particles is conserved. The recoil of a gun on firing, explosion of a bomb into different fragments due to internal forces, the working of rockets and jet planes, etc.; can be explained on basis of momentum conservation.	

	Answer the following with reference to above statement	
i)	A body of mass M moving with velocity V explodes into two equal parts. If one comes to rest and the other part moves with velocity v, what would be the value of v? A) V B) V/√2. C) 4V. D) 2V	1
ii)	A bullet is fired from a rifle. If the rifle recoils freely, then the kinetic energy of the refile is a) less than that of the bullet b) more than that of the bullet C) same as that of the bullet D) equal to or less than that Of the bullet.	1
iii	The explosion of a bomb into different fragments due to internal forces can be explained by A)First law of motion B)second law of motion C)law of conservation of momentum .D) none of the above.	1
iv)	conservation of linear momentum is a consequence of A) 1st law and2rd law B) 2nd law and 3rd law C) 1st law and 2nd law D) none of the above.	1
v)	A body of mass 0.25 kg is projected with muzzle velocity 100 m/s from a tank of mass 100 kg. What is the recoil velocity of the tank ? (A) 5 m/s B) 25 m/s (C) 0.5 m/s (D) 0.25 m/s.	1
3	To drive a nail into a wooden block, we blow a hammer on the nail. When a ball hits a wall, it bounces back In both of these examples, a large force acts for a very short duration producing a finite change in the momentum of the body. Here it is difficult to measure force and time separately. The product of the force and time that produces a finite change of momentum is called impulse. Impulse = Force x time duration = Total change in momentum.SI unit of impulse is Ns or kgm/s. It is a vector quantity having the direction same as that of force or the change in momentum. A large force acting force a short time is called an impulsive force. For a variable force, impulse J is given by $J = P_2 - P_1 = \int dp = \int Fdt$ = Area under the force-time curve.	
i)	A particle is moving in a circle with uniform speed v. In moving from a point to another diametrically opposite point, (a) the momentum changes by mv (b) the momentum changes by 2 mv (c) the kinetic energy changes by (1/2) mv^2 (d) the kinetic energy changes by mv.	1
ii)	A ball strikes a bat with velocity v. The ball has mass m and after striking it retraces its path. What is the impulse imparted by the bat? (a) 3mv (b) mv (c) zero (d) 2 mv	1
iii)	Calculate the impulse necessary to stop a 15kg car travelling at 90 km/h. A)- 375Ns B)-275Ns C)-100Ns D)-360Ns.	1

iv)	A body of mass 0.25 kg moving with velocity 12 m/s is stopped by applying a force of 0.6 N. Calculate the time taken to stop the body. A)5 s B) 3 s C) 20 s D) 6 s.	1
v)	If two balls, each of mass 0.06 kg, moving in opposite directions with speed 4 m/s, collide and rebound with same speed, then impulse imparted to each ball due to other is (A) 0.48 kg m/s. (B) 0.81 kg m/s. (C) 0.53 kg m/s. (D)0.92Kg m/s.	1
4.	Whenever a body moves or tends to move over the surface of another body, a force comes into play which acts parallel to the surface of contact and opposes the relative motion. This opposing force is called friction. Static friction f_S opposes the impending relative motion while the kinetic friction f_K opposes the actual relative motion. Static friction is a self-adjusting force. The maximum value of static friction ($f_{S}=\mu_s N$)which comes into play when a body just starts moving over the surface of another body is called limiting friction. $f_s \leq \mu_s N$ and $f_k = \mu_k N$ where N is the normal reaction between the two surfaces in contact. Both static and kinetic friction are independent of the area of surfaces in contact.	
i)	Which of the following is the dimension of the coefficient of friction (A) $[MLT^{-2}]$ (B) $[M^0 L^0 T^0]$ (C) $[M^2 LT^{-2}]$ (D) $[M^2 LT]$	1
ii)	A body rolled on ice with a velocity of 1m /s comes to rest after travelling 32m. Compute the coefficient of friction. Given g = 10m / s^2 A) 0.0015 B) 0.0035 C)0.0066 D)0.009	1
iii)	A cubical block rests on an inclined plane of $\mu = 1/\sqrt{3}$, determine the angle of inclination when the block just slides down the inclined plane. A) 30^0 B) 40^0 C) 45^0 D) 60^0	1
iv	A body of mass 10 kg is moving on a plane with an initial velocity of 10 m/s. If the coefficient of friction between the surface and body is 0.5, then before stopping, the body will cover a distance of (A) 10 m. C) 7.5 m. (B) 5 m. D) 2.5 m .	1
V)	Two iron blocks of equal masses but with different surface areas slide down an inclined plane with friction coefficient μ. If the first block with surface area A experiences a frictional force f, then the second block with surface area 2 A will experience a frictional force (a) f/2 (b) f (c) 2 f (d) 4 f	1

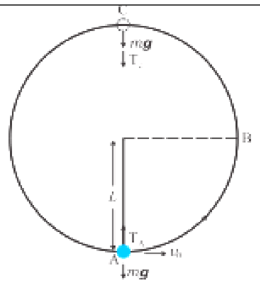
ANSWER KEY

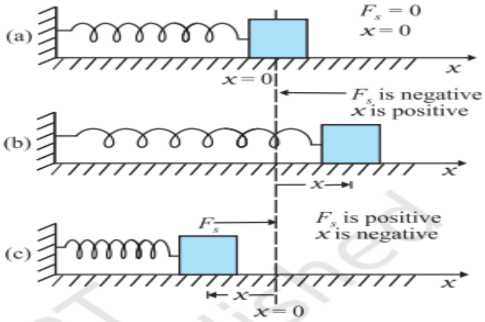
1) i) C ii) A iii) A iv) B v) D
2) i) D ii) A iii) C iv) B v) D
3) i) B ii) D iii) A iv) A v)A
4) i) B ii) A iii) A iv) B v) B

CHAPTER 6: WORK ENERGY AND POWER

1	**Assertion (A):** Work done by a force is zero when the force acts perpendicular to the displacement. **Reason (R) :** Work is calculated as the product of force and displacement in the direction of the force.	1
2	**Assertion (A):** The total mechanical energy of a freely falling object remains constant. **Reason (R) :** The potential energy decreases while kinetic energy increases, keeping the total energy constant.	1
3	**Assertion (A):** When a vehicle accelerates, it does positive work on its engine. **Reason (R) :** The engine must perform work to decrease the vehicle's kinetic energy.	1
4	**Assertion (A):** The work done by a conservative force is path-dependent. **Reason (R) :** The work done against friction is path-independent.	1
5	**Assertion (A):** The work done by a constant force on an object is equal to the change in its kinetic energy. **Reason (R) :** Work is calculated as the product of force and distance moved in the direction of the force.	1
6	**Assertion:** A machine cannot be 100% efficient in converting energy. **Reason:** Some energy is always lost to friction and other factors in real-world applications.	1
7	**Assertion:** An object can have kinetic energy can never have zero velocity. **Reason:** Kinetic energy depends on mass and but not on velocity.	1
8	**Assertion:** A spring stores potential energy when compressed or stretched. **Reason:** This energy can be converted into kinetic energy when the spring returns to its equilibrium position.	1
9	**Assertion:** An object sliding down a frictionless incline converts potential energy to kinetic energy. **Reason:** The mechanical energy of the object can change during its motion.	1
10	**Assertion:** A person lifting a heavy object does more work when lifting it quickly compared to slowly. **Reason:** Work done is dependent on the speed at which the lifting occurs.	1

1	A	1
2	A	1
3	C	1
4	D	1
5	B	1
6	A	1
7	C	1
8	A	1
9	C	1
0	D	1

1	If the initial velocities and final velocities of both the bodies are along the same straight line, then it is called a one-dimensional collision, or head-on collision. Two objects, A and B, collide on a frictionless surface. Object A has a mass of 2 kg and is moving to the right at a speed of 6 m/s. Object B has a mass of 3 kg and is moving to the left at a speed of 4 m/s.  	
i)	**Determine the total momentum of the system before the collision**(a) 0 kg·m/s (b) 6 kg·m/s (c) 18 kg·m/s (d) -6 kg·m/s	**1**
ii)	**What is the total kinetic energy of the system before the collision?** (a) 20 J (b) 24 J (c) 28 J (d) 36 J	**1**
iii)	**If the collision is perfectly elastic, what will be the final velocity of object A after the collision?** (a) 2 m/s (b) 4 m/s (c) 6 m/s (d) 8 m/s	**1**
iv)	**If the collision is perfectly inelastic, what is the final velocity of the combined masses after the collision?** (a) 0 m/s (b) 1.2 m/s (c) 3 m/s (d) 4 m/s **OR** **Which of the following statements is true regarding the collision if it is inelastic?** (a) Kinetic energy is conserved. (b) The objects stick together after the collision. (c) Momentum is not conserved. (d) Both objects move at the same speed after the collision.	**1**
2	A mass m is attached to a string of length r and is swung in a vertical circle. The mass is released from the top of the circle. The study focuses on the forces acting on the mass and the concepts of centripetal force, tension, and energy transformations.  	**1**
i)	**At the highest point of the vertical circle, which forces are acting on the mass, and how do they contribute to the centripetal force?** A) Only gravitational force acts downward, providing all the centripetal force. B) Tension acts upward and gravitational force acts downward, and they together provide the centripetal force. C) Only tension acts upward, which is greater than the gravitational force, providing the centripetal force. D) Gravitational force acts downward, and tension is zero at the highest point, providing no centripetal force.	**1**
ii)	**What happens to the tension in the string as the mass moves from the top to the bottom of the vertical circle?** A) Tension remains constant throughout the motion. B) Tension increases as the mass moves downward. C) Tension decreases as the mass moves downward. D) Tension becomes zero at the bottom of the circle.	**1**
iii)	**What is the minimum speed required at the lowest point to maintain circular motion?** (a)$\sqrt{5rg}$ (b) $2\sqrt{rg}$ (c) $\sqrt{2rg}$ (d) $3\sqrt{rg}$	**1**

iv)	**Which statement best describes the energy transformations that occur as the mass moves from the top to the bottom of the vertical circle?** A) Kinetic energy is converted into potential energy. B) Potential energy is converted into kinetic energy. C) Total mechanical energy decreases. D) Kinetic energy remains constant throughout the motion. **OR** **When the mass reaches the lowest point of the vertical circle, what is true about the forces acting on it?** A) Only gravitational force acts, and the mass experiences no net force. B) Tension in the string is zero, and gravitational force provides centripetal force. C) The net force is directed upward, and tension is greater than gravitational force. D) Both tension and gravitational force act downward, resulting in no centripetal force.	**1**
3	Power is defined as the rate of doing work. A cyclist is moving along a flat road. He has a mass of 70 kg and is pedaling to maintain a constant speed of 5 m/s. The cyclist experiences a frictional force of 20 N acting opposite to the direction of motion.	
i)	What is the power developed by the cyclist to overcome the frictional force? A) 50 W B) 100 W C) 200 W D) 350 W	**1**
ii)	How much work is done by the cyclist in overcoming the frictional force after traveling 100 meters? A) 2000 J B) 500 J C) 1000 J D) 1500 J	**1**
iii)	If the cyclist stops pedaling and coasts to a stop, how much kinetic energy does he initially have? A) 875 J B) 1400 J C) 1750 J D) 3500 J	**1**
iv)	If the cyclist accelerates to a speed of 10 m/s, what will be his new kinetic energy? A) 1750 J B) 1400 J C) 3500 J D) 5000 J OR If the cyclist maintains his speed of 5 m/s for 20 seconds, how much total work is done against friction? A) 500 J B) 2000 J C) 3000 J D) 4000 J	**1**
4	The potential energy of a spring is the energy stored in it when it's stretched or compressed. It describes the work done to stretch the spring and depends on the spring constant k and the distance stretched. The potential energy of a spring is dependent on the stretch or squeeze of the spring, but not on the path taken. 	

i)	A spring with a spring constant of 200 N/m is compressed by 0.3 m. Calculate the potential energy stored in the spring when compressed. A) 9 J B) 12 J C) 18 J D) 30 J	**1**
ii)	A child stretches a spring with a spring constant of 150 N/m to a length of 0.4 m beyond its natural length. If the spring was initially at rest, how much work does the child do on the spring? A) 12 J B) 24 J C)30 J D) 60 J	**1**
iii)	A spring is compressed from its natural length by 0.2 m, and the work done on the spring is measured to be 5 J. What is the spring constant of the spring? A) 25 N/m B) 50 N/m C) 75 N/m D)100 N/m	**1**
iv)	When a spring is stretched and released, then the acceleration at equilibrium position is A)Maximum B)Between zero and maximum C)Zero D)None of the above OR When a spring is stretched and released then the speed is maximum at A)Equilibrium position B)Extreme left C)Extreme right D)None of the above	**1**

1		
i)	**A**	**1**
ii)	**D**	**1**
iii)	**B**	**1**
iv)	**A OR B**	**1**
2		
i)	**A**	**1**
ii)	**B**	**1**
iii)	**A**	**1**
iv)	**B OR C**	**1**
3		
i)	**B**	**1**
ii)	**A**	**1**
iii)	**A**	**1**
iv)	**C OR B**	**1**
4		
i)	**B**	**1**
ii)	**A**	**1**
iii)	**B**	**1**
iv)	**C OR A**	**1**

CHAPTER–7: SYSTEM OF PARTICLES AND ROTATIONAL MOTION

Syllabus: Centre of mass of a two-particle system, momentum conservation and Centre of mass motion. Centre of mass of a rigid body; centre of mass of a uniform rod. Moment of a force, torque, angular momentum, law of conservation of angular momentum and its applications. Equilibrium of rigid bodies, rigid body rotation and equations of rotational motion, comparison of linear and rotational motions. Moment of inertia, radius of gyration, values of moments of inertia for simple geometrical objects (no derivation).

ASSERTION AND REASONING – ROTATIONAL MOTION

SL NO	QUESTION	MARKS
1	**A:** Torque on a body can be zero even if there is a net force on it. R: Torque and force on a body are always perpendicular.	**1**
2	**A:** A boiled egg rotates faster compared to raw egg of same size for the same amount of torque. R: A boiled egg mass distribution takes place from the centre while in raw egg maximum mass is distributed at the edges.	**1**
3	**A:** The motion of the centre of mass of a system is independent of the internal forces acting between the particles. **R:** Internal forces cancel out when considering the system as a whole.	**1**
4	**A:** The position of centre of mass of body depends upon shape and size of the body. **R:** Centre of mass of a body lies always at the centre of the body.	**1**
5	**A**: The angular velocity of a rigid body in motion is defined for the whole body. **R**: All points on a rigid body performing pure rotational motion are having same angular velocity but different linear velocity	**1**
6	**A:** An ice-skater stretches out arms-legs during performance. **R:** Stretching out arms-legs helps the performer to balance his or her body so that he or she does not fall.	**1**
7	**A**: Moment of inertia of a particle is same, whatever be the axis of rotation **R**: Moment of inertia depends on mass and distance of the particles.	**1**
8	**A:** The moment of inertia increases if the mass of a particle is moved further from the axis of rotation. **R:** Moment of inertia is directly proportional to the square of the distance from the axis of rotation.	**1**
9	**A:** A couple does not exert a net force even though it exerts a torque. **R:** Couple is a pair of two forces with equal magnitude but opposite directions acting simultaneously on a body in different lines of action.	**1**
10	**A**: To unscrew a rusted nut, we need a pipe wrench of longer arm. **R**: Wrench with longer arm reduces the force applied on arm.	**1**

ANSWER KEY

1	B	6	B
2	A	7	D
3	A	8	A
4	C	9	A
5	A	10	A

CASE BASED QUESTIONS

SL NO	QUESTION	MARKS
1	The time rate of the total angular momentum of a system of particles about a point (taken as the origin of our frame of reference) is equal to the sum of the external torques (i.e. the torques due to external forces) acting on the system taken about the same point. $\therefore \vec{\tau}_{ext} = \frac{d\vec{L}}{dt}$ Hence, if $\vec{\tau}_{ext} = 0, \frac{d\vec{L}}{dt} = 0$ If then Thus, if the total external torque on a system of particles is zero, then the total angular momentum of the system is conserved, i.e. it remains constant.	
i)	Which of the following can be explained with the help of conservation of angular momentum? a. Driving (b) Ice- skating (c) Diving (d) Running	1
ii)	For angular momentum to be conserved what must be true about the net torque of the system? (a) Net torque is constant. (b) Net torque increases. (c) Net torque decreases. (d) Net torque is zero.	1
iii)	A person sits on a freely spinning lab stool that has no friction in its axle. When this person extends her arms, a. her moment of inertia increases and her angular speed decreases. b. her moment of inertia decreases and her angular speed increases. c. her moment of inertia increases and her angular speed increases. d. her moment of inertia increases, and her angular speed remains the same.	1
iv)	Two children, Ram and Raj, ride on a merry-go-round. Ram is at a greater distance from the axis of rotation than Raj. Which of the following are true statements? a. Raj and Ram have the same tangential speed. b. Ram has a greater tangential speed than Raj. c. Raj has a greater angular speed than Ram. d. Raj has a smaller angular speed than Ram OR If there is a change of angular momentum from 1J to 4 J in 4s then the torque is a. 1 J b. 3/4 J c. 5/4 J d. 4/3 J	1
2	Moment of inertia of body resists a change in its state of angular momentum and depends on tha mass of the body, size and shape of the body, distribution of mass about the axis of rotation, position and orientation of the axis of rotation Three bodies, a ring, a solid sphere, a solid cylinder roll down the same inclined plane without slipping. They start from rest. The radii of the bodies are identical. Answer the following with reference to above statement	
i)	The moment of inertia of solid sphere about its centre given by a.2/3 MR^2 b. 3/2 MR^2 c. 5/2 MR^2 d. 2/5 MR^2	1
ii)	Among the following which will have more moment of inertia for same mass. a. Solid Sphere about a tangent b. Solid sphere about its centre. c. Disc about its centre d. Ring about its centre	1
iii	The acceleration of a solid cylinder rolling down an incline plane of inclination 30^0 is. a.g/2 b.2g/2 c. g/3 d. g/4	1

iv)	Among the following which will reach the bottom first. a. solid sphere b. solid cylinder c. ring d. all three fall at the same time OR Among the following which will have highest final velocity a. solid sphere b. solid cylinder c. ring d. all four will have the same velocity	1
3	**Read the following passage and choose appropriate answers for questions.** Moment of inertia of a body about a given axis is the rotational inertia of the body about that axis. It is represented by $I = MK^2$, where M is mass of body and K is radius of gyration of the body about that axis. It is a scalar quantity, which is measured in kgm^2. When a body rotates about a given axis, and the axis of rotation also moves, then total K.E of body =K.E. of translation + K.E. of rotation $E = 1/2\ mv^2 + 1/2\ I\omega^2$ With the help of above comprehension, choose the most appropriate alternative for each of the following	
i)	Moment of inertia of a body depends on (i) mass of body (ii) size and shape of body (iii) axis of rotation of body (iv) all the above (a) (i) and (ii) (b) (i) and (iii) (c) (ii) and (iii) (d) (iv)	1
ii)	A circular disc and a circular ring of same mass and same diameter have ______about a given axis. (a) same moment of inertia (b) unequal moments of inertia (c) cannot say (d) sometimes equal sometimes no	1
iii)	A 40kg flywheel in the form of a uniform circular disc of diameter 1m is making 120 rpm. Its moment of inertia about a transverse axis through its centre is (a) $40kgm^2$ (b) $5kgm^2$ (c) $10kgm^2$ (d) $20kgm^2$	1
iv)	Angular momentum of rotation of flywheel in the above case is (a)40 π (b) 10π (c) 60π (d) 80π OR The radiation of gyration for a ring about an axis passing through the centre and perpendicular to the plane is given by (a) 2R (b) R/2 (c) R/3 (d) R	1
4.	The cross product of two vectors is given by Vector C = A × B. The magnitude of the vector defined from cross product of two vectors is equal to product of magnitudes of the vectors and sine of angle between the vectors. Direction of the vectors is given by right hand corkscrew rule and is perpendicular to the plane containing the vectors. ∴ |vector C| = ABsinθ and Vector C = ABsinθ n Where, cap n is the unit vector perpendicular to the plane containing the vectors A and B. Following are properties of vector product a) Cross product does not obey commutative law. But its magnitude obeys commutative low. b) It obeys distributive law c) The magnitude cross product of two vectors which are parallel is zero. Since θ = 0; vector |A x B| = AB sin 0° = 0 d) For perpendicular vectors, θ = 90°, vector |A x B| = AB sin 90° |cap n| = AB $\hat{i} \times \hat{i} = \hat{j} \times \hat{j} = \hat{k} \times \hat{k} = 0$ $\hat{i} \times \hat{j} = \hat{k}$; $\hat{j} \times \hat{k} = \hat{i}$; $\hat{k} \times \hat{i} = \hat{j}$ $\hat{j} \times \hat{i} = -(\hat{i} \times \hat{j}) = -\hat{k}$; $\hat{k} \times \hat{j} = -(\hat{j} \times \hat{k}) = -\hat{i}$; $\hat{i} \times \hat{k} = -(\hat{k} \times \hat{i}) = -\hat{j}$	
i)	If θ is angle between two vectors, then resultant vector is maximum when θ is (a) 0 b) 90 c) 180 d) None of these	1

ii)	Cross product is operation performed between a) Two scalar numbers b) One scalar other vector c) 2 vectors d) None of these	1
iii)	A Unit vector is the one which has magnitude (a) Zero (b) one (c) maximum (d) negative	1
iv)	among the following which is an example of dot product (a) torque (b) momentum (c) angular momentum (d) work OR Among the following which is an example of cross product (a) momentum (b) work (c) force (d) torque	1

ANSWER KEY

5) i) b ii) d iii) a iv) b or b
6) i) d ii) a iii) c iv) a or a
7) i) d ii) b iii) c iv) a or d
8) i) a ii) c iii) b iv) d or d

CHAPTER -8: GRAVITATION

SYLLABUS: Kepler's laws of planetary motion, universal law of gravitation, acceleration due to gravity and its variation with altitude and depth. Gravitational potential energy and gravitational potential, escape velocity, orbital velocity of a satellite.

ASSERTION & REASON

S.NO	QUESTIONS	MARKS
1.	**Assertion(A)**: Gravitational force is conservative force. **Reason(R)** : Work done is considered conservative if the work done is in a closed path is zero.	1
2.	**Assertion(A)**: The weight of the of an object decreases as it moves from poles to equator. **Reason(R)** : The earths radius is larger at the equator than at the poles.	1
3.	**Assertion(A)**: A satellite in orbit experiences no gravitational force. **Reason(R)**: Satellites in orbit experience a balance between gravitational force and centrifugal force.	1
4.	**Assertion(A)**: A geostationary satellite appears stationary when viewed from earth. **Reason(R)** : A geostationary satellite revolves around the earth with the same	1
5.	**Assertion(A)**: The escape velocity from earth's surface depends on the mass of the object. **Reason(R)** : Escape velocity is independent of the direction of projection.	1
6.	**Assertion(A)**: Gravitational force between two bodies depends on the product of their masses. **Reason(R)**: Gravitational force between two bodies is directly proportional to the distance between them.	1
7.	**Assertion(A)**: The gravitational potential energy of a system increases as the masses are moved closer together. **Reason(R)**: Gravitational potential energy is inversely proportional to the distance between two masses,	1
8.	**Assertion(A)**: The acceleration due to gravity is maximum at the surface of the earth. **Reason(R)**: Gravitational force decreases with altitude and depth from the Earth's surface.	1
9.	**Assertion(A)**: The gravitational force between two mases can be zero at some point between them. **Reason(R)**: Gravitational force is a vector quantity, and forces due to two masses can cancel each other at some point.	1
10.	**Assertion(A)**: The gravitational potential inside a hollow spherical shell is uniform. **Reason(R)**: Inside a spherical shell, the gravitational field is zero.	1
S.NO	ANSWER KEY	MARKS
1.	**A**	1
2.	**A**	1
3.	**D**	1
4.	**A**	1
5.	**D**	1
6.	**C**	1
7.	**D**	1
8.	**B**	1
9.	**A**	1
10.	**A**	1

CASE BASED QUESTIONS

1. Gravitational Force Between Two Objects

Two objects, $m_1 = 12$ kg and $m_2 = 8$ kg, are placed at a distance of 3 meters apart. The gravitational force F between the two objects is given by Newton's law of gravitation:

$$F = \frac{G\, m1m2}{r2} \quad \text{where } G = 6.67 \times 10^{-11}\ Nm^2kg^{-2.}$$

The table shows the gravitational force between the two objects at various distances:

Distance (m)	Gravitational Force (N)
3	7.11×10^{-10}
2	1.60×10^{-9}
1	6.66×10^{-9}

1. What is the gravitational force between the objects at 3 meters according to the table? 1

   (a) 7.11×10^{-10} N
   (b) 1.60×10^{-9} N
   (c) 6.67×10^{-9}N
   (d) 8.99×10^{-10} N

2. By what factor does the gravitational force increases when the distance between the objects is halved? 1
   (a) 2 times
   (b) 4 times
   (c) 8 times
   (d) 16 times

3. What will be the gravitational force if the objects are brought to 0.5 m apart (estimate using pattern from the data)? 1
   (a) 2.67×10^{-8} N
   (b) 1.60×10^{-8} N
   (c) 2.67×10^{-9} N
   (d) 5.33×10^{-8} N

4. From the table , how does the gravitational force vary with distance? 1
   (a) Inversely proportional to r
   (b) Proportional to r^2
   (c) Inversely proportional to r^2
   (d) Proportional to r

OR

5. If the mass of one object is doubled and the distance between them is also doubled , what will happen to the gravitational force between them?

   (a) It will double
   (b) It will remain the same.
   (c) It will be half

(d) It will decrease by factor of 4

2. Weight on Different Planets

An astronaut weighs 700 N on Earth. The table below shows the acceleration due to gravity on different planets.

Planet	Acceleration due to gravity (m/s^2)
Earth	9.8
Mars	3.7
Jupiter	24.8
Moon	1.6

1. What ws the astronaut's weight on Mars? 1
   (a) 264 N
   (b) 700 N
   (c) 940 N
   (d) 280 N

2. On which planet does the astronaut experience the highest weight? 1
   (a) Earth
   (b) Mars
   (c) Jupiter
   (d) Moon

3. What is the ratio of astronaut's weight on moon to that of weight on earth? 1
   (a) 1:6
   (b) 1:4
   (c) 1:2
   (d) 2:3

4. If the astronauts weight is 70 kg, what is the gravitational force acting on them on the Moon? 1
   (a) 70 N
   (b) 112 N
   (c) 120 N
   (d) 196 N

OR

5. If the same astronaut weighing 700 N on earth were to visit a hypothetically planet where the gravitational acceleration is 3 times that of the earth's gravity, what would be the astronauts weight on that planet?
   (a) 2100 N
   (b) 700 N
   (c) 1400 N
   (d) 350 N

3. Variation of graph with altitude

The following graph shows how the gravitational acceleration g varies with altitude h from the surface of the earth.

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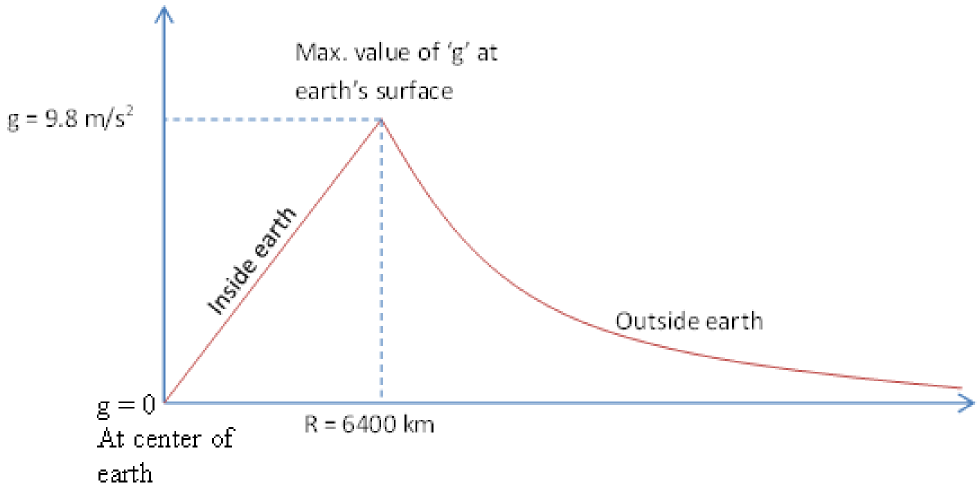

1. From the graph, what happens to 'g' as altitude increases?
(a) It increases exponentially.
(b) It decreases linearly.
(c) It decreases non linearly.
(d) It remains constant
2. If the altitude is 1000km, what is the approximate value of g from the graph?
(a) 9.8 m/s^2
(b) 8.5 m/s^2
(c) 7.0 m/s^2
(d) 6.5 m/s^2
3. At what altitude does the gravitational acceleration become half of its surface value?
(a) 2000 km
(b) 3200km
(c) 4000km
(d) 5000km
4. Which physical law explains the variation in g with altitude?
(a) Hooke's law
(b) Newton's law of universal gravitation
(c) Coulomb's law
(d) Archimedes' principle.
OR
5. If the altitude increases beyond 5000 km, what will happen to the gravitational acceleration?
(a) It will increase after a certain point.
(b) It will decrease and eventually become zero.
(c) It will remain constant after 5000 km.
(d) It will fluctuate based on the mass of the object.
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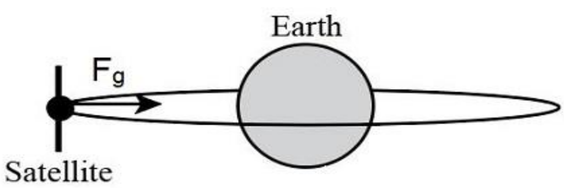
Satellite Orbit Around Earth
A satellite is placed in a circular orbit around the Earth at a height of 500km above the surface. The radius of Earth is approximately 6400 km. Below is simplified diagram of the orbit:


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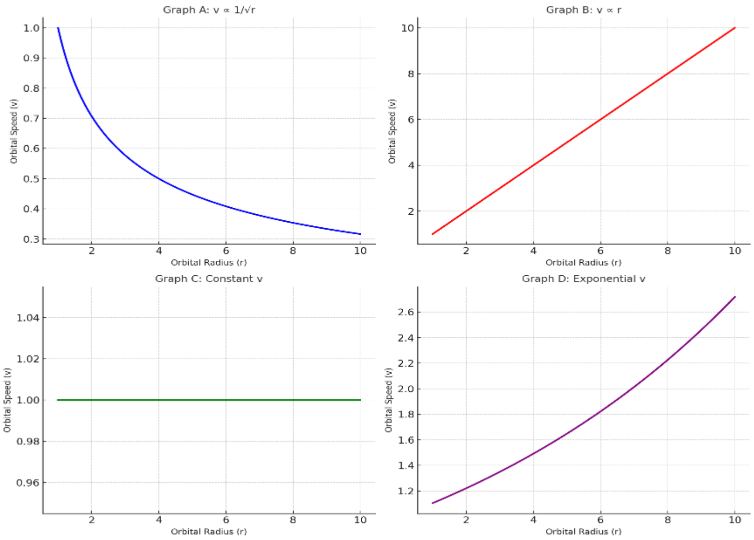
1. What is the total distance from the centre of the Eath to the satellite? 1
   (a) 6400 km
   (b) 6900km
   (c) 7400km
   (d) 5400km
2. If the orbital speed of the satellite is 7.5 km/s , what is the time taken for the satellite to comlete one revolution ariund the earth? 1
   (a) 5300 s
   (b) 6300 s
   (c) 5800 s
   (d) 7500 s
3. If the satellite's height above the earth's surface is increased , what will happen to its orbital speed? 1
   (a) It will increase
   (b) It will decrease
   (c) It will remain the same
   (d) It will double
4. Which of the following graphs best reprents the variation of orbital speed v with radius r for a satellite around the Earth? 1



   (a) Graph A
   (b) Graph B
   (c) Graph C
   (d) Graph D

OR

5. If the satellite moves to an ellipetical orbit with the perigee(closest point) at 400 km and apogee (farthest point) at 800 km from the earth's surface where will the satellite move faster?
   (a) Ath the apogee
   (b) At the perigee
   (c) Speed will remain constant
   (d) Depends on the mass of satellite.

ANSWER KEY

S.NO	ANSWER KEY	MARKS
1.	1.A 2. B 3. A 4. C OR 5.C	1 1 1 1
2.	**1. B** **2.C** **3 B** **4 A OR** 5 B	1 1 1 1
3.	**1. C** **2. C** **3. B** **4. B OR** **5. B**	1 1 1 1
4.	**1. A** **2. C** **3. A** **4. B OR** **5. A**	1 1 1 1

CHAPTER–9: MECHANICAL PROPERTIES OF SOLIDS

SYLLABUS: Elasticity, Stress-Strain Relationship, Hooke’s Law, Young’s Modulus, Bulk Modulus, Shear Modulus of Rigidity (Qualitative Idea Only), Poisson’s Ratio; Elastic Energy.

ASSERTION & REASON

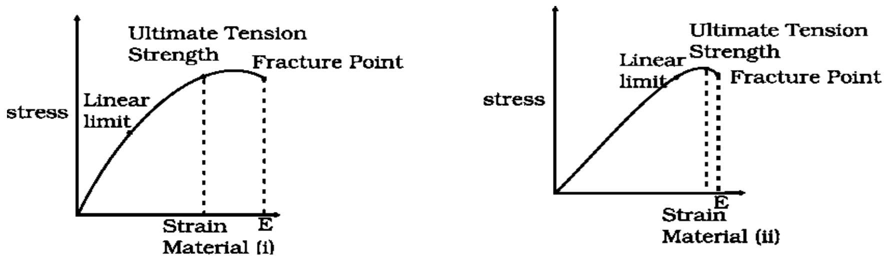
Choose the correct option as per the statements given in assertion and reason:

a) Assertion and Reason both are correct and R is the correct explanation of A.

b) Assertion and Reason both are correct but R is not the correct explanation of A.

c) Assertion is true but Reason is false.

d) Assertion and Reason both are incorrect.

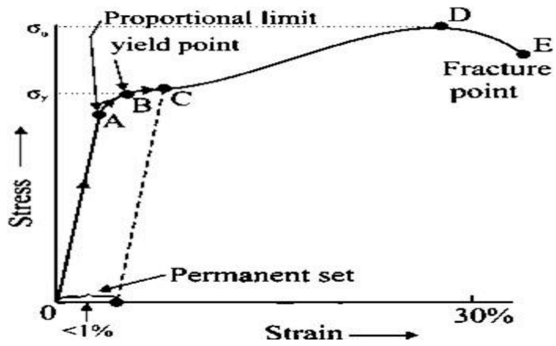
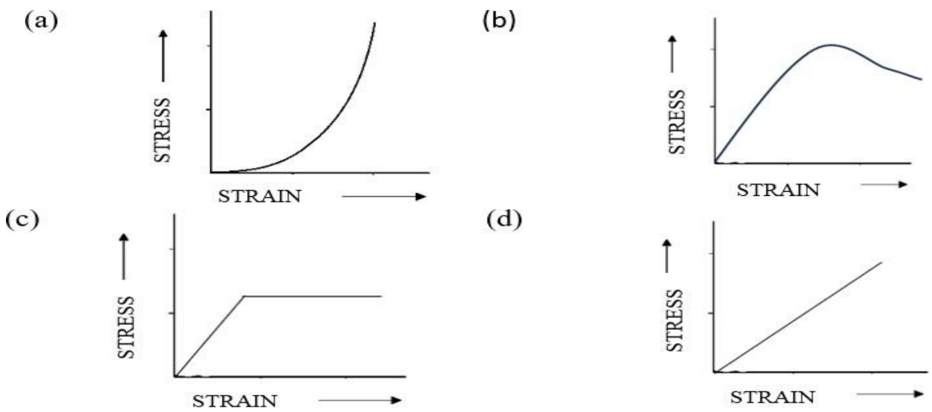
SL NO	QUESTION	MARKS
1	**Assertion:** For an ideal liquid- i) Bulk modulus = ∞ ii) Shear modulus = 0. **Reason:** An ideal liquid is incompressible and has no viscosity	1
2	The stress-strain graphs for two materials are shown  **Assertion:** Material (ii) is more brittle than material (i) **Reason:** The fracture point for the material (ii) is closer than that of material (i).	1
3	**Assertion:** Bulk modulus of elasticity (B) represents incompressibility of the material. **Reason:** Bulk modulus of elasticity given by $B = P \ (\frac{\Delta V}{V})$	1
4	**Assertion:** A solid sphere placed in the fluid under high pressure, is compressed uniformly on all sides. **Reason:** The volume of solid sphere will decrease with change of its geometrical shape**.**	1

5	**Assertion:** When an object is stretched or compressed beyond its elastic limit, the object becomes permanently deformed**.** **Reason:** Elastic limit is the point at which an object no longer returns to its original shape after being stretched or compressed.	**1**
6	**Assertion:** Ropes are always made of a number of thin wires braided together. **Reason:** It helps to ease in manufacturing, flexibility and strength.	**1**
7	**Assertion:** Putty and mud are close to ideal plastics. **Reason: P**utty or mud have no gross tendency to regain their previous shape, and get permanently deformed.	**1**
8	**Assertion:** Young's modulus, Shear modulus and Bulk modulus are used to describe the elastic behaviour of objects as they respond to deforming forces that act on them. **Reason:** Young's modulus and Shear modulus are relevant only for solids. Bulk modulus is relevant for solids, liquid, and gases.	**1**
9	**Assertion:** Metals have larger values of Young's modulus than alloys and elastomers. **Reason:** A material with large value of Young's modulus requires a small force to produce large changes in its length.	**1**
10	**Assertion:** Substances like tissue of aorta, rubber etc. which can be stretched to cause large strains are called elastomers. **Reason:** Elastomers do not obey Hooke's law over most of the region of the stress strain curve.	**1**

ANSER KEY:

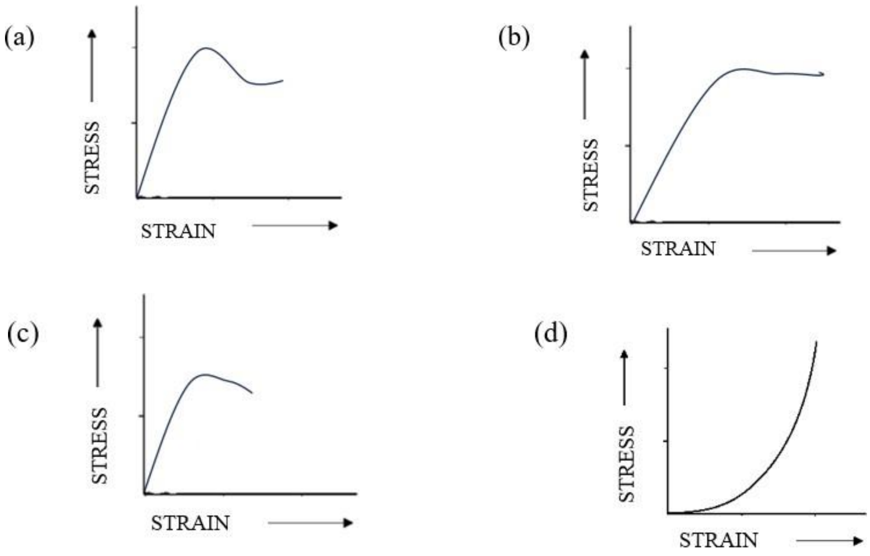
1. a) Assertion and Reason both are correct and R is the correct explanation of A
2. a) Assertion and Reason both are correct and R is the correct explanation of A.
3. c) Assertion is true but Reason is false.
4. c) Assertion is true but Reason is false.
5. a) Assertion and Reason both are correct and R is the correct explanation of A.
6. a) Assertion and Reason both are correct and R is the correct explanation of A
7. a) Assertion and Reason both are correct and R is the correct explanation of A
8. b) Assertion and Reason both are correct but R is not the correct explanation of A.
9. c) Assertion is true but Reason is false.
10. b) Assertion and Reason both are correct but R is not the correct explanation of A.

CASE STUDY BASED QUESTIONS

SL NO	QUESTION	MARKS
1	The stress-strain curves vary from material tomaterial. These curves help us to understand how a given material deforms with increasing loads. From the graph, we can see that in the region between O to A, the curve is linear. In thisregion, Hooke's law is obeyed. The body regains its original dimensions when the applied force is removed. In this region, the solid behaves as an elastic body. 	
i)	Distance between the following two points decides the brittle nature of a material (a) A and B (b) B and C (c) C and D (d) D and E	**1**
ii)	The maximum load a wire can withstand without breaking, when its length is reduced to halfof its original length, will (a) become double. (b) become half. (c) become four times. (d) remain same.	**1**
iii)	Which of the following materials is most elastic? (a) Steel (b) Rubber (c) Copper (d) Glass	**1**
iv)	Which of the following shows the correct stress strain curve for elastomers? 	**1**

OR

The following graphs show the stress strain curves of different material. Which of the materials is the most brittle



2 A bridge must be designed such that it can withstand the load of the flowing traffic, the forceof winds and its own weight. Similarly, in the design of buildings the use of beams and columnsis very common. In both the cases, the overcomingof the problem of bending of beam under a load is of prime importance. The beam should not bend too much or break. A bar of length l, breadth b, and depth d when loaded at the centre by a load W sags by an amount given by $\delta = \frac{Wl^3}{4bd^3Y}$

i) For reducing the bending of a bridge due to its weight, which of the following measure can betaken- 1

(a) selecting a material with large Young's modulus and increasing the breadth of the beam

(b) selecting a material with small Young's modulus and increasing the breadth of the beam

(c) selecting a material with large Young's modulus and increasing the depth of the beam

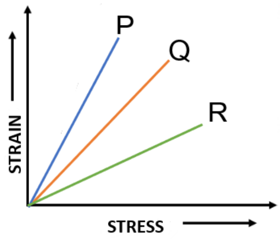
(d) selecting a material with small Young's modulus and increasing the depth of the beam

ii) The breadth and the depth of a metal bar are 'b' and 'd' respectively. If the bar is reconstructed with breadth b/2 and depth 2d, estimate the ratio of the original and final sags in the bar, when loaded by a weight W, at the centre. 1

(a) 1: 16 (b) 16:1 (c) 4:1 (d) 1:4

iii)	Two metal bars A and B of same breadth, depth $d/2$ and d, length l and $l/2$ respectively are loaded with same weight W at their centre. If the amount of sag in both the bars is same then which of the following is correct- (a) Both the bars have equal value of Young's modulus (b) Bar A has a larger Young's modulus in comparison to B (c) Bar B has a larger Young's modulus in comparison to A (d) The given condition is not possible.	1
v)	Buckling is a problem faced in the construction of any bridge, as its difficult to arrange theposition of load in a bridge with moving traffic. Buckling is caused due to - (a) increasing the depth rather than the breadth of the bars (b) decreasing the depth, rather than the breadth of the bars (c) increasing the depth as well as the breadth of the bars (d) decreasing the depth as well as the depth of the bars OR Which of the following is not an implication of the elasticity- (a) using of rope with very thick wire for lifting heavy loads in a Crains (b) use of pillars with distributed shape at the end (c) a hill has a pyramidal shape (d) None of the above	1
3	The property of a body, by virtue of which it tends to regain its original size and shape when the applied force is removed, is known as elasticity and the deformation caused is known as elastic deformation. However, if we apply force to a lump of putty or mud, they have no gross tendency to regain their previous shape, and they get permanently deformed. Such substances are called plastic and this property is called plasticity. Putty and mud are close to ideal plastics. The elastic behaviour of materials plays an important role in engineering design. For example, while designing a building, knowledge of elastic properties of materials like steel, concrete etc. is essential. The same is true in the design of bridges, automobiles, ropeways etc. When a body is subjected to a deforming force, a restoring force is developed in the body. This restoring force is equal in magnitude but opposite in direction to the applied force. The restoring force per unit area is known as **stress.** If F is the force applied normal to the cross–section and A is the area of cross section of the body, magnitude of the stress is given by F/A.	
i)	Which of the following is most elastic substance- a) Aluminium (b) Steel (c) Wood (d) Glass	**1**

ii)	The spring balance does not read properly after prolonged use because- (a) its elasticity increases (b) its elasticity is lost (c) its plasticity decreases (d) it can be used without any such issue	**1**
iii)	A spring is stretched by applying a load to its free end. The strain produced in the spring is (a) volumetric (b) shear (c) longitudinal and shear (d) longitudinal.	**1**
iv)	If a cylinder is compressed under the action of applied forces, the restoring force per unit area is known as-	**1**
	(a) tensile stress (b) compressive stress (c) shearing stress (d) hydraulic stressOR How does temperature affect elasticity of material? (a) elasticity of materials increases with temperature (b) elasticity of materials decreases with temperature (c) elasticity is independent of temperature (d) none of these	
4	The ratio of stress and strain, called modulus of elasticity, is found to be a characteristic of the material. Experimental observation shows that for a given material, the magnitude of the strain produced is same whether the stress is tensile or compressive. The ratio of tensile (or compressive) stress (σ) to the longitudinal strain (ε) is defined as Young's modulus and is denoted by the symbol Y. $Y = \frac{\text{Stress }(\sigma)}{\text{Strain }(\varepsilon)} = \frac{F/A}{\Delta L/L} = \frac{F \times L}{A \times \Delta L}$ Since strain is a dimensionless quantity, the unit of Young's modulus is the same as that ofstress i.e., N m^{-2} or Pascal (Pa)	
i)	Young's modulus of a perfectly rigid body should be- (a) Unity (b)Negative (c) Infinity (d)Zero	**1**
ii)	If the temperature of a metal bar is increased, its modulus of elasticity will- (a) decreases (b) increases (c) remains constant (d) becomes Zero	**1**
iii)	The adjacent figure shows the stress–strain curves of three bars of different materials P, Q and R. Analyse the following statements and find out the correct one: (a) $Y_P < Y_Q < Y_R$ (b) $Y_P > Y_Q > Y_R$ (c) $Y_P < Y_Q > Y_R$ (d) $Y_P = Y_Q = Y_R$	**1**

iv)	A and B are the two wires of different materials but of same sized are subjected to equaltensile force. The bars have elongation in the ratio of 4:7, then the ratio of modulus of elasticity of the two materials will be- (a) 4:7 (b)4:3 (c)3:4 (d)7:4 OR Two bars P and Q, made up of different materials have equal cross-sectional area but lengths 4L and 6L respectively. If they are subjected to same tensile force and have their axial elongation in the ratio of 2:3, then the ratio of modulus of elasticity of the two materials would be: (a) 2:3 (b) 3:2 (c) 3:4 (d) 1:1  	

ANSWER KEY

i) (d) D and E

ii) (d) remain same.

iii) (a) Steel

(iv) graph (a) OR graph (c)

(2) (i) (c) selecting a material with large Young's modulus and increasing the depth of the beam

(ii) (c) 4:1

(iii) (a) Both the bars have equal value of Young's modulus

(iv) (a) increasing the depth rather than the breadth of the bars

OR

(a) using of rope with very thick wire for lifting heavy loads in a Crains

(3) (i) (b) Steel

(ii) (b) its elasticity is lost

(iii) (c) longitudinal and shear

(iv) (b) compressive stress

OR

(b) elasticity of materials decreases with temperature

(4)(i) (c) Infinity

(ii) (a) decrease

(iii) (b) YP > YQ > YR

(iv) (d) 7:4 OR (d) 1:1

CHAPTER–10: MECHANICAL PROPERTIES OF FLUIDS

SYLLABUS: Mechanical property of fluids, pressure due to a fluid column. Pascal's law and its applications (hydraulic lift and hydraulic brakes), Effect of gravity on fluid pressure, viscosity, stock's, law, terminal velocity, streamline and turbulent flow, critical velocity. Bernoulli's theorem and its simple applications.

ASSERTION & REASON

SL NO	QUESTION	MARKS
1	**Assertion:** It is easier to spray water in which some soap is dissolved. **Reason**: Soap is easier to spread.	**1**
2	**Assertion:** Hot soup tastes better than the cold soup. **Reason:** Hot soup has high surface tension and it does not spread properly on our tongue.	**1**
3	**Assertion:** The machine parts are jammed in winter. **Reason:** The viscosity of the lubricants used in the machines increases at low temperature.	**1**
4	**Assertion:** It is better to wash the clothes in cold soap solution. **Reason:** The surface tension of cold solution is less than the surface tension of hot solution.	**1**
5	**Assertion:** Aeroplanes are made to run on the runway before take-off, so that they acquire the necessary lift. **Reason:** This is as per Bernoulli's theorem.	**1**
6	Assertion: A large force is required to draw apart normally two glass plates enclosing a thin water film. Reason: Surface tension of water hold the glass plates together.	**1**
7	Assertion: A small drop of mercury is spherical, but bigger drops are oval in shape. Reason: Surface tension of liquid decreases with increase in size of the drop.	**1**
8	Assertion: The shape of a liquid drop is spherical. Reason: The pressure inside the drop is greater than that of outside.	**1**
9	Assertion: When fluid flows, there is some loss of energy due to friction. Reason: Different layers of the fluid exert forces on each other.	**1**
10	Assertion: The blood pressure in human is greater at the head than at the toe. Reason: Pressure of liquid at any point is only proportional to distance from heart and acceleration due to gravity.	**1**

Answers:

1. (C) Assertion is correct, reason is incorrect
2. (C) Assertion is correct, reason is incorrect
3. (A) Assertion is correct, reason is correct; reason is a correct explanation for assertion
4. (D) Assertion is incorrect, reason is incorrect
5. (A) Assertion is correct, reason is correct; reason is a correct explanation for assertion
6. (A) Assertion is correct, reason is correct; reason is a correct explanation for assertion
7. (C) Assertion is correct, reason is incorrect
8. (B) Assertion is correct, reason is correct; reason is not a correct explanation for assertion
9. (A) Assertion is correct, reason is correct; reason is a correct explanation for assertion
10. (D) Assertion is incorrect, reason is incorrect

CASE BASED QUESTIONS

SL NO	QUESTION	MARKS
1	Suppose that an incompressible fluid is flowing through the pipe of varying cross-sectional area, in a steady flow. Its velocity must change as a consequence of equation of continuity. A force is required to produce this acceleration, which is caused by the fluid surrounding it, the pressure must be different in different regions. Bernoulli's equation is a general expression that relates the pressure difference between two points in a pipe to both velocity changes (kinetic energy change) and elevation (height) changes (potential energy change). The statement of Bernoulli's relation is: As we move along a streamline the sum of the pressure (P), the kinetic energy per unit volume and the potential energy per unit volume (ρgh) remains a constant. Note that in applying the energy conservation principle, there is an assumption that no energy is lost due to friction. In practice, it has a large number of useful applications and can help explain a wide variety of phenomena for low viscosity incompressible fluids.	
i)	Bernoulli's equation for steady, non-viscous, incompressible flow expresses the: (a) conservation of linear momentum (b) conservation of angular momentum (c) conservation of mass (d) conservation of energy	1
ii)	Applications of Bernoulli's theorem can be seen in: (a) dynamic lift of aeroplane (b) dynamic lift due to spinning cricket ball (c) Paint spray gun. (d) in all (a),(b), and (c)	1
iii)	Bernoulli's equation holds good: (a)for non-steady (b)in that situation, velocity and pressure are constantly fluctuating in time (c) in that situation velocity and pressure are not constantly fluctuating in time (d)In all the cases of (a),(b), and (c)	1
iv)	4) Bernoulli's equation ideally applies to fluids with: (a) with zero viscosity (b) with high viscosity (c) both (a) and (b) (d) None of the above	1
2	The property due to which the free surface of liquid tends to have minimum surface area and behaves like a stretched membrane is called surface tension. It is a force per unit length acting in the plane of interface between the liquid and the bounding surface *i.e.*, S = F/L, where F = force acting on either side of imaginary line on surface and L = length of imaginary line. Surface tension decreases with rise in temperature. Highly soluble impurities increases surface tension and sparingly soluble impurities decreases surface tension.	
i)	The excess pressure inside a soap bubble is three times than excess pressure inside a second soap bubble, then the ratio of their surface area is: (a) 9 : 1 (b) 1 : 3 (c) 1 : 9 (d) 3 : 1	1
ii)	Which of the following statements is not true about surface tension? (a) A small liquid drop takes spherical shape due to surface tension. (b) Surface tension is a vector quantity. (c) Surface tension of liquid is a molecular phenomenon.	1

	(d) Surface tension of liquid depends on length but not on the area.	
iii)	Which of the following statement is not true about angle of contact? (a) The value of angle of contact for pure water and glass is zero. (b) Angle of contact increases with increase in temperature of liquid. (c) If the angle of contact of a liquid and a solid surface is less than 90°, then the liquid spreads on the surface of solid. (d) Angle of contact depend upon the inclination of the solid surface to the liquid surface.	1
iv)	A liquid does not wet the solid surface if the angle of contact is (a) 0° (b) equal to 45° (c) equal to 90° (d) greater than 90°	1
3	Pressure is a scalar quantity. It is the component of the force normal to the area under consideration. Its dimensions are [$ML^{-1}T^{-2}$] The SI unit of pressure is N m^{-2}. It has been named as Pascal (Pa) in honour of the French scientist Blaise Pascal (1623-1662) who carried out pioneering studies on fluid pressure.The French scientist Blaise Pascal observed that the pressure in a fluid at rest is the same at all points if they are at the same height. Whenever external pressure is applied on any part of a fluid contained in a vessel, it is transmitted undiminished and equally in all directions. This is another form of the Pascal's law and it has many applications in daily life. A number of devices, such as hydraulic lift and hydraulic brakes, are based on the Pascal's law.	
i)	Mercury barometer is used to measure a) atmospheric pressure b) gauge pressure c) both a and b d) none of these	1
ii)	Pressure is: a) vector b) scalar c) tensor d) none of these	1
iii)	hydraulic brakes works on principle of a) Newton's law b) Pascal's law c) Bernoulli's principle d) None of these	1
iv)	If two forces in the ratio 1 :5 act on two pistons of areas in the ratio 5 : 2, then the pressure exerted by the forces is in ratio: (a) 2 : 21 (b) 6 : 10 (c) 2 :25 (d) 4 : 21	1
4	Variation of pressure with depth $P = P_a + \rho gh$ Thus, the pressure P, at depth below the surface of a liquid open to the atmosphere is greater than atmospheric pressure by an amount rgh. The excess of pressure, $P - P_a$, at depth h is called a gauge pressure at that point. The area of the cylinder is not appearing in the expression of absolute pressure. Thus, the height of the fluid column is important and not cross-sectional or base area or the shape of the container. The liquid pressure is the same at all points at the same horizontal level called as hydrostatic paradox. The flow of the fluid is said to be steady if at any given point, the velocity of each passing fluid particle remains constant in time. This does not mean that the velocity at different points in space is same. The velocity of a particular particle may change as it moves from one point to another. That is, at some other point the particle may have a different velocity, but every other particle which passes the second point behaves exactly as the previous particle that has just passed that point. Each particle follows a smooth path, and the paths of the particles do not cross each other. The path taken by a fluid particle under a steady flow is a streamline. It is defined as a curve whose tangent at any point is in the direction of the fluid velocity at that point. For steady flow equation of continuity hold good and it is a statement of conservation of mass in flow of incompressible fluids.	

i)	The flow of the fluid is said to be steady if at any given point, the velocity of each passing fluid particle a) Remains constant in time b) changes continuously c) continuously increasing d) None of these	1
ii)	The Venturi-meter is a device used to measure the a)Volume occupied by fluid b)Area occupied by fluid. c) Flow speed of incompressible fluid. d) None of these	1
iii)	According to equation of continuity area is a) Directly proportional to velocity b) Inversely proportional to velocity c) Does not depends upon velocity d) None of these	1
iv)	Beyond the critical speed, the flow of fluids becomes: (a) turbulent (b) streamline (c) steady (d) very slow	1

Answer Key:

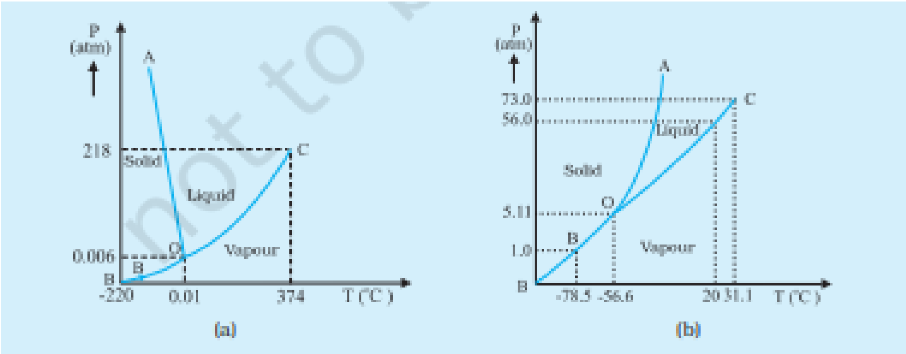
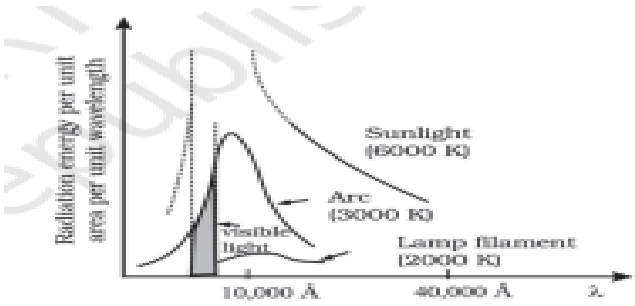
1. (i) d (ii) d (iii)c (iv) a
2. (i) c (ii) b (iii) d (iv) d
3. (i) a (ii) b (iii) b (iv) c
4. (i) a (ii)c (iii)b (iv) a

CHAPTER 11: THERMAL PROPERTIES OF MATTER

Sl. No.	Questions	Marks
1.	**Assertion:** Density of water decreases when cooled from 4°C to 0° C. **Reason:** Water has negative co efficient of thermal expansion at low temperatures (i.e. below 4°C)	1
2.	**Assertion:** A rubber balloon partially inflated in a cool room may expand to full size when placed in warm water. **Reason:** Material of the balloon exhibits positive thermal expansion with rise in temperature.	1
3.	**Assertion:** In desert areas, the earth surface warms up quickly during the day and cools slowly during night. **Reason:** Water has lowest Specific heat capacity.	1
4.	**Assertion:** Even after supplying heat energy to ethanol at 78°C the temperature of ethanol do not rise. **Reason:** At 78°C for ethanol, vapour and liquid state of the substance exist in equilibrium.	1
5.	**Assertion:** Burns from Boiling water is more serious than steam at same temperature. **Reason:** Water has higher Latent heat of fusion as compared to latent heat of vaporisation.	1
6.	**Assertion:** A bimetallic strip when fixed at both ends and supplied with heat energy, becomes curved. **Reason:** Specific heat capacity is the characteristic property of a material.	1
7.	**Assertion:** Air close to the equator has an eastward speed of 1600 km/hr, while it is zero close to the poles. **Reason:** Earth rotates in east west direction.	1
8.	**Assertion:** We should wear light coloured clothes in summer. **Reason:** Amount of heat that a body can absorb depends only on temperature and independent of color, shape and size.	1
9.	**Assertion:** Time period of a simple pendulum having copper bob is more as compared to iron bob, if both are maintained at same temperature. **Reason:** Co efficient of linear expansion for copper is more than that of iron.	1
10.	**Assertion:** Apparent weight of an object immersed in fluid increases with increase in temperature. **Reason:** Density of any solid object increases with decrease in temperature.	1

ANSWERS

Sl. No.	Answers
1.	Assertion is true, Reason is true but Reason is not the correct explanation for the assertion.
2.	Assertion is true, reason is false.
3.	Assertion is false, reason is true.
4.	Assertion is true, Reason is true and Reason is the correct explanation for the assertion.
5.	Assertion is false, Reason is false.
6.	Assertion is true, Reason is true and Reason is the correct explanation for the assertion.
7.	Assertion is true, Reason is false.
8.	Assertion is true, Reason is false.
9.	Assertion is true, Reason is true and Reason is the correct explanation for the assertion.
10.	Assertion is true, Reason is true but Reason is not the correct explanation for the assertion.

Sl. No.	Questions	Marks
1.	A graph between the temperature T and Pressure P of the substance is called a Phase Diagram. The following figure shows the phase diagram of water and carbon dioxide. Such a phase diagram divides the P – T plane into three regions – solid region, vapour region and liquid region  *Figure : Pressure-temperature phase diagrams for (a) water and (b) CO_2 (not to the scale).* i. What is the boiling point of Carbon dioxide at 56 atm pressure? a. 20 °C b. 31.1°C c. 0.01°C d. -56.6°C ii. In this figure, what does O represent? a. Melting Point b. Boiling Point c. Triple Point d. Critical Point iii. Identify the correct statement regarding water a. Melting point is directly proportional to pressure. b. Boiling point is inversely proportional to pressure. c. Melting point is inversely proportional to pressure. d. Both Melting point and boiling points are independent of pressure. iv. At high altitude it is difficult to cook because a. Water boils at lower temperature b. Water boils at higher temperature c. Statement is wrong because boiling point of water is independent of altitude. d. None of the Above	1 1 1 1
2.	Black body radiation curves are universal. They depend only on the temperature and not on the size, shape of the material of the black body. The energy emitted per unit time versus wavelength of a black body is given by  i. Sun's Surface emits maximum energy at $\lambda_m = 475\ nm$, which corresponds to its external temperature of 6060 K, what shall be the wavelength of radiation, if the temperature of sun's surface is reduced to 4080 K? a. 679 nm b. 749 nm c. 475 nm d. 683 nm	1

ii. There are two metallic cubes of side 4 cm and 8 cm respectively. Both of them are heated to a temperature of 196 K and kept inside a vessel containing water at 98 K. What is the ratio of energy emitted per unit time for both the cubes respectively? 1

a. 2:1 b. 1 : 2 c. 1 : 1 d. 16:1

iii. Assuming average surface area of a human body to be $2m^2$ and the body temperature to be 37 °C. Calculate the radiation emitted by an astronaut walking in space far away from any stars in one minute. (Given, $\sigma = 5.67 \times 10^{-8}\ Wm^{-2}K^{-4}, e = 0.9$) 1

a, 10.4×10^2 J b. 5.6×10^4 J c. 9.4×10^2 J d. 6.2×10^4 J

iv. For a particular temperature, the energy emitted by a black body

a. Increases with increasing wavelength

b. decreases with increasing wavelength 1

c. First increases and then decreases with increasing wavelength

d. Remains constant

OR

v. A celestial body appears red. What should be its temperature? (Given: Wien's contact = $2 \times 10^{-3}\ m\ K$)

a. 3900 K b. 4200 K c. 6000 K d. 5020 K

1

3. The specific heat capacity is the property of a substance which determines the change in temperature of the substance due to exchange of heat energy with the surrounding. It is defined as the amount of heat energy absorbed or released per unit mass of the substance to change its temperature by one unit. Its SI unit is given by $J\ kg^{-1}K^{-1}$. Specific heat capacity of some substances at room temperature and atmospheric pressure is given by

Substance	Specific heat capacity ($J\ kg^{-1}\ K^{-1}$)	Substance	Specific heat capacity ($J\ kg^{-1}\ K^{-1}$)
Aluminium	900.0	Ice	2060
Carbon	506.5	Glass	840
Copper	386.4	Iron	450
Lead	127.7	Kerosene	2118
Silver	236.1	Edible oil	1965
Tungesten	134.4	Mercury	140
Water	4186.0		

i. Identify the incorrect statement.

a. Gases have two specific heat capacities – at constant volume and at constant pressure. 1

b. When a gas is heated at constant volume, no work is done by the gas.

c. Specific heat at constant volume is more than specific heat at constant pressure.

d. Specific heat of monoatomic gases is less as compared to diatomic gases.

ii. A heavy truck of mass 12000 Kg is descending down a hill of height 80 m at constant speed. Calculate the temperature increase of 10 kg of brake material with an average specific heat of 800 J/kg·°C if the material retains 10% of the energy. 1

a. 100 $°C$ b. 140 $°C$ c. 120 $°C$ d. 80 $°C$

iii. In order to increase the temperature of a metallic sphere of mass 0.600 kg from 40 °C to 85 ° C, heat energy of 24.4 KJ of heat energy was supplied to it. Identify the metal.

a. Iron b. Aluminium c. Lead d. Copper

iv. Same amount of heat energy is supplied to raise the temperature of two metal balls A and B by same amount. Mass of A is twice that of B. If B is Aluminium, Identify A 1

a. Iron b. Aluminium c. Lead d. Copper

1

4.	In a steady state of heat flow through conduction, the thermal current H through a bar of cross section area A is given by $H = kA(\frac{\Delta T}{\Delta l})$, where $\frac{\Delta T}{\Delta l}$ is temperature gradient along the bar and k is the coefficient of thermal conductivity of the material of the bar. In the above expression the term $\frac{\Delta l}{kA}$ is called thermal resistance offered by a section of bar having length Δl. i. A metal rod AB of length 10x has its one end A in ice at 0°C and the other end B in water at 100 °C. If a point P on the rod is maintained at 400 °C, then it is found that equal amounts of water and ice evaporate and melt per unit time. The latent heat of evaporation of water is 540 cal/g and latent heat of melting of ice is 80 cal/g. If the point P is at a distance of λx from the ice end A, find the value of λ. [Neglect any heat loss to the surrounding] a. 7 b. 6 c. 18 d. 9 ii. Two identical conducting rod of k_1 and k_2 are joined end to end. If the temperatures at the ends of the rod are $\theta_1 and$ θ_2 then temperature at their interface is given by: a. $\frac{(k_1\theta_1+k_2\theta_2)}{(k_1+k_2)}$ b. $\frac{(k_1\theta_2+k_2\theta_1)}{(k_1+k_2)}$ c. $\frac{(k_1\theta_2+k_2\theta_1)}{(k_1-k_2)}$ d. None iii. Two solid spheres, A and B, made of the same material, are at temperatures of 0 °C and 180 °C, respectively. The spheres are placed in thermal contact in an ideal calorimeter, and they reach an equilibrium temperature of 20 °C. What is the ratio of their diameters? a. 4 : 1 b. 1 : 4 c. 2 : 1 d. 1 : 2 iv. When two ends of a rod are wrapped with cotton are maintained at different temperatures and after some time, every point of the end attains a constant temperature, then a. The conduction of heat at different point stops, because temperature is not increasing. b. The rod is a bad conductor of heat. c. Heat is radiated from each point of the rod. d. Each point of the rod is giving heat to its neighbour at the same rate at which it is receiving heat.	1 1 1 1

ANSWERS

Sl. No.	Answers			
1.	i. a ii. c iii. c iv. a		3.	i. c ii. c iii. b iv. a
2.	i. b ii. c iii. b iv. c		4.	i. d ii. a iii. a iv. d

Chapter–12: Thermodynamics

SYLLABUS: Thermal equilibrium and definition of temperature, zeroth law of thermodynamics, heat, work and internal energy. First law of thermodynamics, second law of thermodynamics: gaseous state of matter, change of condition of gaseous state -isothermal, adiabatic, reversible, irreversible, and cyclic processes.

ASSERTION & REASON

SL NO	QUESTION	MARKS
1	**Assertion:** Zeroth law of thermodynamics explains the concept of energy. **Reason:** Energy depends on temperature.	1
2	**Assertion:** Mass of a body will increase when it is heated. **Reason:** The internal energy of a body increases on heating	1
3	**Assertion:** Heat cannot be added to a system without increasing its temperature. **Reason:** Adding heat will increase the temperature in every situation.	1
4	**Assertion:** In isothermal process whole of the heat energy supplied to the body is converted into internal energy. **Reason:** According to the first law of thermodynamics $\Delta Q = \Delta U + W$	1
5	**Assertion**: Air quickly leaking out of a balloon becomes coolers **Reason**: The leaking air undergoes adiabatic expansion.	1
6	**Asser Assertion:** When a bottle of cold carbonated drink is opened a slight fog forms around the opening. **Reason:** Adiabatic expansion of the gas causes lowering of temperature and condensation of water vapours.	1
7	**Assertion**: In adiabatic compression, the internal energy and temperature of the system get decreased. **Reason**: The adiabatic compression is a slow process	1
8	**Assertion**: The specific heat of a gas is an adiabatic process is zero and in an isothermal process is infinite. **Reason**: Specific heat of a gas in directly proportional to change of heat in system and inversely proportional to change in temperature.	1
9	**Assertion**: Reversible systems are difficult to find in real world. **Reason**: Most processes are dissipative in nature	1
10	**Assertion:** Work done by a gas in isothermal expansion is more than the work done by the gas in the same expansion, adiabatically. **Reason:** Temperature remains constant in isothermal expansion and not in adiabatic expansion	1

ANSWER KEY

1. (d) Assertion is incorrect, reason is correct.

2.(d) Assertion is incorrect, reason is correct.

3.(d) Assertion is incorrect, reason is correct.

4.(d) Assertion is incorrect, reason is correct.

5. (a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.

6.(a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.

7.(d) Assertion is incorrect, reason is correct

8. (a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.

9.(a) Assertion is correct, reason is correct; reason is a correct explanation for assertion

10. (b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion

CASE BASED QUESTIONS

SL NO	QUESTION	MARKS
1	Suppose an amount of heat ΔQ supplied to a substance changes its temperature from T to T + ΔT. Heat capacity of a substance to be S = ΔQ /ΔT .We expect ΔQ and, therefore, heat capacity S to be proportional to the mass of the substance. Further, it could also depend on the temperature, i.e., a different amount of heat may be needed for a unit rise in temperature at different temperatures. To define a constant characteristic of the substance and independent of its amount, we divide S by the mass of the substance m in kg : s=S/m=(1/m) ΔQ /ΔT, s is known as the specific heat capacity of the substance. It depends on the nature of the substance and its temperature. The unit of specific heat capacity is J kg^{-1} K^{-1}	
i)	Specific heat capacity of a substance depends on (a) mass of the substance only (b) temperature of the substance only (c) both on mass and substance (d) none of the above	1
ii)	The sprinkling of water reduces slightly the temperature of a closed room because (a) water is a bad conductor of heat (b) water has high heat capacity (c) temperature of water is less than that of the room (d) none	1
iii)	Determine the specific heat capacity if 3000 J of heat is used to heat the iron rod of mass 10 Kg from 20ºC to 40ºC. (a)18 J/kg ºC (b)15 J/kg ºC (c)20 J/kgºC (d)30 J/kgºC	1
iv)	A kettle transfers all of its energy to heating 1.0kg water, which has a specific heat capacity of 4200J/(kg∘C). If the temperature of the water increases by 10∘C, how much energy was transferred? (a) 4200J (b)3600 J (c)42000J (d) 36000J	1
2	Carnot engine is a reversible engine operating between two temperatures T1 (source) and T2 (sink). The Carnot cycle consists of two isothermal processes connected by two adiabatic processes. The efficiency of a Carnot engine is given by $\eta = 1 - T2/T1$	
i)	The efficiency of a Carnot engine is (a) 100% (b) < 100% (c) >100% (d) both a and c	1
ii)	Which of the following statements is incorrect? (a)All reversible cycles have same efficiency (b)Reversible cycle has more efficiency than an irreversible one (c)Carnot cycle is a reversible one (d)Carnot cycle has the maximum efficiency in all cycles	1
iii)	A Carnot engine works between a source and a sink maintained at constant temperatures T1 and T2. For efficiency to be the greatest (a)T1 and T2 should be high (b)T1 and T2 should be low (c)T1 should be low and T2 should be high (d)T1 should be high and T2 should be low	1
iv	A Carnot engine takes 3×10^6 cal. of heat from a reservoir at 627°C, and gives it to a sink at 27°C. The work done by the engine is (a)4.2×10^6 J (b)8.4×10^6 J (c)16.8×10^6 J (d)zero	1

3	For an ideal gas, the equation of state is the ideal gas relation P V = μRT. For a fixed amount of the gas i.e. given μ, there are thus, only two independent variables, say P and V or T and V. The pressure-volume curve for a fixed temperature is called an isotherm. The thermodynamic state variables are of two kinds: extensive and intensive. Extensive variables indicate the 'size' of the system. Intensive variables such as pressure and temperature do not. To decide which variable is extensive and which intensive, think of a relevant system in equilibrium, and imagine that it is divided into two equal parts. The variables that remain unchanged for each part are Intensive.	
i)	Pressure is (a)Intensive variable (b)Extensive variable (c)Both (d)None of them	1
ii)	1litre of water is converted into vapour on heating. This is the example of (a)adiabatic (b) isothermal (c) isobaric (d) all of these	1
iii)	The specific heat of a gas in an isothermal process is (a) infinite (b) zero (c) negative (d) remains constant	1
iv)	A 0.5 mole of gas at temperature 300 K expands isothermally from an initial volume of 2 L to 6 L. find the work done by gas (a)3.360 KJ (b) 2.653 KJ (c) 1.459 KJ (d)1.369 KJ	1
4	The first law of thermodynamics is the general law of conservation of energy applied to any system in which energy transfer from or to the surroundings (through heat and work) is taken into account. It states that the energy supplied to the system goes in partly to increase the internal energy of the system and the rest in work on the environment. Mathematically, $\Delta Q = \Delta U + \Delta W$ where ΔQ is the heat supplied to the system, ΔW is the work done by the system and ΔU is the change in internal energy of the system. ΔQ and ΔW depend on the path taken to go from initial to final states, but the combination $\Delta Q - \Delta W$ is path independent.	
i)	Which of the following quantity remains constant in first law of thermodynamics? (a) pressure (b) volume (c)density (d)energy	1
ii)	The heat of 200 J is added to gaseous system whose internal energy is 80J, then what is the amount of external work? (a)90 J (b)120J (c)180J (d)210J	1
iii)	The heat given to an ideal gas in isothermal conditions is used to : (a) increases temperature (b)do external work (c) increase temperature and in doing external work (d) increase internal energy	1
iv)	An electric heater supplies heat to a system at a rate of 120 W. If system performs work at a rate of 80 J s^{-}, what is the rate of increase in internal energy? (a)40 J/S (b)60 J/S (c)80 J/S (d) 0 J/S	1

ANSWER KEY

1. (i) d (ii)b (iii)b (iv)c
2. (i) a (ii)a (iii)d (iv)b
3. (i)a (ii)b (iii)a (iv)d
4. (i)d (ii)b (iii)b (iv)

CHAPTER 13: KINETIC THEORY OF GASES

SYLLABUS: Kinetic Theory Equation of state of a perfect gas, work done in compressing a gas. Kinetic theory of gases - assumptions, concept of pressure. Kinetic interpretation of temperature; rms speed of gas molecules; degrees of freedom, law of equi-partition of energy (statement only) and application to specific heat capacities of gases; concept of mean free path, Avogadro's number.

ASSERTION & REASON

SL NO	QUESTION	MARKS
1	**Assertion (A):** Real gases obey the ideal gas law at all temperatures and pressures. **Reason (R):** Real gases behave like ideal gases only at high temperatures and low pressures.	
2	**Assertion (A):** The kinetic energy of gas molecules becomes zero at 0°C. **Reason (R):** The movement of gas molecules stops at 0°C.	
3	**Assertion (A):** At constant temperature, when the volume of an ideal gas is doubled the pressure of the gas reduces to half. **Reason (R):** According to Boyle's law, pressure is inversely proportional to volume at constant temperature.	
4	**Assertion (A):** The total internal energy of a diatomic gas at high temperature is higher than that of a diatomic gas at low temperature. **Reason (R):** At high temperatures, rotational and vibrational degrees of freedom also add to the internal energy of the gas.	
5	**Assertion (A):** Diatomic gas has 6 degrees of freedom. **Reason (R):** Diatomic gas has 6 degrees of freedom in total 3 from translational and 3 from rotational.	
6	**Assertion (A):** The mean free path for the given gas decreases for increase in temperature. **Reason (R):** When temperature increases the collision between the molecules increases.	
7	**Assertion (A):** Solid atom vibrating about its mean position in one dimension has 3 degrees of freedom **Reason (R):** Vibrating solid atom has linear, rotational and Vibrational energies.	
8	**Assertion(A):** According to law of equipartition of energy each vibrational mode contributes $2 \times \frac{1}{2} k_B T = k_B T$. **Reason (R):** Since Vibrational mode involves rotation and revolution energies.	
9	**Assertion(A):** During random motion and collision of the ideal gas in the container the total kinetic energy is conserved. **Reason (R):** All collisions between molecules among themselves or between molecules and the walls are elastic.	
10	**Assertion(A):** When a gas in a cylinder is compressed by pushing in a piston with an adiabatic wall the temperature of the gas increases. **Reason (R):** When the gas is compressed its kinetic energy decreases.	

Answers:

1) **Ans:** A is false, but R is true.
2) **Ans:** A is false, R is false.
3) **Ans:** Both A and R are true, and R is the correct explanation of A.
4) **Ans:** Both A and R are true, and R is the correct explanation of A.
5) **Ans:** Both A and R are true, and R is the correct explanation of A.
6) **Ans:** Both A and R are true, and R is the correct explanation of A.
7) Ans: Both A and R are wrong
8) **Ans:** A is true but R is false.
9) **Ans:** Both A and R are true, and R is the correct explanation of A.
10) **Ans:** A is true but R is false.

CASE BASED QUESTIONS

SL NO	QUESTION	MARKS
1	The molecule of a monatomic gas has only three translational degrees of freedom. Thus, the average energy of a molecule at temperature T is (3/2) k_B T. The total internal energy of a mole of such a gas is U= 3/2 RT, and Cv= 3/2 R. A diatomic molecule treated as a rigid rotator, like a dumbbell, has 5 degrees of freedom: 3 translational and 2 rotational. Using the law of equipartition of energy, the total internal energy of a mole of such a gas is U =5/2 RT, C_V =5/2 R. A polyatomic molecule has 3 translational, 3 rotational degrees of freedom and a certain number (f) of vibrational modes. According to the law of equipartition of energy it is easily seen that one mole of such a gas has $U=\left(\frac{3}{2}k_BT+\frac{3}{2}k_BT+fk_BT\right)N_A$, C_V = (3+ f) R. Note : C_P-C_V=R is true for any ideal gas, whether mono, di or polyatomic. The ratio of specific heats $\gamma=\frac{C_p}{C_v}$	
i)	The total degrees of freedom for a poly atomic gas which has 3 vibrational modes is a) 5 b) 7 c) 6 d) 9	
ii)	The ratio of specific heats for rigid diatomic gas is a) 1.66 R b)1.28 R c) 1.40 R d) 1.50 R	
iii)	If 2 moles of the ideal gas are heated from 300 K to 600 K, and the gas has C_V=3/2 R for a monatomic gas, calculate the heat supplied to the gas at constant volume. **a)** 450R J **(b)** 900R J **(c)**1350R J **(d)** 1800R J	
iv)	The work done to rise the temperature from 100k to 200k at constant pressure is Wp and for the same temperature the work done at constant volume is W_V, then which of the following is true. a) $W_P < W_V$ b) $W_P > W_V$ c) $W_P = W_V$ d) Can't determine. **OR** When the temperature of the one mole of mono atomic ideal gas changes from 50^0C to 100^0C and back to 100^0C then the change in internal energy of the gas for the whole cycle is **a)** 75R J b) 50R J c) 0 J d)-75R J	

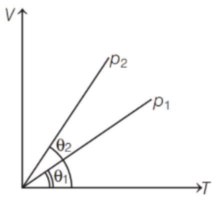
Ans:

SL NO	
1	**i) D) 9** **ii) C)1.40 R** **iii) B) 900R J** **iv)** b) $W_P > W_V$ **OR** **c) 0 J**

2 Properties of gases are easier to understand than those of solids and liquids. This is mainly because in a gas, molecules are far from each other and their mutual interactions are negligible except when two molecules collide. The perfect gas equation can be written as PV = μ RT where μ is the number of moles and $R = N_A k_B$ is a universal constant. The temperature T is absolute temperature. Choosing kelvin scale for absolute temperature, $R = 8.314 \text{ J mol}^{-1}\text{K}^{-1}$. If we fix μ and T in the equation, we get PV = constant i.e., keeping temperature constant, pressure of a given mass of gas varies inversely with volume. This is the famous Boyle's law. Next, if you fix P, shows that V ∝ T i.e., for a fixed pressure, the volume of a gas is proportional to its absolute temperature T (Charles' law).

i) In the given (V-T) diagram, which relation is true for pressures P_1 and P_2?

(a) $P_1 = P_2$
(b) $P_1 > P_2$
(c) $P_1 < P_2$
(d) Cannot be predicted



ii) In Boyle's Law, the product of pressure and volume remains constant, provided which condition is maintained?

A) Constant temperature B) Constant mass
C) Constant volume D) Constant pressure

iii) An ideal gas has a volume of 8 L at a temperature of 100 K. If the temperature of the gas is increased to 400 K at constant pressure, what will be the new volume of the gas?

a) 4L b) 32 L c) 2L d) 16L

iv) An ideal gas at 27^0C is heated at constant pressure so as to thrice its volume. The temperature of the gas will be.

a) 900^0C b)81^0C c)627 ^{0}C d) 436^0C

ANS:

i) (c) $P_1 < P_2$
ii) A) Constant temperature
iii) b) 32 L
iv) c)627 ^{0}C

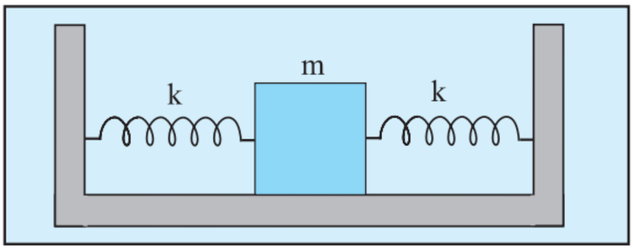
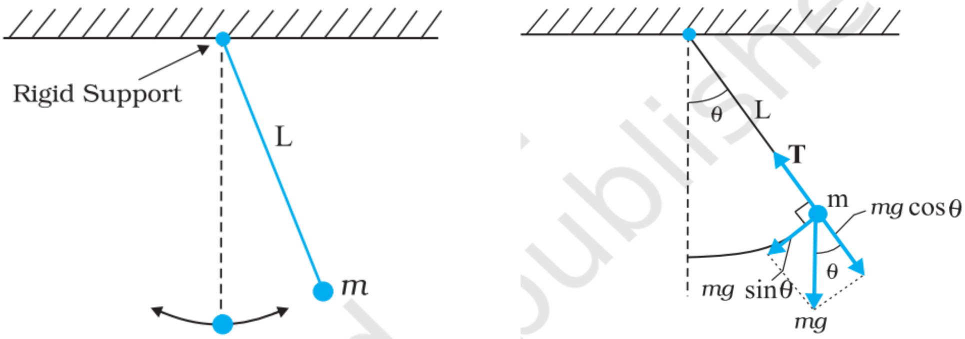
CHAPTER–14: OSCILLATIONS

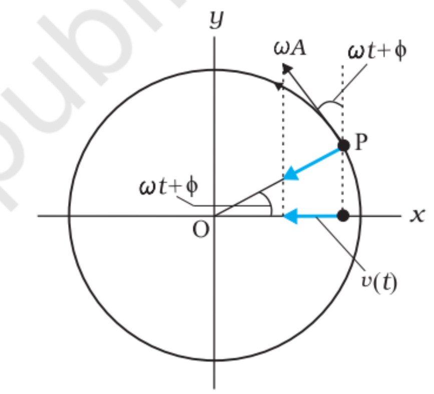
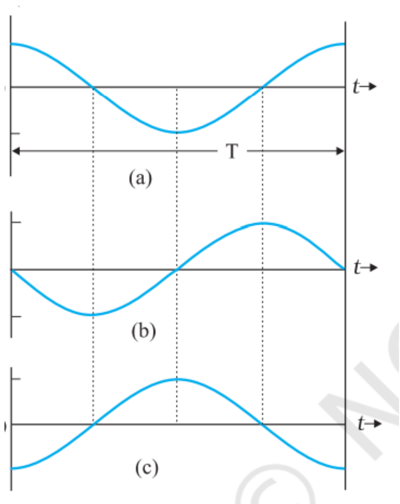
SYLLABUS: Periodic motion - time period, frequency, displacement as a function of time, periodic functions and their applications. Simple harmonic motion (S.H.M) and its equations of motion; phase; oscillations of a loaded spring- restoring force and force constant; energy in S.H.M. Kinetic and potential energies; simple pendulum derivation of expression for its time period.

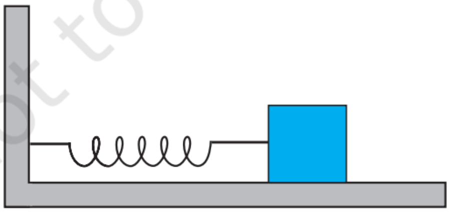
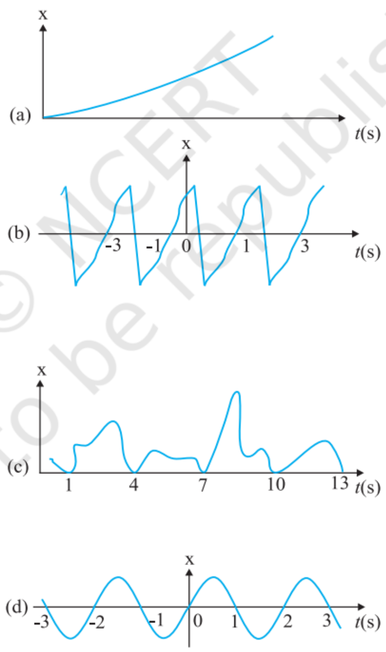
ASSERTION & REASON

SL NO	QUESTION	Marks/ Ans
1	Assertion (A): Every oscillatory motion is periodic, but every periodic motion need not be oscillatory. Reason (R): Circular motion is a periodic motion, but it is not oscillatory.	1 (a)
2	Assertion (A):The total mechanical energy of a harmonic oscillator is independent of time. Reason (R): Simple harmonic motion is not a conservative force.	1 (c)
3	Assertion (A): The total mechanical energy of a simple harmonic oscillator remains constant during oscillation. Reason (R): Energy is continuously converted between kinetic and potential forms, but the total energy remains unchanged.	1 (a)
4	Assertion : The graph between acceleration and displacement for a harmonic oscillator is a straight line. Reason : Displacement in SHM varies sinusoidally.	1 (d)
5	Assertion (A) :Displacement, velocity and acceleration of a particle in simple harmonic motion have the same period T, but they differ in phase. Reason (R) : Restoring force always directed towards mean position.	1 (b)
6	Assertion (A) :The projection of uniform circular motion on a diameter of the circle follows simple harmonic motion. Reason (R) :Circular motion and Simple Harmonic motion are related to each other.	1 (b)
7	Assertion (A) : Any periodic function can be expressed as a superposition of sine and cosine functions of different time periods with suitable coefficients. Reason (R) : sin ωt + cos ωt is not a periodic function.	1 (c)
8	Assertion (A) : The force acting on a particle of mass m in SHM is restoring force. Reason (R) : Force is always directed towards the mean position in SHM.	1 (a)
9	Assertion (A) :Oscillations and vibrations are almost similar. Reason (R) : If frequency is small , we call it oscillation and if frequency is very high, we call it vibration.	1 (a)
10	Assertion (A) : Circular motion is a periodic motion, but it is not oscillatory. Reason (R) : If the body is given a small displacement from the position, a force comes into play which tries to bring the body back to the equilibrium point, gives rise to oscillatory motion.	1 (a)

CASE BASED QUESTIONS

SL NO	QUESTION	MARKS
1	Two identical springs of spring constant k are attached to a block of mass m and to fixed supports as shown in Fig. 	
i)	What is the net force acting on mass m? a)kx b)-kx c)2kx d)-2kx	1
ii)	The force on one side trying to pull or push the force is a)kx b)-kx c)k/x d)-k/x	1
iii)	What is the total energy of this system, if A is the amplitude a)kA^2 b)$1/2\ kA^2$ c)$2kA^2$ d)$3/2kA^2$	1
iv)	If the mass is 80kg and the spring constant is $10Nm^{-1}$, then what is the time period of oscillation a) π b)2 π c)4 π d)8 π OR What is the angular speed of oscillation ω , if k= 40 Nm^{-1} and mass is 20 kg? a)1 $rads^{-1}$ b)2 $rads^{-1}$ c) 4 $rads^{-1}$ d)8 $rads^{-1}$	1 OR 1
2	Consider simple pendulum — a small bob of mass m tied to an inextensible massless string of length L. The other end of the string is fixed to a rigid support. The bob oscillates in a plane about the vertical line through the support. Let θ be the angle made by the string with the vertical. 	
i)	In which case, the time period will be greater ? a)When mass is increased b) When length of the string is increased c)both mass and length of string is increased d)when relocated to North pole of Earth	1
ii)	The radial force that provides the necessary centripetal force but no torque about the support is , a) T-mg cosθ b) T-mg sinθ c) T+mg cosθ d) T+mg sinθ	1
iii)	The tangential force that provides the restoring torque? a)mg cos θ b)mg sin θ c)mg tan θ d) T- mg cos θ	1
iv)	What is the length of this simple pendulum, if it's time period is 2s? a)1m b)2m c)3m d)4m OR	1 OR

	What is the time period of simple pendulum if the length is 9.8m? Take g=9.8 ms^{-1}? a)π b) π/2 c) 2π d) 1/2π	1
3	A class XI student tied a ball to the end of a string and made it move in a horizontal plane about a fixed point with a constant angular speed. She observed that the ball then performed a uniform circular motion in the horizontal plane. Now ,she observed the ball sideways fixing her attention in the plane of motion. The ball appeared to execute to and fro motion along a horizontal line with the point of rotation as the midpoint. She then made the following figure to explain the situation graphically .  	
i)	What will be the velocity v(t) of the particle in mathematical form? a) $\omega A \sin(\omega t + \varphi)$ b)- $\omega A \sin(\omega t + \varphi)$ c)$A \sin(\omega t + \varphi)$ d)-$A \sin(\omega t + \varphi)$	1
ii)	What will be the acceleration a(t) of the particle in mathematical form? a) $\omega A \cos(\omega t + \varphi)$ b) $-\omega A \cos(\omega t + \varphi)$ c)$\omega^2 A \cos(\omega t + \varphi)$ d) $-\omega^2 A \cos(\omega t + \varphi)$	1
iii)	Which among the following fig. represent the graph of velocity if displacement is given as $x= A \cos(\omega t + \varphi)$  a) Graph a b) Graph b b) Graph c d) All the graphs are correct	1
iv)	If $x= 5 \cos(2\pi t + \pi)$, calculate the displacement of the body at t=0.5s a)2.5 b)0.25 c)5 d)0.5 OR A body oscillates with SHM according to the equation (in SI units), $x = 5 \cos[2\pi t + \pi/4]$. If displacement is -3.535 , what will be the acceleration? a)100m s^{-2} b) 120 m s^{-2} c)140 m s^{-2} d)160 m s^{-2}	1 OR 1

4	Sameena made a setup in the following manner. A spring having a spring constant 1200 N m^{-1} is mounted on a horizontal table as shown in Fig. A mass of 3 kg is attached to the free end of the spring. The mass is then pulled sideways to a distance of 2.0 cm and released. 	
i)	Which among the following graphs shows the motion of the above situation in an apt manner?  a)Graph a b)Graph b c) Graph c d)Graph d	1
ii)	The relation between acceleration ,a ,displacement, x and spring constant,k is given below. Which among the following is correct for this situation? (a) $a = + kx$ (b) $a = + kx^2$ (c) $a = – kx^2$ (d) $a = – kx$.	1
iii)	If the spring is replaced with another spring and the ratio of spring constants of two springs is 2:3.What is the ratio of their potential energy, if they are stretched by the same force? a)2:3 b)3:2 c)4:9 d)9:4	1
iv)	What is the frequency of oscillation for the given setup? a)5/ π b)10/π c)5 π d)10π OR What will be the maximum acceleration of mass in the given setup? a)2 ms^{-2} b)4 ms^{-2} c)6 ms^{-2} d)8 ms^{-2}	1 OR 1

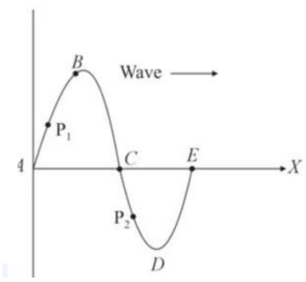
Q NO	ANSWER KEY	MARKS
1		
i)	d	1
ii)	b	1
iii)	b	1

iv)	b OR b	1 OR 1
2		
i)	b	1
ii)	a	1
iii)	b	1
iv)	a OR c	1 OR 1
3		
i)	b	1
ii)	d	1
iii)	b	1
iv)	c OR c	1 OR 1
4		
i)	d	1
ii)	d	1
iii)	a	1
iv)	b OR d	1 OR 1

CHAPTER–15: WAVES

SYLLABUS: Wave motion: Transverse and longitudinal waves, speed of travelling wave, displacement relation for a progressive wave, principle of superposition of waves, reflection of waves, standing waves in strings and organ pipes, fundamental mode and harmonics, Beats.

ASSERTION & REASON

SL NO	QUESTION	MARKS
	Directions: This question consist of two statements, each labelled as Assertion and Reason. While answering this question, you have to choose any one of the following four responses. (a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion (b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion. (c) If the Assertion is correct but Reason is incorrect. (d) If both the Assertion and Reason are incorrect.	
1	**Assertion :** The transverse wave is travelling along a string in the positive x axis as shown Points A&P1 moving ↓ (downward) and points C&P2 moving (upward). **Reason :** In a wave propagating in positive x direction the points with +ve slope move downward and vice versa. 	**1**
2	Assertion : Standing waves do not transferred energy in the medium. Reason : Every particle vibrates with its own energy and it does not share its energy with any other particle	
3	Assertion: Longitudinal waves are called pressure waves. Reason: Propagation of longitudinal waves through a medium involves changes in pressure in the medium.	
4	**Assertion :** When a guitar string is plucked , the frequency of the plucked string will not be the same as the wave it produces in air . **Reason:** The speeds of the waves depend on the medium in which they are propagating.	**1**
5	**Assertion:** In a standing wave on a string , the spacing between nodes is Δx. If the tension in string is increased wave same as before , then the separation between nearest node and antinode will be Δx. **Reason:** Spacing between nodes (consecutive) in the standing wave is equal to the wavelength of component waves.	**1**
6	**Assertion:** All our communications essentially depend on transmission of signals through waves. **Reason:** Speech means production of sound waves in air and hearing amounts to their detection	**1**

7	**Assertion:** The quantity similar to extension or compression of the spring is the change in density **Reason:** If a region is compressed, the molecules in that region are packed together, and they tend to move out to the adjoining region, thereby decreasing the density or creating rarefaction	**1**
8	**Assertion:** Transverse waves can, therefore, be propagated only in those media, which can sustain shearing stress, such as solids and not in fluids. **Reason:** Fluids, as well as, solids can sustain compressive strain; therefore, longitudinal waves can be propagated in all elastic media.	**1**
9	**Assertion:** Oscillation of an air column with one end closed and the other open. A glass tube partially filled with water illustrates this system. The end in contact with water is a node, while the open end is an antinode. **Reason:** At the node the pressure changes are the largest, while the displacement is minimum (zero). At the open end - the antinode, it is just the other way - least pressure change and maximum amplitude of displacement.	**1**
10	**Assertion:** In a harmonic progressive wave of a given frequency, all particles have the same phase but different amplitudes at a given instant of time. **Reason:** In a stationary wave, all particles between two nodes have the same amplitude at a given instant but have different phases.	**1**
	ANSWERS	
1	The relation between wave velocity and particle velocity when, graph between wave and particle displacement is given. $v_p = v_w$ (-dy/dx), dy/dx is the slope of the point of the position of the particle. The point A & P1 have same positive slope, if slope is positive the velocity of the particle is negative, they will move downward. The point C & P2 will move upward because they have negative slope. Therefore, both assertion and reason are correct and the reason is the correct explanation of the assertion.	
2	A standing wave pattern is a vibrational pattern created within a medium when the vibrational frequency of the source causes reflected waves from one end of the medium to interfere with incident waves from the source. This interference occurs in such a manner that specific points along the medium appear to be standing still. Because the observed wave pattern is characterised by points that appear to be standing still, the pattern is often called a standing wave pattern. Since the vibrations of all points are still in their position, there is no transfer of energy.	
3	When longitudinal waves propagates through a medium, it causes displacement of particles of motion along the direction of wave propagation. Hence at some points particles are close to each other while at some points they are farther apart. This creates a density difference in medium, due to which pressure difference arises in the material medium. Since propagation of longitudinal waves through a medium creates pressure disturbances in the medium, hence these waves are called pressure waves. The correct option is A Both assertion and reason are correct and reason is the correct explanation of assertion.	
4	Both the assertion and reason are incorrect. The frequency of a plucked guitar string is the same as the wave it produces in air. However, the speed of the waves depends on the medium in which they propagate.	

	When a guitar string is plucked, it vibrates in a transverse wave pattern, while the sound produced in the air is a longitudinal wave. The vibration of the string is transmitted through the bridge of the guitar, resonating throughout the top, side, and back of the instrument. The sound is finally produced from the sound hole.	
5	Assertion is true because increasing tension increases the separation between nodes. Reason is false because the spacing between nodes is indeed half the wavelength	
6	both the assertion and reason are correct, and the reason is the correct explanation for the assertion. Explanation Speech is the expression of ideas and thoughts through vocal sounds, and hearing is the ability to detect those sounds. Both speech and hearing are based on the transmission of signals through waves, as explained below: Speech: Speech is the production of sound waves in air. Hearing: Hearing is the process of detecting sound waves in the air and converting them into electrical signals that are sent to the brain by the auditory nerve. Sound waves are a type of energy that are created when an object vibrates, causing the particles in a medium like air to move. These vibrations continue until the particles run out of energy.	
7	both the assertion and reason are correct:	
8	both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.	
9	both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.	
10	Both Assertion and Reason are incorrect	

CASE BASED QUESTIONS

SL NO	QUESTION	MARKS
1	If you drop a little pebble in a pond of still water, the water surface gets disturbed. The disturbance does not remain confined to one place, but propagates outward along a circle. If you continue dropping pebbles in the pond, you see circles rapidly moving outward from the point where the water surface is disturbed. It gives a feeling as if the water is moving outward from the point of disturbance. If you put some cork pieces on the disturbed surface, it is seen that the cork pieces move up and down but do not move away from the centre of disturbance. This shows that the water mass does not flow outward with the circles, but rather a moving disturbance is created. Similarly, when we speak, the sound moves outward from us, without any flow of air from one part of the medium to another. The disturbances produced in air are much less obvious and only our ears or a microphone can detect them. These patterns, which move without the actual physical transfer or flow of matter as a whole, are called waves	

i)	Water waves produced by a motorboat sailing in water are a) neither longitudinal nor transverse b) both longitudinal and transverse c) only longitudinal d) only transverse	
ii)	The waves transmit a) mass b) energy c) both mass and energy d) neither mass nor energy	
iii)	Speed of sound wave in air a) is independent of temperature b) increases with pressure c) increases with an increase in humidity d) decreases with an increase in humidity	
2	Beats is an interesting phenomenon arising from interference of waves. When two harmonic Sound waves of slightly different frequencies and comparable amplitude are heard at the same time, we hear a sound of similar frequency (the average of two close frequencies), but we hear something else also. We hear audibly distinct waxing and waning of the intensity of the sound, with a frequency equal to the difference in the two close frequencies. Artists use this phenomenon often while tuning their instruments with each other. They go on tuning until their sensitive ears do not detect any beats.	
i)	Two tuning forks when sounded together produced 4beats/sec. The frequency of one fork is 256. The number of beats heard increases when the fork of frequency 256 is loaded with wax. The frequency of the other fork is a)504 b) 520 c) 260 d) 252	
ii)	Two adjacent piano keys are struck simultaneously. The notes emitted by them have frequencies n_1 and n_2 . The number of beats heard per second is a) $n_1 \sim n_2$ b) $n_1 + n_2$ c) $n_1 \times n_2$ d) $n_1 - n_2$	
iii)	Two tuning forks have frequencies 450 Hz and 454 Hz respectively. On sounding these forks together, the time interval between successive maximum intensities will be a) $\frac{1}{4}$ sec b) $\frac{1}{2}$ sec c) 1 sec d) 2 sec	
3	Let us consider a familiar situation, a string fixed at either end or an air column in a pipe with either end closed in which reflection takes place at two or more boundaries. In a string, for example, a wave travelling in one direction will get reflected at one end, which in turn will travel and get reflected from the other end. This will go on until there is a steady wave pattern set up on the string. Such wave patterns are called standing waves or stationary waves. To see this mathematically, consider a wave travelling along the positive direction of x-axis and a reflected wave of the same amplitude and wavelength in the negative direction of x-axis. The Equations, with φ = 0, can be written as $y_1(x, t) = a \sin(kx - \omega t)$ $y_2(x, t) = a \sin(kx + \omega t)$ The resultant wave on the string is, according to the principle of superposition:	

	$y(x, t) = 2a \sin kx \cos \omega t$	
i)	The amplitude of the resultant wave is a) $2a$ b) $2a\ sinkx$ c) $2a\ sin\omega t$ d) $2a\ cos\omega t$	
ii)	Identify the correct statement among the following a) In standing wave pattern, the amplitude varies from point-to-point, but each element of the string oscillates with the same angular frequency ω or time period b) There is no phase difference between oscillations of different elements of the wave. c) The wave pattern is neither moving to the right nor to the left. d) The points at which the amplitude is zero (i.e., where there is no motion at all) are antinodes.	
iii)	A string is cut into three parts having fundamental frequencies $n_1,\ n_2\ ,\ n_3$ The original fundamental frequency n is related by the expression a) $n = n_1 + n_2 + n_3$ b) $n = n_1 \times n_2 \times n_3$ c) $n = \frac{n_1 + n_2 + n_3}{3}$ d) $\frac{1}{n} = \frac{1}{n_1} + \frac{1}{n_2} + \frac{1}{n_3}$	
4	**REFLECTION OF WAVES** What happens if a pulse or a wave meets a boundary? If the boundary is rigid, the pulse or wave gets reflected. The phenomenon of echo is an example of reflection by a rigid boundary. If the boundary is not completely rigid or is an interface between two different elastic media, the situation is some what complicated. A part of the incident wave is reflected and a part is transmitted into the second medium. If a wave is incident obliquely on the boundary between two different media the transmitted wave is called the refracted wave. The incident and refracted waves obey Snell's law of refraction, and the incident and reflected waves obey the usual laws of reflection.	
i)	The reflected wave has the same shape as the incident pulse but it suffers a phase change of π on reflection. This is because a) The boundary is rigid and the disturbance must have zero displacement at all times at the boundary b) The boundary is rigid and the disturbance must have maximum displacement at all times at the boundary c) The boundary is rigid and the disturbance must have maximum amplitude at all times at the boundary d) The boundary is rigid and the disturbance must have zero amplitude at all times at the boundary	
ii)	As the pulse arrives at the wall, it exerts a force on the wall. the wall exerts an equal and opposite force on the string generating a reflected pulse that differs by a phase of π. This is in accordance with a) By Newton's Third Law b) By superposition principle c) By Snell's law of refraction d) By Hook's law	
iii)	Since the wall is rigid, the wall does not move, so no ripples are generated at the boundary. This implies that the amplitude at the boundary is a) zero b) maximum c) minimum d) can't be predicted	
1	**ANSWERS**	

i)	b) both longitudinal and transverse	
ii)	b) energy	
iii)	C) The speed of sound in air increases with an increase in humidity. This is because humid air is less dense than dry air, and as the density of the medium decreases, so does the speed of sound**.**	
2 (i)	c) 260	
ii)	a) $n_1 \sim n_2$	
iii)	a) $\frac{1}{4}$ sec	
3(i)	. b) $2a\ sinkx$	
ii)	d) The points at which the amplitude is zero (i.e., where there is no motion at all) are antinodes.	
iii)	d) $\frac{1}{n} = \frac{1}{n_1} + \frac{1}{n_2} + \frac{1}{n_3}$	
4(i)	a) The boundary is rigid and the disturbance must have zero displacement at all times at the boundary	
ii)	a) By Newton's Third Law	
iii)	a) zero	