Half Yearly Examination

Class XI

Time Allowed: 3 hours **Maximum Marks: 70**

General Instructions:

- **The question paper is divided into 5 Sections A, B, C, D and E**
- **Section A consists of 18 MCQs carrying 1 mark each**
- **Section B consists of 7 Questions carrying 2 marks each.**
- **Section C consists of 5 questions carrying 4 marks each**
- **Section D consists of 3 Questions carrying 5 marks each**
- **Section E consists two case study based questions of 4 marks each.**

All questions in all sections are compulsory, However, there is an internal choice in some question

Section A

1. The dimensions of kinetic energy is
(a) $[M^2L^2T]$ (b) $[ML^2T]$ (c) $[ML^2T^{-2}]$ (d) $[ML^2T^{-1}]$
2. In SI system, fundamental quantities are
(a) meter, kilogram, second, ampere, Kelvin, mole and candela
(b) meter, kilogram, second, coulomb, Kelvin, mole and candela
(c) meter, Newton, second, ampere, Kelvin, mole and candela
(d) meter, kilogram, second, ampere, Kelvin, mole and flux
3. The area under velocity time graph for a particle in a given interval of time represents
(a) velocity (b) acceleration (c) work done (d) displacement
4. A small body attached at the end of an inextensible string completes a vertical circle then its
(a) angular momentum remains constant (b) linear momentum remains constant
(c) angular velocity remains constant (d)total mechanical energy remains constant
5. A body makes a displacement of 4m due East from a point O and then makes displacement of 3m due North. Its resultant displacement from O
(a) 7m (b) 1m (c) 5m (d) 1.2m
6. A body is moving along a circle with an increasing speed. It possesses
(a) centripetal acceleration only (a_c) (b) tangential acceleration only (a_T)
(c) both tangential and centripetal acceleration (a_T and a_c) (d) no acceleration
7. A passenger in a moving bys is thrown forward when tehbus si suddenly stoped. This is explained

(a) by Newtons first law (b)by Newtons second law
(c) by Newtons third law (b) by the principle of conservation of momentum

8 Rocket worked on the principle of conservation of
(a) energy (b) momentum (c) mass (d) all of these

9. The SI unit of impulse is
(a) N (b) N/S (c) NS (d) NS^2

10. When a torque acting on a system is zero, then which of the following should not change?
(a) linear velocity (b) angular momentum
(c) angular displacement (d) force acting on the body

11. Two particles of masses m_1 and m_2 ($m_1 > m_2$) attract each other with a force inversely proportional to the square of the distance between them. The particles are initially held at rest and then released. Then
(a) the CM moves towards m_2 (b) the CM moves towards m_1
(c) the CM remains at rest (d) CM moves at right angle to the line joining m_1 & m_2

12. Force of gravitational attraction is least
(a) at the equator (b) at the poles
(c) at a point in between equator and pole (d)same every where

13. A body weighs 500N on the surface of the earth. How much would it weight half way below the surface of the earth?
(a) 1000N (b) 500N (c) 250N (d) 125N

14. In the projectile motion, if air resistance is ignored, the horizontal motion is at
(a) constant acceleration (b) constant velocity
(c) variable acceleration (d) constant retardation

15. A quantity of 6000J is done in 5 minutes. The power utulised is
(a) 60W (b) 1200W (c) 20W (d) 200W

Two statements are given one labeled Assertion (A) and other labeled Reason (R). Select The correct answer to these questions.

(a) Assertion is correct, Reasons is correct; reason is correct explanation for assertion
(b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion
(c) Assertion is correct, reason is incorrect (d) Assertion is incorrect, reason is correct

16. Assertion: The slope of momentum versus time curve gives us the force
Reason: Acceleration is given by the rate fo change of momentum

17. Assertion: Displacement of a body may be zero when distance is travelled by it is not zero
Reason: The displacement is the longest distance between initial and final position.

18. Assertion: Kinetic energy of a system can be increased or decreased without applying any external force on the system.
Reason: KE can be increased or decreased without applying any external forfrce, as internal forces can do work.

Section B

19. State the number of significant figures in the following: (a) 6.320J (b) 6.032 Nm^{-2}
(c) 0.0006032 m^2 (d) 2.64×10^{24}kg

20. The position of an object moving along x axis is given by $x = a+bt^2$ where a = 8.5m, b = 2.5 ms^{-2} and it is measured in seconds. What is its velocity at t = 0s and t = 2.0s. What is the average velocity between t = 2.0s and t = 4.0s?

Or

A ball is thrown vertically upwards with a velocity of 20 ms^{-1} from ground. (a) How high will ball rise? And (b) How long wil it be before the ball hits the ground? (Take g = $10ms^{-2}$).

21. Draw position time graph of the following:
(a) Body moving with uniform velocity (b) Body moving with uniform acceleration.

22. State parallelogram law of vector addition.

Or

State triangle law of vector addition.

23. (a) State the law of conservation of linear momentum.
(b) A shell of mass 0.020 kg is fired by a gun of mass 100kg. If the muzzle speed of the shell is 80 ms^{-1}, what is the recoil speed of the gun?

24. A constant force acting on a body of mass 3.0 kg changes its speed from 2.0 ms^{-12} to $2.5ms^{-1}$ in 25s. The direction of the motion of the body remains unchanged. What is the magnitude and direction of the force?

Or

Two bodies of masses 10kg and 20kg respectively kept on a smooth, horizontal surface are tied to the ends of a light string, a horizontal force F = 600N is applied to (i) A (ii) B along the direction of the string. What is the tension in the string in each case?

25. A body of mass 0.5kg travels in a straight line with velocity $v = ax^{3/2}$ where $a = 5m^{-1/2}s^{-1}$. What is the work done by the net fore during its displacement from x = 0 to x = 2m?

Section C

26. The time period (T) of an oscillation depens on density (d), radius (r) and surface tension (s). Obtain formula for T by dimensional analysis. Surface tension is defined as force per unit length.

27. Given are the vectors $\vec{A} = 2\hat{i} + \hat{j} + \hat{k}$ and $\vec{B} = \hat{i} - \hat{j} + 2\hat{k}$. (Note i, j, k are unit vectors).
(a) Find the angle between these two vectors. (b) Determine unit vector perpendicular to both $\vec{A}$ and $\vec{B}$.

28. Derive the expression for maximum possible velocity for a vehicle of mass m, on a banked circular road, with radius R, coefficient of friction between road and tyres is μ.

29. (a) Define centre of mass of a body.
(b) Deduce the expression for centre of mass of a uniform rod of mass M and length L.

Or

From a uniform disk of radius R, a circular hole of radius R/2 is cut out. The centre of the hole is at R/2 from the centre of the original disc. Locate the centre of mass of the resulting flat body.

30. Deduce an expression to depict the variation of acceleration due to gravity with depth h, below the earth surface.

Section D (5 marks each)

31. (a) Derive the expression for time of flight, maximum height attained and horizontal range in case of projectile motion.

(b) A cricketer can throw a ball to a maximum horizontal distance fo 100m. How much high above the ground can the cricketer throw the same ball with the same initial velocity.

Or

(a) From the velocity time graph of uniformly accelerated motion deduce the equation of motion for (i) velocity and time (ii)Position and time (iii) Position and velocity.

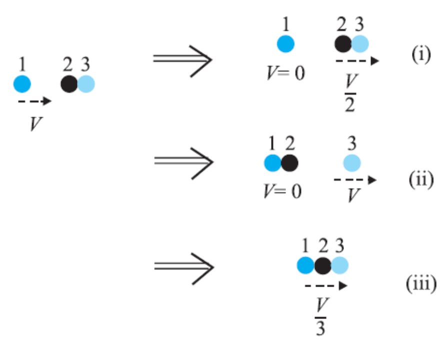
(b) A car moving along a straight highway with speed of 126 kmh^{-1} is brought to a stop by applying brakes within a distance of 200m. What is the retardation of the car (assumed uniform), a how long does it take for the car to stop?

32. (a) Derive the expression for final velocities acquired by bodies of masses m_1 and m_2 after elastic collision in one dimension, if their velocities were u_1 and u_2.

(b) A mud ball of mass 5kg moving with sped 10m/s, collides with a stationary mud ball of same mass. After collision the balls stick together and move. Calculate their common speed after collision.

Or

(a) Two identical bearings in contact with each other and resting on a frictionless table are hit head on by another ball bearing of the same mass moving initially with speed v. If this collision is elastic which of the following is the possible result after collision.



(b) A light body and a heavy body have same kinetic energy. Which one has greater linear momentum.

33. (a) Derive an expression for torque in Cartesian coordinate system taking x-y plane.

(b) Define moment of inertia write its SI unit also write factors on which moment of inertia depends.

Or

(a) State and explain the principle of conservation of angular momentum. Give at least two examples.

(b) The speed of a wheel increases from 600rpm to 1200rpm in 20sec. What is the angular acceleration?

Section E (Case study type)

34. If $\vec{A}$ is vector is given by $\vec{A}$ - Ax I + Ay j where the quantities A_x and A_y are called x and y components of the vector $\vec{A}$. Not that Ax is itself not a vector, byt A_xi is a vector and so is A_yj. Using simple trigonometry we can express A_x and A_y in terms fo the magnitude of A and the angle θ it makes with the x axis.

Ax = A cos (θ)

Ay = A sin(θ)

If A and θ are given, Ax and Ay can be obtained using and if Ax and Zy are gien, A and θ can be obtained as follows:

$A_x^2 + A_y^2 = (A\cos\theta)^2 + (A\sin\theta)^2$ or $A_x^2 + A_y^2 = A^2\cos^2\theta + A^2\sin^2\theta$

$\Rightarrow A_x^2 + A_y^2 = A^2(\cos^2\theta + \sin^2\theta)$ or $A_x^2 + A_y^2 = A^2$ (since $\cos^2\theta + \sin^2\theta = 1$)

Or $A^2 = A_x^2 + A_y^2$

$\Rightarrow A = \sqrt{A_x^2 + A_y^2}$ …(iv)

Dividing A_y by A_x we get

$\frac{A_y}{A_x} = \frac{A\sin\theta}{A\cos\theta} \Rightarrow \frac{A_y}{A_x} = \tan\theta$ or $\tan\theta = \frac{A_y}{A_x}$ or $q = \tan^{-1}\left(\frac{A_y}{A_x}\right)$ …(v)

(i) If $\vec{A}$ is a vector given by $\vec{A}$ = Axi + Ayj. If the magnitude of vector is A and the angle θ it makes with the x axis Ax can be given by

(a) Ax = A cos(θ) (b) Ax = A sin (θ) (c) Ax = A tan(θ) (d) none of these

(ii) If the position of the point A is given by (2, 3, 4) and the position fo point B is given by (3, - 5, 2) the find the position vector $\overrightarrow{AB}$.

(iii) If $\vec{A}$ is vector given by $\vec{A}$ = Axi + Ayj where obtain expression for resultant amplitude of vector and its angle with x axis.

35. Friction: Let us consider the example of a body of mass m at rest on a horizontal table. The force of gravity (mg) is cancelled by the normal reaction force (N) of the table. Now suppose force F is applied horizontally to the body. We know from experience that a small applied force may not be enough to move the body, But if the applied force F were the only external force on the body, it must move with acceleration F/m, however small. Clearly the body remains at rest because and opposes the applied force F, resulting in zero net force on the body. This force f_s parallel to the surface of the body in contact with the table is known as frictional force, or simply friction. It comes into play the moment there is an applied force. As the applied force F increases, f_s also increases, remaining equal and opposite to the applied force (up to a certain limit), keeping the body at rest. Hence it is called the static friction. It is found experimentally that the limiting value of

static friction (f_s) max , f is independent of the area of contact and varies with the normal force (N) approximately as: $(f_s)max = \mu_s N$

Where μ_s is a constant of proportionality and depending only on the nature of the surfaces in contact. The constant m_s is called the coefficient of static friction.

frictional force that opposes relative motion between surfaces in contact is called kinetic or sliding friction and is denoted by f_k. Kinetic friction like static friction is found to be independent of the area of contact. Further, it is nearly independent of the velocity. It satisfies a law similar to that for static friction: $f_k = \mu_k N$.

(i) A block of mass m has been placed on an inclined plane. The angle of inclination of slope θ is such that the block slides down the plane with constant speed. The coefficient of kinetic friction is

(a) 1 (b) sin θ (c) cos θ (d) tan θ

(ii) Which of the following does not applies to the static friction

(a) It is self adjusting

(b) It opposes the relative motion between two surfaces

(c) It depends on the nature of two surfaces

(d) It has constant value, no matter how much external force is applied.

(iii) A block of mass 3kg is lying on a rough surface. A force of 15N is applied on the block towards right. If the coefficient of static friction is 0.4, the force of friction between the block and the surface is given by

(a) 1.5N (b) 12N (c) 2.5N (d) 30N

(iv) A block of mass 1kg is placed on the floor. The coefficient of static friction is 0.2. If a force of 1N applied to the block, the force of friction is

(a) 2N (b) 0.2N (c) 1N (d) 0.1N