CLASS XI - PHYSICS

✣ General instructions:

(1) There are 33 questions in all. All questions are compulsory.
(2) This question paper has five sections: Section A, Section B, Section C, Section D and Section E.
(3) All the sections are compulsory.
(4) Section A contains sixteen questions, twelve MCQ and four Assertion Reasoning based of 1 mark each, Section B contains five questions of Two marks each, Section C contains seven questions of three marks each, Section D contains two case study-based questions of four marks each and Section E contains three long answer questions of five marks each.
(5) There is no overall choice. However, an internal choice has been provided in one question in Section B, one questions in Section C, one question in each CBQ in Section D and all three questions in Section E: You have to attempt only one of the choices in such questions.
(6) Use of calculators is not allowed.

✣ SECTION A

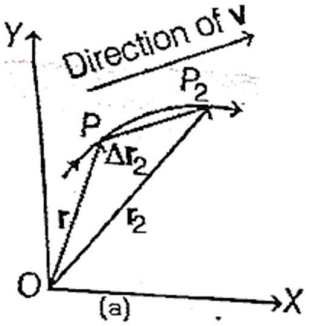
1) Which of the following physical quantities is dimensionless?
   a) Gravitational constant b) Relative density
   c) Surface tension d) Angular momentum

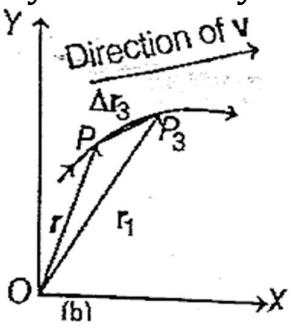
2) A car starts from rest and moves with constant acceleration. Which of the following graphs is a straight line?
   a) Displacement vs. time b) Velocity vs. time
   c) Acceleration vs. time d) Both b and c

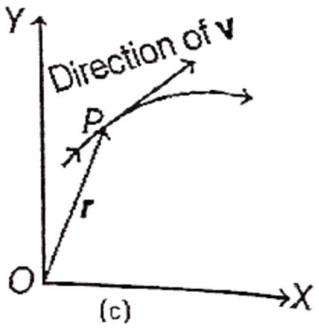
3) Which of the following statements is true?
   a) Speed is always greater than velocity
   b) Speed is always equal to velocity
   c) Speed is always less than velocity
   d) Speed may be greater or equal to velocity

4) The resultant of two vectors of equal magnitude is minimum when the angle between them is:
   a) 0° b) 90° c) 180° d) 120°

5) The direction of instantaneous velocity is shown by







(d) none of these 6

6) Identify the correct statement:
   a) Static friction depends on the area of contact.
   b) Kinetic friction depends on the area of contact.
   c) Coefficient of kinetic friction doesn't depend on the nature of the surfaces in contact.
   d) Coefficient of kinetic friction is less than the coefficient of limiting friction.

7) A ball is travelling with uniform translational motion. This means that
   a) it is at rest
   b) the path can be straight line or circular and the ball travel with uniform speed
   c) all parts of the ball have the same velocity and the velocity is constant
   d) the centre of the ball moves with constant velocity and the ball spins about its centre uniformly

8) A force F= 5i +6j -4k acting on a body produces a displacement s= 6i +5k. The work done by the force is
   a) 15 units b)10 units c) 18 units d) 12 units

9) Two bodies of masses m_1 and m_2 have same momentum. The ratio of their KE is
   a) $\sqrt{m2/m_1}$ b) $\sqrt{m1/m2}$
   c) m1/m2 d) m2/m1

10) When a disc rotates with uniform angular velocity, which of the following is not true?
   a) The sense of rotation remains same.
   b) The orientation of the axis of rotation remains same.
   c) The speed of rotation is non-zero and remains same.
   d) The angular momentum is zero and remains same.

11) The moment of inertia of a body doesn't depend upon:
   a) Angular velocity b) Axis of rotation
   c) Mass of a body d) distribution of mass

12) Kepler's second law is based upon:
   a) Newton's first law
   b) Newton second law
   c) Special theory of relativity
   d) Conservation of angular momentum

<u>ASSERTION REASON</u>

Choose the correct option in give assertion and reason.
a) Both assertion and reason are true and the reason is the correct explanation of the assertion.
b) Both assertion and reason are true but reason is not the correct explanation of the assertion.
c) Assertion is true but reason is false.
d) Assertion is false and reason is also false
e) Assertion is false but reason is true.

13) Assertion: Action and reaction forces don't cancel out each other.
   Reason: It is because both do not act on the same body.

14) Assertion: When a body moves along a circular path no work is done by the centripetal force.
   Reason: The centripetal force acts tangentially.

15) Assertion: A force applied at the center of mass of a rigid body produces only linear acceleration but no angular acceleration.
Reason: Torque about the center of mass is zero if the line of action of force passes through it.

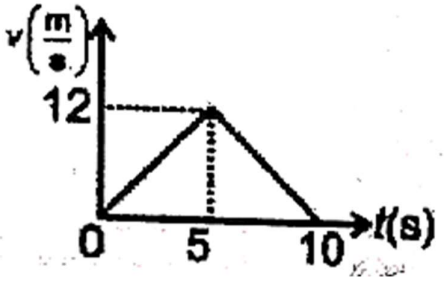
16) Assertion: Weight of an object decreases as it is taken deep inside the Earth.
Reason: Inside the Earth, effective gravitational force varies linearly with distance from the center.

✣ SECTION B

17) A book with many printing errors contains two different formulae for a displacement 'y' of a particle undergoing a certain periodic motion (i) $y=a \sin(2\pi t/T)$ (ii) $y=(a/T) \sin(t/a)$; where a= maximum displacement of the particle, T= time period of motion. Rule out wrong formulae on dimensional grounds.

18) The length, breadth and height of a rectangular block of wood were measured to be $l=12.13\pm0.02$ cm, $b=8.16\pm0.01$cm and $h= 3.46\pm0.01$ cm. Determine the percentage error in the volume of the block.

19) The velocity time graph of a particle moving along a fixed direction is as shown in figure. Find the displacement in 0s to 10s.



20) (a) If unit vectors $\hat{a}$ and $\hat{c}$ are inclined at an angle θ, then prove that $|\hat{a} - \hat{c}| = \sqrt{2}\,(1-\cos\theta)^{1/2}$
(b) Can we call the motion of the particle as one with uniform acceleration? Why?

21) Derive the Expression showing relation between torque and angular momentum.

✣ SECTION C

22) The time of oscillation T of a small drop of a liquid under surface tension, whose dimension are those of force per unit length, depends upon the density d, the radius r and the surface tension σ. Derive formula for T in terms of d, r and o using dimensional analysis.

23) The displacement x of a particle varies with time t as
$X = 34t^2 - 15t + 25$.
(i) Find the velocity and acceleration of the particle at t= 0.

24) Obtain all three equations of motion for constant acceleration using method of calculus or graphical method,
(i) $v = u + at$ (i) $s = ut + (1/2)at^2$
(iii) $v^2 - u^2 = 2as$
All symbols are having their usual meanings.

25) Show that the magnitude of resultant of two vectors A and B inclined at an angle θ is $R = (A2 + B^2 + 2AB\cos\theta)12$. Find the direction of resultant also.

26) (a) Define impulse. Write its SI unit. Derive the expression for an impulse-momentum theorem.

OR

(b) State and explain the law of conservation of linear momentum with an example and prove it from Newton's second law of motion.

27) Three masses 3 kg, 4 kg, 5 kg are located at the corners of an equilateral triangle of side 1 m, then what are the coordinates of the center of mass of this system.

OR

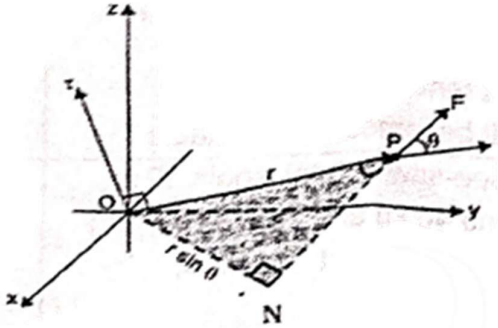
(b)Prove that $|\hat{a} - \hat{c}| \leq |\hat{a}| + |\hat{c}|$

28) Derive an expression for acceleration due to gravity below the surface of earth. Show the graphical representation of 'g' with distance from the center of earth.

✤ SECTION D(Case Study-Based)

29) The turning effect of force is called moment of force or torque. It is measured as the product of the magnitude of the force and the perpendicular distance between the line of action of force and the axis of rotation.

$$t = F \times ON = F \times d = Fr \sin\theta$$



In vector form, $\tau = r \times F$

The direction of torque is perpendicular to the plane of r and F and its sense is given by right hand rule. If a torque applied on a body rotates it through an angle $\Delta\theta$, the work done by the torque is

$$\Delta W = \tau \Delta\theta = \text{Torque x Angular displacement}$$

Power of torque, $P = \Delta W/\Delta t = \tau \Delta\theta/\Delta t = \tau\omega$

(i) Turning effect of force is produced by

a) Perpendicular component of force
b) Radial component of force
c) None of these
d) both a and b

(ii) Which of the following statement is incorrect?

a) Moment of couple is independent of point about which moment is taken.
b) For translational equilibrium of a body vector sum of all the forces on it must be zero
c) A body may be in translational equilibrium but may not be in rotational equilibrium simultaneously
d) Rotational equilibrium depends on location of origin about which torques are taken

(iii) If the earth were to shrink suddenly, what would happen to the length of the day?

a) It increases
b) It remains the same
c) It decreases
d) It becomes unpredictable

(iv) In order to balance a see-saw of total length 10 m, two kids weighing 20 kg and 40 kg are sitting at an end and at a distance x from the fulcrum at its centre, respectively. The value x (in cm) is

a) 250 b) 150 c)450 d) 350

or

(iv) Find the torque of a force $F = -3i + j + 5k$ acting at a point $r = 7i + 3j + k$.(i, j, k are unit vectors along standard axis)

a) $14i - 38j + 16k$
b) $4i + 4j + 6k$
c) $-14i + 38j - 16k$
d) $-21i + 3j + 5k$

30) When a spring is stretched through distance x, the restoring force F set up in the spring due to its elasticity is such that

$F \propto -x$ or $F = -kx$ where k is a force constant or spring constant of the spring. It is the restoring force set up in the spring per unit extension. Its SI unit is N/m. The work done in stretched spring through the distance x will be

$$W = {}_0\int^x kx\,dx = \tfrac{1}{2}kx^2$$

This work done is stored as potential energy U of the spring. Therefore,

$$U = \tfrac{1}{2}kx^2$$

(i) In the equation,

$$W = {}_0\int^x kx\,dx = \tfrac{1}{2}kx^2$$

Write the dimension of k.

(ii) A spring of force constant 800 N/m has an extension of 5 cm. Find the work done in extending it from 5 cm to 15 cm.

(iii) Two springs of spring constant 1500 N/m and 3000 N/m respectively are stretched with a same force. Find the ratio of their potential energies.

(iv) If a spring extends by x on loading, then how much energy will be stored in the spring in terms of T (where T is the tension in the spring and k is the spring constant).

OR

(iv) A spring 40 mm long is stretched by the application of a force. If 10 N force is required to stretch the spring through 1mm, then how much work is done in stretching the spring through 40 mm.

✣ SECTION E

31 I. (a) A projectile is fired with a velocity u making an angle θ with the horizontal. Obtain the expressions for its

(i) Time of flight (ii) Maximum height of a projectile.

(b) A cricket ball is thrown at speed of 20 ms^{-1} in a direction 30º above the horizontal, Calculate

(i) the maximum height

(ii) the time taken by the ball to return to the same level.

OR

II. (a) Define centripetal acceleration. Derive an expression for the centripetal acceleration of an object moving with uniform speed v along a circular path of radius r.

(b) A stone tied to the end of a string 80 cm long is whirled in a horizontal circle with the constant speed. If the stone makes 14 revolutions in 25s, what is the magnitude and direction of the acceleration of the stone?

32 I. (a) Why are circular roads banked? Derive an expression for the maximum safe speed of a car on a banked circular road having coefficient of friction μ.

(b) A circular race track of radius 300 m is banked at angle of 15° .If the coefficient of friction between the wheels of a race car and the road is 0.2. What is the

(i) Optimum speed of the race car to avoid wear and tear

on its Tyre

(ii) Maximum permissible speed to avoid slipping?

(tan15°=0.267)

II. (a) Define:

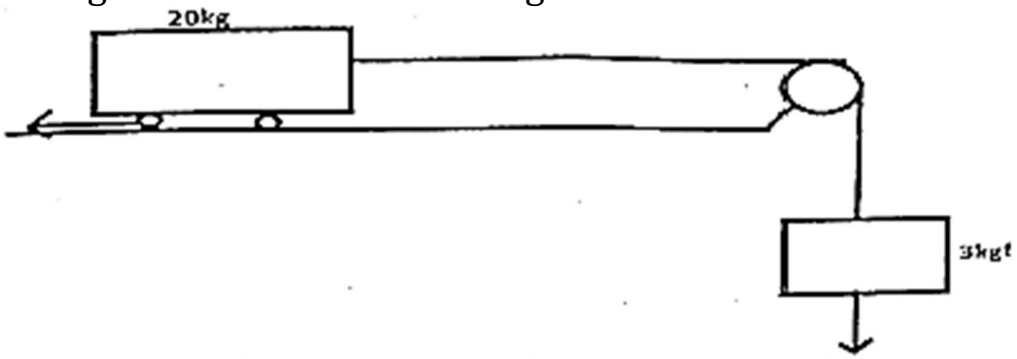
(i) Angle of friction

(ii) kinetic friction

(iii) Angle of repose

OR

(b) What is the acceleration of the block and the trolley system shown in figure. If the coefficient of kinetic friction between the trolley and the surface is 0.04. What is the tension in the string? Neglect the mass of the string.



33 I. (a) A body tied to one and of string is made to revolve in a vertical circle. Draw diagram and use it to find the expression for

(i) The velocity of the body and

(ii) Tension in the string, at lowest and highest point of the circle.

OR

II. (a)Prove that

(i) In an elastic one-dimensional collision between two bodies, the relative velocity of approach before collision is equal to the relative velocity of separation after collision.

(ii) When two bodies of equal masses suffer one dimensional elastic collision, their velocities get exchanged after the collision.

* * * * * * * * * * * * * * *