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 question 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. The significant figures in each of the given measurements 1.67×10^7 kg and 0.270 cm are:
   (A) 3 and 3 (B) 2 and 3
   (C) 3 and 2 (D) 3 and 4
2. The motion of a particle is described by the u = at, where a is any constant. The distance travelled by the particle in first 4 second is
   (A) 4a (B) 8a (C) 6a (D) 12a
3. If the first one-third of a journey is travelled at 20 km/h, next one-third at 40 km/h and the last one-third 60 km/h, the average speed of the whole journey will be
   (A) 45 km/h (B) 30 km/h
   (C) 32.7 km/h (D) 35 km/h
4. A body moves 6 m North, 8 m east and 10 m vertically upwards, the resultant displacement from its in position is
   (A) 20 m (B) 10 m (C) $10\sqrt{2}$ m (D) $10\sqrt{2}$ m
5. If both the speed and radius of the circular path of a body are doubled, how will its centripetal acceleration change?
   (A) twice (B) 8 times (C) 4 times (D) no change

6. The angle between the two vectors if magnitude of their cross product and dot product are equal is
   (A) 90° (B) 45° (C) 0° (D) 30°
7. Dimensions of impulse are same as that of
   (A) force (B) energy
   (C) momentum (D) acceleration
8. For the given cyclic process CAB as shown for a gas, the work done is
   (A) 30 J (B) 1 J (C) 5 J (D) 10 J
9. $\Delta U + \Delta W = 0$ is valid for
   (A) adiabatic process (B) isothermal process
   (C) isobaric process (D) isochoric process
10. A ballet dancer outstretching her arms and legs. It
    (A) increases his linear velocity
    (B) decreases his angular velocity
    (C) decreases his linear velocity
    (D) increases his angular velocity
11. The ratio between the potential energy and the total energy of a particle executing SHM, when displacement is half of its amplitude is
    (A) 3:4 (B) 4:1 (C) 1:4 (D) 1:1
12. Two waves each of amplitude a and frequency f have a phase difference $\pi/2$. The amplitude and frequency of resultant wave due to their superposition in a medium will be
    (A) $a/\sqrt{2}$, f/2 (B) $a/\sqrt{2}$, f
    (C) 2a, f/2 (D) $\sqrt{2}$a, f

FOR QUESTIONNS FROM 13 TO 16:

Two statements are given-one labelled Assertion (A) and other labelled reason (R). Select the correct answer to these questions from the code (a), (b), (c) and (d) as given below.

(a) Both A and R are true and R is the correct explanation of A.
(b) Both A and R are true and R is not the correct explanation of A.
(c) A is true but R is false.
(d) Both A and R are false.

13. Assertion (A): If a pendulum falls freely, then its time period is infinite.
    Reason (R): Free falling body has acceleration equal to g.
14. Assertion (A): Stress is the internal force per unit area of a body.

Reason (R): Rubber is more elastic than steel.

15. Assertion (A): Good conductors of heat are also good conductors of electricity and vice versa.
    Reason (R): Mainly electrons are responsible for these conductors.
16. Assertion (A): Action of hydraulic lift is based on Pascal's law.
    Reason (R): Pressure is defined as thrust per unit area.

✣ SECTION B

17. What are beats? The beats are not heard if the difference in frequencies of the two sounding notes is more than 10. Why?
18. Does the function $y = Sin^2wt$ represent a periodic or a simple harmonic motion? What is the time period the motion?
19. Railway lines are laid with gaps to allow for expansion. If the gap between steel rails 66 m long be 3.63 cm at 10 °C, then at what temperature will the lines just touch? Coefficient of linear expansion of Steel is $11 \times 10^{-6}\ ^0C^{-1}$
20. State equation of continuity. Write expression of different forms of energy possessed by a flowing liquid per unit volume.
21. Using Newton's law of gravitation, prove Kepler's law of period of planetary motion for circular orbits.
22. What is the coefficient of restitution? What is its significance to explain perfectly elastic and perfectly inelastic collision?
23. Find the dimensions of product of a and b in the relation:
    $P = (b - x^2) / [at]$ where P is power, x is distance and t is time.

✣ SECTION C

24. Obtain an expression for the maximum speed with which a vehicle can safely negotiate a curved road banked at an angle θ. The coefficient of friction between the wheels and the road is μ.

    OR

    Two vectors A and B are inclined to each other at an angle θ. Using parallelogram law of vector addition find analytically the magnitude and direction with vector B of their resultant.
25. In a common observation that rain clouds can be at about a kilometer altitude about the ground.

(a) If a rain drop falls from such a height freely under gravity, what will be its speed?
(b) A typical rain drop is about 4 mm diameter. Estimate its Momentum when it hits ground.
(c) Estimate the time required to flatten the drop.

26. (a) Write the expressions of torque and angular momentum in term of moment of inertia of a rigid body about an axis of rotation.
(b) Prove that the angular momentum of a particle is equal to twice the product of its mass and areal velocity.
(c) A wheel of mass 8 kg and radius of gyration 25 cm is rotating at 300 rpm. What is its moment of inertia?

OR

Show that the total mechanical energy of a body falling freely under gravity is conserved and also represent it graphically.

27. (a) Define modulus of elasticity and its dimensional formula.
(b) Draw stress-strain curves for ductile and brittle materials and give an example of each.

28. (i) State the four postulates of the kinetic theory of gases.
(ii) Show that the average kinetic energy of a gas molecule is directly proportional to the temperature.

✣ SECTION D

29. **VISCOSITY**

Viscosity is the property of a fluid by virtue of which an internal force Of friction comes into play when a fluid is in motion and which opposes the relative motion between its different layers. The backward dragging force, called viscous drag force or viscous force, acts tangentially to the different layer of the fluid in motion and tends to destroy its motion. Viscous force F is directly proportional to (i) the area A of the layers in contact and (ii) the velocity gradient dv/dx between the two layers.

$$F \propto A\, dv/dx \quad \text{or} \quad F = -\eta A\, dv/dx$$

η is called coefficient of viscosity of the liquid. It is defined as the tangential force per unit area of the layer, required to maintain unit velocity gradient. Its CGS unit is poise and SI unit is poiseuille. Thin liquid like water, alcohol, etc. are less viscous than thick liquids, like coal tar, blood, glycerine, etc.

[1] The SI unit of coefficient of viscosity is
(a) Nm/s (b) N/m^2s
(c) Ns/m^2 (d) Nms^2

[2] Viscous force exerted by the liquid flowing between two plates in a streamline flow depends upon
(a) Velocity gradient in the direction perpendicular to its plates
(b) Area of the plates
(c) Coefficient viscosity of the liquid
(d) All of these

[3] The coefficient of viscosity for hot air
(a) Is greater than coefficient of viscosity for cold air
(b) Is smaller than coefficient of viscosity for cold air
(c) Is same as a coefficient of viscosity for cold air
(d) Will increase or decrease depending on the external pressure

[4] The relative velocity of two consecutive layers is 8 cm/s. If the perpendicular distance between the layers n 0.1 cm, then the velocity gradient will be
(a) 0.8 s (b) 80 s (c) 8 s (d) 0.08 s

OR

[5] A Square Plate of 0.1 m side moves parallel to a second plate with a velocity of 0.1 m/s, both plates being immersed in water. If the viscous force is 0.002 N and the coefficient of viscosity is 0.01 poise, the distance between the plates is
(a) 0.1 m (b) 0.0005 m (c) 0.005 m (d) 0.05 m

30. CONSERVATION OF LINEAR MOMENTUM:

Consider an isolated system of n interacting particles. The mutual forces between pairs of particles in the system cause changes in the moments 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 momentum for any pair of particles are F.dt and - F.dt. Thus the momentum changes cancel in pairs and total momentum of the system remains constant. This law lends 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 the basis of momentum conservation.

[1] A gun fires a bullet of mass 50 g with a velocity of 30 m/s. Because of this, the gun is pushed back with a velocity of 1 m/s. The mass of the gun is

(a) 5.5 kg (b) 3.5 kg
(c) 1.5 kg (d) 0.5 kg

[2] A body of mass m moving with velocity V explodes into 2 equal parts. If one comes to rest and other part moves with a velocity v, what would be the value of v?

(a) V (b) V/2
(c) 4V (d) 2V

[3] 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) 0.25 m/s (b) 25 m/s
(c) 0.5 m/s (d) 5 m/s

[4] A bullet is fired from a rifle, if the rifle recoils freely, then the kinetic energy of the rifle is

(a) more than that of the bullet
(b) less than that of the bullet
(c) same as that of the bullet
(d) equal to or less than that of the bullet

OR

[5] A boy of mass m plan stands on one end of a wooden plank of length L and mass M. The plank is floating on water. Is a boy walks from one end of the Planck to the other end at a constant speed, the resulting displacement of the plank is given by

(a) mL/M (b) mL/(M+m)
(c) ML/m (d) mL/(M-m)

✣ SECTION E

31. (a) Define projectile. A projectile is fired with a velocity u making an angle θ with the horizontal. Draw a labelled diagram related to it.
(b) Show mathematically that its trajectory is parabolic in nature.
(c) Derive expressions for its (i) time of flight, (ii) maximum height.

OR

(i) Mention the four limitations of the method of dimensional analysis.

(ii) A planet moves around the sun in nearly circular orbit. Its period of revolution T depends upon radius of orbit, mass M of the sun and the gravitational constant G. Show dimensionally that $T^2 \alpha r^3$.

32. (a) Define escape velocity. Derive an expression for the escape velocity of an object in term of g from the surface of the earth.

(b) Find the percentage decrease in the weight of a body when taken to a height of 32 km above the surface of the earth. Radius of earth is 6400 km.

OR

(i) Define centre of mass of a system.

(ii) Where does the centre of mass of uniform triangular lamina lie?

(iii) If two particles of masses m_1 and m_2 move with velocities v_1 and v_2 towards each other on a smooth horizontal table, what is the velocity of their centre of mass?

(iv) Three masses 3, 4 and 5 kg are located at the corners of an equilateral triangle of sides 1m lies in XY plane whose one vertex is origin and another lie on X axis at which 3 kg and 4 kg masses are located respectively. Find the coordinate of the Centre of mass of it.

33. A harmonic wave on a string is described by $y(x,t)=0.1 \sin (300t - 0.01x + \pi/3)$ mm, where x is in cm and t is in seconds.

[1] Calculate the time period of the harmonic wave.

[2] Find the wavelength of the harmonic wave.

[3] Calculate value of wave velocity.

[4] Calculate the amplitude of particle velocity of a medium particle.

[5] Calculate the phase at a particular location changes in 0.01 s.

OR

(a) In SHM of a particle, draw graphs showing variation in
(i) displacement (ii) velocity and
(iii) acceleration with the time. Hence discuss the phase relationship between them using proper equations.

(b) Draw a diagram and show that for simple oscillations the motion of a simple pendulum is simple harmonic.

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