PLUS ONE HSE MODEL EXAMINATION AUG 2021/
PHYSICS

Max. marks : 60

Duration : 2 hr

I Answer any SIX questions from 1 to 10 (6 × 1 = 6)

1. Which one of the following is the weakest force in nature?

   (strong nuclear force, weak nuclear force, electromagnetic force, gravitational force).

2. Study of light and its properties is termed as ____.

3. Find the odd one from the following.
   (length, temperature, electric current, electric charge)

4. For ____ motion, average velocity and instantaneous velocity are equal.

5. Pick out the vector quantity from the following.
   (speed, mass, momentum, pressure).

6. Static friction is always greater than kinetic friction. (True/False)

7. On the surface of the earth, acceleration due to gravity is ____ (minimum/maximum)

8. 98°F = ____ kelvin (36.7, 40, 309.8, 371)

9. Heat engine is a device which is used to convert heat energy into ____ energy.

10. Rotational analogue of force is ____.

II Answer any <u>SEVEN</u> questions from 11 to 23. (7×2=14)

11. Write down any two postulates of kinetic theory of gases.

12. A transverse harmonic wave in a string is described as $y(x,t) = 3.0 \sin(36t + 0.018x + \frac{\pi}{4})$ where x and y are in cm and t is in second.

    a) Is this wave a travelling wave or a stationary wave (1)

    b) what are the values of amplitude and wavelength (1)

13. Two parallel rail tracks run north-south. Train A moves north with a speed of **15 m/s** and train B moves south with a speed of **25 m/s**.

    a) what is the velocity of B wrto A (1)

    b) what is the velocity of ground wrto B (1)

14. Acceleration due to gravity changes with altitude and depth from the surface.

    a) Write down the equations for the variation of acceleration due to gravity at a height and depth in terms of the mass of the earth (1)

    b) Draw the variation of acceleration due to gravity with distance from the centre of the earth (1)

15. Derive the mathematical expression for the time period of oscillation of a simple pendulum

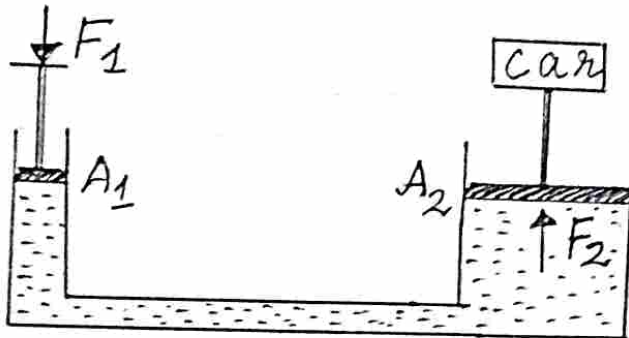16. Using the principle of homogeneity of dimensions, check whether the equation is correct

$$T = 2\pi \sqrt{g/l}$$

(T - time, g - acceleration, l - length)

17. Ballet dancers bring their hands close to their body to rotate faster.

    a) Name the principle employed by them   (1)

    b) Write down the relation between linear momentum and angular momentum   (1)

18. A tank of 5m height is filled with water. Calculate the velocity of efflux through a hole 2m above the bottom surface.

19. a) Write down the expression for SHM   (1)

    b) For a SHM, time period, T = 2 second. If the displacement from the mean position is 10 cm, calculate the instantaneous acceleration. (1)

20. a) Average ~~velocity~~ kinetic energy of a molecule is proportional to ___ of the gas   (1)

    b) Write down the expression for the pressure of an ideal gas   (1)

21. In a car lift, compressed air exerts a force F_1 on a small piston having

radius 5 cm. This pressure is transmitted to a second piston of radius 15 cm. If the mass of the car to be lifted is 1350 kg, calculate F_1.

22. A progressive wave is represented by the equation,

$$y(x, t) = A \sin(\omega t + kx + \phi)$$

a) The direction of propagation is ___ ? (1)
b) Write down the equation for the speed of transverse wave on a stretched string (1)

23. Newton's law of gravitation explains the force between all particles in the universe.
a) The force of attraction due to a hollow spherical shell of uniform density on a point mass situated inside it is ___ (1)
b) A point mass is situated at a depth 20 km below the surface of the earth. At what height, it experience the same acceleration due to gravity at a height above the surface (1)
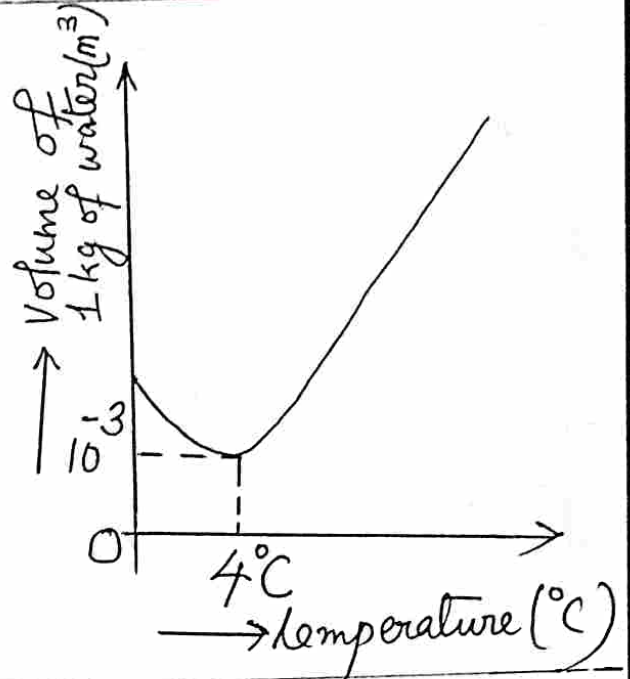
III Answer any **six** questions from 24 to 35 $(6 \times 3 = 18)$

24. Moment of inertia is the rotational analogue of mass in linear dynamics.

a) State and explain parallel axis theorem of moment of inertia (2)

b) Moment of inertia of a disc about its diameter is $\frac{MR^2}{4}$. Obtain an expression for the MI of the disc about its tangent (1)

25. Obtain an expression for the angular velocity in circular motion (3)

26. a) Dimension of gravitational constant is ____ . (1)

b) A physical quantity is given by $h = \frac{Fv^2}{L}$ where F is the force, v is the velocity and L is the angular momentum. Find the dimension of h (2)

27. Bernoulli's theorem is in accordance with the law of conservation of energy. State and prove Bernoulli's theorem for the streamline flow of an incompressible fluid (3)

28. Earth satellites are objects which revolves around the earth.

a) Time period of a geostationary satellite is ____ (1)

b) Derive the expression for the orbital velocity of a satellite (2)

29. Graph below exhibits the anomalous expansion of water Based on the graph explain how lakes freeze from the top to the bottom rather than from bottom to top

30. Energy of a body is defined as its capacity to do work.

a) The energy possessed by a body by virtue of its motion is known as ⎯⎯ (1)

b) A body of mass 5kg initially at rest is subjected to a horizontal force of 20N. What is the kinetic energy acquired by the body at the end of 10 second (2)

31 A large force acting for a short interval of time is called impulsive force.
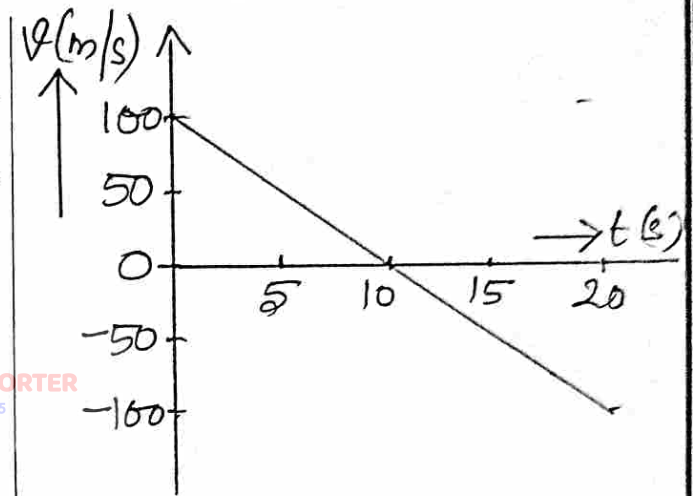
a) what is the SI unit of impulse (1)

b) Two billiard balls each of mass 0.05 kg moving in opposite direction with a speed of 6m/s collide and rebounce with the same speed. What is the impulse imparted to each other. (2)

32. Velocity-time graph of a ball thrown vertically upwards with an initial velocity is shown in the figure.

a) What is the magnitude of the initial velocity of the ball (1)

b) Calculate the distance travelled by the ball in 10 second (1)

c) Calculate the acceleration of the ball from the graph (1)

33. a) A man throws a stone up into air at an angle θ with the horizontal. What is the angle between velocity and acceleration at the highest position (1)

b) At what angle of projection, the maximum height equals the range of the projectile (2)

34. A gun moves backward when a shot is fired from it.

   a) Choose the correct statement.   (1)

     i) Speed of the gun and the bullet are equal.

     ii) Momenta of the bullet and the gun are equal in magnitude and opposite in direction

     iii) Momenta of the of the bullet and the gun are equal in magnitude and in the same direction

     iv) Velocity of the bullet and the gun are equal.
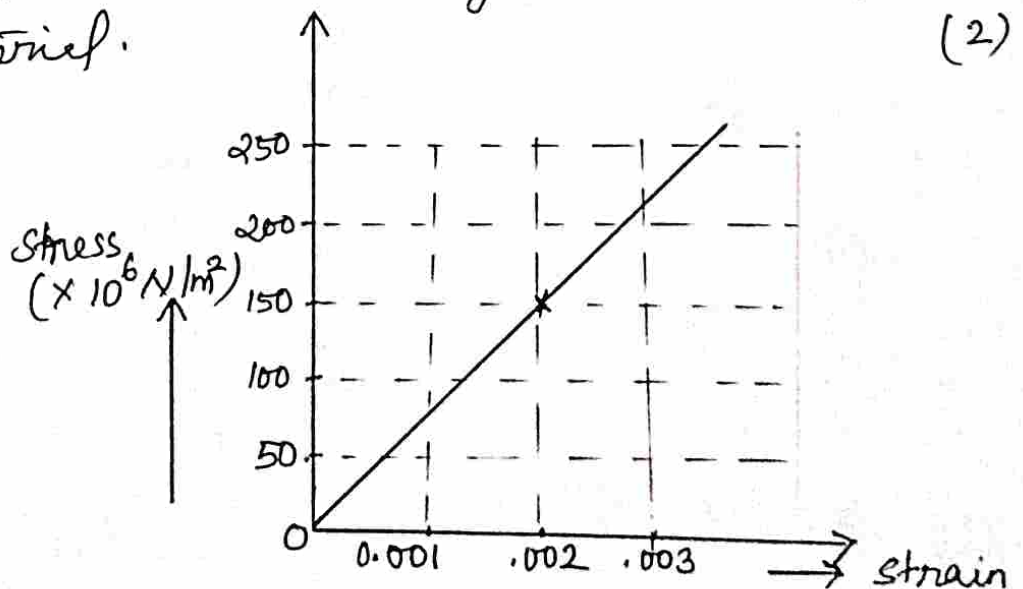
   b) By using suitable conservation law in physics, prove your answer   (2)

35. a) Derive the mathematical relation between angular momentum and torque   (2)

   b) State the law of conservation of angular momentum (1)

IV Answer any THREE questions from 36 to 42 (3×4=12)

36 a) Figure shows the stress-strain curve for a material. What is the Young's modulus of the material.   (2)

36 b) Young's modulus of aluminium is $70 \times 10^9 \, N/m^2$ and that of copper is $120 \times 10^9 \, N/m^2$. Same strain is to be produced on both wire of equal cross-section. Which wire require more force (1)

c) Reciprocal of bulk modulus is called ——— (1)

37 Acceleration due to gravity may vary with altitude and depth.

a) Write down the expression for the acceleration due to gravity on the surface of the earth (1)

b) Arrive at an expression for the acceleration due to gravity at a height h $(h << R_E)$ (2)

c) Acceleration due to gravity is independent of ———. (mass of earth / mass of body). (1)

38. We cannot add velocity with temperature of a body.

a) Name the principle behind this (1)

b) Check the correctness of the equations (3)

　　(i) $S = ut + \frac{1}{2} at^2$

　　(ii) $KE = \frac{2}{3} m v^2$

39. When a horse suddenly starts moving, the rider falls backward.

a) Name and state the law used to explain the above situation (2)

b) Using the second law of motion, prove the law of conservation of linear momentum (2)

40. a) State and prove work - energy theorem for a constant force. (2)

b) Show that the potential energy of a body is completely converted to KE under free fall. (2)

41. a) Obtain the expression for the total KE of a body rolling without slipping on the surface of the sphere. (3)

b) Velocity acquired by a sphere rolling down through an inclined plane is

i) $\sqrt{\dfrac{4gh}{3}}$ ii) $\sqrt{gh}$ iii) $\sqrt{\dfrac{10gh}{7}}$ iv) $\sqrt{\dfrac{5gh}{4}}$ (1)

42. First law of thermodynamics obeys the law of conservation of energy.

a) Write down the equation that explains first law of thermodynamics (1)

b) Obtain the expression of work done during an isothermal process (2)

c) Work done in an isochoric process is _____. (1)
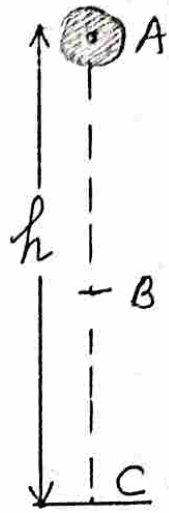
V Answer any two questions from 43 to 46. (2×5=10)

43. The figure shows a body of mass 'm' placed at a height 'h'. A, B, C are the points on the trajectory of this body on freely falling.

43. a) Which type of energy is possessed by the body at the point A (1)

   b) Show that the total mechanical energy is conserved at points A, B & C. (2)

   c) A body of mass 5kg is thrown vertically up with a kinetic energy of 490 J. Find the height at which the kinetic energy of the body becomes half of the original value (2)

44. When a body is projected into air with an initial velocity making an angle with the horizontal, it is executing projectile motion.

   a) What are the vertical and horizontal components of velocity. (1)

   b) With a diagram derive the expressions for
      i) maximum height (2)
      ii) time of flight (2)

45. An object is released from a point near the surface of the earth, it is said to be in free fall (neglect air resistance).
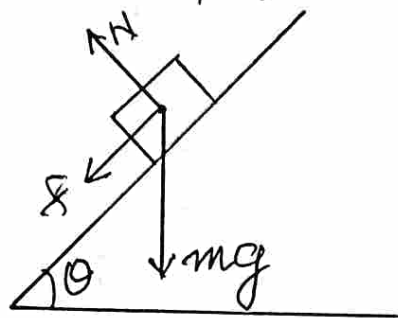
   a) Free fall is an example of ___ accelerated motion. (1)

   (uniformly / nonuniformly)

45 b) Draw the velocity-time graph for the above type of motion   (1)

c) Using the above graph, obtain the expression for the displacement of the particle in a time 't'.   (3)

46. The schematic diagram for the circular motion of a car on a banked road is shown in the figure.

a) Redraw the diagram showing horizontal and vertical components of normal reaction N and frictional force f and arrive at an expression for the maximum safe speed   (4)

b) The optimum speed of a car on a circular level road is given by ———

(i) $\sqrt{\mu rg \tan\theta}$ (ii) $\sqrt{1 + \mu rg}$

(iii) $\sqrt{\mu rg}$ (iv) $\sqrt{\dfrac{\mu}{rg \tan\theta}}$ (1)

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