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INDIAN SCHOOL SALALAH

FIRST TERM EXAMINATION - SEPTEMBER 2025

PHYSICS (042)

Class: XI **Date: 22/09/2025**

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

General Instructions:

a. There are 33 questions in all. All questions are compulsory.

b. This question paper has five sections: Section A, Section B, Section C, Section D and Section E.

c. All the sections are compulsory.

d. 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.

e. There is no overall choice. However, an internal choice has been provided in two questions in Section B, one question in Section C and all three questions in Section E. You must attempt only one of the choices in such questions.

f. Use of calculators is not allowed.

SECTION A

1 Which of the following units is not a part of the SI system? **1**

(A) km/h (B) candela (C) newton (D) $joule/m$

2 Pick out the only vector quantity in the following list: **1**

(A) coefficient of friction (B) pressure (C) impulse (D) gravitational potential

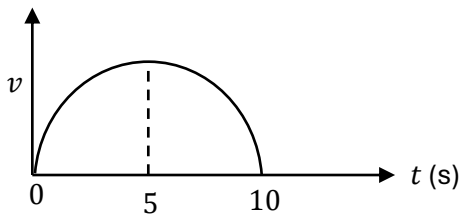
3 A body starts from origin with a velocity $10\ ms^{-1}$ and acceleration $-4\ ms^{-2}$. Its average velocity during 3^{rd} second is: **1**

(A) 0 m/s (B) 2 m/s (C) $-$ 2 m/s (D) 4 m/s

4 Given that, $\vec{C} = \vec{A} + \vec{B}$. If $|\vec{A}| = 8$, $|\vec{B}| = 6$ and angle between $\vec{A}$ and $\vec{B}$ is 30^0, then magnitude of component of $\vec{C}$ perpendicular to $\vec{A}$ is: **1**

(A) 3 (B) 4 (C) $3\sqrt{3}$ (D) $4\sqrt{3}$

5 Choose the correct statement based on the following $v - t$ graph of an object in one dimensional motion. **1**



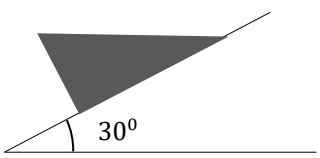
(A) Motion of the object is uniformly accelerated motion.

(B) Average acceleration from 0 to 5 s = Average acceleration from 5 to 10 s.

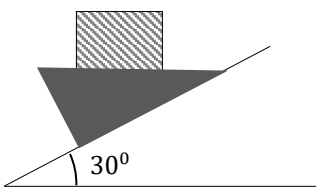
(C) Magnitude of average velocity is equal to average speed.

(D) Object returns to its initial position at 10 s.

6 A block of mass m is placed on a rough incline (Fig. 1). It is just about to slide down when the angle of inclination is increased slightly. If another block is gently placed on it (Fig. 2), then: **1**



$Fig - 1$



$Fig - 2$

(A) The system will slide down with uniform acceleration.

(B) The system will slide down with increasing acceleration.

(C) The system will slide down with uniform velocity.

(D) The system will remain at rest.

7 Force acting on an object varies with distance as $\vec{F} = 5 \sin \pi x \, \hat{\imath}$ N. What is the work done by this force when object is displaced through a distance 2 m along x axis. **1**

(A) $0\ J$ (B) $12.5\ J$ (C) $-12.5\ J$ (D) $24\ J$

8 A passenger in a bus falls forward when the bus suddenly stops. This happens because: **1**

(A) The passenger's mass decreases suddenly.

(B) The passenger tends to resist the change in motion due to inertia.

(C) The bus exerts a forward force on the passenger.

(D) Gravity pulls the passenger forward.

9 Kinetic energy of a body of mass 2 g moving with velocity 100 m/s is: **1**

(A) $0.01\ J$ (B) $0.1\ J$ (C) $10\ J$ (D) $10000\ J$

10 A football (mass = 400 g) and a glass ball (mass = 400 g) are dropped from the same height onto a concrete floor. The football bounces back to its initial position while the glass ball shatters instantly. Which statement is correct? **1**

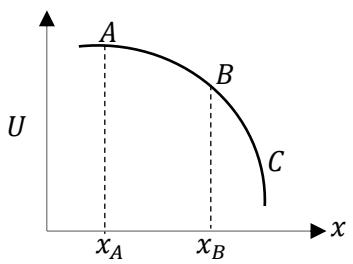
(A) Both balls exert equal force on the floor.

(B) Football experiences greater force from the concrete floor and bounces

(C) Both balls experience suffers equal change in momentum.

(D) Football suffers greater change in momentum.

11 Potential energy of an object varies with displacement along x axis is shown below. Choose the correct interpretation. **1**



(A) Magnitude of conservative force is greatest at A.

(B) Work done by conservative force from x_A to x_B is positive.

(C) There is one component of conservative force along negative x axis.

(D) Work done by the conservative force is zero.

12 The change in gravitational potential energy of an object of mass 5 kg when it is lifted to a height of 10 m from the ground is: [Take g = 10 m/s^2] **1**

(A) -5 J (B) 5 J (C) -500 J (D) 500 J

For Questions 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 options given below.

(A) Both Assertion and Reason are true, and Reason is the correct explanation of Assertion.

(B) Both Assertion and Reason are true, but Reason is not the correct explanation of Assertion.

(C) Assertion is true, but Reason is false.

(D) Both Assertion and Reason are false.

13 **Assertion (A):** The magnitude of the sum of two vectors can never be equal to the magnitude of their difference. **1**

Reason (R): Multiplying a vector by a scalar cannot produce a vector in the opposite direction of the given vector.

14 **Assertion (A):** In any interaction between two objects, the component of velocity perpendicular to the line of impact remains unaffected. **1**

Reason (R): According to Newton's second law, change in momentum takes place in the direction of motion of the object.

15 **Assertion (A):** If three forces acting on a particle are concurrent and in equilibrium, then particle will definitely remain at rest. **1**

Reason (R): The vector sum of all concurrent forces acting on any particle is always zero.

16 **Assertion (A):** Total momentum of the system is conserved during the collision whereas kinetic energy of the system is not conserved during a perfectly elastic collision. **1**

Reason (R): Total mechanical energy is not conserved during a perfectly elastic collision.

SECTION B

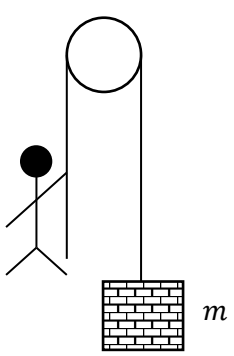
17 Two paper screens A and B are separated by a distance of 100 m. A bullet pierces A and then B. The hole in B is 10 cm below the hole in A. If the bullet is travelling horizontally at the time hitting the screen A, calculate the velocity of the bullet when it hits the screen A. Neglect the resistance of paper and air. [Take $g = 9.8\ m/s^2$] **2**

18 Explain why **2**

(a) A horse cannot pull a cart and run in empty space.

(b) It is easier to pull a lawn mower than to push it.

19 An inextensible, massless string passes over a smooth, frictionless pulley as shown in the figure. One end of the string is attached to a block of mass m , and the other end is free for a man of mass $70\ kg$ to climb on. Find the minimum value of the block's mass m so that the block remains at rest in the following cases: **2**



(a) upwards with a uniform speed of $10\ m\ s^{-1}$.

(b) downwards with a uniform acceleration of $5\ m\ s^{-2}$.

(c) upwards with a uniform acceleration of $5\ m\ s^{-2}$.

(d) downwards freely under gravity.

20(I) (a) Write dimensional formula of force. **2**

(b) If the unit of force is 100 N, unit of length is 10 m and unit of time is 100 s, what is the unit of mass in this system of units?

OR

20(II) Number of particles n crossing a unit area perpendicular to x – axis in unit time is given by the equation $n = -D\left(\frac{n_2-n_1}{x_2-x_1}\right)$, where n_1 and n_2 are the number of particles per unit volume for the values of x meant to be x_1 and x_2. What is the dimensional formula of diffusion constant D? **2**

21(I) A particle moves in a circular orbit of radius r under the action of a central conservative force given by $F_{(r)} = -k/r^2$, where k is a positive constant. If this force is responsible for providing the necessary centripetal force to the particle, determine the total mechanical energy of the particle in this orbit. **2**

OR

21(II) State and prove conservation of mechanical energy. **2**

SECTION C

22 The escape velocity v of a body from the surface of a planet is assumed to depend on (a) the mass of the planet M, (b) the radius of the planet R, and (c) the universal gravitational constant G. Using the method of dimensions, obtain an expression for escape velocity in terms of M, R, and G. **3**

23 Two objects, A and B, are projected vertically upwards simultaneously from the same point with initial speeds u_1 and u_2 , respectively. It is observed that object B continues to move upwards for 2 seconds longer than object A after the instant when the speed of A becomes zero during its upward motion. If the maximum vertical distance between the two objects during their motion is $120\,m$, calculate their initial speeds. Take $g = 10\,m/s^2$. **3**

24 Obtain (i) velocity – time relation and (ii) position – time relation of motion for constant acceleration using method of calculus. **3**

25 Find the magnitude and direction of the resultant of two vectors A and B in terms of their magnitudes and angle θ between them. **3**

26 A projectile is fired at an angle with horizontal. Show that its trajectory is a parabola. Also obtain expression for time of flight. **3**

27(I) (a) What do you mean by perfectly elastic collision? **3**

(b) Show that in a glancing collision between two identical smooth spheres (or bodies), where one body is initially at rest, the two bodies move at right angles (perpendicular) to each other after the collision.

OR

27(II) (a) What do you mean by perfectly inelastic collision? **3**

(b) Show that in a perfectly inelastic collision of two identical bodies, system loses its kinetic energy.

28 An object of mass m is projected from ground level with initial speed u at an angle of 60^0 to the horizontal such that it can lands back on the ground at a horizontal range of $50\ m$. But at the highest point of its trajectory the object explodes into three equal fragments. Two of these fragments fly off instantly with speeds $\frac{3u}{2}$, one in the upward direction and the other in the downward direction; both make an angle of 60^0 with the horizontal and lie in the same vertical plane as the original motion. **3**

(a) Find the momentum (vector) of the third fragment immediately after the explosion.

(b) Where (horizontal distance from the launch point) does the third fragment land on the ground?

SECTION D

29 Uniformly Accelerated Motion happens when a body moves in a straight line with the same acceleration all the time. In this motion, the velocity increases regularly with time, and the displacement increases much faster - it depends on the square of time (and on the square of velocity). Because of this, the displacement–time graph is a curve, and the position–velocity graph is also not a straight line.

A thief escapes in a car from a check-post at the origin. Starting from rest, the car moves along a straight road with uniform acceleration $a = 10\ m/s^2$.

After some time, when the car has already gained speed, a gun mounted in the car fires a bullet backwards (toward the origin). The muzzle speed of the gun - defined as the speed with which a bullet emerges when the gun is at rest - is $200\ m/s$. The bullet eventually hits a fixed target at the origin.

It is observed that the time taken by the bullet to hit the target equals half of the time the car took (from $t = 0$) to reach the position from where the bullet was fired.

Answer the following:

I The time taken by thief's car to reach the firing point is: **1**

(A) $5.3\ s$ (B) $10\ s$ (C) $15.6\ s$ (D) $20\ s$

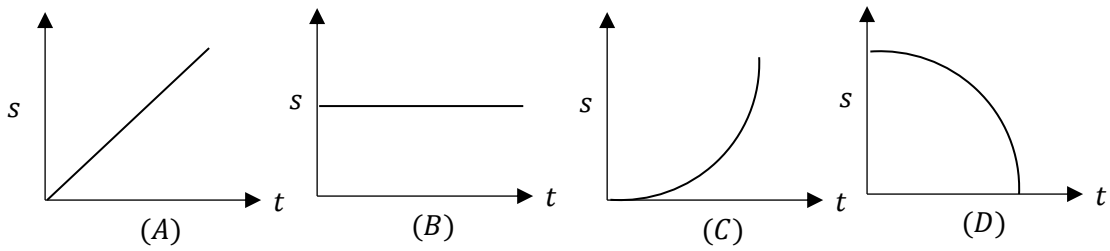
II The distance of the firing point from the origin is: **1**

(A) $140.5\ m$ (B) $2000\ m$ (C) $500\ m$ (D) $1217\ m$

III Speed gained by the thief's car when bullet was fired. **1**

(A) $200\ m/s$ (B) $156\ m/s$ (C) $53\ m/s$ (D) $100\ m/s$

IV The correct $d-t$ graph that describes motion of the thief's car is: **1**



30 A student wants to determine the density of a small solid metallic sphere in the laboratory. He first measures the radius of the sphere using a vernier calliper. The observed value is 2.35 cm, and the least count of the vernier calliper is 0.01 cm.

He then measures the mass of the sphere using a digital balance. The measured value is 48.2 g, with the least count of 0.1 g.

To calculate the density, he uses the formula: $\rho = \frac{m}{V}, V = \frac{4}{3}\pi r^3$

He is instructed to:

- express the result with correct significant digits,
- determine its order of magnitude, and
- calculate the percentage error considering errors in both radius and mass.

I Calculate the density of the metallic sphere (in g/cm^3), expressing the answer with the correct number of significant digits. Also state the order of magnitude of the result. **2**

II Calculate the maximum percentage error in the density of the sphere using error propagation. **1**

III State one rule he must have used to answer the above two questions in each of the following cases: **1**

(a) Rounding off numbers

(b) Counting significant digits

SECTION E

31(I) In each of the following diagrams, the black dots (●) represent the successive positions of a moving object at equal time intervals. The motion takes place in the XY plane. **5**

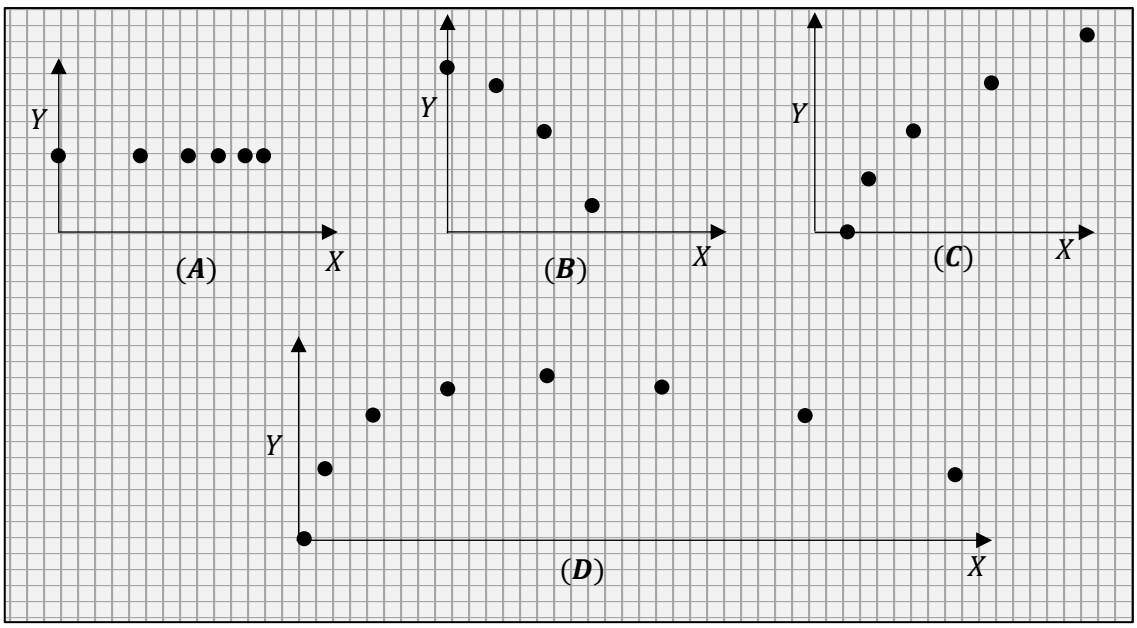
Match each diagram (A–D) with the corresponding equation of motion(most suitable) given below and justify your selection with proper reasoning. Further, describe the

direction and nature of motion represented by the equation that does not correspond to any of these four diagrams.

(a) $\vec{r} = (a - bt)\hat{\imath} + c\,\hat{\jmath}$, (b) $\vec{r} = (at - bt^2)\,\hat{\imath} + c\,\hat{\jmath}$

(c) $\vec{r} = (at + bt^2)\,\hat{\imath} + (ct - bt^2)\hat{\jmath}$, (d) $\vec{r} = at\,\hat{\imath} + (b - ct^2)\,\hat{\jmath}$

(e) $\vec{r} = (a + bt^2)\,\hat{\imath} + ct\,\hat{\jmath}$



OR

31(II) (a) Derive an expression for the acceleration of a body of mass m moving with a uniform speed v in a circular path of radius r. **5**

(b) An insect trapped in a circular groove of radius 12 cm moves along the groove steadily and completes 7 revolutions in 100 s. What is the (i) angular speed of the motion, (ii) the linear speed of the motion (iii) Is the acceleration vector a constant vector? What is its magnitude?

32(I) (a) What is meant by banking of roads? What is the need for banking of roads? **5**

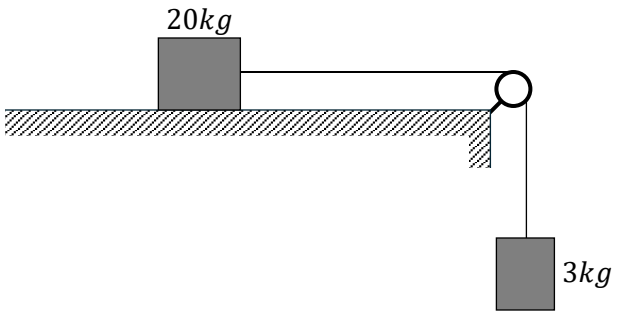
(b) With the help of neat vector diagram, obtain an expression for the maximum speed, which a vehicle can safely negotiate a curved road banked at an angle θ.

(c) Keeping the banking angle same, the maximum safe speed with which a vehicle can travel on a curved road is to be increased by 10%. What should be the new radius of curvature if its initial value is 20 m?

OR

32(II) (a) Define the terms (i) angle of friction and (ii) angle of repose. Obtain the relation between these two angles with the help of neat diagrams. **5**

(b) What is the acceleration of the block and trolley system shown in the figure, if the coefficient of kinetic friction between the trolley and the surface is 0.04? What is the tension in the string? (Take $g = 10\ m\ s^{-2}$). Neglect the mass of the string.



33(I) (a) An elastic spring of spring constant k is compressed by an amount x. Obtain an expression for potential energy stored in it. **5**

(b) Plot the following graphs (i) spring force versus elongation, (ii) Variation of total energy, kinetic energy and potential energy with elongation.

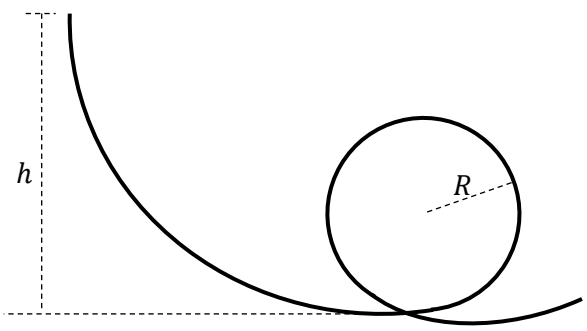
(c) To simulate car accidents, automobile manufacturers study the collisions of moving cars with horizontally mounted springs of different spring constants. In one such simulation, a car of mass $1000\,kg$ is moving at a speed of $18\,km/h$ on a rough horizontal road and collides with a spring of spring constant 6.25 x 10^3 N/m. Calculate the maximum compression of the spring. Take coefficient of friction between the tyres and the road is $\mu = 0.5$.

OR

33(II) (a) A small block of mass m is released from rest at a height h above the lowest point of a smooth vertical circular track of radius R. **5**

(i) Derive the condition on h for the block to just complete the vertical loop.

(j) Hence find the minimum value of h in terms of R.



(b) A pump on the ground floor of a building can pump up water to fill a tank of volume $30\ m^3$ in 15 min. If the tank is 40 m above the ground, and the efficiency of the pump is 30%, how much electric power is consumed by the pump?

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