DIRECTORATE OF EDUCATION, GNCT OF DELHI

MID-TERM

CLASS: XI SUBJECT: PHYSICS (042)

PRACTICE PAPER

(SESSION: 2026-27)

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

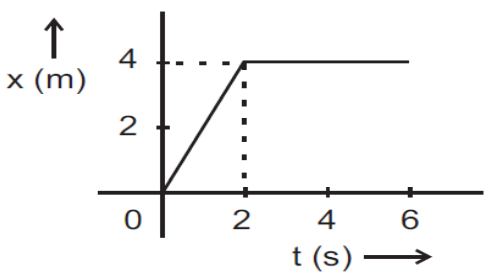
General Instructions

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, two question 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.

   You may use the following values of physical constants and mathematical formulae wherever necessary.

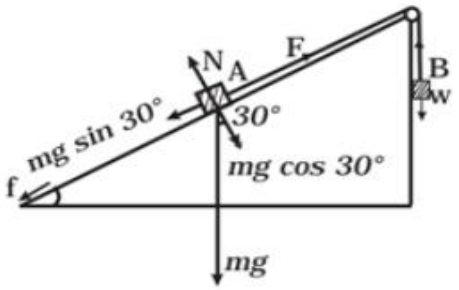
- Acceleration due to gravity g=9.8m/s^2
- Universal Gravitational constant G=6.67x10^{-11} Nm^2/Kg^2
- Mass of the Earth M=5.98 x 10^{24} kg
- Density of the Earth $\rho = 5478.4\ kg\ m^{-3}$
- Radius of the Earth R=6400 km
- $If\ Y = x^n$ then $\frac{dy}{dx} = nx^{n-1}$, $\frac{d}{dx}(constant) = 0$
- $\int x^n dx = \frac{x^{n+1}}{n+1}$, $\int dx$=x
- $\int_a^b x^n = nb^{n-1} - na^{n-1}$
- Binomial expansion with neglecting higher order term

  $(1+x)^n=(1+nx)$

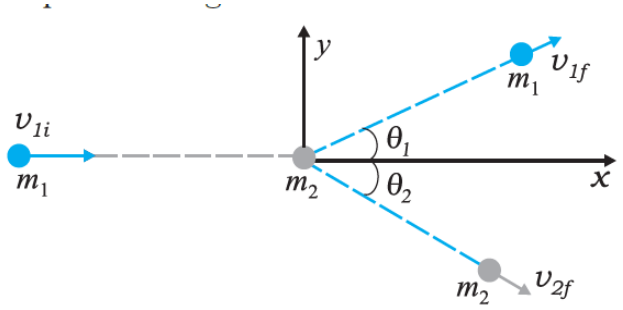
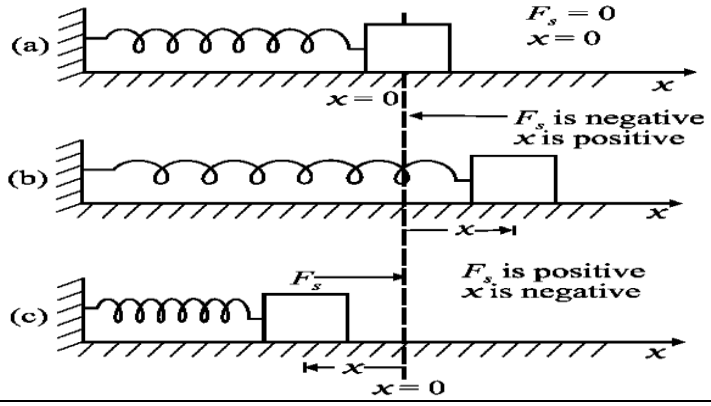
Q.N.	SECTION (A)	MARKS
1.	If $x = a + bt + ct^2$, where x is position, t is time and a, b, c are constant. The unit of c represent: (A) Velocity (B) Acceleration (C) displacement (D) Momentum	1
2.	A vernier calipers has 1mm marks on main scale. It has 20 divisions on the vernier scale which matches with 16 main scale division. The least count of this vernier calipers is: (A) 0.2 mm (B) 0.2cm (C) 0.02 mm (D) 0.002 cm	1
3.	Two balls are dropped to the ground from different heights. One ball is dropped 2s after the other but they both strike the ground at the same time. If the first ball takes 5s to reach the ground, then the difference in initial heights is (g = 10 ms^{-2}): (A) 20 m (B) 80 m (C) 170 m (D) 40 m	1
4.	A train starting from rest accelerates uniformly to a speed of 20 m/s in 10 seconds. What is the distance covered by the train during this time? (A) 50 m (B) 100 m (C) 200 m (D) 20 m	1
5.	A particle moves in x-y plane under the action of force $\vec{F}$ such that the value of its linear momentum ($\vec{p}$) at any instant **t** is $p_x = 2$ cos t and $p_y = 2$ sin t. The angle Θ between $\vec{F}$ and $\vec{p}$ at a given time **t** will be: (A) 0^0 (B)30^0 (C) 90^0 (D)180^0	1
6.	In the figure given, the position-time graph of a particle of mass 0.1 kg is shown the impulse at t = 2s (A) −0.4 kg m/s (B) 0.1 kg m/s (C) 0.2 kg m/s (D) −0.2 kg m/s 	1

	For V.I. Students Dimensions of Impulse is same as: (A) Force (B) Angular momentum (C) linear momentum (D) Kinetic energy	
7.	A body of mass 2 kg travels according to the given equation $x = at + bt^2 + ct^3$ .Where a=3m/s, b=4 m/s^2 and c=5m/s^3. The force acting on the body at t=2s is: (A) 68 N (B) 134 N (C) 136N (D) 158N	1
8.	A block of mass 0.5 kg is moving with a speed of 2m/s on a smooth surface. It strikes another mass of 1 kg and then they move together as a single body. The energy loss during the collision is: (A) 0.16J (B) 1.00 J (C) 0.34J (D) 0.67 J	1
9.	How much water a pump of 2 Kilowatt can raise in 60 seconds to a height of 10m? (g = 10 ms^{-2})? (A) 1200 litres (B) 120 litres (C) 1000 litres (D) 10 litres	1
10.	A bullet of mass m moving with a speed *v* strikes a wooden block of mass M & gets embedded into the block. The final speed is: (A) $\sqrt{\frac{M}{M+m}}V$ (B) $\sqrt{\frac{m}{M+m}}V$ (C) $\frac{m}{M+m}V$ (D) V/2	1
11.	When a disc rotates with uniform angular velocity, which of the following is correct? (A) The sense of rotation remains the same (B) The orientation of the axis of the rotation remains the same (C) The speed of rotation is non-zero & remains the same (D) The angular acceleration is non-zero & remains the same.	1

12.	If both the mass and radius of the earth, each decreased by 50%, the acceleration due to gravity would: (A) remains same (B) decreases by 50% (C) decreases by 100% (D) increases by 100%	1
	NOTE: The following questions from 13 to 16 consists of two statements each, labelled as Assertion (A) and the other labelled as Reason (R). While answering these questions, you are required to choose any of the following from options (a), (b), (c) & (d). **(a) If both A & R are true and R is the correct explanation of A.** **(b) If both A & R are true but R is not the correct explanation of A.** **(c) If A is true but R is false.** **(d) If A is false and R is also false.**	
13.	**Assertion:** The number 0.002308 m has four significant figures. **Reason:** Zeros to the right of the decimal point but to the left of the first non-zero digit are not significant.	1
14.	**Assertion (A):** A body cannot have energy without possessing momentum but it can have momentum without having energy. **Reason (R):** Momentum and energy have same dimensions.	1
15.	**Assertion (A):** In rolling, all points of a rigid body have the same linear velocity. **Reason (R):** The rotational motion does not affect the linear velocity.	1
16.	**Assertion (A):** The difference in the value of acceleration due to gravity at pole and equator is proportional to square of angular velocity of earth. **Reason (R):** The value of acceleration due to gravity is minimum at the equator and minimum at the pole.	1
	SECTION (B)	5x2=10
17.	A boy stands on the edge of a cleft 500 m above the ground and throws a stone horizontally with an initial speed of 15 m/s. Neglecting air resistance, find the time taken by the stone to reach the ground and the speed with which it hits the ground. (g = 10 ms^{-2}).	2

18.	(a) The position of an object moving along x-axis is given by $x = \alpha + \beta t^2$ where $\alpha = 8.5$ m, $\beta = 2.5$ m s^{-2} and t is measured in seconds. (i) What is its initial velocity. (ii)What is the average velocity between t = 2.0 s and t = 4.0 s? **OR** (b) A man at rest observes the rain falling vertically. When he walks at 4 km/h, he has to hold his umbrella at an angle of 53° from the vertical. Find the velocity of raindrops.	2
19.	If the net force acting upon the particle is zero, show that its linear momentum remains constant. Give an example where momentum remain constant.	2
20.	Block A of weight 100 N rests on a frictionless inclined plane of slope angle 30° (Fig.). A flexible cord attached to A passes over a frictionless pulley and is connected to block B of weight W. Find the weight W for which the system is in equilibrium.  **For V.I. Students** A force of 100 N gives a mass m_1, an acceleration of 10 ms^{-2} and of 20 ms^{-2} to a mass m_2. What acceleration must be given to it if both the masses are tied together?	2
21.	A bob is pulled sideway so that string becomes parallel to horizontal and released. Length of the pendulum is 2 m. If due to air resistance loss of energy is 10%, what is the speed with which the bob arrived at the lowest point.	2
	SECTION (C)	7x3=21
22.	The velocity 'v' of sound waves, through a medium may be assumed to depend on: (i) density of the medium, ρ, and (ii) its modulus of elasticity, *E*. Modulus of elasticity is a ratio of stress to strain and stress is force per unit area. Deduce by the method of dimensions the formula for the velocity of sound.	3

23.	An e-commerce logistics company tests an autonomous vertical-takeoff delivery drone. Launching straight up from a ground depot (y = 0) at (t = 0), its vertical micro-thrusters deliver a variable acceleration profile governed by the time-dependent function: $$a(t) = \alpha t - \beta t^2$$ Where structural constants are calibrated as $\alpha = 6\ m/s^3$ and $\beta = 1.2\ m/s^4$ .The drone starts from rest. (i) Derive the algebraic expressions for both the instantaneous velocity v(t) and the vertical position y(t) of the delivery drone as explicit functions of time. (ii) State fundamentally why the standard three kinematic equations of motion (v = u + at), etc.) cannot be applied directly to solve this scenario	3
24.	(a) (i) If a person running with constant speed 'v' on a circular track of radius 'r'. Show that his motion is an accelerated motion. (ii) A cyclist is riding with a speed of 27 km/h. As he approaches a circular turn on the road of radius 30 m, he applies brakes and reduces his speed at the constant rate 0.5 ms^{-2}. What is the magnitude and direction of the net acceleration of the cyclist on the circular turn? **OR** **(b)** If $\hat{\imath}$ and $\hat{\jmath}$ are unit vectors along *x* & *y* axis respectively then what is magnitude and direction of $(\hat{\imath} + \hat{\jmath})$ and $(\hat{\imath} - \hat{\jmath})$. (b) Find the components of vector $\vec{r} = 3\hat{\imath} + 7\hat{\jmath}$ along the direction of $(2\hat{\imath} + 3\hat{\jmath})$ and $(2\hat{\imath} - 3\hat{\jmath})$.	3
25.	Two masses 13 kg and 17 kg are connected at the two ends of a light inextensible string that goes over a frictionless pulley. Find the acceleration of the masses, and the tension in the string when the masses are released.	3
26.	A body of mass 0.3 kg is taken up an inclined plane to length 10 m and height 5 m and then allowed to slide down to the bottom again. The coefficient of friction between the body and the plane is 0.15. What is the (i) work done by the gravitational force over the round trip. (ii) work done by the applied force over the upward journey. (iii) work done by frictional force over the round trip.	3

27.	Two billiard balls with equal masses $m_1 = m_2$ collide in such a manner is shown in the figure. If their kinetic energy and linear momentum do not change with time.  The first ball is called the cue while the second ball is called the target. The billiard player wants to 'sink' the target ball in a corner pocket, which is at an angle $\theta_2 = 37°$. Obtain θ_2. **For V.I. Students** Answer carefully, with reasons: (a) In an elastic collision of two billiard balls, is the total kinetic energy conserved during the short time of collision of the balls (i.e. when they are in contact)? (b) Is the total linear momentum conserved during the short time of an elastic collision of two balls? (c) What are the answers to (a) and (b) for an inelastic collision?	3
28.	Find the potential energy of a system of four particles, each of mass *m*, placed at the vertices of a square of side. Also obtain the potential at the centre of the square	3
	SECTION (D)	2x4=8
29	The spring force is an example of a variable force which is conservative. Fig. shows a block attached to a spring and resting on a smooth horizontal surface. The other end of the spring is attached to a rigid wall. The spring is light and may be treated as massless.  	

In an ideal spring, the spring force *Fs* is proportional to *x* where *x* is the displacement of the block from the equilibrium position. The displacement could be either positive or negative. This force law for the spring is called Hooke's law and is mathematically stated as

$$F_s = -kx$$

The constant *k* is called the spring constant. Its unit is N m^{-1}. The spring is said to be stiff if *k* is large and soft if *k* is small. The work done to displace the block from the equilibrium position is stored in the form of potential energy. Mathematically it is stated as

$$U = \frac{1}{2}\mathrm{k}x^2$$

(i) A spring with a spring constant of 200N/m is compressed by 0.1m. What is the potential energy stored in the spring? 1

(a) 1 J (b) 2 J

(c) 10 J (d) 20 J

(ii) The ratio of spring constants of two springs is 2: 3. What is the ratio of their potential energy, if they are stretched by the same force? 1

(a) 2: 3 (b) 3: 2

(c) 4: 9 (d) 9: 4

(iii) The potential energy of a spring increases by 15 J when stretched by 3 cm. If it is stretched by 4 cm, the increase in potential energy is 1

(a) 27 J (b) 30 J

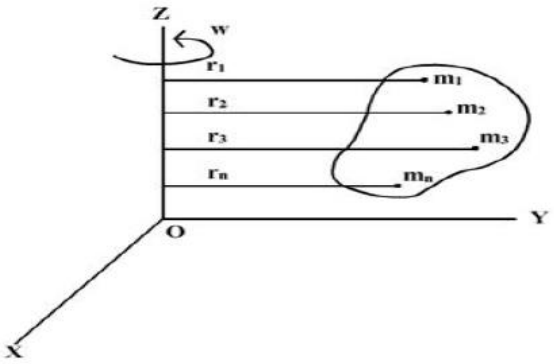
(c) 33 J (d) 36 J

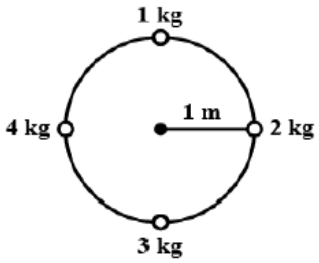
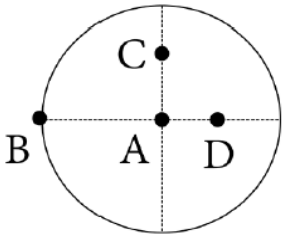
(iv)(A) The potential energy of a spring when stretched through a distance *x* is 10 J. What is the amount of work done on the same spring to stretch it through an additional distance *x*? 1

(a) 10 J (b) 20 J

(c) 30 J (d) 40 J

OR

	(B) Consider a typical simulation with a car of mass 1000 kg moving with a speed 18.0 km/h on a smooth road and colliding with a horizontally mounted spring of spring constant 5.25×10^3 N m^{-1}. What is the maximum compression of the spring? (a) 2.0 m (b) 1.0 m (c) 3.0 m (d) 0.5 m	1
30.	The mass of a body resists a change in its state of linear motion, It is a measure of inertia in linear motion. Similarly, the moment of inertia of a body about an axis of rotation resists a change in its rotational motion. The greater the moment of inertia of a body, the greater is the torque required to change its state of rotation. It is a measure of rotational inertia of a body. The moment of inertia of rigid body about a fixed axis is defined as the sum of the products of the masses of the particles constituting the body and the squares of their respective distances from the axis of rotation. $$I = m_1 r_1^2 + m_2 r_2^2 + \ldots\ldots\ldots\ldots + m_n r_n^2 = \sum_{i=1}^{n} m_i r_i^2$$ Thus, the moment of inertia of a rigid body depends on the mass of the body, its shape and size, distribution of mass about the axis of rotation, and the position and orientation of the axis of rotation.  (i) If a person sitting on a rotating stool with his hands outstretched, suddenly lowers his hands, then his moment of inertia: (a) Increases (b) Decreases (c) Becomes zero (d) Remains constant (ii) The moment of inertia of a body does not depend upon: (a) Angular Velocity (b) Axis of rotation	1 1

	(c) The mass of a body (d) The distribution of mass	
	(iii) (A) Four balls each of radius 10 cm and mass 1 kg, 2 kg, 3 kg and 4 kg are attached to the periphery of massless plate of radius 1m. What is moment of inertia of the system about the Centre of plate?  (a) 12.04 Kgm^2 (b) 10.04 Kgm^2 (c) 11.50 Kgm^2 (d) 13.05 Kgm^2	1
	OR (B) The moment of inertia of a uniform circular disc is maximum about an axis perpendicular to the disc and passing through the point - (a) B (b) C (c) D (d) A  	1
	(iv) What is the ratio of the moments of inertia of two rings radii r and nr about an axis perpendicular to their plane and passing through their centres? (a) 1: n^2 (b) 1: n (c) 1: 2n (d) n^2: 1	1
	SECTION (E)	**3x5=15**
31.	(a) A bullet is fired from gun obliquely with a velocity *u*. Show that after firing, the bullet follows a parabolic path. Also obtain expression for: - (i) time to reach its maximum height. (ii) horizontal distance from initial position to the point where bullet hits the ground	5

	(iii) At what velocity it hits the ground. **OR** (b) (i) Prove that the maximum horizontal range is four times the maximum height attained by the projectile, when fired at an inclination so as to have maximum range. **(ii)** Show that there are two values of time for which a projectile is at the same height. Also show that the sum of these two times is equal to the time of flight.	
32.	(a) (i) A heavily loaded commercial truck encounters a steep, sharp mountain bend on a rainy day. Explain the physical hazards this vehicle faces if the road is flat. (ii) How does banking the road mitigate these risks? Support your explanation with a detailed mathematical derivation for the maximum safe speed, and (iii) discuss how real-world conditions like tyre wear and weather alter this limit. **OR** (b) A rectangular box lies on a rough inclined surface. The coefficient of friction between the surface and the box is (μ). Let the mass of the box be m. (i) At what angle of inclination θ of the plane to the horizontal will the box just start to slide down the plane? (ii) What is the force acting on the box down the plane, if the angle of inclination of the plane is increased to $\alpha > \theta$. (iii) What is the force needed to be applied upwards along the plane to make the box either remain stationary or just move up with uniform speed?	5
33.	(a) Astrophysicists study the atmospheres of different planets to assess their habitability. It is observed that smaller planets like Mercury have virtually no atmosphere, while gas giants like Jupiter have thick atmospheres containing light gases like Hydrogen and Helium. This phenomenon depends heavily on the relationship between escape velocity and the thermal velocity of gas molecules.	5

	(i) Define escape velocity. Derive its expression from the surface of a planet of mass (M) and radius (R) using the principle of conservation of energy. (ii) A planet has a mass 4 times that of Earth and a radius 2 times that of Earth. If the escape velocity on Earth is (11.2 km/s), calculate the escape velocity on this planet. (iii) Explain the physical reason why lighter gases (H_2, He) easily escape Earth's atmosphere, whereas heavier gases (O_2, N_2) remain trapped. **OR** (b) An aerospace company is designing a low-altitude reconnaissance drone and a medium-Earth-orbit weather satellite. The propulsion system must constantly adjust its thrust to compensate for the changing gravitational pull of the Earth as the vehicles climb to their respective operational altitudes. (i) Derive the exact expression for the acceleration due to gravity g_h at a height (h) above the Earth's surface. (ii) Using the binomial theorem, approximate this expression for cases where (h<< R) (very close to the surface). State the exact physical boundary or condition where this approximation fails and becomes invalid for engineering calculations. (iii)The weather satellite is stationed at an altitude equal to the radius of the Earth (h = R). Calculate the percentage reduction in the gravitational force acting on the satellite compared to when it was sitting on the launchpad.	