O. P. JINDAL SCHOOL, SAVITRI NAGAR
Half Yearly Examination (2026 – 2027)

Class: XI **Maximum Marks: 50**

Subject: Physics **Time Allowed: 2 Hours**

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, eight MCQ and four assertion reasoning based of 1 mark each, Section B contains four questions of two marks each, Section C contains four questions of three marks each, Section D contains two case study-based questions of four marks each and Section E contains two long answer questions of five marks each.
(5)There is no overall choice. However, an internal choice has been provided in two questions in Section B, Section C and all two questions in Section E. You have to attempt only one of the choices in such questions.
(6) Use of calculators is not allowed.
(7) You may use the following values of physical constants where ever necessary
(i) G=6.674 × 10–11 N.m2/kg2
(ii)k=1.38 × 10–23 J/K
(iii) h=6.626 × 10–34 J.s
(iv)R=8.314 J/(mol. K)

SECTION A

Q1. The dimensional formula for Universal Gravitational Constant (G) is:

(a) $[M^{-1} L^3 T^{-2}]$ (b) $[M^1 L^2 T^{-1}]$

(c) $[M^{-1} L^2 T^{-2}]$ (d) $[M^1 L^3 T^{-2}]$

Q2. If vectors $A = 2\,i + 3\,j - k$ and $B = -4\,i - 6\,j + \lambda\,k$ are collinear (parallel) to each other, the value of scalar λ is:

(a) 2 (b) −2

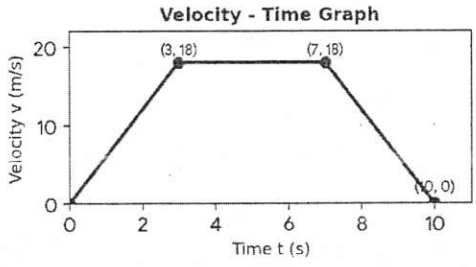
(c) 4 (d) 3

Q3. The displacement x of a particle moving along a straight line varies with time t as $x = 2t^3 - 6t^2 + 4t$. The magnitude of velocity of the particle at the instant when its acceleration is zero is:

(a) 0 m/s^2 (b) 6 m/s^2

(c) 2 m/s^2 (d) 8 m/s^2

Q4. The velocity-time graph of an object moving along a straight line is shown below. The total displacement of the object in 10 seconds is:



(a) 180 m (b) 126 m

(c) 144 m (d) 90 m

Q5. A body of mass m is executing uniform circular motion in a circle of radius R with a constant speed v. The magnitude of its centripetal acceleration is:

(a) v / R (b) v^2 / R

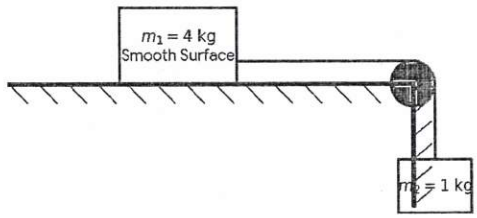
(c) $v^2 R$ (d) v / R^2

Q6. A hammer of mass 1 kg moving with a speed of 6 m/s strikes a nail and comes to rest in 0.02 s. The average impulse force exerted on the nail is:

(a) 60 N (b) 120 N

(c) 300 N (d) 600 N

Q7. Two bodies of masses $m_1 = 4$ kg and $m_2 = 1$ kg are connected by a light inextensible string passing over a frictionless light pulley as shown. The horizontal surface is smooth. Taking $g = 10$ m/s², the common acceleration of the system is:



(a) 2 m/s² (b) 2.5 m/s²

(c) 5 m/s² (d) 8 m/s²

Q8. A box of mass 8 kg rests on a rough horizontal floor ($\mu_s = 0.5$). If a horizontal pulling force of 30 N is applied to the box, the magnitude of the static friction force developed is (Take $g = 10$ m/s²):

(a) 40 N (b) 30 N

(c) 10 N (d) Zero

Directions for Q9 to Q12: In each question, a statement of Assertion (A) is followed by a statement of Reason (R). Choose the correct option:

(a) Both (A) and (R) are true and (R) is the correct explanation of (A).

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

(c) (A) is true but (R) is false.

(d) (A) is false but (R) is true.

Q9. Assertion (A): Dimensional analysis can be used to convert the value of a physical quantity from one system of units to another.

Reason (R): The numerical value of a physical quantity is inversely proportional to its unit size, keeping the magnitude nu constant.

Q10. Assertion (A): The position-time (x-t) graph of a particle executing uniform velocity is a straight line inclined to the time axis.

Reason (R): The slope of the position-time graph gives the instantaneous velocity of the particle.

Q11. Assertion (A): In oblique projectile motion, the horizontal component of velocity remains constant throughout the flight in the absence of air resistance.

Reason (R): Gravitational force acts purely in the vertically downward direction, resulting in zero acceleration along the horizontal axis.

Q12. Assertion (A): The limiting force of static friction depends on the area of contact and independent of materials.

Reason (R): The limiting force of kinetic friction is independent of the area of contact and depends on materials.

SECTION B

Q13. Find the angle θ between the two vectors $A = 2\,i + 2\,j - k$ and $B = 6\,i - 3\,j + 2\,k$ using the scalar (dot) product.

Q14(I). A man is walking towards the east with a velocity of 2 m/s. Rain is falling vertically downward with a velocity of 5 m/s. Find the velocity of rain relative to the man and direction of opening of his umbrella.

OR

Q14(II). A man can swim at the rate of 5 km/h in still water. A 1 km wide river flows at the rate of 3 km/h The man wishes to swim across the river directly opposite to the starting point.

(i) Along what direction must the man swim?

(ii) What should be his resultant velocity?

(iii) How much time will he take to cross the river?

Q15. A truck is accelerating towards the right with an acceleration of 4 m/s^2. A small stone of mass 200 g is suspended from the roof of the truck by a light string. Find the angle made by the string with the vertical. (Take $g = 10\ ms^{-2}$)

Q16. A constant horizontal force of 24 N acts on a body of mass 4 kg initially at rest on a smooth horizontal surface. Calculate:

(i) The acceleration produced in the body.

(ii) The velocity and displacement of the body after 5 seconds.

SECTION C

Q17(I). Using calculus, derive the third kinematic equation of motion: $v^2 = u^2 + 2as$.

OR

Q17(II). A block of mass $m = 5$ kg is placed on a rough inclined plane of inclination $\theta = 30°$ with the horizontal. The coefficient of kinetic friction between the block and the incline is $\mu_k = 0.2$. A force $F = 20$ N is applied parallel to the incline in the upward direction as shown. Taking $g = 10\ m/s^2$ and $\sqrt{3} = 1.7$, determine the acceleration of the block along the incline.

Q18. Define Uniform Circular Motion. Derive the relation between linear velocity v and angular velocity ω ($v = r\,\omega$). Hence, state the expression for centripetal acceleration in terms of ω.

Q19(I). Two masses m_1 and m_2 are connected by a light inextensible string passing over a frictionless light fixed pulley (Atwood machine).

(i) Draw the free body diagrams (FBD) for both masses.

(ii) Derive the expression for the acceleration of the system.

OR

Q19(II). A monkey of mass 10 kg is climbing a light vertical rope. It accelerates upward with an acceleration of 2 m/s^2. Find the tension in the rope. If the monkey later accelerates downward with an acceleration of 2 m/s^2, find the tension in the rope in that case. Take $g = 10\ m/s^2$.

Q20. A ball is projected horizontally with an initial velocity of 20 m/s from the roof of a building of height 80 m. Taking $g = 10\ m/s^2$:

(i) Calculate the time taken by the ball to reach the ground.

(ii) Find the horizontal distance from the base of the building to the landing point.

(i) Determine the magnitude of the velocity vector with which the ball strikes the ground.

SECTION D

Q21. A student is performing an experiment to determine the time period of a simple pendulum. He measures the length of the pendulum as 1.00 m and observes that the time period is approximately 2 s. The student knows that the time period T depends on the length l of the pendulum and acceleration due to gravity g. He wants to use dimensional analysis to understand the possible relation between these quantities.

Based on the case given above, answer the following three sub-questions:

(i) Write the dimensions of acceleration due to gravity g.

(ii) Using dimensional analysis, which of the following could represent the dependence of T on l and g? Mark and show how u reached to that relation.

(a) $T \propto \sqrt{\frac{l}{g}}$ (b) $T \propto \sqrt{lg}$

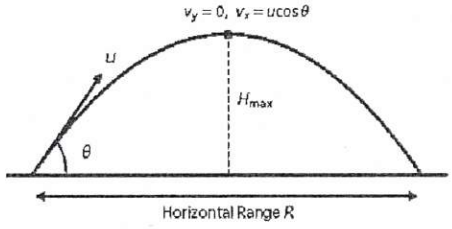
(c) $T \propto \frac{g}{l}$ (d) $T \propto \frac{l}{g}$

(iii) If the length of the pendulum is increased by a factor of 4, by what factor will the time period change according to the relation obtained above?

Q22. When a person of mass m stands on a spring weighing scale inside an elevator cabin, the scale measures the normal contact reaction force R exerted by the floor on the person's feet. This registered normal force represents the 'apparent weight' of the person. When the elevator accelerates vertically, the apparent weight differs from the true gravitational weight (W = mg), depending on the direction and magnitude of the cabin's acceleration.
Based on the paragraph above, answer the following questions for a person of mass m = 50 kg (Take g = 10 m/s²)
(i) Calculate the apparent weight registered by the scale when the elevator accelerates upward at a = 2.5 m/s².
(ii) Calculate the apparent weight registered when the elevator accelerates downward at a = 2.0 m/s²,
(iii) State the reading if the cable breaks (free fall).

SECTION E

Q23(I). Answer all parts of the following problem on Projectile Motion :



(i) A body is projected with an initial velocity u at an angle θ with the horizontal as shown in the diagram. Derive the expressions for the time of flight T and horizontal range R.

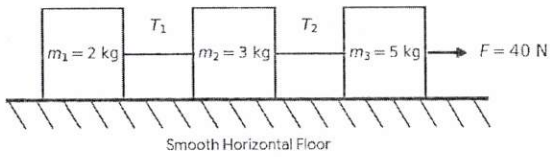
(ii) A projectile is thrown with a velocity of 30 m/s at an angle of 30° with the horizontal. Taking g = 10 m/s², calculate the total time of flight T and horizontal range .

OR

Q23(II). A car starts from rest and moves with a uniform acceleration of 2 m/s² for 10 seconds. It then moves with uniform velocity for the next 20 seconds. Finally, it is brought to rest with a uniform retardation of 4 m/s².

(i) Find the velocity of the car after the first 10 seconds.
(ii) Find the distance travelled during the first 10 seconds.
(iii) Find the time taken by the car to come to rest.

Q24(I). Answer all parts of the following problem on Connected Bodies and Motion along Incline



(i) Three blocks of masses $m_1 = 2$ kg, $m_2 = 3$ kg, and $m_3 = 5$ kg are connected by light inextensible strings on a smooth horizontal floor as shown in the diagram. A constant horizontal pulling force F = 40 N is applied to mass m_3.

(a) Draw the individual Free Body Diagrams (FBD) for all three blocks.

(b) Calculate the common acceleration 'a' of the system.

(c) Determine the tensions T_1 and T_2 in the connecting strings.

(ii) A block of mass m = 6 kg is placed on a rough horizontal surface with coefficient of static friction $\mu_s = 0.4$ and kinetic friction $\mu_k = 0.3$. Taking g = 10 m/s²:

(a) Calculate the limiting static friction force.

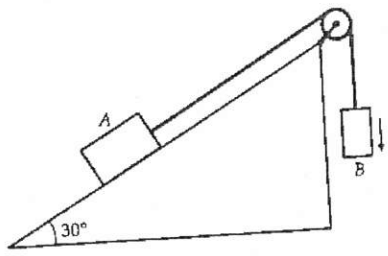
(b) Determine the acceleration of the block if a horizontal force of F = 36 N is applied.

OR

Q24(II). A block 'A' of mass 14 kg moves along an inclined plane that makes an angle of 30° with the horizontal. Block A is connected to another block B of mass 14 kg by a taut massless string that runs around a frictionless, massless pulley. The block B moves downward with constant velocity. (Take g = 10 ms^{-2}) What is

(i) the magnitude of the frictional force and

(ii) the coefficient of kinetic friction



(ii) Derive the formula for the maximum safe speed V_{max} with which a car can negotiate a rough banked circular road of radius R and banking angle θ, having a coefficient of static friction μ_s between tires and road:

$$V_{max} = \sqrt{\frac{R\,g\,(\mu_s + \tan\theta)}{(1 - \mu_s \tan\theta)}}$$

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