COMPREHENSIVE SUMMATIVE ASSESSMENT

Class IX • Science (Physics) • Term Assessment

Topics: 1. Describing Motion Around Us
2. How Forces Affect Motion

Time Allowed: 2 Hours (120 Mins)
Maximum Marks: 50 Marks

Student Name: _____

Roll No / Section: _____

General Instructions:

1. This question paper comprises **5 Sections**: Section A (12 Marks), Section B (10 Marks), Section C (12 Marks), Section D (8 Marks), and Section E (8 Marks).
2. All questions are compulsory. Internal choices are provided in selected 3-mark and 5-mark questions.
3. Calculators are strictly prohibited. Neat graphs and diagrammatic representations carry credit where specified.
4. Take acceleration due to gravity, $g = 9.8\ m/s^2$ or $10\ m/s^2$ where explicitly mentioned.

SECTION A: Objective & Multiple Choice Questions [12 × 1 = 12 Marks]

Q1. An athlete runs along a circular track of radius R. What is the magnitude of displacement and the total distance covered respectively after completing 2.5 rounds? [1]

(a) $0,\ 5\pi R$
(b) $2R,\ 5\pi R$
(c) $2\pi R,\ 2.5R$
(d) $2R,\ 2.5\pi R$

Q2. The area under a velocity-time graph represents a physical quantity whose SI unit is: [1]

(a) m/s
(b) m^2
(c) m
(d) m/s^2

Q3. A body moves with uniform circular motion. Which of the following physical quantities remains constant throughout the motion? [1]

(a) Velocity
(b) Speed
(c) Acceleration
(d) Momentum

Q4. Which of the following represents an object moving with non-uniform acceleration? [1]

(a) A free-falling stone under gravity
(b) A car moving on a straight, frictionless highway at constant speed
(c) A car maneuvering through congested city traffic
(d) A ball rolling down a smooth inclined plane

Q5. Inertia of an object directly depends on its: [1]

(a) Velocity
(b) Surface area
(c) Mass
(d) Shape

Q6. A net external force of $15\ N$ acts on a body of mass $3\ kg$ initially at rest. Its velocity after $4\ seconds$ is: [1]

(a) $12\ m/s$
(b) $20\ m/s$
(c) $15\ m/s$
(d) $60\ m/s$

Q7. Action and reaction forces described in Newton's Third Law: [1]

(a) Act on the same body in opposite directions
(b) Act on different bodies in opposite directions
(c) Are not necessarily equal in magnitude
(d) Act simultaneously on the same point of contact

Q8. When a carpet is beaten with a stick, dust particles fall out. This phenomenon is an application of: [1]

(a) Newton's Third Law
(b) Inertia of rest
(c) Law of conservation of momentum
(d) Inertia of direction

Q9. A bullet of mass $20\ g$ is fired horizontally with a velocity of $150\ m/s$ from a rifle of mass $2\ kg$. The recoil velocity of the rifle is: [1]

(a) $-1.5\ m/s$ (b) $-3.0\ m/s$

(c) $+1.5\ m/s$ (d) $-0.15\ m/s$

Q10. A passenger in a moving train tosses a coin that falls behind him. This observation proves that the train's motion is: [1]

(a) Accelerated (b) Retarded

(c) Uniform (d) Along a circular track

Direction for Q11 & Q12: *In each question, a statement of Assertion (A) is followed by a statement of Reason (R). Choose: (a) Both A and R are true and R is the correct explanation; (b) Both A and R are true but R is NOT the correct explanation; (c) A is true, R is false; (d) A is false, R is true.*

Q11. Assertion (A): The displacement of a moving body can be zero even if the distance travelled is non-zero. [1]
Reason (R): Displacement depends strictly on the initial and final positions, while distance is the total path length.

Q12. Assertion (A): A cricket fielder pulls his hands backwards while catching a fast-moving cricket ball. [1]
Reason (R): By increasing the contact time to stop the ball, the rate of change of momentum is reduced, thereby decreasing the impact force.

SECTION B: Short Answer Questions - I [5 × 2 = 10 Marks]

Q13. Distinguish clearly between **speed** and **velocity** on the basis of: (i) Nature of quantity (scalar/vector), and (ii) Possibility of being zero or negative during continuous motion. [2]

Q14. State Newton's First Law of Motion. Why is it commonly termed the *"Law of Inertia"*? [2]

Q15. A bus starting from rest accelerates uniformly at $0.2\ m/s^2$ for $2\ minutes$. Calculate: [2]

1. The final speed acquired in m/s.
2. The total distance travelled by the bus during this duration.

Q16. Using Newton's Third Law of Motion, explain how an inflated rubber balloon darts forward when air is abruptly released from its mouth. [2]

Q17. (Internal Choice) [2]

Option A: A motorcar has a mass of $1200\ kg$. What force is required to stop the vehicle in $10\ seconds$ if it is travelling at a velocity of $72\ km/h$?

— OR —

Option B: Which requires a greater force — accelerating a $2\ kg$ mass at $5\ m/s^2$ or a $4\ kg$ mass at $2\ m/s^2$? Justify mathematically.

SECTION C: Short Answer Questions - II [4 × 3 = 12 Marks]

Q18. Derive the first two equations of motion using the graphical method (velocity-time graph for uniform acceleration): [3]

1. $v = u + at$
2. $s = ut + \frac{1}{2}at^2$

(Include a neat, labeled sketch of the velocity-time graph).

Q19. State Newton's Second Law of Motion in words. Show that the mathematical relation $F = ma$ is a direct consequence of this law for a body of constant mass. Define the SI unit of force from this relation. [3]

Q20. A stone is thrown vertically upwards with an initial velocity of $20\ m/s$. If the acceleration due to gravity is $10\ m/s^2$ downwards: [3]

1. Find the maximum height reached by the stone.
2. Find the total time taken to return to the thrower's hand.
3. What is the velocity and acceleration of the stone at the highest point?

Q21. (Internal Choice) [3]

Option A: State the Law of Conservation of Linear Momentum. Two hockey players of opposite teams, while trying to hit a hockey ball, collide and immediately become entangled. Player A has a mass of $60\ kg$ and was moving at $5.0\ m/s$, while Player B has a mass of $55\ kg$ and was moving at $6.0\ m/s$ towards Player A. In which direction and with what velocity will they move together after getting entangled?

— OR —

Option B: Give scientific reasons for each of the following:

1. Passengers lean outward when a speeding bus takes a sharp turn on a curved road.
2. It is advised to wear seatbelts in a moving car.
3. Glassware is packed wrapped in straw or bubble wrap during transit.

SECTION D: Long Answer Question [1 × 5 = 5 Marks (Adjusted to 8 with sub-parts) → Standard 5+3 Marks Breakdown]

Q22. A train starts from rest at station A and accelerates uniformly at $0.5\ m/s^2$ for $40\ s$. It then travels at constant speed for $100\ s$. Finally, brakes are applied, producing a uniform retardation of $1.0\ m/s^2$ until it comes to rest at station B. [5]

1. Plot the velocity-time graph for the entire journey.
2. Find the maximum speed attained by the train in km/h.
3. Calculate the time taken during the braking phase.
4. Determine the total distance between station A and station B using the area under the v-t graph.
5. Find the average speed of the train for the whole trip.

Q23. [3]

1. Why does a heavy truck parked on the side of a road not move even though atmospheric and gravitational forces act on it? State the condition for balanced forces.
2. Explain why road accidents at high speeds are much more severe than accidents at low speeds, using the concept of momentum and impulse.

SECTION E: Case Study / Competency-Based Questions [2 × 4 = 8 Marks]

Q24. Case Study 1: Satellite Mechanics and Uniform Circular Motion [4]

When an artificial satellite orbits the Earth in a circular path at constant altitude, its speed remains constant, yet physicists classify it as an accelerated motion. The satellite continuously changes its direction of motion at every single instant along the circular trajectory. According to Newton's second law, any acceleration requires a net unbalanced centripetal force directed toward the centre of curvature. In orbital mechanics, this necessary inward force is provided by the Earth's gravitational pull.

1. Why is circular motion with constant speed called accelerated motion? [1]
2. What provides the centripetal force for the Moon revolving around the Earth? [1]
3. An artificial satellite takes $24\ hours$ to complete one orbit around Earth in a circular path of radius $42{,}000\ km$. Calculate its linear speed in km/s. (Take $\pi = 3.1416$) [2]

Q25. Case Study 2: Space Propulsion & Deep Space Coasting [4]

In deep interstellar space, far away from any star or planet, atmospheric friction and gravitational influences are negligible. A deep-space scientific probe executes an engine burn to accelerate to a velocity of $25{,}000\ m/s$. Once the desired speed is achieved, the flight computers completely cut off fuel flow and shut down the rocket thrusters. Many novice students mistakenly predict that the probe will quickly come to a halt because "no force is pushing it forward". However, Newton's laws tell a completely different story.

1. Will the probe stop, slow down, or continue moving at $25{,}000\ m/s$ after the engine cuts off? Name the law of motion governing this behaviour. [1]
2. Explain why common human intuition on Earth incorrectly predicts that objects must stop when applied forces cease. [1]
3. If the mass of the space probe is $800\ kg$ and retro-thrusters firing in the opposite direction apply a constant braking force of $4{,}000\ N$, calculate:
    1. The deceleration produced.
    2. The total time taken to bring the probe to a complete stop. [2]