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Class	9th	Chapter	02
Subject	Physics	Board	Punjab

CHAPTER 02: KINEMATICS — SOLUTIONS

A. Multiple Choice Questions

- **2.1. The numerical ratio of displacement to distance is:**
  - **Options:** (a) always less than one | (b) always equal to one | (c) always greater than one | (d) **equal to or less than one** *(Correct Answer)*
  - *Explanation:* Displacement is the shortest straight-line distance, which is either less than or equal to the actual path length (distance). Hence, their ratio is always ≤ 1.
- **2.2. If a body does not change its position with respect to some fixed point, then it will be in a state of:**
  - **Options:** (a) **rest** *(Correct Answer)* | (b) motion | (c) uniform motion | (d) variable motion
  - *Explanation:* Rest is defined as the state of a body when it does not change its position with respect to its surroundings.
- **2.3. A ball is dropped from the top of a tower, the distance covered by it in the first second is:**
  - **Options:** (a) **5 m** *(Correct Answer)* | (b) 10 m | (c) 50 m | (d) 100 m
  - *Explanation:* Using $S = v_i t + \frac{1}{2} g t^2$ where $v_i = 0$, $g = 10$ m/s^2, $t = 1$ s: $S = \frac{1}{2}(10)(1)^2 = 5$ m.
- **2.4. A body accelerates from rest to a velocity of 144 km h^{-1} in 20 seconds. The distance covered by it is:**
  - **Options:** (a) 100 m | (b) **400 m** *(Correct Answer)* | (c) 1400 m | (d) 1440 m
  - *Explanation:* $v_f = 144$ km/h $= 144 \times \left(\frac{5}{18}\right) = 40$ m/s. Acceleration $a = \frac{v_f - v_i}{t} = \frac{40}{20} = 2$ m/s^2. Distance $S = v_i t + \frac{1}{2} a t^2 = 0 + \frac{1}{2}(2)(20)^2 = 400$ m.

- **2.5. A body is moving with constant acceleration starting from rest. It covers a distance S in 4 seconds. How much time is it take to cover one-fourth of this distance?**
  - **Options:** (a) 1 s | (b) **2 s** *(Correct Answer)* | (c) 4 s | (d) 16 s
  - *Explanation:* $S \propto t^2$ (since $v_i = 0$ and a is constant). If distance is reduced to $\frac{S}{4}$, time becomes $\frac{t}{2} = \frac{4}{2} = 2$ s.
- **2.6. The displacement time graphs of two objects A and B are shown in the figure. Point out the true statement from the following:**
  - **Options:** (a) **The velocity of A is greater than B.** *(Correct Answer)* | (b) The velocity of A is less than B. | (c) The velocity of A is equal to that of B. | (d) The graph gives no information in this regard.
  - *Explanation:* The slope (gradient) of the displacement-time graph gives velocity. Graph A has a steeper slope than B.
- **2.7. The area under the speed-time graph is numerically equal to:**
  - **Options:** (a) velocity | (b) uniform velocity | (c) acceleration | (d) **distance covered** *(Correct Answer)*
  - *Explanation:* Area = Speed × Time = Distance.
- **2.8. Gradient of the speed-time graph is equal to:**
  - **Options:** (a) speed | (b) velocity | (c) **acceleration** *(Correct Answer)* | (d) distance covered
  - *Explanation:* Gradient $= \frac{\Delta \text{ Speed}}{\Delta \text{ Time}} =$ Acceleration.
- **2.9. Gradient of the distance-time graph is equal to the:**
  - **Options:** (a) **speed** *(Correct Answer)* | (b) velocity | (c) distance covered | (d) acceleration
  - *Explanation:* Gradient $= \frac{\Delta \text{ Distance}}{\Delta \text{ Time}} =$ Speed.
- **2.10. A car accelerates uniformly from 80.5 km h^{-1} at t = 0 to 113 km h^{-1} at t = 9 s. Which graph best describes the motion of the car?**
  - **Options:** (a) [Curved upward v-t] | (b) **[Straight inclined line v-t starting from non-zero intercept]** *(Correct Answer)* | (c) [Line starting from 0] | (d) [Downward slope]
  - *Explanation:* Uniform acceleration is represented by a straight inclined line in a speed-time graph, and since initial speed is non-zero (80.5 km/h), the line starts above the origin.

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B. Short Answer Questions

- **2.1. Define scalar and vector quantities.**
  - **Answer:**
    - *Scalar quantity:* A physical quantity described completely by its magnitude along with a proper unit (e.g., mass, time, speed).
    - *Vector quantity:* A physical quantity that requires both magnitude and a specific direction for its complete description (e.g., displacement, velocity, force).
- **2.2. Give 5 examples each for scalar and vector quantities.**
  - **Answer:**
    - *Scalar examples:* Mass, length, time, temperature, speed.
    - *Vector examples:* Displacement, velocity, acceleration, force, momentum.
- **2.3. State head-to-tail rule for addition of vectors.**
  - **Answer:** The head-to-tail rule states that vectors are added by placing the tail of the second vector at the head of the first vector. The resultant vector is drawn from the tail of the first vector to the head of the last vector.
- **2.4. What are distance-time graph and speed-time graph?**
  - **Answer:**
    - *Distance-time graph:* A graph plotted with time on the x-axis and distance on the y-axis, used to determine the speed of an object.
    - *Speed-time graph:* A graph plotted with time on the x-axis and speed on the y-axis, used to determine acceleration and distance covered.
- **2.5. Falling objects near the Earth have the same constant acceleration. Does this imply that a heavier object will fall faster than a lighter object?**
  - **Answer:** No. Acceleration due to gravity (g) is constant for all freely falling objects regardless of their mass (neglecting air resistance). Both heavy and light objects fall at the same rate and hit the ground simultaneously.
- **2.6. The vector quantities are sometimes written in scalar notation (not bold face). How is the direction indicated?**
  - **Answer:** In scalar notation, the direction of a vector is indicated by placing an arrow over the symbol (e.g., $\vec{v}$) or by explicitly stating the sign/direction alongside the magnitude.
- **2.7. A body is moving with uniform speed. Will its velocity be uniform? Give reason.**
  - **Answer:** Not necessarily. Uniform speed only means the magnitude is constant. If the body changes its direction of motion (e.g., moving in a circle), its velocity changes because velocity depends on direction as well as magnitude.
- **2.8. Is it possible for a body to have acceleration? When moving with: (i) constant velocity (ii) constant speed**
  - **Answer:**

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- (i) *Constant velocity:* No, because acceleration is the rate of change of velocity. If velocity is constant, acceleration is zero.
- (ii) *Constant speed:* Yes, if the direction of motion is changing (e.g., uniform circular motion), the velocity changes, producing centripetal acceleration.

C. Constructed Response Questions

- **2.1. Distance and displacement may or may not be equal in magnitude. Explain this statement.**
  - **Answer:** Distance is the total length of the actual path covered, while displacement is the shortest straight-line distance between initial and final points. When a body moves along a straight line in one direction without turning back, distance equals displacement. However, if the body moves along a curved or zig-zag path, or returns to its starting point, distance is greater than displacement.
- **2.2. When a bullet is fired, its velocity with which it leaves the barrel is called the muzzle velocity of the gun. The muzzle velocity of one gun with a longer barrel is lesser than that of another gun with a shorter barrel. In which gun is the acceleration of the bullet larger? Explain your answer.**
  - **Answer:** The acceleration is larger in the gun with the shorter barrel. Since acceleration $a = \frac{v_f^2 - v_i^2}{2s}$, for a higher or comparable final velocity achieved over a shorter distance (barrel length s), the acceleration must be significantly higher.
- **2.3. For a complete trip, average velocity was calculated. Its value came out to be positive. Is it possible that its instantaneous velocity at any time during the trip had the negative value? Give justification of your answer.**
  - **Answer:** Yes, it is entirely possible. Average velocity depends only on total displacement divided by total time ($v_{\text{avg}} = \frac{\Delta d}{\text{total time}}$). During the trip, the object could have moved backward (negative instantaneous velocity) for a period, as long as the net forward displacement remained positive.

D. Comprehensive Questions

- **2.1. How a vector can be represented graphically? Explain.**
  - **Answer:** A vector is represented graphically by a directed line segment with an arrowhead. The length of the line, drawn to a suitable scale, represents the magnitude of the vector, while the arrowhead indicates its direction.
- **2.2. Differentiate between: (i) rest and motion (ii) speed and velocity**
  - **Answer:**
    - (i) *Rest vs Motion:* A body is at rest if it does not change position relative to its surroundings; it is in motion if it changes position with time.
    - (ii) *Speed vs Velocity:* Speed is the distance covered per unit time (scalar), whereas velocity is the rate of change of displacement (vector).

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- **2.3. Describe different types of motion. Also give examples.**
  - **Answer:**
    1. *Translatory motion:* Motion where every point of a body moves uniformly along a line/curve (e.g., a car moving on a straight road).
    2. *Rotatory motion:* Spinning motion of a body about a fixed axis (e.g., motion of a ceiling fan).
    3. *Vibratory (oscillatory) motion:* To and fro back-and-forth motion about a mean position (e.g., motion of a pendulum).
- **2.4. Explain the difference between distance and displacement.**
  - **Answer:** Distance is a scalar quantity representing total path length covered, whereas displacement is a vector quantity representing the shortest straight-line distance from start to finish.
- **2.5. What do gradients of distance-time graph and speed-time graph represent? Explain it by drawing diagrams.**
  - **Answer:**
    - Gradient of distance-time graph = Speed (slope $\frac{\Delta S}{\Delta t}$).
    - Gradient of speed-time graph = Acceleration (slope $\frac{\Delta v}{\Delta t}$).
- **2.6. Prove that the area under speed-time graph is equal to the distance covered by an object.**
  - **Answer:** For uniform speed v over time t, distance $S = v \times t$, which equals the rectangular area under the speed-time graph. For variable speed, the area under the curve is divided into small strips of rectangles; the sum of areas of all strips gives total distance covered.
- **2.7. How equations of motion can be applied to the bodies moving under the action of gravity?**
  - **Answer:** For freely falling bodies under gravity, acceleration 'a' is replaced by acceleration due to gravity 'g' (approx. 9.8 m/s^2 or 10 m/s^2), and distance 'S' is replaced by height 'h'. The equations become:
    1. $v_f = v_i + gt$
    2. $h = v_i t + \frac{1}{2} g t^2$
    3. $2gh = v_f^2 - v_i^2$

E. Numerical Problems

- **2.1. Draw the representative lines of the following vectors:**
  - **(a) A velocity of** $400\ \text{m s}^{-1}$ **making an angle of** 60° **with x-axis.**
  - **(b) A force of** $50\ \text{N}$ **making an angle of** 120° **with x-axis.**
  - **Answer:**

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- (a) Scale: Let 100 m/s = 1 cm. Draw a line of length 4 cm at an angle of 60° counter-clockwise from the positive x-axis with an arrowhead.
- (b) Scale: Let 10 N = 1 cm. Draw a line of length 5 cm at an angle of 120° from the positive x-axis with an arrowhead.

- **2.2. A car is moving with an average speed of** 72 km h^{-1}**. How much time will it take to cover a distance of** 360 km**?**
  - **Answer:**
    - Speed = 72 km/h
    - Distance = 360 km
    - Time = $\frac{\text{Distance}}{\text{Speed}} = \frac{360 \text{ km}}{72 \text{ km/h}} = \mathbf{5}$ hours.
- **2.3. A truck starts from rest. It reaches a velocity of** 90 km h^{-1} **in** 50 seconds**. Find its average acceleration.**
  - **Answer:**
    - Initial velocity $v_i = 0$
    - Final velocity $v_f = 90$ km/h $= 90 \times \left(\frac{5}{18}\right) = 25$ m/s
    - Time $t = 50$ s
    - Acceleration $a = \frac{v_f - v_i}{t} = \frac{25-0}{50} = \mathbf{0.5}$ m/s^2.
- **2.4. A car passes a green traffic signal while moving with a velocity of** 5 m s^{-1}**. It then accelerates to** 1.5 m s^{-2}**. What is the velocity of car after** 5 seconds**?**
  - **Answer:**
    - Initial velocity $v_i = 5$ m/s
    - Acceleration $a = 1.5$ m/s^2
    - Time $t = 5$ s
    - Final velocity $v_f = v_i + at = 5 + (1.5 \times 5) = 5 + 7.5 = \mathbf{12.5}$ m/s.
- **2.5. A motorcycle initially travelling at** 18 km h^{-1} **accelerates at constant rate of** 2 m s^{-2}**. How far will the motorcycle go in** 10 seconds**?**
  - **Answer:**
    - Initial velocity $v_i = 18$ km/h $= 18 \times \left(\frac{5}{18}\right) = 5$ m/s
    - Acceleration $a = 2$ m/s^2
    - Time $t = 10$ s
    - Distance $S = v_i t + \frac{1}{2}at^2 = (5 \times 10) + \frac{1}{2}(2)(10)^2 = 50 + 100 =$ **150** m.

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- **2.6. A wagon is moving on the road with a velocity of** $54\ \text{km h}^{-1}$**. Brakes are applied suddenly. The wagon covers a distance of** $25\ \text{m}$ **before stopping. Determine the acceleration of the wagon.**
  - **Answer:**
    - Initial velocity $v_i = 54\ \text{km/h} = 54 \times \left(\frac{5}{18}\right) = 15\ \text{m/s}$
    - Final velocity $v_f = 0\ \text{m/s}$
    - Distance $S = 25\ \text{m}$
    - Using $2aS = v_f^2 - v_i^2$: $2(a)(25) = 0^2 - 15^2 \Longrightarrow 50a = -225 \Longrightarrow a = \frac{-225}{50} = \mathbf{-4.5}\ \text{m/s}^2$.
- **2.7. A stone is dropped from a height of** $45\ \text{m}$**. How long will it take to reach the ground? What will be its velocity just before hitting the ground?**
  - **Answer:**
    - Height $h = 45\ \text{m}$, $v_i = 0$, $g = 10\ \text{m/s}^2$
    - (a) Using $h = v_i t + \frac{1}{2}gt^2$: $45 = 0 + \frac{1}{2}(10)t^2 \Longrightarrow 45 = 5t^2 \Longrightarrow t^2 = 9 \Longrightarrow \mathbf{t = 3}\ \text{s}$.
    - (b) Using $v_f = v_i + gt$: $v_f = 0 + (10 \times 3) = \mathbf{30}\ \text{m/s}$.
- **2.8. A car travels** $10\ \text{km}$ **with an average velocity of** $20\ \text{m s}^{-1}$**. Then it travels in the same direction through a diversion at an average velocity of** $4\ \text{m s}^{-1}$ **for the next** $0.8\ \text{km}$**. Determine the average velocity of the car for the total journey.**
  - **Answer:**
    - Part 1: $d_1 = 10\ \text{km} = 10{,}000\ \text{m}$, $v_1 = 20\ \text{m/s}$. Time $t_1 = \frac{10{,}000}{20} = 500\ \text{s}$.
    - Part 2: $d_2 = 0.8\ \text{km} = 800\ \text{m}$, $v_2 = 4\ \text{m/s}$. Time $t_2 = \frac{800}{4} = 200\ \text{s}$.
    - Total distance $= 10{,}000 + 800 = 10{,}800\ \text{m}$.
    - Total time $= 500 + 200 = 700\ \text{s}$.
    - Average velocity $= \frac{\text{Total Distance}}{\text{Total Time}} = \frac{10{,}800}{700} = \mathbf{15.4}\ \text{m/s}$.
- **2.9. A ball is dropped from the top of a tower. The ball reaches the ground in** $5\ \text{seconds}$**. Find the height of the tower and the velocity of the ball with which it strikes the ground.**
  - **Answer:**
    - Time $t = 5\ \text{s}$, $v_i = 0$, $g = 10\ \text{m/s}^2$
    - (a) Height $h = v_i t + \frac{1}{2}gt^2 = 0 + \frac{1}{2}(10)(5)^2 = 5 \times 25 = \mathbf{125}\ \text{m}$.
    - (b) Final velocity $v_f = v_i + gt = 0 + (10 \times 5) = \mathbf{50}\ \text{m/s}$.
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- **2.10. A cricket ball is hit so that it travels straight up in the air. An observer notes that it took** 3 seconds **to reach the highest point. What was the initial velocity of the ball? If the ball was hit** 1 m **above the ground, how high did it rise from the ground?**

  - **Answer:**

    - Time to highest point $t = 3$ s, final velocity at top $v_f = 0$, $g = 10$ m/s^2 (downward).
    - (a) Initial velocity: $v_f = v_i - gt \Rightarrow 0 = v_i - (10 \times 3) \Rightarrow \mathbf{v_i = 30}$ m/s.
    - (b) Maximum height above release point: $h = v_i t - \frac{1}{2}gt^2 = (30 \times 3) - \frac{1}{2}(10)(3)^2 = 90 - 45 = 45$ m.
    - Total height from ground $= 45$ m $+ 1$ m $= \mathbf{46}$ m.

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