

Name: _____ Date: _____

Answer Key: Predicting the Unseen: Advanced Kinematics for 10th Grade

Calculate terminal velocities and relative motion vectors within non-inertial frames of reference to solve complex trajectory challenges.

1. A drone is flying due North at 15 m/s relative to the air. A crosswind is blowing due East at 8 m/s. What is the magnitude of the drone's resultant velocity relative to an observer on the ground?

Answer: A) 17 m/s

Resultant velocity is the vector sum of the drone's velocity and the wind velocity. Using the Pythagorean theorem ($\sqrt{15^2 + 8^2}$), the magnitude is 17 m/s.

2. If an object's velocity-time graph is a horizontal line above the x-axis, the object's acceleration is non-zero and constant.

Answer: B) False

A horizontal line on a v-t graph indicates constant velocity, meaning the slope (acceleration) is zero.

3. An experimental maglev train starts from rest and accelerates uniformly at 4.0 m/s^2 . The distance it covers during the 5th second of its motion is _____ meters.

Answer: C) 18.0 m

The distance in the nth second is calculated by $s_n = u + a/2(2n - 1)$. Here, $0 + 4/2(2 \cdot 5 - 1) = 2(9) = 18$ meters.

4. A projectile is launched at an angle across level ground. At the peak of its trajectory, which of the following statements regarding its velocity (v) and acceleration (a) is true?

Answer: C) v is horizontal, a is downward

At the peak, vertical velocity is zero but horizontal velocity remains. Gravity (acceleration) still acts downward at 9.8 m/s^2 .

5. A spacecraft decelerates from 100 m/s to 40 m/s over a displacement of 420 meters. The constant acceleration of the craft during this period is _____ m/s^2 .

Answer: B) -10.0

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Using $v^2 = u^2 + 2as$: $40^2 = 100^2 + 2(a)(420)$. $1600 = 10000 + 840a$. $-8400 = 840a$, so $a = -10 \text{ m/s}^2$.

6. In a vacuum, a heavy lead sphere and a light feather dropped from the same height will have the same instantaneous velocity at any point during their fall.

Answer: A) True

In the absence of air resistance, all objects accelerate at the same rate (g) regardless of mass, resulting in identical velocities.

7. Two cars, A and B, are moving in the same direction. Car A travels at 25 m/s and Car B travels at 15 m/s. What is the velocity of Car A relative to Car B?

Answer: B) 10 m/s

Relative velocity is $V_{ab} = V_a - V_b$. Thus, $25 - 15 = 10 \text{ m/s}$.

8. A particle moves such that its position is defined by $x = 3t^2 + 2t + 5$. The instantaneous velocity of the particle at $t = 3$ seconds is _____ m/s.

Answer: A) 20

Velocity is the first derivative of position: $v(t) = 6t + 2$. At $t=3$, $v = 6(3) + 2 = 20 \text{ m/s}$.

9. An object moving with a constant speed can still be undergoing acceleration.

Answer: A) True

Acceleration is a change in velocity. Since velocity is a vector, changing direction (like in uniform circular motion) constitutes acceleration even if speed is constant.

10. A ball is thrown vertically upward with an initial speed of 29.4 m/s. Taking $g = 9.8 \text{ m/s}^2$, how much time passes before it returns to the thrower's hand?

Answer: C) 6 seconds

Time to peak is $t = v/g = 29.4 / 9.8 = 3$ seconds. Total flight time (up and down) is double that: 6 seconds.