Acceleration 2

Use the acceleration equations on the Reference Table to answer the following questions. Show all work on your notebook, including formulas with substitution, significant figures and units.

Average velocity

1. A skater increases her velocity from 2.0 m/s to 10.0 m/s in 3.0 s. What is her average velocity during this time interval?

\[ \bar{v} = \frac{V_i + V_f}{2} = \frac{2.0 \text{ m/s} + 10.0 \text{ m/s}}{2} = 6.0 \text{ m/s} \]

2. While traveling along the highway a driver slows down from 24 m/s to 15 m/s in 12 s. What is the driver’s average velocity?

\[ \bar{v} = \frac{V_i + V_f}{2} = \frac{24 \text{ m/s} + 15 \text{ m/s}}{2} = \frac{39 \text{ m/s}}{2} \approx 19.5 \text{ m/s} \]

3. A helicopter is going east and its speed increases from 25 m/s to 60 m/s in 5.0 s. What is the magnitude and direction of the helicopter’s average velocity?

\[ \bar{v} = \frac{V_i + V_f}{2} = \frac{25 \text{ m/s} + 60 \text{ m/s}}{2} = 42.5 \text{ m/s east} \]

Velocity and Displacement

4. A plane starting at rest at one end of the runway undergoes a uniform acceleration of 4.8 m/s² for 15 s before takeoff. What is its speed at takeoff? How long must the runway be for the plane to be able to take off?

\[ v_i = 0 \text{ (at rest)} \]

\[ a = 4.8 \text{ m/s}^2 \]

\[ t = 15 \text{ s} \]

\[ v_f = ? \]

\[ v_f = v_i + at \]

\[ v_f = 0 + 4.8 \text{ m/s} \cdot 15 \text{ s} \]

\[ v_f = 72 \text{ m/s} \]

\[ d = v_i t + \frac{1}{2} at^2 \]

\[ d = 0 \text{ m} + \frac{1}{2} (4.8 \text{ m/s}^2)(15 \text{ s})^2 \]

\[ d = 540 \text{ m} \]

\[ d = \bar{v} \cdot \bar{t} \]

\[ d = \frac{0 + 72}{2} \cdot 15 \text{ s} \]

\[ d = 540 \text{ m} \]

\[ d = 36 \text{ m/s} \cdot 15 \text{ s} \]

\[ d = 540 \text{ m} \]
5. A car with an initial speed of 6.5 m/s accelerates at a uniform rate of 0.92 m/s² for 3.6 s. Find the final speed and displacement of the car during this time.

\[ v_f = v_i + at = 6.5 \text{ m/s} + 0.92 \frac{\text{m}}{\text{s}^2} (3.6 \text{ s}) \]

\[ v_f = 9.8 \text{ m/s} \]

\[ d = \frac{1}{2} at^2 = \frac{1}{2} (0.92 \frac{\text{m}}{\text{s}^2}) (3.6 \text{ s})^2 \]

\[ d = 29 \text{ m} \]

6. An automobile with an initial speed of 4.30 m/s accelerates at the rate of 3.00 m/s² after 5.00 s. Find the final speed and displacement.

\[ v_f = v_i + at = 4.30 \text{ m/s} + 3.00 \frac{\text{m}}{\text{s}^2} (5.00 \text{ s}) \]

\[ v_f = 19.3 \text{ m/s} \]

\[ d = \frac{1}{2} at^2 = \frac{1}{2} (3.00 \frac{\text{m}}{\text{s}^2}) (5.00 \text{ s})^2 \]

\[ d = 59 \text{ m} \]

7. A car starts from rest and travels for 5.0 s with a constant acceleration of -1.5 m/s². What is the final velocity of the car after this time interval?

\[ v_f = v_i + at = 0 + (-1.5 \frac{\text{m}}{\text{s}^2}) (5.0 \text{ s}) \]

\[ v_f = -7.5 \text{ m/s} \]

\[ d = \frac{1}{2} at^2 = \frac{1}{2} (-1.5 \frac{\text{m}}{\text{s}^2}) (5.0 \text{ s})^2 \]

\[ d = 19 \text{ m} \]

8. A driver of a car traveling at 15.0 m/s applies the brakes, causing a uniform acceleration of -2.0 m/s². How long does it take the car to accelerate to a speed of 10.0 m/s? How far has the car moved during the braking period?

\[ t = \frac{v_f - v_i}{a} = \frac{10.0 \text{ m/s} - 15.0 \text{ m/s}}{-2.0 \frac{\text{m}}{\text{s}^2}} \approx 2.5 \text{ s} \]

\[ d = \frac{1}{2} at^2 = \frac{1}{2} (-2.0 \frac{\text{m}}{\text{s}^2}) (2.5 \text{ s})^2 \]

\[ d = 31 \text{ m} \]

9. A person pushing a stroller starts from rest, uniformly accelerating at a rate of 0.500 m/s². What is the velocity of the stroller after it has traveled 4.75 m? What is the velocity if the stroller has traveled 6.32 m?

\[ v_f^2 = v_i^2 + 2ad \]

\[ d = 4.75 \text{ m} \]

\[ v_f^2 = (0.0 \text{ m/s})^2 + 2(0.500 \frac{\text{m}}{\text{s}^2})(4.75 \text{ m}) \]

\[ v_f = \sqrt{4.75 \frac{\text{m}}{\text{s}}^2} \approx 2.18 \text{ m/s} \]

\[ d = 6.32 \text{ m} \]

\[ v_f = \sqrt{6.32 \frac{\text{m}}{\text{s}}^2} \approx 2.51 \text{ m/s} \]
10. A car traveling initially +7.0 m/s accelerates uniformly at the rate of +0.80 m/s² for a distance of 245 m.

\[ V_i = +7.0 \text{ m/s} \]
\[ a = +0.80 \text{ m/s}^2 \]
\[ d = 245 \text{ m} \]

\[ V_f = ? \]
\[ V_f^2 = V_i^2 + 2ad \]
\[ V_f^2 = (7.0 \text{ m/s})^2 + 2(0.80 \text{ m/s}^2)(245 \text{ m}) \]
\[ V_f = 21 \text{ m/s} \]

a. What is its velocity at the end of the acceleration?

b. What is its velocity after it accelerates for 125 m?

\[ V_f^2 = V_i^2 + 2ad \]
\[ V_f^2 = (7.0 \text{ m/s})^2 + 2(0.80 \text{ m/s}^2)(125 \text{ m}) \]
\[ V_f = 16 \text{ m/s} \]

c. What is its velocity after it accelerates for 67 m?

\[ V_f^2 = V_i^2 + 2ad \]
\[ V_f^2 = (7.0 \text{ m/s})^2 + 2(0.80 \text{ m/s}^2)(67 \text{ m}) \]
\[ V_f = 12.497 \text{ m/s} \approx 12 \text{ m/s} \]

11. A car accelerates uniformly in a straight line from rest at the rate of 2.3 m/s².

\[ V_i = 0.0 \text{ m/s} \]
\[ a = 2.3 \text{ m/s}^2 \]
\[ d = 55 \text{ m} \]

\[ V_f = ? \]
\[ V_f^2 = V_i^2 + 2ad \]
\[ V_f^2 = (0.0 \text{ m/s})^2 + 2(2.3 \text{ m/s}^2)(55 \text{ m}) \]
\[ V_f = 16 \text{ m/s} \]

b. How long does it take the car to travel 55 m?

\[ V_f = V_i + at \]
\[ t = \frac{V_f - V_i}{a} \]
\[ t = \frac{16 - 0.0}{2.3} \text{ s} \approx 7.0 \text{ s} \]

12. A motorboat accelerates uniformly from a velocity of 6.5 m/s to the west to a velocity of 1.5 m/s to the west. If its acceleration was 2.7 m/s² to the east, how far did it travel during the acceleration?

\[ V_i = 6.5 \text{ m/s} \text{ W} \]
\[ V_f = 1.5 \text{ m/s} \text{ W} \]
\[ a = 2.7 \text{ m/s}^2 \text{ E} \]
\[ a = -2.7 \text{ m/s}^2 \]

\[ V_f^2 = V_i^2 + 2ad \]
\[ \left(1.5 \text{ m/s}\right)^2 = (6.5 \text{ m/s})^2 + 2(-2.7 \text{ m/s}^2)d \]
\[ 2.25 \text{ m}^2/\text{s}^2 = 42.25 \text{ m}^2/\text{s}^2 - 5.4 \text{ m/s}^2 \cdot d \]
\[ d = -40 \text{ m} \approx 7.4 \text{ m} \]