1.2 Equations of Motion

Textbook pp. 17–21

Vocabulary

free fall

MAIN IDEA: The five key equations for uniformly accelerated motion involve the variables: displacement, initial velocity, final velocity, acceleration, and time interval.

STUDY TIP

Develop an Equation Organizer

As you work through this course, organize key equations on a separate page. Be sure to include where the equations apply.

Equations for Uniformly Accelerated Motion

	Equation
1	$\Delta\vec{d} = \left(\frac{\vec{v}_f + \vec{v}_i}{2}\right)\Delta t$
2	$\vec{v}_f = \vec{v}_i + \vec{a}_{av}\Delta t$
3	$\Delta\vec{d} = \vec{v}_i\Delta t + \frac{1}{2}\vec{a}_{av}\Delta t^2$
4	$v_f^2 = v_i^2 + 2a_{av}\Delta d$
5	$\Delta\vec{d} = \vec{v}_f\Delta t - \frac{1}{2}\vec{a}_{av}\Delta t^2$

These equations only apply to a body with a constant acceleration.

1. **Figure 1** shows the velocity–time graph for a motorcyclist heading north. Explain how you can determine the displacement of the motorcyclist from the velocity–time graph. Provide several methods. Use one method to determine the displacement.

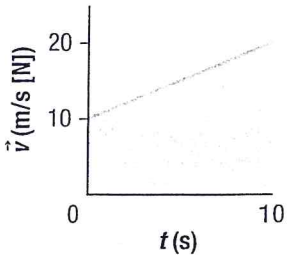

Figure 1

2. An oil tanker sailing west has an engine problem. It coasts to a stop in 0.50 h, moving 10 km in a straight line. What is the average acceleration of the ship?

3. While driving on a slippery road at 15.0 m/s [E], the driver applies the brakes to come to a stop. The braking system limits the acceleration to 0.200 m/s^2 [W] or causes a deceleration of −0.200 m/s^2 [W]. Determine the stopping distance for the car.

4. A toy car at the 0 cm mark on a metre stick moves toward the 100 cm mark at a constant speed of 5.0 cm/s. Another toy car starts at the 100 cm mark at the same time, accelerating toward the 0 cm mark at 1.0 m/s^2. How long will it take for the two cars to collide?

MAIN IDEA: Free fall is the motion of an object when it is moving only under the influence of gravity. The acceleration due to gravity at the surface of the Earth is 9.8 m/s^2 [down].

5. A ball launcher on the ground is aimed straight up, and it launches a baseball with an initial velocity of 49.0 m/s [up]. The ball continues upward to a stop, and then falls until caught by a player leaning out of a window 78.4 m above the ground. How long is the ball in the air before the player catches it?

6. While flying her helicopter in a hovering position 40.0 m above the ground, the pilot threw a rope with an initial velocity of 4.00 m/s [down]. What is the speed of the rope at the instant that it hits the ground?