

Kinematic Problems – Freefall

$$d=vt \quad v_f = v_i + at \quad d = v_i t + \frac{1}{2}at^2$$

1) A(n) \_\_\_\_\_ is dropped. It lands 8 s later. How far did it fall?

$$\begin{aligned} v_i &= 0 \text{ m/s} & d &= v_i t + \frac{1}{2}at^2 \\ a &= 9.8 \text{ m/s}^2 & d &= 0 + \frac{1}{2}(9.8)(8)^2 \\ t &= 8 \text{ s} & d &= 4.9(64) = \boxed{313.6 \text{ m}} \\ d &= ? & & \end{aligned}$$

2) A(n) \_\_\_\_\_ is dropped. It lands 4 s later. How far did it fall?

$$\begin{aligned} v_i &= 0 \text{ m/s} & d &= v_i t + \frac{1}{2}at^2 \\ a &= 9.8 \text{ m/s}^2 & d &= \frac{1}{2}at^2 \\ t &= 4 \text{ s} & d &= \frac{1}{2}(9.8)(4)^2 = \boxed{78.4 \text{ m}} \\ d &= ? & & \end{aligned}$$

3) A ball is dropped from a height of 35 m. How long did it take to land?

$$\begin{aligned} v_i &= 0 \text{ m/s} & d &= v_i t + \frac{1}{2}at^2 \\ d &= 35 \text{ m} & 35 &= \frac{1}{2}(9.8)t^2 \\ a &= 9.8 \text{ m/s}^2 & 35 &= 4.9t^2 \\ t &= ? & \frac{35}{4.9} &= t^2 = 7.14 \\ & & & t = \sqrt{7.14} \\ & & & \boxed{t = 2.67 \text{ s}} \end{aligned}$$

4) A stapler is dropped from a height of 2900 cm. How long did it take to land?

$$\begin{aligned} d &= 2900 \text{ cm} & d &= v_i t + \frac{1}{2}at^2 \\ d &= 29 \text{ m} & 29 &= \frac{1}{2}(9.8)t^2 \\ a &= 9.8 \text{ m/s}^2 & 29 &= 4.9t^2 \\ v_i &= 0 \text{ m/s} & \frac{29}{4.9} &= t^2 = 5.92 \\ t &= ? & & t = \sqrt{5.92} \\ & & & \boxed{t = 2.43 \text{ s}} \end{aligned}$$

5) Mr. \_\_\_\_\_ is fired into the air at a speed of 300 m/s. How long does it take for him to reach his high point?

$$\begin{aligned} v_i &= 300 \text{ m/s} & v_f &= v_i + at \\ a &= -9.8 \text{ m/s}^2 & 0 &= 300 + (-9.8)t \\ v_f &= 0 \text{ m/s} & -300 &= -9.8t \\ t &= ? & \frac{-300}{-9.8} &= t = 30.6 \text{ s} \end{aligned}$$

6) How high did the person in problem 5 go?

$$d = vt$$

$$d = \left(\frac{0 + 300}{2}\right)(30.6) = (150)(30.6) = 4590$$

$$4.59 \times 10^3 \text{ m}$$

7) An object is fired into the air at a speed of 50 m/s. How long does it take to reach its high point?

$$v_i = 50 \frac{\text{m}}{\text{s}}$$

$$a = -9.8 \text{ m/s}^2$$

$$v_f = 0$$

$$t = ?$$

$$v_f = v_i + at$$

$$0 = 50 + (-9.8)t$$

$$-50 = -9.8t$$

$$\frac{-50}{-9.8} = t = 5.10 \text{ s}$$

8) How high did the object go?

$$d = vt$$

$$d = \left(\frac{50 + 0}{2}\right)(5.10) = 127.5 \text{ m}$$

9) An object is fired straight into the air at 400 m/s. How high does it go?

$$v_i = 400 \text{ m/s}$$

$$a = -9.8 \text{ m/s}^2$$

$$v_f = 0$$

$$t = ?$$

$$v_f = v_i + at$$

$$0 = 400 + (-9.8)t$$

$$-400 = -9.8t$$

$$\frac{-400}{-9.8} = t = 40.8 \text{ s}$$

$$d = vt$$

$$d = \left(\frac{0 + 400}{2}\right)(40.8)$$

$$d = (200)(40.8) = 8160$$
$$8.16 \times 10^3 \text{ m}$$

10) An object was thrown straight down from a platform at an initial speed of 15 m/s. It hit the ground 2.4 s later. How high is the platform?

$$v_i = 15 \frac{\text{m}}{\text{s}}$$

$$t = 2.4 \text{ s}$$

$$a = 9.8 \text{ m/s}^2$$

$$d = ?$$

$$d = v_i t + \frac{1}{2} a t^2$$

$$d = (15)(2.4) + \frac{1}{2}(9.8)(2.4)^2$$

$$d = 36 + 28.2 = 64.2 \text{ m}$$

Answers 1) 313.6 m 2) 78.4 m 3) 2.67 s 4) 2.43 s 5) 30.6 s 6)  $4.59 \times 10^3 \text{ m}$

7) 5.10 s 8) 127.5 m 9)  $8.16 \times 10^3 \text{ m}$  10) 64.2 m