Free Fall

Conceptual Questions

1. If an object is accelerating, the velocity of the object (**CHANGES**, ~~STAYS THE SAME~~)

2. An object is thrown upwards. The velocity of the object at its highest point is _**ZERO**__.

3. If the object had a zero velocity, would the object be moving? (~~YES~~, **NO**)

4. A ball is thrown straight up in the air.
   (a) Is the velocity changing before it is at its highest point? (**YES**, ~~NO~~)
   (b) Is the velocity changing after it is at its highest point? (**YES**, ~~NO~~)
   (c) Is the velocity changing at its highest point? (**YES**, ~~NO~~)
   (d) Is the object accelerating at its highest point? (**YES**, ~~NO~~).

5. You stand on a table and throw a ball up at a speed of 10.0 m/s. Your friend is lying on the floor and catches the ball. Just before your friend catches the ball, the ball is moving (~~THE SAME SPEED~~, **FASTER THAN**, ~~SLOWER THAN~~) you threw it.

Free fall

Problems

① (a) $v_i = 6.0\ m/s$
$a = -9.8\ m/s^2$
$d = 0$
$t = ?$

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

$t = \frac{-2v_i}{a}$

$= \frac{-2(6.0)}{-9.8}$

$t = 1.2\ s$

(b) $v_i = 6.0\ m/s$
$a = -9.8\ m/s^2$
$v_f = 0$
$t = ?$

$v_f = v_i + at$

$t = \frac{v_f - v_i}{a}$

$= \frac{-6.0}{-9.8}$

$t = 0.61\ s$

② (a) $v_i = 0$
$a = -9.8\ m/s^2$
$t = 1.5\ s$
$d = ?$

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

$= \frac{1}{2}(-9.8)(1.5)^2$

$= -11.0\ m$

∴ the bridge is 11.0 m high.

(b) $v_i = 0$
$a = -9.8\ m/s^2$
$t = 1.5\ s$
$v_f = ?$

$v_f = v_i + at$

$= -9.8(1.5)$

$= -14.7\ m/s$

14.7 m/s downward.

(3) (a) $v_i = 0$

$a = -1.62\ m/s^2$

$d = -0.95\ m$

$v_f = ?$

$v_f^2 = v_i^2 + 2ad$

$v_f = \sqrt{2(-1.62)(-.95)}$

$v_f = 1.75\ m/s$

1.75 m/s down.

(b) $v_i = 0$

$a = -1.62\ m/s^2$

$d = -0.95\ m$

$t = ?$

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

$t = \sqrt{\frac{2d}{a}}$

$= \sqrt{\frac{2(-0.95)}{-1.62}}$

$t = 1.085$

(4) $v_i = 30.0\ m/s$

$v_f = 0$

$a = -9.8\ m/s^2$

$d = ?$

$v_f^2 = v_i^2 + 2ad$

$d = \frac{v_f^2 - v_i^2}{2a}$

$= \frac{-(30)^2}{2(-9.8)}$

$d = 45.9\ m$

(5) $v_i = -100.0\ m/s$

$a = -9.8\ m/s^2$

$t = 1.0\ s$

$v_f = ?$

$v_f = v_i + at$

$= -100 + (-9.8)(1)$

$= -109.8\ m/s$

109.8 m/s down

(6) $a = -9.8\ m/s^2$

$t = 10.0\ s$

$d = 0$

$v_i = ?$

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

$v_i = -\frac{1}{2}at$

$= -\frac{1}{2}(-9.8)(10)$

$v_i = 49\ m/s$

(7) Ball A

$v_i = 40\ m/s$

$a = -9.8\ m/s^2$

$d = -20\ m$

$v_f = ?$

$v_f^2 = v_i^2 + 2ad$

$v_f = \sqrt{(40)^2 + 2(-9.8)(-20)}$

$v_f = 44.6\ m/s$ down

Ball B

$v_i = 0$

$a = -9.8\ m/s^2$

$d = -20m$

$v_f = ?$

$v_f^2 = v_i^2 + 2ad$

$v_f = \sqrt{2(-9.8)(-20)}$

$v_f = 19.8\ m/s$ down

Ball C

$v_i = -20\ m/s$

$a = -9.8\ m/s^2$

$d = -20m$

$v_f = ?$

$v_f^2 = v_i^2 + 2ad$

$v_f^2 = \sqrt{(-20)^2 + 2(-9.8)(-20)}$

$v_f = 28.1\ m/s$ down

Ball A is traveling fastest

(8) (a) $v_i = 20\ m/s$

$v_f = 10\ m/s$

$a = -9.8\ m/s^2$

$t = ?$

$$v_f = v_i + at$$

$$t = \frac{v_f - v_i}{a}$$

$$= \frac{10 - 20}{-9.8}$$

$$t = 1.02\ s$$

(b) $v_i = 20\ m/s$

$v_f = -10\ m/s$

$a = -9.8\ m/s^2$

$t = ?$

$$v_f = v_i + at$$

$$t = \frac{v_f - v_i}{a}$$

$$= \frac{-10 - 20}{-9.8}$$

$$t = 3.06\ s$$

(9) (a) $a = -9.8\ m/s^2$

$d = -50\ m$

$t = 5\ s$

$v_i = ?$

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

$$v_i = \frac{d - \frac{1}{2}at^2}{t}$$

$$= \frac{-50 - \frac{1}{2}(-9.8)(5)^2}{5}$$

$$v_i = 14.5\ m/s \ (up)$$

9(b) $v_f = 0$

$a = -9.8\ m/s^2$

$v_i = 14.5\ m/s$

$d = ?$

$$v_f^2 = v_i^2 + 2ad$$

$$d = \frac{v_f^2 - v_i^2}{2a}$$

$$= \frac{-(14.5)^2}{2(-9.8)}$$

$d = 10,7\ m$

(10) throws

$v_i = ?$

$a = -9.8\ m/s$

$t = 3.0\ s$

$d = -78.4\ m$

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

$$v_i = \frac{d - \frac{1}{2}at^2}{t}$$

$$= \frac{-78.4 - \frac{1}{2}(-9.8)(3)^2}{3}$$

$v_i = -11.4\ m/s$

11.4 m/s down

drops

$v_i = 0$

$a = -9.8\ m/s^2$

$t = 4.0\ s$

$d = ?$

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

$$= \frac{1}{2}(-9.8)(4.0)^2$$

$$= -78.4\ m$$