

Free Fall

① a) $a = -9.8 \text{ m/s}^2$

b) No. Since a and v are in the same direction (down) it is speeding up.

c) $v_i = -9 \text{ m/s}$ $d = ?$
 $t = 0.50 \text{ s}$

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

$$= (-9)(0.5) + \frac{1}{2}(-9.8)(0.5)^2$$

$$d = \boxed{-5.725 \text{ m}}$$

② $v_i = 0$ $v_f = ?$
 $a = -9.8 \text{ m/s}^2$
 $d = -99.4 \text{ m}$

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

$$= 0^2 + 2(-9.8)(-99.4)$$

$$v_f^2 = 1948.24$$

$$v_f = \boxed{-44.1 \text{ m/s}}$$

③

Up

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

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

$$v_f = 0$$

$$t = ?$$

$$v_f = v_i + at$$

$$0 = (15) + (-9.8)t$$

$$t = 1.53 \text{ s}$$

$$\text{Total time} = 2(1.53) = \boxed{3.06 \text{ s}}$$

④

$$v_i = 5 \text{ m/s}$$

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

$$v_f = 0$$

$$d = ?$$

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

$$0^2 = 5^2 + 2(-9.8)d$$

$$d = \boxed{1.28 \text{ m}}$$

⑤

$$v_i = 0$$

$$d = -6 \text{ m}$$

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

$$t = ?$$

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

$$-6 = (0)t + \frac{1}{2}(-9.8)t^2$$

$$-6 = -4.9 t^2$$

$$t = \boxed{1.11 \text{ s}}$$

⑥

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

$$t = 8 \text{ s}$$

$$d = 0 \text{ (starts and ends at same place)}$$

$$v_i = ?$$

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

$$0 = v_i (8) + \frac{1}{2}(-9.8)(8)^2$$

$$0 = 8v_i - 313.6$$

$$v_i = \boxed{39.2 \text{ m/s}}$$

⑦ a)

$$v_i = 1.8 \text{ m/s}$$

$$d = -3 \text{ m}$$

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

$$v_f = 0$$

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

$$= 1.8^2 + 2(-9.8)(-3)$$

$$v_f^2 = 62.04$$

$$v_f = \boxed{-7.88 \text{ m/s}}$$

b)

Up

$$v_i = 1.8 \text{ m/s}$$

$$v_f = 0$$

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

$$d = ?$$

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

$$0^2 = 1.8^2 + 2(-9.8)d$$

$$0 = 3.24 - 19.6d$$

$$d = 0.165 \text{ m}$$

$$\text{Above water} = 3 + 0.165 = \boxed{3.165 \text{ m}}$$

8

$$d = 16 \text{ m}$$

$$v_f = 0$$

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

$$v_i = ?$$

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

$$0^2 = v_i^2 + 2(-9.8)(16)$$

$$0 = v_i^2 - 313.6$$

$$v_i = 17.7 \text{ m/s}$$

$$d = ?$$

$$v_f = 17.7 / 2 = 8.85 \text{ m/s}$$

$$v_i = 17.7 \text{ m/s}$$

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

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

$$8.85^2 = 17.7^2 + 2(-9.8)d$$

$$78.3 = 313.3 - 19.6d$$

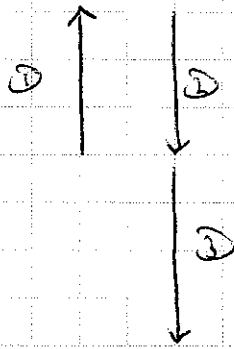
$$-235 = -19.6d$$

$$d = \boxed{12 \text{ m}}$$

⑨

Gun A

Gun B



The time for part 3 of Gun A will be the same as the time for all of Gun B. Thus, the difference can be found by determining the time for part 1 and 2 of Gun A.

Part 1

$$v_i = 30 \text{ m/s}$$

$$v_f = 0$$

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

$$t = ?$$

$$v_f = v_i + at$$

$$0 = 30 - 9.8t$$

$$t = 3.06 \text{ s}$$

Part 2

$$t = 3.06 \text{ s (mirror image of part 1)}$$

$$\text{Total Time} = \boxed{6.12 \text{ s}}$$