MORE UNIFORMLY ACCELERATED MOTION - SOLUTIONS

1. a) SPEEDING UP IN (+) DIRECTION
   GOING EAST, SPEEDING UP
   b) SLOWING DOWN IN (+) DIRECTION
   GOING EAST, SLOWING DOWN
   c) CONSTANT (+) VELOCITY
   GOING EAST AT CONSTANT VELOCITY
   d) SLOWING DOWN IN (−) DIRECTION
   GOING WEST, SLOWING DOWN
   e) SPEEDING UP IN (−) DIRECTION
   GOING WEST, SPEEDING UP
   f) CONSTANT (−) VELOCITY
   GOING WEST AT CONSTANT VELOCITY
   g) STARTS FROM REST, ACCELERATES IN (+)/EAST DIRECTION
   h) STARTS FROM REST, ACCELERATES IN (−)/WEST DIRECTION.

2. $v_i = 60 \frac{km}{h} = 16.\overline{6} \frac{m}{s}$
   $v_f = 0$
   $t = 4.00\ s$
   $d = ?$

$$d = \left(\frac{v_i + \cancel{v_f}^{0}}{2}\right)t$$

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

$$= \left(\frac{16.\overline{6}}{2}\right)(4.00)$$

$$= \boxed{33.3\ m}$$

3. $v_i = 90 \frac{km}{h} = 25 \frac{m}{s}$

$v_f = 0$

$d = 0.80\ m$

$a = ?$

$v_f^2 = v_i^2 + 2ad$ ($v_f = 0$)

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

$= -\frac{25^2}{2(0.80)}$

$= \boxed{-391\ m/s^2}$

$= \boxed{39.9\ g's}$

4. a) ↑ (+)

$v_i = +25\ m/s$

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

$v_f = 0$

$d = ?$

$v_f^2 = v_i^2 + 2ad$ ($v_f = 0$)

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

$= -\frac{(25)^2}{2(-9.8)}$

$= \boxed{31.9\ m}$

b) $+\uparrow$

$v_i = +25\ m/s$

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

$d = 0$

$v_f = -25\ m/s$

$t = ?$

ONLY NEED THREE

$d = v_i t + \frac{1}{2}at^2$ (d = 0)

$0 = t\left(v_i + \frac{1}{2}at\right)$

$t = 0$ REJECT

$v_i + \frac{1}{2}at = 0$

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

$= \frac{-2(25)}{(-9.8)}$

$= \boxed{5.10\ s}$

CAN ALSO FIND TIME TO REACH MAX HEIGHT AND DOUBLE.

5. $+\uparrow$

$v_i = +5.40\ m/s$

$d = -105\ m$

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

$v_f = ?$

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

$v_f = \pm\sqrt{v_i^2 + 2ad}$

$= \pm\sqrt{(5.40)^2 + 2(-9.8)(-105)}$

$= \pm 45.7\ m/s$

VELOCITY IS DOWN (NEGATIVE) BUT ONLY NEED MAGNITUDE FOR SPEED.

$\boxed{45.7\ m/s}$

6. $v_i = 0$

$v_f = 30\ m/s$

$a = 3.0\ m/s^2$

$d = ?$

$v_f^2 = v_i^2 + 2ad$ ($v_i = 0$)

$d = \dfrac{v_f^2}{2a}$

$= \dfrac{30^2}{2(3.0)}$

$= \boxed{150\ m}$

7. a) ↑ (+)

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

$t = 3.3\ s$

$d = 0$

$v_i = ?$

$d = v_i t + \frac{1}{2} a t^2$ ($d = 0$)

$0 = v_i t + \frac{1}{2} a t^2$

$v_i = -\dfrac{at}{2}$

$= -\dfrac{(-9.8)(3.3)}{2}$

$= 16.17\ \frac{m}{s}$ $\quad \boxed{16.2\ \frac{m}{s}}$

CAN ALSO USE $v_f = -v_i$. OR CAN USE $v_f = 0$ AT $t = \frac{3.3}{2}\ s$ (MAX HEIGHT).

b) ↑ (+)

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

$t = \frac{3.3}{2} = 1.65\ s$

$v_f = 0$

$v_i = +16.17\ m/s$

$d = ?$

ONLY NEED THREE

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

$= (16.17)(1.65) + \frac{1}{2}(-9.8)(1.65)^2$

$= \boxed{13.3\ m}$

8. a)

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

$d = -1.8\ m$

$t = 2.5\ s$

$v_i = ?$

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

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

$$= \frac{(-1.8) - \frac{1}{2}(-9.8)(2.5)^2}{2.5}$$

$$= \boxed{11.5\ m/s}$$

WHILE IT IS POSSIBLE TO SOLVE BY FINDING MAX HEIGHT, IT IS NOT NECESSARY TO DO THAT.

9. a)

$v_i = 0$

$a = +3.2\ m/s^2$

$d = +775\ m/s$

$v_f = ?$

$$v_f^2 = \cancel{v_i^2}^{\,0} + 2ad$$

$$v_f = \pm\sqrt{2ad}$$

$$= \pm\sqrt{2(3.2)(775)}$$

REJECT NEGATIVE

$$= \cancel{\pm}\ 70.4\ m/s$$

$$= \boxed{+70.4\ m/s}$$

UP

b)

$v_i = 0$

$a = +3.2\ m/s^2$

$d = +775\ m/s$

$v_f = +70.4\ m/s$

$t = ?$

ONLY NEED THREE

$$d = \cancel{v_i t}^{\,0} + \frac{1}{2}at^2$$

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

$$= \sqrt{\frac{2(775)}{3.2}}$$

$$= \boxed{22.0\ s}$$

c) 

$v_i = 70.4\ m/s$

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

$v_f = 0$

$d = ?$

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

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

$= \frac{-(70.4)^2}{2(-9.8)}$

$= 253\ m$

$d_T = d_1 + d_2$

$= 775 + 253$

$= \boxed{1028\ m}$

d) 

$v_i = 70.4\ m/s$

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

$v_f = 0$

$d = +253\ m$

$t = ?$

ONLY NEED THREE

$v_f = v_i + at$

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

$= \frac{-70.4}{9.8}$

$= 7.19\ s$

$t_{TOT} = t_1 + t_2$

$= 22.0 + 7.19$

$= \boxed{29.2\ s}$

e) $v_i = 0$

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

$d = -1028\ m$

$v_f = ?$

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

$v_f = \pm\sqrt{2ad}$

$= \pm\sqrt{2(-9.8)(-1028)}$

REJECT POSITIVE

$= \pm 142\ \frac{m}{s}$

$= \boxed{-142\ \frac{m}{s}}$

DOWN

f) $v_i = 0$

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

$d = -1028\ m$

$v_f = -142\ m/s$

$t = ?$

ONLY NEED THREE

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

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

$= \sqrt{\frac{2(-1028)}{-9.8}}$

$= 14.5\ s$

$t_{tot} = t_1 + t_2 + t_3$

$= 22.0 + 7.19 + 14.5$

$= \boxed{43.7\ s}$

10. a)

$v_i = +20\ m/s$

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

$d = -100\ m$

$t = ?$

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

$-100 = 20t + \frac{1}{2}(-9.8)t^2$

$0 = \underbrace{4.9}_{a} t^2 \underbrace{-20}_{b} t \underbrace{-100}_{c}$

$$t = \frac{20 \pm \sqrt{(-20)^2 - 4(4.9)(-100)}}{2(4.9)}$$

REJECT

$= -2.92\ s$, $\boxed{7.00\ s}$

CAN AVOID QUADRATIC FORMULA BY SPLITTING INTO PARTS (UPWARDS AND DOWNWARDS)

b) $\boxed{20\ m/s \text{ DOWN}}$ OR 20 m/s IN ANY DIRECTION

c)

$v_i = +20\ m/s$

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

$v_f = 0$

$t = ?$

$v_f = v_i + at$ ($v_f = 0$)

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

$= \frac{-(20)}{-9.8}$

$= 2.04\ s$

BY SYMMETRY, THE ROCK IS AT THE SAME HEIGHT 0.5 s BEFORE AND AFTER 2.04 s.

$\boxed{1.54\ s - 2.54\ s}$

11. ADIN:

$v_A = 4.0\ s$ $\quad d_A = v_A t_A$

$t_A = ?$

$d_A = ?$

BRAD:

$a_B = 0.80\ m/s^2$

$v_{iB} = 0$

$t_B = t_A - 5\ s$

$d_B = d_A = ?$

$d_B = \cancel{v_{iB}}^{0} t_B + \frac{1}{2} a_B t_B^2$

$= \frac{1}{2} a_B t_B^2$

$= \frac{1}{2} a_B (t_A - 5.0)^2$

$d_A = d_B$

$v_A t_A = \frac{1}{2} a_B (t_A - 5)^2$

$v_A t_A = \frac{1}{2} a_B (t_A^2 - 10 t_A + 25)$

$v_A t_A = \frac{1}{2} a_B t_A^2 - 5 a_B t_A + 12.5 a_B$

$0 = \frac{1}{2} a_B t_A^2 - (v_A - 5 a_B) t_A + 12.5 a_B$

$= \frac{1}{2}(0.80) t_A^2 - \left(4.0 + (5)(0.80)\right) t_A + 12.5(0.80)$

$= \underbrace{0.40}_{a} t_A^2 \ \underbrace{-8.0}_{b} t_A \ \underbrace{+10}_{c}$

$$t_A = \frac{8.0 \pm \sqrt{(-8.0)^2 - 4(0.40)(10)}}{2(0.40)}$$

REJECT AS $t_A > 5\ s$

$= 1.3\ s,$ $\boxed{18.7\ s}$

12. a)

$v_i = 0$

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

$d = +300\ m$

$t_{DOWN} = ?$

$d = \cancel{v_i t_{DOWN}}^{0} + \frac{1}{2} a t_{DOWN}^2$

$t_{DOWN} = \sqrt{\frac{2d}{a}}$

$= \sqrt{\frac{2(300)}{9.8}}$

$= 7.82\ s$

$v = +343\ m/s$

$d = +300\ m$

$t_{up} = ?$

$d = v t_{up}$

$t_{up} = \frac{d}{v}$

$= \frac{300}{343}$

$= 0.875\ s$

$t_{TOT} = t_{DOWN} + t_{up}$

$= 7.82 + 0.875$

$= \boxed{8.70\ s}$

b)

$v_i = 0$

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

$t_{DOWN} = ?$

$d = ?$

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

$= \frac{1}{2} a t_{DOWN}^2$

$v = +343\ m/s$

$t_{up} = t_{TOT} - t_{DOWN} = ?$

$d = ?$

$d = v t_{up}$

$= v(t_{TOT} - t_{DOWN})$

$d_{up} = d_{down}$

$v(t_{TOT} - t_{DOWN}) = \frac{1}{2} a t_{DOWN}^2$

$v t_{TOT} - v t_{DOWN} = \frac{1}{2} a t_{DOWN}^2$

$0 = \frac{1}{2} a t_{DOWN}^2 + v t_{DOWN} - v t_{TOT}$

$= \frac{1}{2}(9.8) t_{DOWN}^2 + 343 t_{DOWN} - (343)(6.35)$

$= \underbrace{4.9}_{a} t_{DOWN}^2 + \underbrace{343}_{b} t_{DOWN} \underbrace{- 2178.05}_{c}$

$$t_{DOWN} = \frac{-343 \pm \sqrt{(343)^2 - 4(4.9)(-2178.05)}}{2(4.9)}$$

REJECT

$= -75.9\ s,\ \underline{5.86\ s}$

$d = \frac{1}{2} a t_{DOWN}^2$

$= \frac{1}{2}(9.8)(5.86)^2$

$= \boxed{168\ m}$