Homework #2 Solutions

physis 2414

1. $v = \boxed{109\,\text{km/h}} = 109\frac{\text{km}}{\text{hr}} \times \frac{1000\,\text{m}}{1\,\text{km}} \times \frac{1\,\text{hr}}{3600\,\text{s}} = 30.27\,\text{m/s}$

$vt = d = 30.27\frac{\text{m}}{\text{s}} \cdot \boxed{2.0\,\text{s}} = 60.5 = \underline{60.56\,\text{m}}$ (≈ 61)

2. a, avg. speed $= \dfrac{d + \frac{1}{2}d}{t} = \dfrac{140 + \frac{1}{2}140\,\text{m}}{\boxed{11.0 + 4.6}\,\text{s}}$ $\boxed{d = 140\,\text{m}}$

$= \underline{13.46\,\text{m/s}}$

b. avg. velocity : horse is $\boxed{+70\,\text{m}}$ away from trainer at end of journey

avg. $v = \dfrac{70\,\text{m}}{(11.6 + 4.6)\,\text{s}} = \underline{4.49\,\text{m/s} \ + \text{direction}}$

3. time for sound $= \dfrac{\boxed{15.5\,\text{m}}}{340\,\text{m/s}} = 0.0455882\,\text{s}$

time for ball $= \boxed{2.10\,\text{s}} -$ time for sound $= 2.05441\,\text{s}$

ball speed $= \dfrac{15.5\,\text{m}}{\text{time for ball}} = \dfrac{15.5\,\text{m}}{2.05441\,\text{s}} = 7.54474 = \underline{7.545}\,\text{m/s}$

4. $V_{initial} = \dfrac{\boxed{90\,\text{m}}}{\boxed{4.8\,\text{s}}} = 18.75\,\text{m/s}$ deceleration $= \dfrac{V_f - V_i}{\Delta t} = \dfrac{0 - 18.75\,\text{m/s}}{\boxed{4.0\,\text{s}}}$

$a = -4.6875\,\text{m/s}^2$ $g = 9.80\,\text{m/s}^2$

$a = -\dfrac{4.6875}{9.80}g = \underline{-0.478}\,g$

5.

a. acceleration = $\frac{v_f - v_i}{\Delta t}$ = $\frac{\boxed{35 m/s} - \boxed{15 m/s}}{\boxed{7.0 s}}$ = $\underline{2.857 \, m/s^2}$

b. $V_f^2 - V_i^2 = 2a\Delta x$ = $35^2 - 15^2 = 2 \cdot 2.857 \cdot \Delta x$

$\Delta x = \underline{175 \, m}$

6. a. $v_f^2 - v_i^2 = 2a\Delta x$

$V_f = 0$

$V_i = \boxed{47 \frac{km}{h} = 13.0556 \, m/s}$

$a = \boxed{-7.0 \, m/s^2}$

$0^2 - 13.0556^2 = -2 \cdot 7.0 \cdot \Delta x$

$\Delta x = 12.1748 m$

$= \underline{12.17 m}$

b. time before light turns red : $\boxed{2.0 s = t}$

acceleration

$a = \frac{\boxed{70 km/h} - \boxed{47 km/h}}{\boxed{6.9 s}}$

$= 0.925926 \, m/s^2$

$x = x_0 + v_0 t + \frac{1}{2} a t^2$

$x = 0 + 13.0556 t + \frac{1}{2} \cdot 0.925926 t^2$

$= 27.9631 \, m = \underline{27.96 \, m}$

c. <u>stop</u>

7. a. $x = x_0 + v_0 t + \frac{1}{2} g t^2$ assume Kong starts at rest ($v_0 = 0$) (and time at $t=0$)

$x - x_0 = \Delta x = \boxed{370m} = \frac{1}{2} g t^2$ $g = 9.80 m/s^2$

$\frac{2 \cdot 370}{g} = t^2 \longrightarrow t = \sqrt{\frac{2 \cdot 370m}{9.80 m/s^2}} = \underline{8.69 s}$

b. $v = v_0 + gt$ (g down)

$v = gt = 9.8 \times 8.69 = 85.1587$

$= \underline{85.2 m/s \text{ downward}}$

8. a. $x = x_0 + v_0 t + \frac{1}{2} g t^2$ say top of cliff is 0 @ x_0 and v_0 is upwards (positive), g is down (negative). Starts @ $t_0 = 0$.

$\boxed{-59.0} = \boxed{15.0}\, t + -\frac{1}{2} \cdot 9.8 t^2$

$\frac{1}{2} \cdot 9.8 t^2 - 15.0 t - 59.0 \longrightarrow$ Use quadratic eq.

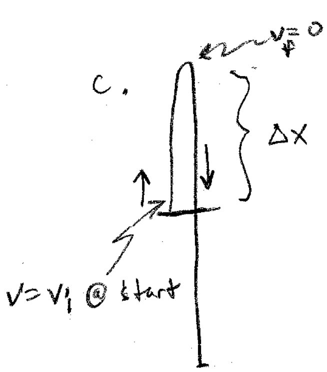
$t = \frac{15.0 \pm \sqrt{15.0^2 + 4 \cdot \frac{1}{2} \cdot 9.8 \cdot 59.0}}{9.8}$

$= \underline{5.32}$, ~~-2.26~~ ← pick positive (negative is meaningless)

b. $v = v_0 + gt = 15.0 - 9.8t$

$= -37.167 m/s \longrightarrow \underline{37.17 m/s}$ (the negative sign indicates downward direction. - we just want speed)

c.



$2 \Delta x g = v_f^2 - v_i^2 = -2 \Delta x 9.8 = 0 - 15^2$

$\Delta x = \frac{15^2}{2 \cdot 9.8} = 11.4796m$

total distance traveled $= 2\Delta x + \text{cliff height}$

$= \underline{81.96 m}$

9. The second stone falls for an interval Δt_2 and acquires speed $\boxed{13\,m/s}$. Stones start at rest ($v_0 = 0$) and time $t=0$

$$V = V_0 + g t_2 = -9.8\,\Delta t_2 = -13\,m/s \quad \rightarrow \quad \Delta t_2 = 1.3265\,s$$

At the time the second stone travels at 13 m/s, the First has already Fallen an extra $\boxed{2.00\,s}$:

$$\Delta t_1 = 2.00\,s + \Delta t_2 = 3.3265\,s$$

Use:

$$x - x_0 = \Delta x = \tfrac{1}{2} g (\Delta t)^2 \quad \text{For both stones:}$$

$$x_1 = \tfrac{1}{2} g (1.3265)^2 \qquad x_2 = \tfrac{1}{2} g (3.3265)^2$$

$x_2 - x_1$ = distance stones are apart:

$$= \tfrac{1}{2} \cdot 9.8 \left[3.33^2 - 1.33^2 \right]$$

$$= 45.6\,m$$

10. $d = 1$ lap

$9t_1$ = time for first 9 laps

t_2 = time for last lap

$V_1 = \boxed{195.0\,km/h}$ (speed of First 9 laps)

V_2 = speed of last lap

V_{avg} = (average speed for all 10 laps) $= \boxed{198.0\,km/hr}$

$$V_{avg} = \frac{10d}{9t_1 + t_2} \qquad V_1 t_1 = d \qquad V_2 t_2 = d \qquad \left(\text{substitute } t_1 = \frac{d}{V_1},\ t_2 = \frac{d}{V_2}\right)$$

$$V_{avg} = \frac{10d}{9\frac{d}{V_1} + \frac{d}{V_2}} = \frac{10\cancel{d}}{\left(\frac{9}{V_1} + \frac{1}{V_2}\right)\cancel{d}} = 198.0 \qquad \frac{10}{198.0} = \frac{9}{195.0} + \frac{1}{V_2}$$

$$\frac{1}{V_2} = \frac{10}{198} - \frac{9}{195} = 0.0043512\,m^{-1}s$$

$$V_2 = 229.8\,m/s$$

11. $v_{Bill} = \boxed{4.1}\, v_{Joe}$ at the apex of each throw, $v_f = 0$

$$v_f^2 - v_i^2 = 2g\Delta x$$

$$0^2 - v_{Bill}^2 = -2g\,\Delta x_{Bill}$$

divide eqns $\longrightarrow$ $\dfrac{v_{Bill}^2}{v_{Joe}^2} = \dfrac{\Delta x_{Bill}}{\Delta x_{Joe}}$

$$0^2 - v_{Joe}^2 = -2g\,\Delta x_{Joe}$$

substitute $v_{Bill} = 4.1\, v_{Joe}$:

$$\left(\frac{4.1\, v_{Joe}}{v_{Joe}}\right)^2 = \frac{\Delta x_{Bill}}{\Delta x_{Joe}} = 4.1^2$$

$$\Delta x_{Bill} = 4.1^2\,\Delta x_{Joe} = \underline{16.81}\,\Delta x_{Joe}$$

12. trip down $v_f = gt$ $\boxed{t = 2.0s}$

$$v_f = -9.8t \qquad x_f = \tfrac{1}{2}gt^2 = -\tfrac{1}{2}9.8\,2.0^2 = -19.6\text{ m below}$$

trip up

$v_f = 0$

$$v_f^2 - v_i^2 = 2g\Delta x = -2\cdot 9.8\cdot[0 - (-19.6)] = -2\cdot 9.8\cdot 19.6$$

$$0^2 - v_i^2 = -2\cdot 9.8\cdot 19.6$$

$$v_i = \sqrt{2\cdot 9.8\cdot 19.6} = \underline{19.6\text{ m/s}}$$