PHY 101 Homework 1 Solutions

Chapter 3 Exercises

9) The weight of an object, W, is determined by the formula $W = mg$, where m is the mass of the object and g measures the strength of the gravitational force, which depends on the mass and size of the object exerting the gravitational force. Near the surface of the Earth, $g_E = 9.8\,m/s^2$. Near the surface of the Moon, $g_M = \frac{1}{6}(9.8\,m/s^2)$. So $W_E = mg_E = (10\,kg)(9.8\,m/s^2) = 98\,N$ on the Earth and $W_M = mg_M = (10\,kg)(\frac{1}{6}(9.8\,m/s^2)) = 16.3\,N$. Note that the mass of the object stays the same in both cases.

14) Year after year, <u>each</u> rope supports 250N (or half of Harry's weight), which is 50 N less than the breaking point. The one day Harry decides to involve the flag in his efforts,

there is only <u>one</u> rope supporting (as opposed to two previously). 500 N exceeds the breaking point of the rope and look what's happens! Harry winds up in the hospital. If only he had taken Prof. Schwartz's PHY101 class!

24) If you start at 60 mi/hr while spotting the sign and arrive at 60 mi/hr and end up at <u>rest</u> at your destination, then you will take <u>more than</u> 2 hours to reach your destination, provided you didn't ever exceed the speed limit. However, if you barrel on by your destination at 60 mi/hr, then you will reach it in 2 hours exactly.

<u>Chapter 3 problems</u>

3) Since the firefighter sliding down the pole at constant speed, his acceleration is zero, so $\sum F_i = 0$. The forces on the firefighter are gravity and friction, which opposes

the motion. $\uparrow F_t$, $\downarrow F_g = W$ Using $\sum F_i = 0$, we have $F_t - W = 0$, or

$F_t = W = (100\,kg)(9.8\,m/s^2) = \underline{980\,N}.$

4) Using $\text{speed} = \dfrac{\text{distance}}{\text{time interval}}$, we can find the time interval.

Since we know the speed $1.5\,mm/year$ and we know the distance increased, $3000\,mm$ ($= 3\,m$), we can plug these two knowns into

$$\text{time interval} = \frac{\text{distance}}{\text{speed}} = \frac{3000\,mm}{1.5\,mm/year} = 2000\text{ years}$$

and get the correct answer. Notice that we had to use the same units for distance to get the correct answer.

8) a) velocity is 0 at highest point

b) $9.8\,m/s$

c) The amount of change in velocity in 1s is $9.8\,m/s$ and it is decreasing (negative).

d) $-9.8\,m/s$

e) Same as (c).

f) $\Delta V = V_f - V_i = -9.8\,m/s - 9.8\,m/s = -19.6\,m/s$.

(g) The acceleration is always g!

9) For an object undergoing constant acceleration a (due to a constant force), we have

$$t = \frac{V_f - V_o}{a} \quad \text{and} \quad V_{ave} = \frac{V_o + V_f}{2}.$$

Using $d = V_{ave}\, t$, $d = \left(\frac{V_o + V_f}{2}\right)\left(\frac{V_f - V_o}{a}\right) = \frac{V_f^2 - V_o^2}{2a}$.

Extra credit: Use the formula we just constructed! So, for the first part of the takeoff, $V_{1f}^2 - V_{1i}^2 = 2a_1 d_1$, where $V_{1i} = 0$ m/s, $a_1 = 10\ ft/s^2$ and d_1 is the distance of the point of no return from the beginning of the runway.

We can also apply this equation to the deceleration part of the plane's trajectory, or $V_{2f}^2 - V_{2i}^2 = 2a_2 d_2$, where $V_{2i} = V_{1f}$, $a_2 = -7\ ft/s^2$ and $d_2 = d - d_1$ where d is the total distance of the runway (1.5 mi) and $V_{2f} = 0$.

We have several equations now. Let's see if we can put them together.

$$\left.\begin{aligned} V_{1f}^2 &= 2a_1 d_1 \\ -V_{1f}^2 &= 2a_2(d - d_1) \end{aligned}\right] \rightarrow 2a_1 d_1 = -2a_2(d - d_1)$$

$$\downarrow$$

$$d_1 = -\frac{a_2 d}{a_1 - a_2} = \frac{a_2 d}{a_2 - a_1}.$$

Using $d = (1.5\,mi)\left(\frac{5280\,ft}{1\,mi}\right) = 7920\,ft$, $d_1 = \left(\frac{-7\,ft/s^2}{-7\,ft/s^2 - 10\,ft/s^2}\right) 7920\,ft$

$$d_1 = 3261\ ft.$$

To find the time to d_1, use $d_1 = \frac{1}{2} a_1 (\Delta t)^2$, or $\Delta t = \sqrt{\frac{2 d_1}{a_1}}$,

$$= \sqrt{\frac{2(3261\,ft)}{10\,ft/s^2}}$$

$$= 25.5 \text{ seconds!}$$