Solutions to the Extra Practice Problems for Chapter 2

1. 0 to 8.0 s and 24.0 to 34.0 s. Since east is positive, when the slope is positive, the acceleration is to the east. A rising graph indicates a positive slope.

2. 0 to 8.0 s, 16.2 to 24.0 s, and 31.0 to 34.0 s, and 36.4 s to 40.0s. To speed up, the acceleration and velocity must be in the same direction, so they must have the same sign. This happens when **v** is positive and the slope is positive (rising graph) or **v** is negative and the slope is negative (falling graph).

3. 8.0 s, 24.0 s, 34.0 s. The acceleration is zero right in between where it changes sign, so when the graph falls and then rises, or vice-versa.

4. From 34.0 s to 40.0 s, the graph is a straight line, so the instantaneous and average accelerations are the same over that entire interval. I will use the whole interval, but you can use a different part of that interval if you want.

$$\mathbf{a} = \frac{\text{rise}}{\text{run}} = \frac{-18\ \frac{\text{m}}{\text{s}} - 11\ \frac{\text{m}}{\text{s}}}{40.0\ \text{s} - 34.0\ \text{s}} = \frac{-29\ \frac{\text{m}}{\text{s}}}{6.0\ \text{s}} = -4.8\ \frac{\text{m}}{\text{s}^2}$$

Since positive means east, the acceleration is 4.8 m/s^2 west. Since the x-axis is marked off in ones, you can estimate to the tenths place. When you subtract those numbers, the answer must also go to the tenths place. Since the y-axis is mark of in units of 10, you can estimate between the lines to get a precision to the ones place. When you subtract, the answer must have its last significant figure in the ones place. When you divide, you have two significant figures.

5. 98 m/s^2 west. Newton's Second Law allows us to calculate the acceleration, but the mass unit must be kg. Defining west as positive:

$$\mathbf{F} = \text{m}\cdot\mathbf{a}$$

$$3.4\ \text{N} = (0.0346\ \text{kg})\cdot(\mathbf{a})$$

$$\mathbf{a} = \frac{3.4\ \text{N}}{0.0346\ \text{kg}} = \frac{3.4\ \frac{\cancel{\text{kg}}\cdot\text{m}}{\text{s}^2}}{0.0346\ \cancel{\text{kg}}} = 98\ \frac{\text{m}}{\text{s}^2}$$

6. 9.3 s. We know $\mathbf{a} = 98\ \text{m/s}^2$ west, $\mathbf{v}_0 = 0$, and $\mathbf{v}_f = 916$ m/s west. We need to determine time. Equation (2.4) relates them. Defining west as positive:

$$\mathbf{v_f} = \mathbf{v_o} + \mathbf{a}\cdot\text{t}$$

$$916\frac{\text{m}}{\text{s}} = 0 + (98\frac{\text{m}}{\text{s}^2})\cdot\text{t}$$

$$\text{t} = \frac{916\frac{\cancel{\text{m}}}{\cancel{\text{s}}}}{98\frac{\cancel{\text{m}}}{\cancel{\text{s}^2}}} = 9.3\ \text{s}$$

7. 47 N south. We can get the force if we determine the acceleration. We know $\mathbf{v}_f = 0$, and $\mathbf{v}_0 = 9.2$ m/s north. We also know $\Delta\mathbf{x} = 7.1$ m north. Equation (2.11) relates these things. Defining north as positive:

$$\mathbf{v}_f^2 = \mathbf{v}_0^2 + 2\mathbf{a} \cdot \Delta\mathbf{x}$$

$$(0)^2 = \left(9.2\ \frac{\text{m}}{\text{s}}\right)^2 + 2(\mathbf{a}) \cdot (7.1\ \text{m})$$

$$\mathbf{a} = \frac{-\left(9.2\ \frac{\text{m}}{\text{s}}\right)^2}{2 \cdot (7.1\ \text{m})} = \frac{-84.64 \frac{\text{m}^2}{\text{s}^2}}{2 \cdot (7.1\ \text{m})} = -6.0\ \frac{\text{m}}{\text{s}^2}$$

That means the force is:

$$\mathbf{F} = \text{m}\cdot\mathbf{a} = (7.9\ \text{kg}) \cdot \left(-6.0 \frac{\text{m}}{\text{s}^2}\right) = -47\ \frac{\text{kg} \cdot \text{m}}{\text{s}^2}$$

Negative means south.

8. 75 m above the ground. We know $\mathbf{v}_0$ = 2.8 m/s up, $\mathbf{a}$ = 9.81 m/s^2 down, and t = 4.2 s. We need to determine $\Delta\mathbf{x}$ to determine how far it fell to reach the ground. Equation (2.16) relates these things. Defining up as positive:

$$\Delta\mathbf{x} = \mathbf{v}_0\text{t} + \frac{1}{2}\mathbf{a}\text{t}^2 = \left(2.8\ \frac{\text{m}}{\cancel{\text{s}}}\right)(4.2\ \cancel{\text{s}}) + \frac{1}{2}\left(-9.81\ \frac{\text{m}}{\cancel{\text{s}^2}}\right)(4.2\ \cancel{\text{s}})^2 = 12\ \text{m} - 87\ \text{m} = -75\ \text{m}$$

We had to round each term to two significant figures before we did the subtraction. At that point, both numbers had their last significant figure in the ones place, so the answer must have its last significant figure in the ones place as well. Since the rock ended up 75 meters below the height from which it was launched, that means it was launched 75 m above the ground.

9. 95.5 m/s up. At the maximum height, $\mathbf{v}_f$ = 0. We know that height ($\Delta\mathbf{x}$ = 465 m up), and we know $\mathbf{a}$ = 9.81 m/s^2 down. Equation (2.11) allows us to figure out $\mathbf{v}_0$. Defining up as positive:

$$\mathbf{v}_f^2 = \mathbf{v}_0^2 + 2\mathbf{a} \cdot \Delta\mathbf{x}$$

$$(0)^2 = \mathbf{v}_0^2 + 2(-9.81 \frac{\text{m}}{\text{s}^2}) \cdot (465\ \text{m})$$

$$\mathbf{v}_0 = \sqrt{2(9.81 \frac{\text{m}}{\text{s}^2}) \cdot (465\ \text{m})} = \pm 95.5 \frac{\text{m}}{\text{s}}$$

We know it had to be shot up, so we can choose the positive answer.

10. 120 pounds. The weight will change when the astronaut is on Mars, but the mass will not. Thus, let's figure out the mass:

$$\text{weight} = \text{m} \cdot \text{g}$$

$$310\ \text{pounds} = \text{m} \cdot (32.2\ \frac{\text{ft}}{\text{s}^2})$$

$$\text{m} = \frac{310\ \frac{\text{slug} \cdot \cancel{\text{ft}}}{\cancel{\text{s}^2}}}{32.2\ \frac{\cancel{\text{ft}}}{\cancel{\text{s}^2}}} = 9.6\ \text{slugs}$$

That is the same no matter where the astronaut is, so her mass is also 9.6 slugs on Mars. That means to determine the weight on Mars, we can put the acceleration due to gravity on Mars (12.2 ft/s^2) in for "g" in Equation (2.17):

$$\text{weight} = \text{m} \cdot \text{g} = (9.6\ \text{slugs})\left(12.2\ \frac{\text{ft}}{\text{s}^2}\right) = 120\ \frac{\text{slug} \cdot \text{ft}}{\text{s}^2}$$