Solutions to the Extra Practice Problems for Chapter 1

1. <u>Total distance = 142 cm, displacement is 8 cm east</u>. In both cases, you just add to get the total. Since distance has no direction:

$$\text{Total Distance} = 67\text{ cm} + 75\text{ cm} = 142\text{ cm}$$

When adding you look at decimal place. Both numbers have their last significant figure in the ones place, so the answer should as well. Displacement requires direction, so let's say west is positive. That means

$$\text{Total Displacement} = 67\text{ cm} + -75\text{ cm} = -8\text{ cm}$$

The answer can only be reported to the ones place, since both numbers have their last significant figure in that place. Since it is negative, we know the direction is east. If you state that west is positive, then you can just say that the displacement is -8 cm. If you state that east is positive, you can say 8 cm.

2. <u>Her speed is 4.1 m/s, while her velocity is 0.6 m/s south</u>. Speed is the change in distance over the change in time.

$$\text{Total Distance} = 21\text{ m} + 28\text{ m} = 49\text{ m}$$

$$\text{speed} = \frac{\Delta \text{d}}{\Delta \text{t}} = \frac{49\text{ m}}{12\text{ s}} = 4.1\ \frac{\text{m}}{\text{s}}$$

Velocity, however, is displacement divided by time. If north is positive:

$$\text{Total Displacement} = 21\text{ m} + -28\text{ m} = -7\text{ m}$$

$$\mathbf{v} = \frac{\Delta \mathbf{x}}{\Delta \text{t}} = \frac{-7\text{ m}}{12\text{ s}} = -0.6\ \frac{\text{m}}{\text{s}}$$

Since 21 and 28 have their last significant figure in the ones place, the displacement must have its last significant figure in the ones place. That gives you only one significant figure for v. Since positive is north, we know the velocity is south.

3. <u>The relative velocity is 2.6 m/s south. If they don't collide, the faster one must be in front</u>. The problem gives directions, so we need to define the signs. Let's say north is positive. That means both balls have positive velocities. Let's use the faster ball as the reference:

$$\text{Relative velocity} = \text{Velocity of moving object} - \text{Velocity of reference object}$$

$$\text{Relative velocity} = 4.1\frac{\text{m}}{\text{s}} - 6.7\frac{\text{m}}{\text{s}} = -2.6\ \frac{\text{m}}{\text{s}}$$

Since the relative velocity is negative, it is south. This means if the faster one is in front, it will see the other ball moving south, getting farther away.

4. <u>Your displacement will be 10,000 m west</u>. We must always check units when there are multiple measurements in a problem. The time you walk is in hours, while the time unit in velocity is seconds. Thus, we must convert.

$$\frac{1.5\ \cancel{\text{hr}}}{1} \times \frac{3600\text{ s}}{1\ \cancel{\text{hr}}} = 5{,}400\text{ s}$$

Because 1.5 has two significant figures and conversion relationships are exact, the answer needs two significant figures. Now that we have the units consistent, we can continue. Defining west as positive makes the velocity positive, which means Equation (1.2) becomes

$$\mathbf{v} = \frac{\Delta\mathbf{x}}{\Delta t}$$

$$2\ \frac{\text{m}}{\text{s}} = \frac{\Delta\mathbf{x}}{5{,}400\ \text{s}}$$

$$\Delta\mathbf{x} = 2\ \frac{\text{m}}{\cancel{\text{s}}} \cdot 5{,}400\ \cancel{\text{s}} = 10{,}000\ \text{m}$$

Since 2 has only one significant figure, the displacement can have only one. The fact that it's positive tells us it is west.

5. <u>The relative velocity is 9 km/hr north, and the faster one would have to be in front</u>. Defining south as positive and using the faster bicycle as the reference:

$$\text{Relative velocity} = \text{Velocity of moving object} - \text{Velocity of reference object}$$

$$\text{Relative velocity} = 14\frac{\text{km}}{\text{hr}} - 23\frac{\text{km}}{\text{hr}} = -9\ \frac{\text{km}}{\text{hr}}$$

Since both velocities have their last significant figure in the ones place, the answer must be reported to the ones place. So according to the faster bicycle, the slower bicycle is moving north. If they never meet, then the slower bicycle must be north of the faster bicycle so they just keep getting farther away. That means the faster bicycle is in front.

6. <u>It will take 0.00320 hr</u>. We must always check units when there are multiple measurements in a problem. The distance is in meters, but the distance unit in velocity is km. Thus, we must convert.

$$\frac{541\ \cancel{\text{m}}}{1} \times \frac{1\ \text{km}}{1{,}000\ \cancel{\text{m}}} = 0.541\ \text{km}$$

This is hard unless we treat one car as stationary and the other as moving with the relative velocity. It doesn't matter which one, so let's define east as positive and use the east-bound car as the reference. The south-bound car's velocity will be negative.

$$\text{Relative velocity} = \text{Velocity of moving object} - \text{Velocity of reference object}$$

$$\text{Relative velocity} = -81\frac{\text{km}}{\text{hr}} - 88\frac{\text{km}}{\text{hr}} = -169\ \frac{\text{km}}{\text{hr}}$$

So if the east-bound car is sitting still, the other car is traveling west at 169 km/hr. To collide, then, it must have a displacement of 0.541 km west, which is -0.541 km.

$$\mathbf{v} = \frac{\Delta\mathbf{x}}{\Delta t}$$

$$-169\ \frac{\text{km}}{\text{hr}} = \frac{-0.541\ \text{km}}{\Delta t}$$

$$\Delta t = \frac{-0.541\ \cancel{\text{km}}}{-169\ \frac{\cancel{\text{km}}}{\text{hr}}} = 0.00320\ \text{hr}$$

Since both velocities have their last significant figure in the ones place, the relative velocity must as well. That gives you three significant figures for the relative velocity, and since there are three significant figures in the displacement, the time must have three.

7. At 4.0 seconds, the acceleration is to the south. At 6.0 seconds, the acceleration is to the south. At 10.0 seconds, it is to the north, and at 12.0 seconds, it is to the north. At 16.0 seconds, it is to the north. The velocity is constant from 0 to 4.0 seconds, and it is north, since the slope is positive (rising up). To slow it down, then, the acceleration must be opposite. At 6.0 seconds, the velocity goes from zero to something negative (the slope is falling). Thus, the acceleration is negative which means south. At 10.0 seconds, the velocity goes from negative to zero, so the acceleration needs to be opposite, which means positive, which is north. At 12.0 seconds, it goes from zero to positive (rising slope), so acceleration must be positive, which is north. At 16.0 seconds, the slope gets steeper and stays positive. That means the velocity increases, which can only happen when acceleration is in the same direction, which is positive and therefore north.

8. From 4.0 seconds to 6.0 seconds and from 10.0 seconds to 12.0 seconds. A horizontal line has a zero slope, so and for this graph, the slope is the velocity.

9. From 0 to 9.0 seconds and from 14.0 to 20.0 seconds. North is positive, so any positive position is north of the starting point. The graph stays above zero from 0 to 9.0 seconds but then drops below zero until 14.0 seconds, and after that, it stays above zero.

10. They are the same from 6.0 to 10.0 seconds, but not from 12.0 to 20.0 seconds. The slope of a straight line is constant, and the graph is a straight line from 6.0 to 10.0 seconds. However, from 12.0 to 20.0 seconds, the slope changes at 16.0 seconds. Thus, the velocity is different from 16.0 to 20.0 seconds compared to 12.0 to 16.0 seconds. That means the average value will be in between those two velocities, and it will not equal either of them.

11. It is 2.0 m/s north. From 12.0 to 16.0 s, the graph is a straight line, so its slope is the same everywhere. That means you can choose any interval from 12.0 s to 16.0 s for calculating the slope. I will choose the entire interval, but you can choose differently if you want.

$$\text{slope} = \frac{\text{rise}}{\text{run}} = \frac{4.0\text{ m} - -4.0\text{ m}}{16.0\text{ s} - 12.0\text{ s}} = \frac{8.0\text{ m}}{4.0\text{ s}} = 2.0\text{ m/s}$$

That means 2.0 m/s east. Since the sign of the direction is given by the problem, you can also report the answer as 2.0 m/s, since the positive means east.

For significant figures, remember that you can estimate between the lines to get one more decimal place than the label. Thus, you can read the y-axis to the tenths place (it is marked off in 5's, which are in the ones place) and the x-axis to the tenths place. When you subtract, you look at decimal place. The distances both have their last significant figure in the tenths place, so the difference must as well. The times both have their last significant figure in the tenths place, so the answer must as well. When you divide, you count significant figures. Since both the distance and time have two significant figures, the answer must have two as well.