1.2.3 In Class or Homework Exercise

1. Slimy the slug is crawling east to meet his friend Slurpy, who lives 45.0 cm away. Slimy has a speed of 0.85 cm/s. If Slurpy leaves his home to meet Slimy at the same time but is only travelling 0.55 cm/s west:

   a. How long will it take them to meet?

$$\vec{v}_1 = 0.85 cm/s \qquad \vec{v}_2 = -0.55 cm/s \qquad \Delta\vec{d}_{12} = 45.0 cm$$

$$\vec{v}_{12} = \vec{v}_1 - \vec{v}_2 = 0.85 - (-0.55) = 1.40 cm/s$$

$$\vec{v}_{12} = \frac{\Delta\vec{d}_{12}}{t} \qquad 1.40 = \frac{45.0}{t} \qquad t = \boxed{32.1s}$$

   b. How far will Slurpy have travelled when they meet?

$$v_2 = 0.55 cm/s \qquad t = 32.1s \qquad \Delta d = ?$$

$$v = \frac{\Delta d}{t} \qquad 0.55 = \frac{\Delta d}{32.1} \qquad \Delta d = \boxed{18cm}$$

2. A police car is 5.00 km behind you. You are travelling at 120. km/h and the police car is travelling at 180. km/h.

   a. How long will it take the police car to catch you?

$$\vec{v}_p = 180. km/h \qquad \vec{v}_y = 120. km/h \qquad \Delta\vec{d}_{py} = 5.00 km$$

$$\vec{v}_{py} = \vec{v}_p - \vec{v}_y = 180. - 120. = 60. km/h$$

$$\vec{v}_{py} = \frac{\Delta\vec{d}_{py}}{t} \qquad 60. = \frac{5.00}{t} \qquad t = \boxed{0.083h}$$

   b. How far will the police car travel to catch you?

$$v_p = 180. km/h \qquad t = 0.083h \qquad \Delta d_p = ?$$

$$v_p = \frac{\Delta d_p}{t} \qquad 180. = \frac{\Delta d_p}{0.083} \qquad \Delta d_p = \boxed{15 km}$$

3. A car leaves Wau travelling toward Daru at 150. km/h. Another car leaves Daru travelling toward Wau at 120. km/h. The distance between Wau and Daru is 435 km.

   a. If both cars leave at the same time, how far from Daru will they meet?

$$\vec{v}_D = 120.km/h \qquad \vec{v}_{DW} = \vec{v}_D - \vec{v}_W \qquad \vec{v}_{DW} = \frac{\Delta\vec{d}_{DW}}{t}$$

$$\vec{v}_H = -150.km/h \qquad = 120. - (-150.) \qquad 270. = \frac{435}{t}$$

$$\Delta\vec{d}_{SH} = 435\,km \qquad = 270.km/h \qquad t = 1.61h$$

Since it takes 1.61 h to meet, now we can look at how far the car from Daru travels in this time.

$$v_D = 120.km/h \qquad v_D = \frac{\Delta d_D}{t}$$

$$t = 1.61h \qquad 120. = \frac{\Delta d_D}{1.61}$$

$$\Delta d_D = ? \qquad \Delta d_D = \boxed{193\,km}$$

b. If the car from Wau leaves 30. minutes before the car from Daru, how far from Daru will they meet?

It is first necessary to take care of the headstart:

$$v_W = 150.km/h \qquad v_W = \frac{\Delta d_W}{t}$$

$$t = 0.50h \qquad 150. = \frac{\Delta d_W}{0.50}$$

$$\Delta d_W = ? \qquad \Delta d_W = 75\,km$$

Since the car from Wau traveled 75 km before the car from Daru even left, they are only (435-75=360 km) apart at the time that the car from Daru leaves. The rest of the problem can now be done the same as the (a) part.

$$\vec{v}_D = 120.km/h \qquad \vec{v}_{DW} = \vec{v}_D - \vec{v}_W \qquad \vec{v}_{DW} = \frac{\Delta\vec{d}_{DW}}{t}$$

$$\vec{v}_W = -150.km/h \qquad = 120. - (-150.) \qquad 270. = \frac{360.}{t}$$

$$\Delta\vec{d}_{DW} = 360.km \qquad = 270.km/h \qquad t = 1.33h$$

Since it takes 1.33 h to meet, now we can look at how far the car from Daru travels in this time.

$v_D = 120.\,km/h$

$t = 1.33h$

$\Delta d_D = ?$

$$v_D = \frac{\Delta d_D}{t}$$

$$120. = \frac{\Delta d_D}{1.33}$$

$$\Delta d_D = \boxed{160.\,km}$$

4. Fred is running at a constant velocity of 2.0 m/s east. Bill is running at a constant velocity of 3.5 m/s in the same direction, but Bill started running 1.0 minute after Fred. Assuming that they started from the same location, how long will it take Bill to catch Fred?

It is first necessary to take care of Fred's headstart:

$v_F = 2.0\,m/s$

$t = 1.0\min = 60.\,s$

$\Delta d_F = ?$

$$v_F = \frac{\Delta d_F}{t}$$

$$2.0 = \frac{\Delta d_F}{60.}$$

$$\Delta d_F = 120\,m$$

This is now similar to the other catching problems that were done.

$\vec{v}_B = 3.5m/s$

$\vec{v}_F = 2.0m/s$

$\Delta\vec{d}_{BF} = 120m$

$$\vec{v}_{FB} = \vec{v}_F - \vec{v}_B$$

$$= 3.5 - 2.0$$

$$= 1.5m/s$$

$$\vec{v}_{FB} = \frac{\Delta\vec{d}_{FB}}{t}$$

$$1.5 = \frac{120}{t}$$

$$t = \boxed{80.\,s}$$