Problem 4.1

a.) Determine the net displacement:

Being careful with units and simply reading the parameters out of the book, the displacements for each vector is:

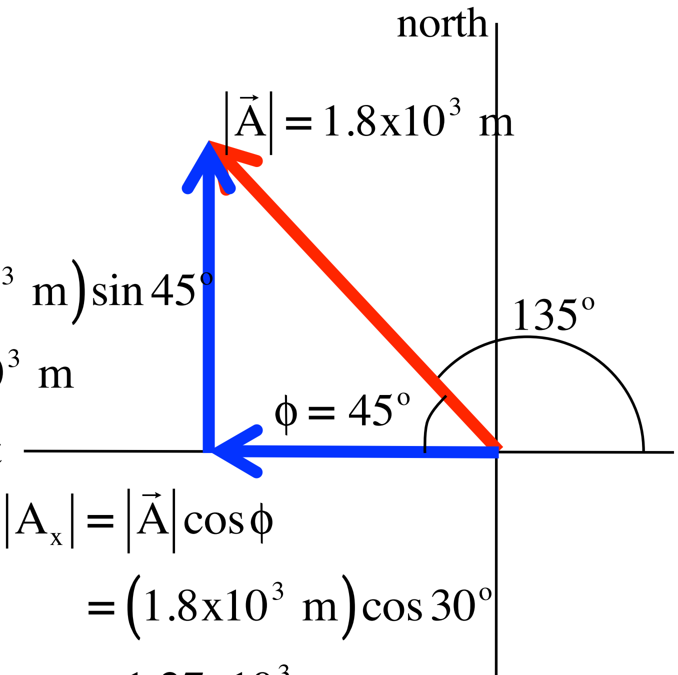
$$\vec{d}_1 = \vec{v}_1 \, \Delta t_1$$
$$= \left[(20 \text{ m/s})\left(-\hat{j}\right)\right]\left[(3 \text{ min})(60 \text{ s/min})\right]$$
$$= -\left(3.6\text{x}10^3 \text{ m}\right)\hat{j}$$

$$\vec{d}_2 = \vec{v}_2 \, \Delta t_2$$
$$= \left[(25 \text{ m/s})\left(-\hat{i}\right)\right]\left[(2 \text{ min})(60 \text{ s/min})\right]$$
$$= -\left(3\text{x}10^3 \text{ m}\right)\hat{i}$$

$$\vec{d}_3 = \left(\vec{v}_3 \, \Delta t_3 \right)\measuredangle 135^\circ$$
$$= \left[(30 \text{ m/s})\right]\left[(1 \text{ min})(60 \text{ s/min})\right]\measuredangle 135^\circ$$
$$= \left(1.8\text{x}10^3 \text{ m}\right)\measuredangle 135^\circ$$

What’s inconvenient about this is that the last vector is in polar notation. Converting it appropriately (note sketch to right):

$$\vec{d}_3 = \left(1.8\text{x}10^3 \text{ m}\right)\measuredangle 135^\circ$$
$$= -1270\hat{i} + 1270\hat{j}$$



$$|A_y| = |\vec{A}|\sin\phi$$
$$= \left(1.8\text{x}10^3 \text{ m}\right)\sin 45^\circ$$
$$= 1.27\text{x}10^3 \text{ m}$$

$$|A_x| = |\vec{A}|\cos\phi$$
$$= \left(1.8\text{x}10^3 \text{ m}\right)\cos 30^\circ$$
$$= 1.27\text{x}10^3 \text{ m}$$

Adding the three vectors yields:

$$\vec{d}_1 = 0\hat{i} - \left(3.6\text{x}10^3 \text{ m}\right)\hat{j}$$
$$\vec{d}_2 = -\left(3.00\text{x}10^3 \text{ m}\right)\hat{i} + 0\hat{j}$$
$$+\ \vec{d}_3 = -\left(1.27\text{x}10^3 \text{ m}\right)\hat{i} + \left(1.27\text{x}10^3 \text{ m}\right)\hat{j}$$

$$\vec{d}_{net} = -\left(4.27\text{x}10^3 \text{ m}\right)\hat{i} - \left(2.33\text{x}10^3 \text{ m}\right)\hat{j}$$

Converting this to polar notation:

$$\vec{d}_{net} = -\left(4.27x10^3 \text{ m}\right)\hat{i} - \left(2.33x10^3 \text{ m}\right)\hat{j}$$

$$= \left(\left(-4.27x10^3 \text{ m}\right)^2 + \left(-2.33x10^3 \text{ m}\right)^2\right)^{1/2} \measuredangle \left[\tan^{-1}\left(\frac{-2330}{-4270 \text{ m}}\right) + 180^o\right]$$

$$= \left(4.87x10^3 \text{ m}\right) \measuredangle 208^o \qquad \text{(this is the same as } 4.87x10^3 \text{ m at } 28^o \text{south of west)}$$

b.) Average speed:

Average speed is not a vector (in fact, speed in general is not a vector). That means it is NOT the net displacement (like, what we just calculated) divided by the time. Instead, it's the TOTAL DISTANCE TRAVELED per unit time. As such, we can write:

$$s_{avg} = \frac{d_{total}}{\Delta t_{total}}$$

$$= \frac{\left(3.60x10^3 \text{ m}\right) + \left(3.00x10^3 \text{ m}\right) + \left(1.80x10^3 \text{ m}\right)}{360. \text{ s}}$$

$$= 23.3 \text{ m/s}$$

c.) The average velocity is:

$$\vec{v}_{avg} = \frac{\vec{d}_{net}}{\Delta t}$$
$$= \frac{\left(4.87x10^{3}\ m\right)\measuredangle 208^{o}}{360.\ s}$$
$$= \left(13.5\ m/s\right)\measuredangle 208^{o}$$