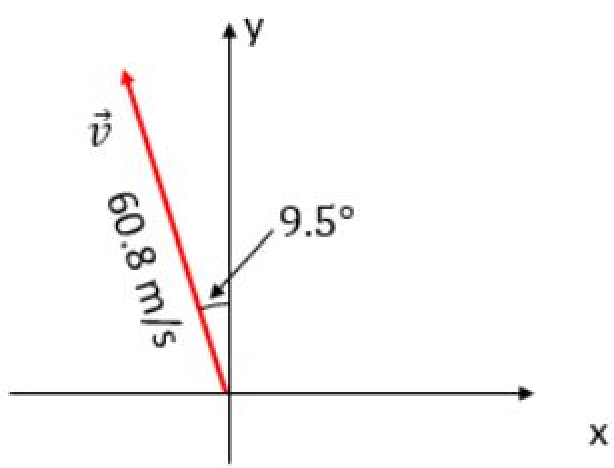
PHY151H1F – Practice Problem Set 1 SOLUTIONS

1. Let's define: $t_{max} = t_1 + t_2 + t_3$. t1 is the time of the pitch from the pitcher's mound to Home. t_2 = 0.45 s is the delay time of the catcher. t_3 is the time of the throw from Home to Third Base. Convert the distances to SI units. d_1 = 61 ft (12 in / 1 ft) (0.0254 m / 1 in) = 18.5928 m. d_3 = 90 ft (12 in / 1 ft) (0.0254 m / 1 in) = 27.432 m.
   Pitch time $t_1 = d_1/v_1$ = 18.5928 / 20 = 0.92964 s,
   Third Base throw time $t_3 = d_3/v_3$ = 27.432 / 20 = 1.3716 s,
   So he's got a maximum time of t_{max} = 0.92964 + 0.45 + 1.3716 = 2.75124 s
   t_{max} = 2.8 s.

   Do I think he'll make it? Well, I know that Donovan Bailey, starting from rest, ran the 50 m dash in 5.56 s. Assuming constant acceleration (which is a bad assumption for runners, but better than assuming constant velocity), then $d = \frac{1}{2} a t^2$, so $a = 2d/t^2 = 2(50\text{ m})/5.56^2 = 3.23\text{ m/s}^2$. So if our runner could accelerate as fast as Donovan Bailey, he could run the 90 ft, or 27 m in a time $t = \sqrt{2d/a}$ = 4.11 s. So **no, I don't think he's going to make it** in 2.8 s. I would suggest that in order for a baseball player to steal a base, he's got to take a big lead, and hope the catcher is more delayed.

2. $v = \sqrt{(-10\frac{m}{s})^2 + (60\frac{m}{s})^2} = 60.8\text{ m/s} \quad \theta = tan^{-1}\left(\frac{10}{60}\right) = 9.5°$



3. **INTERPRET:** Let the *x*-direction be east and the *y*-direction be north. Use subscripts M, W, and E for Mary, the water, and the earth, respectively. Let the origin be Mary's starting point on the south bank.

DEVELOP: In the reference frame of the water Mary has no east-west motion; in that frame she travels $100\ \text{m}$ across the river at $2.0\ \text{m/s}$ so $\Delta t = 50\ \text{s}$.

EVALUATE:

(a)

$$\begin{aligned}\vec{r}_{\text{ME}} &= \vec{r}_{\text{MW}} + \vec{r}_{\text{WE}} \\ &= \vec{v}_{\text{MW}}\Delta t + \vec{v}_{\text{WE}}\Delta t \\ &= (2.0\ \text{m/s})\,\hat{j}(50\ \text{s}) + (1.0\ \text{m/s})\,\hat{\imath}(50\ \text{s}) \\ &= (50\ \text{m})\hat{\imath} + (100\ \text{m})\,\hat{j}\end{aligned}$$

So she lands 50 m east (downstream) from where she intended.

(b)

$$v_{\text{ME}} = \sqrt{(v_x)^2 + (v_y)^2} = \sqrt{(1.0\ \text{m/s})^2 + (2.0\ \text{m/s})^2} = 2.236\ \text{m/s} \approx 2.2\ \text{m/s}$$

ASSESS: Most of Mary's speed with respect to the shore is due to her rowing rather than the current.