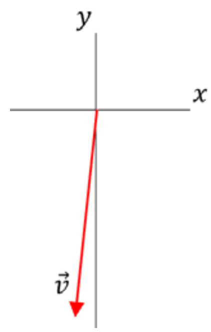
PHY151H1F – Practice Problem Set 1 SOLUTIONS

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 $d = ½\, a\, t^2$, 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. $v = \sqrt{(-10 \text{ m/s})^2 + (-100 \text{ m/s})^2} = 100 \text{ m/s},$ $\theta = \tan^{-1}\left(\frac{100}{10}\right) = 84°$



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 m across the river at 2.0 m/s so $\Delta t = 50$ s.

   EVALUATE:

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

   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.