Class Practice for Proficiency

Overtake: Application of Linear Motion

1. In England (Circa 1215), Sir Watercress is involved in a joust with the Duke of York. Sir Watercress and the Duke are separated by a distance of 25 rods (125m). The bell sounds and the two riders charge toward each other at a rate of 2.3m/s and 1.8 m/s respectively.
   a. Sketch this situation out with some stick figures here.

   WC → ← *Duke*
   2.3 | 125 | -1.8
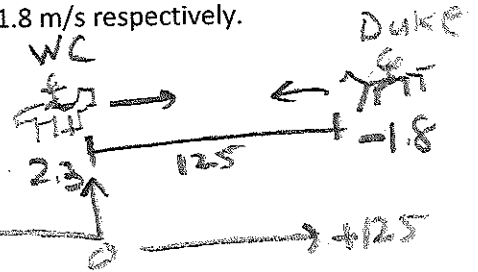
   b. What is your reference point?

   Zero ————————→ +125

   c. At what location will the two riders collide?

   SIR   Duke
   $X_t + V_i t + \frac{1}{2}at^2 = X_t = X_t + V_i t + \frac{1}{2}at^2$
   $0 + 2.3t + 0 = X_t = 125 + -1.8t$

2. A large stone is shot straight upward at 30m/s. 2 seconds later a second small rock also thrown directly upward at 30m/s. (Sketch a picture on the side)
   a. Where is the large stone when the small stone is launched?

   $V_t = V_i + at$
   $30 + -9.8(2) = 10.4$

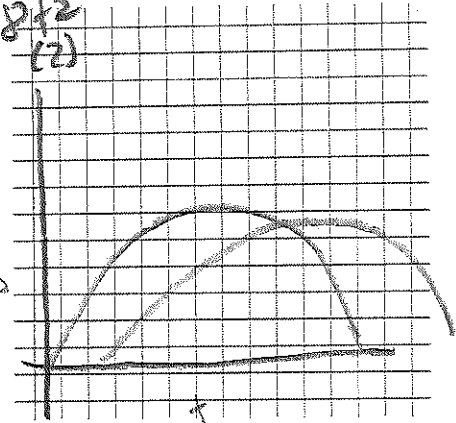 $Y_t = Y_0 + V_i t + \frac{1}{2}at^2$ $\square = 0 + 30t + \frac{1}{2}-9.8t^2$
   (2)   (2)
   $\boxed{40.4 \frac{m}{s}}$ 60 -19.6

   b. At what time do they cross?

   $Y_t = Y_0 + V_i t + \frac{1}{2}at^2 =$
   $0 + 30t + -4.9t^2 = 40.4 + 10.4t + -4.9t^2$

   $19.6t = 40.4$
   $t = 2.0$

   c. At what location do they cross?

   $Y_t = 0 + 30(4) + -4.9(4)^2$
   $\boxed{Y = 41m}$ $\int$ for 1st ball

   add 2sec $\int$ for 1st ball

3. A ball is rolled down a ramp causes a ball to accelerate at 3m/s. A second ball is given a 5m/s push and then accelerates at 3m/s. Graph this scenario and estimate when they will cross?

   Bottom   top
   $0 + 5t + -\frac{1}{2}(3)t^2 = X_t = 20 + -\frac{1}{2}(3)t^2$

   $5t = 20$
   $t = 20/5$
   $t = 4sec$

   where
   $X_t = 5(4) + -1.5(4)^2$
   $20 = -24$

   $x = -4$

1. A red Buick moving at 2.10 m/s comes through an intersection at the same time a blue car leaves the intersection accelerating at 0.150m/s². If the red Buick is accelerating at .05m/s² when will it be caught the blue Ford?
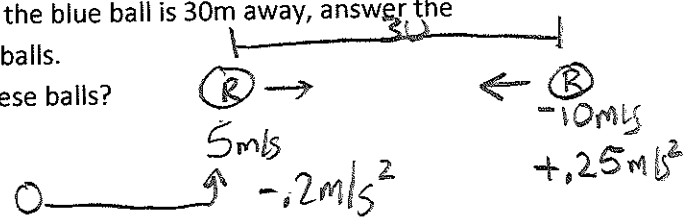
$$0 + \overset{R}{2.10t} = X_t = 0 + 0 + \frac{1}{2} \cdot \overset{B}{0.150t^2}$$

$$0 = 2.10t - .075t^2$$

$$t = 0, 28 \quad \text{(use Quad}_{solved})$$

2. A red ball is rolling to the right at 5m/s slowing down at 0.2m/s² toward a blue ball rolling to the left at 10m/s slowing down at 0.25m/s². If the blue ball is 30m away, answer the following questions about the locations of the balls.

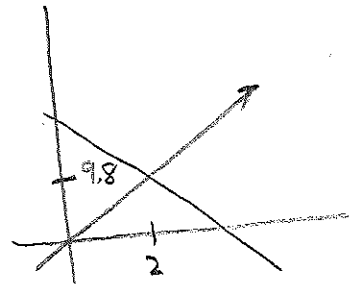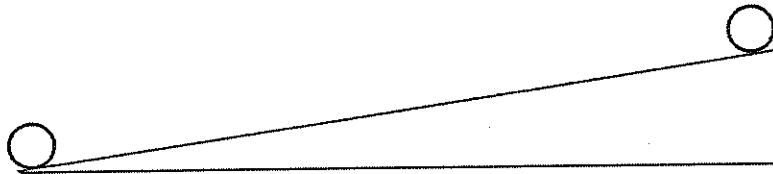   a. What is your frame of reference for these balls?

   $$\overset{R}{\textcircled{R}} \rightarrow \qquad \leftarrow \overset{B}{\textcircled{B}}$$
   $$5m/s \qquad\qquad -10m/s$$
   $$0 \underrightarrow{\quad\quad} -.2m/s^2 \qquad +.25m/s^2$$

   b. What time will they meet?

   $$5t + \frac{1}{2} -.2t^2 = 30 + -10t + \frac{1}{2}(.25)t^2) \quad \text{use Quad or graph}$$
   $$X = 2.06 \text{sec}$$

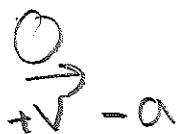   c. At what location will they run into each other?

   $$X_t = 0 + 5(2) + -(.1)(2)^2$$
   $$X_t = 9.6$$

3. Two balls on a rough surface are given an identical push on the ramp. A student hypothesizes that both balls have same velocity initial, friction and the same acceleration due to gravity so they should meet in the middle. Justify or nullify this student's theory.

   True, Same V_i + a + Friction
   but Frame of reference is opposite
   one block is speeding up
   + the other slowing down

   $$\underset{+V \; -a}{\textcircled{O} \rightarrow} \qquad \underset{-V \; -a}{\leftarrow \textcircled{O}}$$