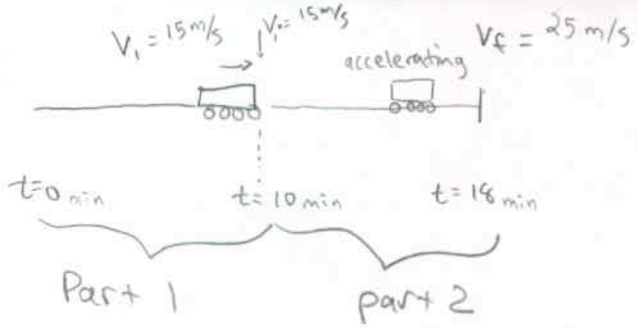
1.



The train had constant acceleration from $t = 10$ min to $t = 18$ min.

$\Delta t = 18\text{min} - 10\text{ min} = 8\text{ min}$

In this time, it started at $V_i = 10 m/s$ and finished at $V_f = 25 m/s$.

$\Delta v = 25 m/s - 15 m/s = 10 m/s$

The constant acceleration is "a"

$a = \frac{\Delta v}{\Delta t} = \frac{10 m/s}{8 \text{ min}}$

$a = \frac{10 \text{ meters}}{\text{second}} \cdot \frac{1}{8 \text{ min}} \cdot \frac{1 \text{ min}}{60 \text{ seconds}} = .0208 m/s^2$

$a = 2.08 \times 10^{-2} m/s^2$

In Part 1, the train travels $\Delta x_1 = V_1 \cdot \Delta t_1 = 15 m/s \cdot 10 \text{ min} \cdot \frac{60 \text{sec}}{1 \text{ min}} = 9000$ m

9.00×10^3 m

In part 2, since acceleration $\neq 0$, in otherwords since v is not constant, we cannot use that equation.

Instead we use $\Delta x_2 = V_i \Delta t_2 + \frac{1}{2} a_2 (\Delta t_2)^2$

$\Delta x_2 = \frac{15m}{s} \cdot 8\text{min} \cdot \frac{60 s}{1 \text{ min}} + \frac{1}{2}\left(2.08 \times 10^{-2} \frac{m}{s^2}\right)\left(8 \text{ min} \cdot \frac{60 \text{ sec}}{1 \text{ min}}\right)^2$

$\Delta x_2 = 7200 \text{ m} + 1.04 \times 10^{-2} \frac{m}{s^2} (480 s)^2$

$\Delta x_2 = 7200 \text{ m} + 1.04 \times 10^{-2} \frac{m}{s^2} (230400 s^2)$

$\Delta x_2 = 7200 m + 2396.16$ m

$\Delta x_2 = 9596.16 m = 9.60 \times 10^3$ m

How far it went during the entire time let's call ΔX_T

(T here stands for total)

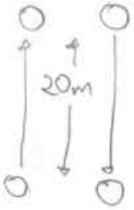
$\Delta X_T = \Delta X_1 + \Delta X_2$

$\Delta X_T = 9.00 \times 10^3 m + 9.60 \times 10^3 m = 18.6 \times 10^3 m$

$\Delta X_T = 1.86 \times 10^3 m$

b

(2.)



The time the ball takes going up equals the time it takes going down, so $t_T = t_{total} = t_{up} + t_{down}$

$t_T = 2 \cdot t_{down}$

lets look at the ball falling

What do we know?

$V_f = V_{bottom}$? Don't know

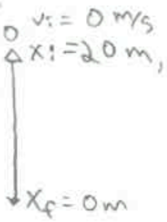
$V_i = V_{top}$ → At the top the ball stops for an instant before changing directions and coming down. Therefore

$V_i = 0$

$\Delta x = 20\ m$

$a = g = -9.8 \frac{m}{s^2}$ → Earth's gravity is acting on the ball to produce the usual acceleration g.

$$X = X_i + V_i \Delta t + \frac{1}{2} a (\Delta t)^2$$



$$X_f - X_i = V_i \Delta t + \frac{1}{2} a (\Delta t)^2$$

$$0 - 20m = 0 + \frac{1}{2}(-9.8\ m/s^2)(\Delta t)^2$$

$$-20m = -4.9\ m/s^2\ (\Delta t)^2$$

$$(-20m)\left(\frac{-1\ s^2}{4.9\ m}\right) = (\Delta t)^2$$

$$4.082\ s^2 = \Delta t^2$$

$$t = \sqrt{4.082\ s^2}$$

$$t = 2.02\ s$$

However, this is just the time going down.

$t_{total} = 2 \cdot t_{down} = 2 \cdot 2.06\ s = 4.12\ s$ D

(3) $V_c = 120\ km/h$ $V_g = 96.0\ km/h$

At some point the cheetah, since it is going faster than the gazelle, will catch up to the gazelle. We seek the time at which this happens.

Lets say the spot they meet is called X_L (X_{lunch}). Let us start the cheetah initially at $X = 0\,m$ and the gazelle at $X = 84m$ ($\Delta X = 84\,m$).

The distance the cheetah travels is X_L.

The distance the gazelle travels is $X_L - 84\,m$.

Also, they meet at the same time, and realizing this is the key to solving the problem.

$\Delta x = V \cdot \Delta t_c$

$\Delta x_c = V_c \cdot \Delta t_c$

$\Delta x_g = V_g \cdot \Delta t_g$ (c and g subscripts mean cheetah and gazelle)

$t_c = t_g$ so lets just call it t, and if we call $t_{initial} = 0$,

$\Delta t = t_f - t_i = t_f$, so $\Delta t = t$ (this isnt that important, but we put it in to be explicit.)

$\Delta x_c = V_c \cdot t$

$\Delta x_g = V_g \cdot t$

Remembering that they meet at X_L

$X_L = V_c \cdot t \rightarrow t = X_L / V_c$

$(X_L - 84\,m) = V_g \cdot t$

plug in your substitution for t

$(X_L - 84m) = V_g \cdot \frac{X_L}{V_c}$

$X_L - \frac{V_g}{V_c} X_L = 84\,m$

$X_L \left(1 - \frac{V_g}{V_c}\right) = 84m$

3 cont.

$$X_L\left(1-\frac{96\ km/h}{120\ km/h}\right) = 84m$$

$$X_L(.2) = 84\ m$$

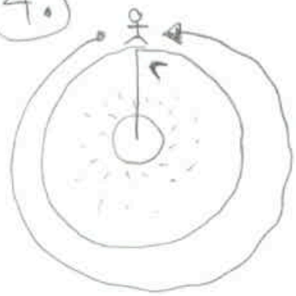
$$X_L = 420\ m$$

How long does it take for the cheetah to get to X_L (which is the same for the gazelle to get to X_L.)

$$t = X_L/v_c = 420m \cdot \frac{hr}{120\ km} \cdot \frac{1\ km}{1000m} \cdot \frac{3600s}{1hr}$$

$t = 12.6\ s$ 9

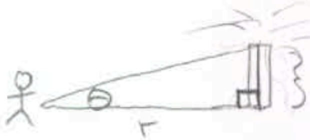
4.



$C = \text{Circumference} = 150\ m$

$C = 2\pi r = 150\ m$

$r = \frac{150\,m}{2\pi} = 23.87\ m$



The fountain is in the middle of the pool, so the distance to the fountain = $\frac{1}{2}$ diameter = r

We want to know the height.

SOHCAHTOA so...

$\tan = \frac{\text{opposite}}{\text{adjacent}}$

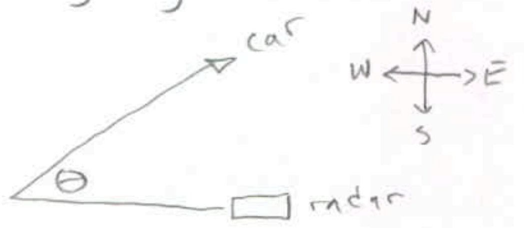
$\tan\theta = \frac{h}{r}$ $\theta = 55°$

$r \cdot \tan\theta = h$ $r = 23.87\ m$

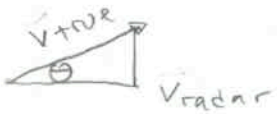
$(23.87m)(\tan 55°) = h$

$h = 34\ m$ e

(5) The radar detector only works correctly if it is facing you. If you are moving at an angle away from it, it only measures the component of your velocity that is going in its direction.



→ In this case, the car is moving to the NE, but the radar detector can only measure the speed in the E (or W) direction, which is less.



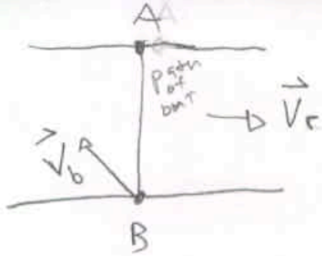
$$\cos\theta = \frac{v_{radar}}{v_{true}}$$

$$v_{true} = \frac{v_{radar}}{\cos\theta}$$

$$v_{true} = \frac{112 \text{ km/h}}{\cos(14^\circ)}$$

$$v_{true} = 115 \text{ km/h}$$

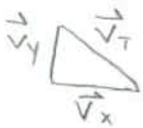
60



The velocity of the boat $\vec{V}_b = \vec{V}_{bx} + \vec{V}_{by}$.
The velocity of the river $\vec{V}_r = \vec{V}_{rx}$ since it has no y component.

Since A is directly across from B, the boat does not travel in the y direction. Therefore its x component velocity must cancel with the river.

$$\vec{V}_{bx} = -\vec{V}_r$$



$$|\vec{V}_x|^2 + |\vec{V}_y|^2 = |\vec{V}_T|^2$$

$$|V_y| = \sqrt{V_T^2 - V_x^2}$$

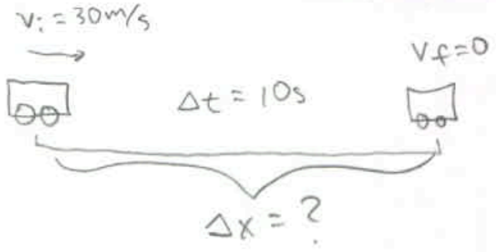
$$|V_y| = \sqrt{7.6^2 - 3^2} \text{ m/s}$$

$$|V_y| = 6.98 \text{ m/s} = 7.0 \text{ m/s}$$

since the boat is only going in the y direction, the magnitude of the velocity in the y direction = the speed of the boat.

7.0 m/s

7.



$V_i = 30 m/s$

$V_f = 0 m/s$

$t_i = 0 s$

$t_f = 10 s$ → $\Delta t = 10 s$

$X_i = 0 m$

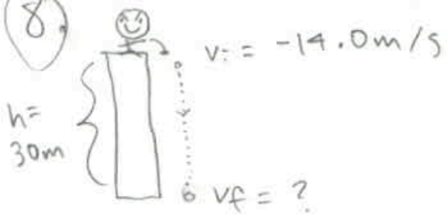
$X_f = ?$ } find ΔX or X_f, both are the same here

$$X_f = X_i + \frac{1}{2}(V_f + V_i)\Delta t$$

$$X_f = \frac{1}{2}(30 m/s) 10 s = 150 m$$

$$X_f = 150 m$$

8.



$\vec{v_i} = -14.0 m/s$
$\vec{v_f} = ?$ → find
$x_i = 30m$
$x_f = 0m$
$a = \text{gravity} = g = -9.8 m/s^2$

$$v_f^2 = v_i^2 + 2a(x_f - x_i)$$
$$v_f^2 = (-14.0 m/s)^2 + 2(-9.8 m/s^2)(0 - 30m)$$
$$v_f^2 = 196 m^2/s^2 + 588 m^2/s^2$$

$$v_f^2 = 784$$
$$\vec{v_f} = \pm\sqrt{784} \, m/s = \pm 28 m$$

actually $\vec{v_f} = -28$ m/s since $\vec{v_f}$ = negative means it is travelling in the minus y direction aka down.

The problem asks for speed, though, which is always positive.

28 m/s