B version

(1.) A car is traveling on a straight road with a speed of $22.0\,m/s$ when the driver hits the brakes causing a constant deceleration of $2.50\,m/s^2$. How far does the car go while stopping?

(a) $96.8\,m$	(b) $194\,m$	(c) $22.0\,m$	(d) $55.0\,m$	(e) $8.80\,m$

KNOWN: $x_i = 0$

$(V_x)_i = 22\,m/s$

$(V_x)_F = 0$

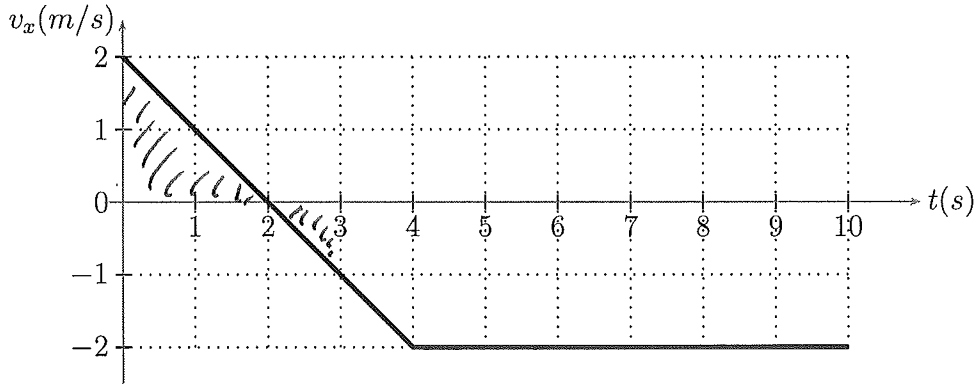
$a_x = -2.5\,m/s^2$

UNKNOWN: Δt, x_F

DON'T CARE ABOUT Δt $\Rightarrow (V_x)_F^2 = (V_x)_i^2 + 2a_x(x_F - x_i)$

$\Rightarrow 0 = (22\,m/s)^2 + 2(-2.5\,m/s^2)(x_F - 0) \Rightarrow x_F = \dfrac{(22\,m/s)^2}{5\,m/s^2} = 96.8\,m$

(2.) A train has the following velocity versus time graph. If the train starts at $x = 0$ at $t = 0$, what is the train's position after $3.0\,s$?

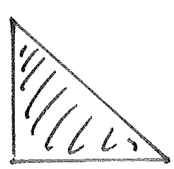


(a) $-1\,m$	(b) $-0.5\,m$	(c) $0.5\,m$	(d) $-1.5\,m$	$\boxed{\text{(e) } 1.5\,m}$

ON V_x vs t graph $\Delta X = $ AREA. FOR $t_i = 0$, $t_f = 3s$, $X_i = 0$, $X_f = ?$

$\Rightarrow \Delta X = X_f - 0 = X_f$

2m/s

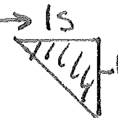


2s

$\frac{1}{2}(2s)(2m/s) = 2m$

1s

3s−2s

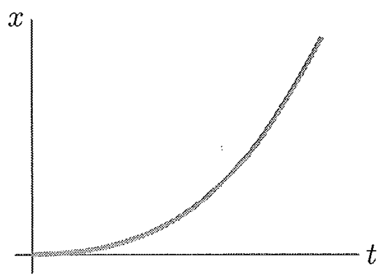


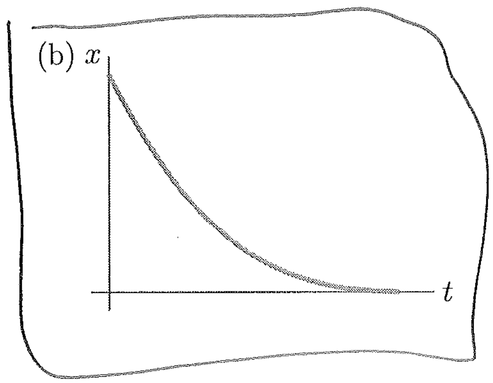
−1m/s

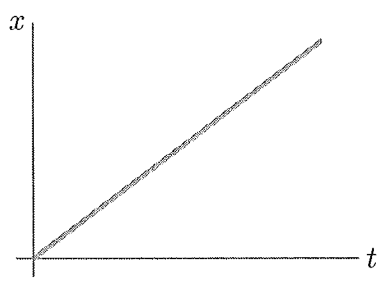
$\frac{1}{2}(1s)(-1m/s) = -0.5m$

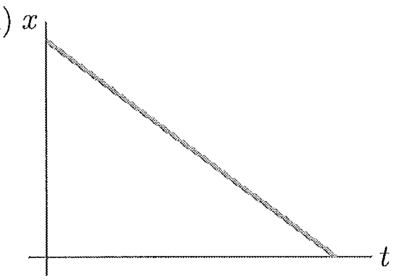
$\Rightarrow X_f = \Delta X = 2m - 0.5m = 1.5m$

(3.) For the motion diagram shown, which of the following is the correct position-versus-time graph?

(a)


(b)


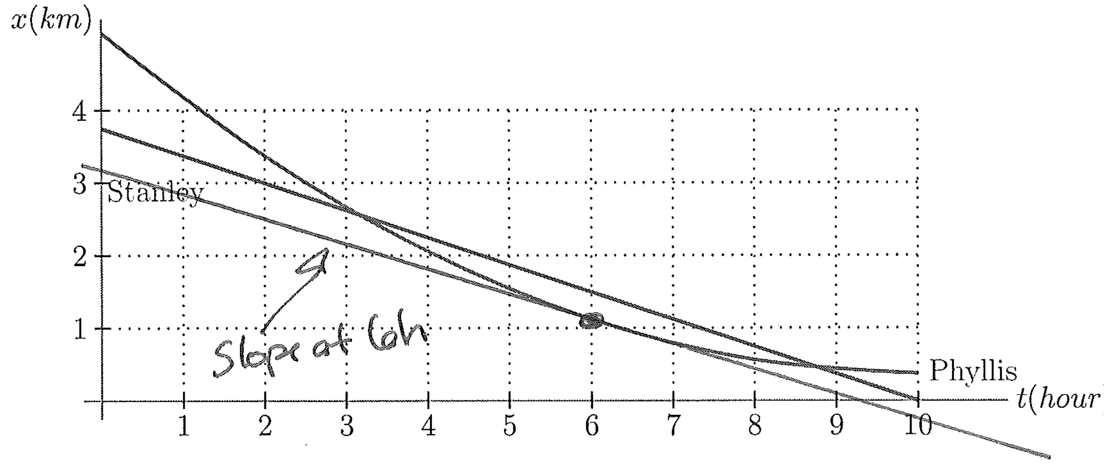
(c)


(d)


(e)


Motion to LEFT ⇒ DECREASING POSITION. Spacing getting SMALLER ⇒ DECELERATION ⇒ PARABOLA

(4.) The position-versus-time graphs for two people, Phyllis and Stanley, are shown below. At what time or times do they have the same velocity?



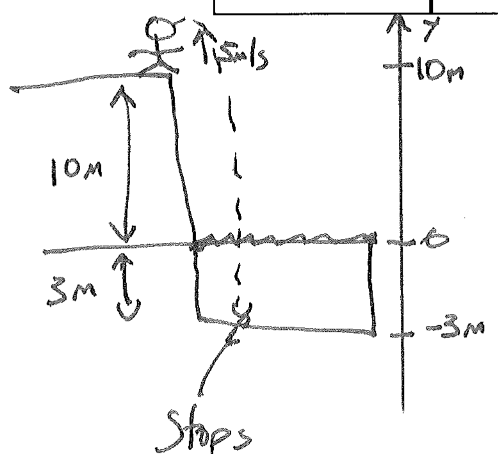
(a) $3\,h$	(b) $6\,h$	(c) $9\,h$	(d) Both $3\,h$ and $9\,h$	(e) None are Correct

On X vs. t. Slope gives velocity

at $t=6h$, slope of Phyllis's curve = slope of Stanley's line

(5.) An olympic diver is on a platform that is $10.0\,m$ above a swimming pool that is $3.0\,m$ deep. If she launches herself upwards with a speed of $5.0\,m/s$, what is the magnitude *AND DIRECTION* of the minimum acceleration needed to keep her from hitting the bottom of the pool? Use the standard convention that up is positive and ignore air resistance.

(a) $33\,m/s^2$	(b) $-33\,m/s^2$	(c) $37\,m/s^2$	(d) $-37\,m/s^2$	(e) $-9.8\,m/s^2$



1st Motion: Known: $(V_y)_{i1} = 5m/s$, $y_i = 10m$

$y_f = 0$, $a_y = -9.8m/s^2$ (No Air Resistance)

Unknown: $(V_y)_{f1}$, Δt_1

2nd Motion: Known: $y_i = 0$, $y_f = -3m$, $(V_y)_{f2} = 0$

Unknown: $(V_y)_{i2}$, Δt_2, $a_2 = ?$

$(V_y)_f^2 = (V_y)_i^2 + 2a_y(y_f - y_i) \overset{\text{1st Motion}}{\Rightarrow} (V_y)_{f1}^2 = (5m/s)^2 + 2(-9.8m/s^2)(0-10m) = 25m^2/s^2 + 196m^2/s^2$

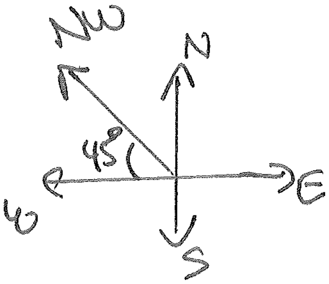
$\Rightarrow (V_y)_{f1}^2 = 221m^2/s^2 \Rightarrow (V_y)_{f1} = \pm\sqrt{221m^2/s^2} = -14.866m/s$ ← choose negative since going downward

So $(V_y)_{i2} = -14.866m/s$. $(V_y)_f^2 = (V_y)_i^2 + 2a_y(y_f - y_i) \Rightarrow 0 = (-14.866m/s)^2 + 2a_2(-3m-0)$

$\Rightarrow 0 = 221m^2/s^2 - a_2(6m) \Rightarrow a_2 = \frac{+221m^2/s^2}{6m} = +36.833m/s^2 = +37m/s^2$

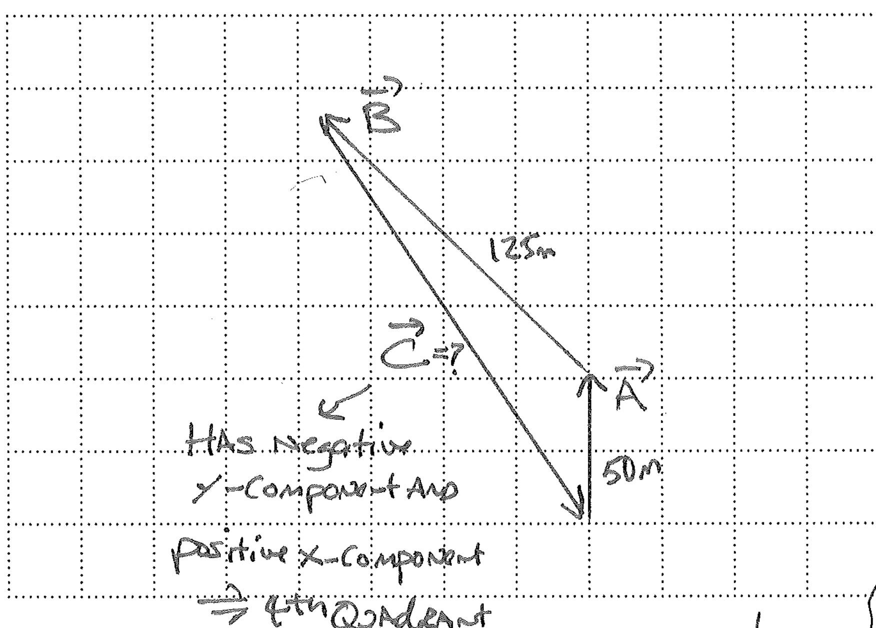
Correct sign since negative velocity and slowing down

⇒ Positive Acceleration.



(6.) A man leaves his house and walks 50 m due north. He then walks northwest 125 m. Finally, he walks straight home. How far and at what standard angle did the man walk to get home? Please notice the included grid to help with your sketching.

(a) 164 m at $-78°$	(b) 175 m at 123°	(c) 175 m at $-57°$
(d) 164 m at 123°	(e) 164 m at $-57°$	



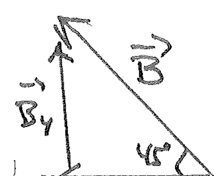
Here $\vec{A}+\vec{B}+\vec{C}=0$

Since we go BACK to start

$\Rightarrow A_x+B_x+C_x=0$

$A_y+B_y+C_y=0$

$A_x=0,\ A_y=50m$



$\vec{B}_x \rightarrow$ to left $\Rightarrow$

$B_x=-125m\cos 45° = -88.4m$

$\vec{B}_y$ up $\Rightarrow B_y = 125m\sin 45° = +88.4m$

For $\vec{B}$: CAN Also USE STANDARD Angle: 45° θ

$\theta = 180°-45° = 135°$, $B_x = 125m\cos 135° = -88.4m$

$B_y = 125m\sin 135° = +88.4m$

$A_x+B_x+C_x=0 \Rightarrow 0-88.4m+C_x=0 \Rightarrow C_x=+88.4m$

$A_y+B_y+C_y=0 \Rightarrow 50m+88.4m+C_y=0 \Rightarrow C_y=-138.4m$

$C=\sqrt{C_x^2+C_y^2}$

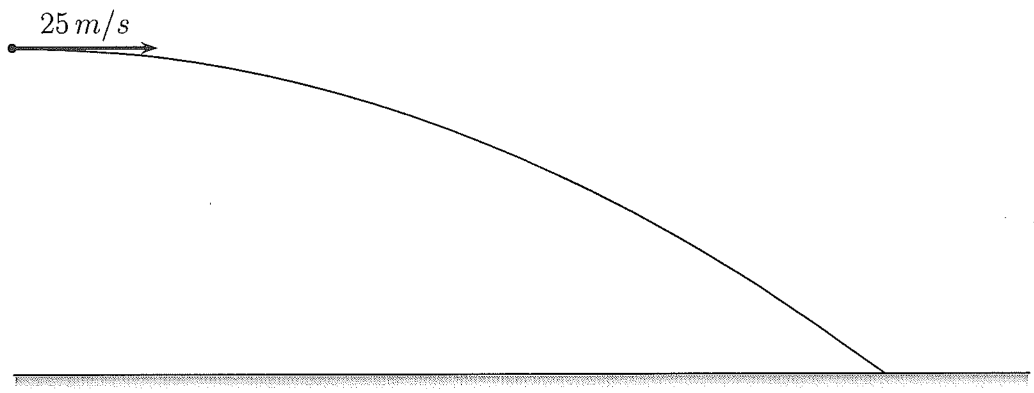
$C=\sqrt{(88.4)^2+(138.4)^2}$

$\Rightarrow C=164m$

4th QUAD. $\Rightarrow$ CAlculator OK, $\theta=\tan^{-1}\left(\frac{C_y}{C_x}\right)=\tan^{-1}\left(\frac{-138.4}{88.4}\right)=-57.43°=-57°$

(7.) A projectile is launched horizontally at 25 m/s and hits the ground 3.0 s later. What direction is the projectile going when it hits the ground?

(a) $-30.5°$	(b) $-50°$	(c) $-90°$	(d) $-81.5°$	(e) $-9.8\, m/s^2$



Velocity GIVES DIRECTION OF MOTION!

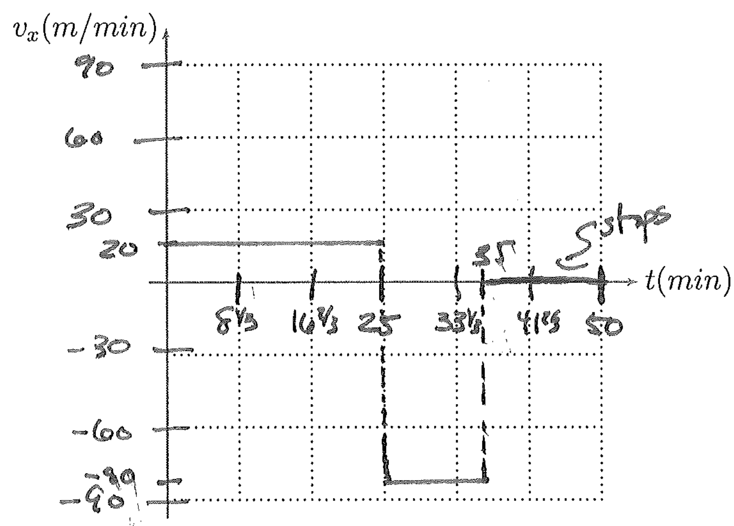
HORIZONTAL LAUNCH $\Rightarrow (V_x)_i = 25 m/s, \; (V_y)_i = 0$

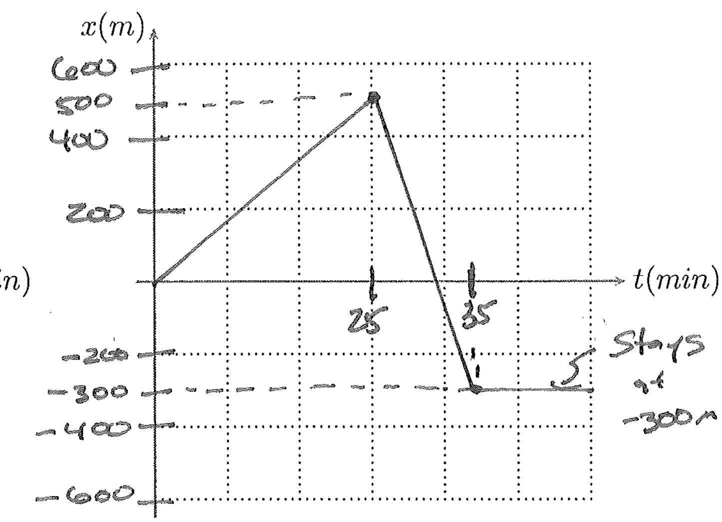
$(V_x)_F = (V_x)_i = 25 m/s, \quad (V_y)_F = (V_y)_i - g\Delta t = 0 - 9.8 m/s^2 (3s) = -29.4 m/s$

$\theta = \tan^{-1}\left(\frac{(V_y)_F}{(V_x)_F}\right) = \tan^{-1}\left(\frac{-29.4}{25}\right) = -49.624° \approx -50°$

(8.) A man leaves his house and walks his dog at $20\,m/min$ down the street. After $25\,min$ of walking, the dog spies a cat, yanks the leash out of his owner's hands, and runs after the cat back towards the man's house at $80\,m/min$. After $10\,min$ of running the dog gets tired and stops.

In the region below, sketch the dog's velocity-versus-time graph, and position-versus-time graph. Assume that all motion is along a (very-long) straight street. For full points, each graph must have the correct numerical values for position, velocity, and time. Please show all calculations in the region below the graphs. They must also have the correct shape. Please label whether you are attempting to draw a straight line, horizontal line, or parabola.





Constant V_x ⇒ HORIZONTAL lines

For $t=0$ to $t=25$ min, $V_x = +20$ m/min.

Graph gives total time ⇒ From $t=25$ min to $t=25$ min $+ 10$ min $= 35$ min, dog runs in opposite direction at 80 m/min

⇒ $V_x = -80$ m/min. Stops ⇒ $V_x = 0$

Constant velocity ⇒ UNIFORM MOTION ⇒ $\boxed{\text{STRAIGHT LINES}}$

$V_x = \frac{\Delta x}{\Delta t} \Rightarrow \Delta x = V_x \Delta t$

$\Delta x_1 = (20\,m/min)(25\,min) = 500\,m$

For $t_i = 0$, $x_i = 0 \Rightarrow x_f = \Delta x = 500\,m$

but $V_2 = \frac{\Delta x_2}{\Delta t_2} \Rightarrow \Delta x_2 = V_2 \Delta t_2$. $\Delta x_2 = x_F - 500\,m$

$\Rightarrow x_F = 500\,m + V_2 \Delta t_2 = 500\,m + (-80\,\frac{m}{min})(10\,min) = -300$