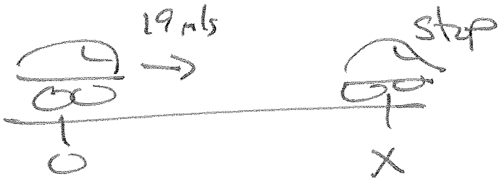
(1.) A car is traveling on a straight road with a speed of $19.0\,m/s$ when the driver hits the brakes causing a constant deceleration of $1.5\,m/s^2$. How far does the car go while stopping?

(a) $10.3\,m$	(b) $59.2\,m$	(c) $67.6\,m$	(d) $120\,m$	(e) $241\,m$



KNOWN: $x_0 = 0$, $V_0 = 19\,m/s$

$a_x = -1.5\,m/s^2$, $V_x = 0$

↑ Slowing Down

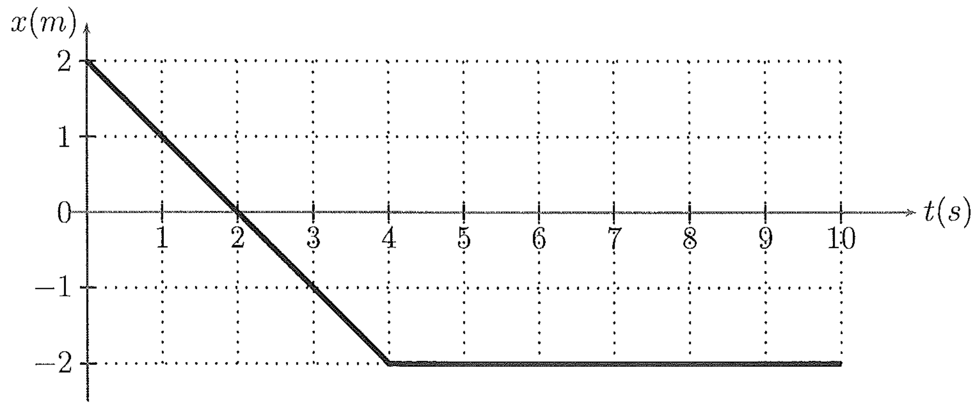
UNKNOWN: x, t

$V_x^2 = V_0^2 + 2a_x(x - x_0)$ gives Answer in 1 step

$$0 = (19\,m/s)^2 + 2(-1.5\,m/s^2)(x - 0)$$

$$\Rightarrow x = \frac{-(19\,m/s)^2}{2(-1.5\,m/s^2)} = +120.33\,m$$

(2.) A car has the following position-versus-time graph. What is the car's *average* velocity for the time interval from 0 s to 9.0 s?



(a) $-1\,m/s$	(b) $-0.57\,m/s$	(c) $-0.44\,m/s$	(d) $-0.22\,m/s$	(e) $0\,m/s$

Average Velocity: $V_{AV} = \frac{\Delta x}{\Delta t}$

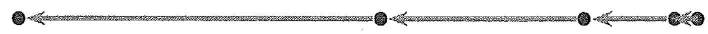
For $t_1 = 0$, $X_1 = 2m$ ← From graph
$t_2 = 9s$, $X_2 = -2m$ ←

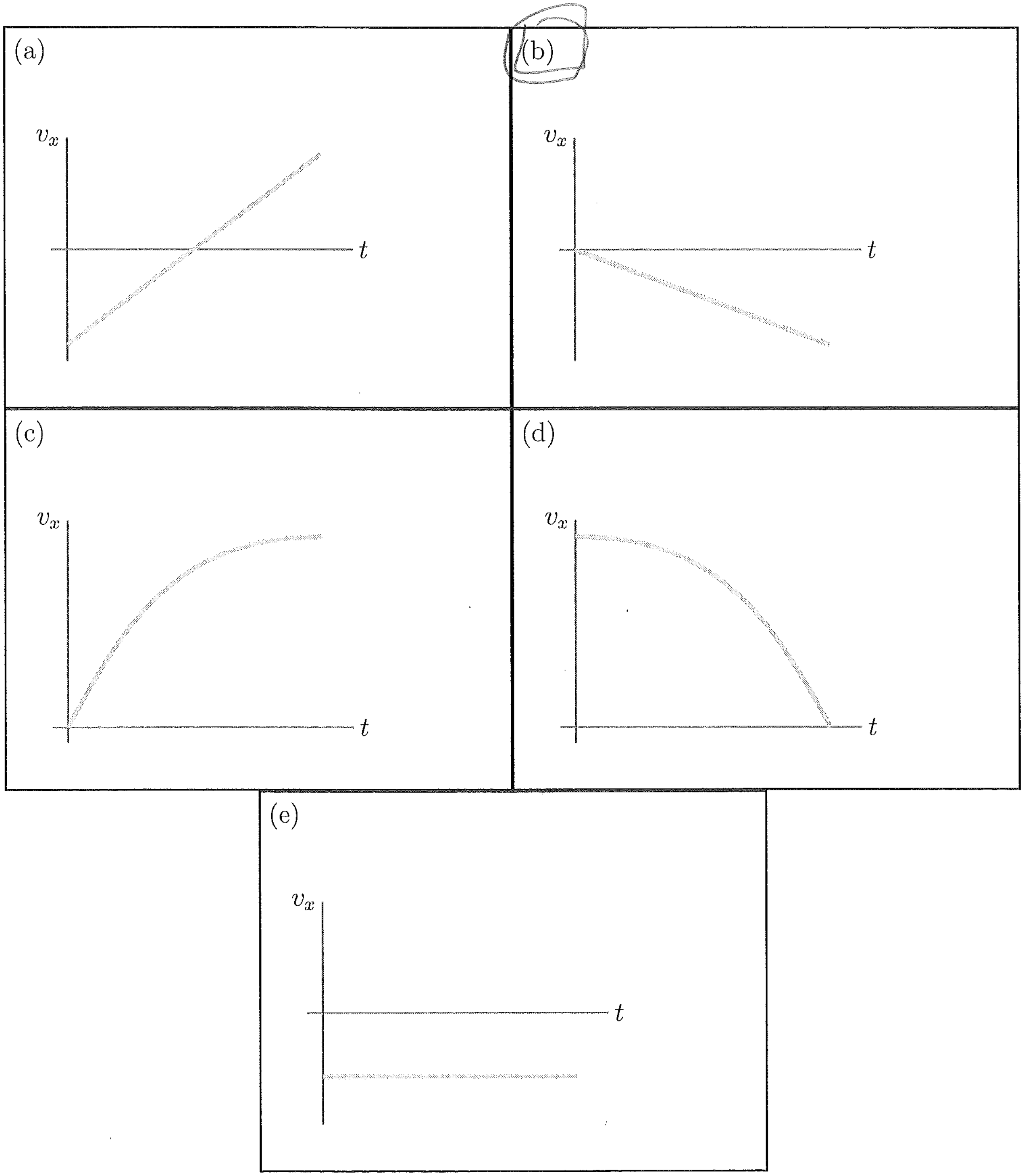
$$V_{AV} = \frac{-2m - 2m}{9s - 0} = \frac{-4m}{9s} = -0.44\,m/s$$

with steadily increasing speed

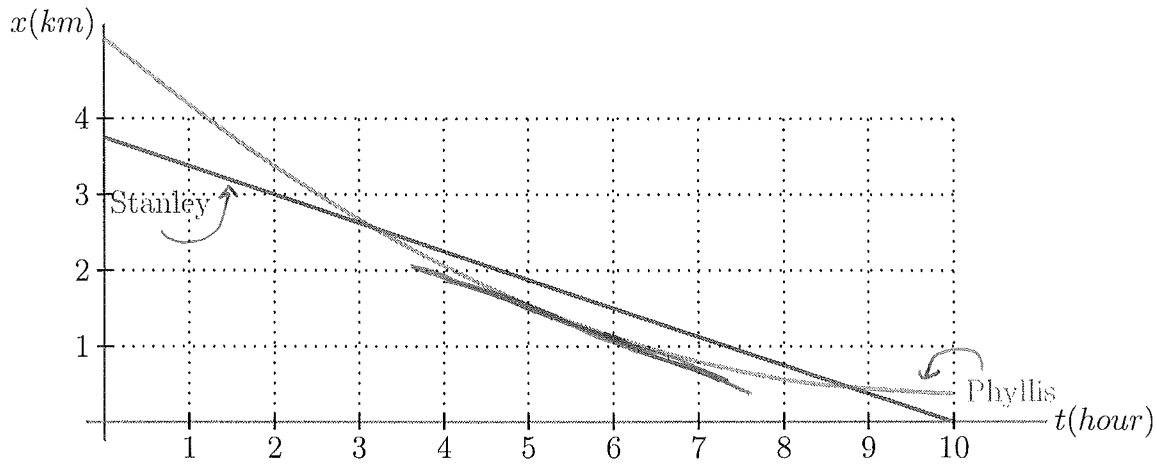
(3.) A man starts from rest and walks to the left as shown in the following motion diagram. Which of the graphs below correctly shows his velocity versus time? (**Note:** The origin of each graph is at $v = 0$ and $t = 0$.)

Constant Acceleration ⇒ STRAIGHT LINE Starting at $V = 0$





(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?

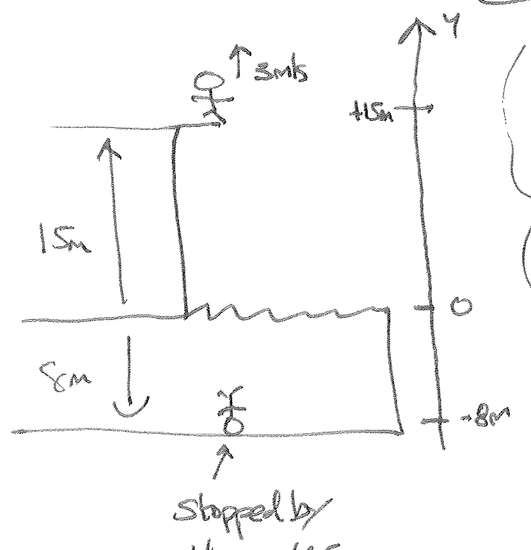


(a) $3\,h$	(b) $6\,h$	(c) $9\,h$	(d) Both $3\,h$ and $9\,h$	(e) At $3\,h$, $6\,h$ and $9\,h$

Only at 6h Does the slope of Phyllis's Curve match the slope of Stanley's Line.

(5.) An olympic diver is on a platform that is 15 m above a swimming pool that is 8.0 m deep. If she launches herself upwards with a speed of 3.0 m/s, what is the magnitude *AND DIRECTION* of the minimum acceleration needed in the water to keep her from hitting the bottom of the pool? Use the standard convention that up is positive and ignore air resistance. Assume the diver goes in a completely straight line.

(a) $-19\,m/s^2$	(b) $19\,m/s^2$	(c) $13\,m/s^2$	(d) $-13\,m/s^2$	(e) $8.3\,m/s^2$



2 MOTIONS:

1st MOTION KNOWN: $V_0 = 3\,m/s$, $y_{01} = 15\,m$, $y_1 = 0$

$a_y = -9.8\,m/s^2$ ← NO AIR RESISTANCE

1st MOTION UNKNOWN: V_1, t_1

2ND MOTION KNOWN: $y_0 = 0$, $y_2 = -8\,m$, $V_2 = 0$ ← stopped

UNKNOWN: V_{02}, a_2, t_2

Since 1st Motion leads directly into 2ND: $V_{02} = V_1$, So FIND V_1

$V_1^2 = V_{01}^2 + 2a_1(y_1 - y_{01}) \Rightarrow V_1^2 = (3\,m/s)^2 + 2(-9.8\,m/s^2)(0 - 15\,m) = 9\,m^2/s^2 + 294\,m^2/s^2 = 303\,m^2/s^2$

So $V_1 = \pm\sqrt{303\,m^2/s^2}$ but pick $-\sqrt{303\,m^2/s^2} = -17.4\,m/s$ since we know going DOWN

NOW USE SAME EQUATION but with 2ND INFO: $V_2^2 = V_{02}^2 + 2a_2(y_2 - y_{02})$

$\Rightarrow 0 = (-\sqrt{303\,m^2/s^2})^2 + 2a_2(-8\,m - 0) \Rightarrow 0 = 303\,m^2/s^2 - 16\,m\,a_2 \Rightarrow a_2 = \frac{+303\,m^2/s^2}{16\,m}$

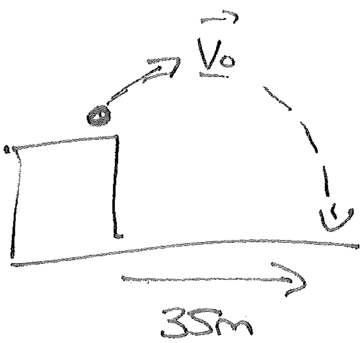
$= +18.9375\,m/s^2$

$= +19\,m/s^2$

Makes sense, ACC. MUST be opposite to velocity to slow her DOWN.

(6.) A projectile is launched from the top of a cliff with a speed of $25\,m/s$. If its range is $35\,m$ and it hits the ground after $4.5\,s$, at what angle was it launched?

(a) 71.9°	(b) 61.9°	(c) 16.6°	(d) 4.88°	(e) Cannot be determined without knowing the cliff's height



KNOWN: $X_0 = 0,\ X = 35m$

$V_0 = 25m/s,\ t = 4.5s,\ y = 0$

UNKNOWN: $y_0,\ V_{0x},\ V_{0y},\ V_x, V_y,\ \alpha$

$X = X_0 + V_{0x}t$ ∴ FIND V_{0x} then use $V_{0x} = V_0 \cos\alpha$ to find α

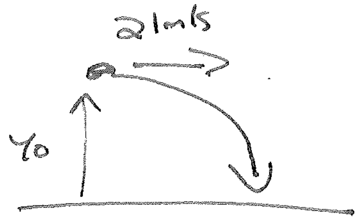
$35m = 0 + V_{0x}(4.5s)$ ∴ $V_{0x} = \frac{35m}{4.5s} = 7.778 m/s$

$\cos\alpha = \frac{V_{0x}}{V_0} = \frac{7.778 m/s}{25 m/s} = 0.3111$

$\alpha = \cos^{-1}(0.3111) = 71.9°$

(7.) A projectile is launched horizontally at $21.0\,m/s$ some distance above the ground. It hits the ground $2.50\,s$ later. With what speed does the projectile hit the ground?

(a) $0\,m/s$	(b) $21.0\,m/s$	(c) $24.5\,m/s$	$\boxed{\text{(d) } 32.3\,m/s}$	(e) $45.5\,m/s$



Horizontal launch $\Rightarrow$ $V_{ox} = 21m/s$

$V_{oy} = 0$

$t = 2.5s$

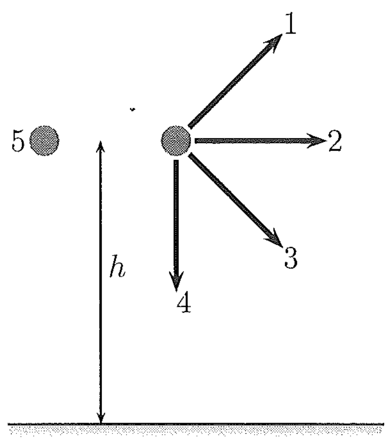
speed $\Rightarrow$ $V = \sqrt{V_x^2 + V_y^2}$

$V_x = V_{ox} = 21m/s$

$V_y = V_{oy} - gt = 0 - 9.8m/s^2(2.5s) = -24.5m/s$

$\therefore\ V = \sqrt{(21m/s)^2 + (24.5m/s)^2} = 32.3m/s$

(8.) Four balls are simultaneously launched with the same speed, from the same height, h, above the ground, but with the different directions shown. At the same instant, ball 5 is released from rest at the same height h. Which of the following is the correct ranking, from shortest to longest, for the amount of time it takes each of these balls to hit the ground. Any pairs that hit the ground simultaneously have been circled.



(a) 1, 2, 3, 4, 5
(b) 1, 2, 5, 3, 4
(c) 1, 2, 5, 3, 4
(d) 4, 3, 2, 5, 1
(e) 4, 3, 2, 5, 1

SAME Height AND LAUNCH Speed ⇒ Angle only FACTOR THAT could determine time of Flight. To Hit Floor ⇒ to BE AT $y = 0$ ⇒ VERTICAL Motion.

LAUNCH Angle DETERMINES $V_{0y} = V_0 \sin\alpha$. FOR 2, $\alpha = 0 \Rightarrow V_{0y} = 0$, FOR 5, $V_{0y} = 0$

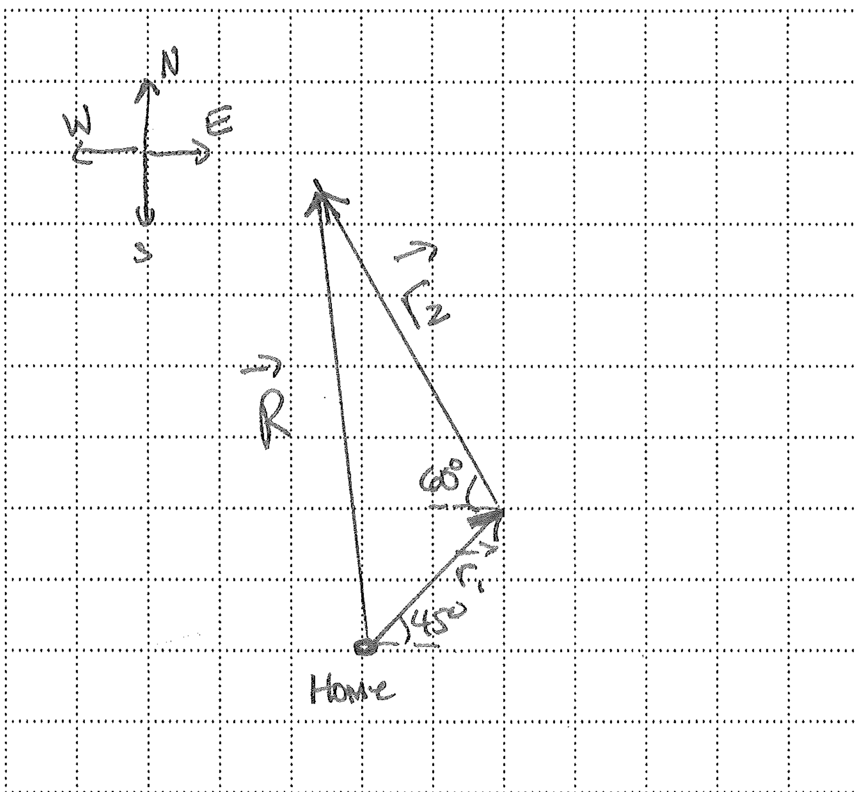
Also SO 2 AND 5 take SAME AMOUNT OF TIME.

4 THROWN STRAIGHT DOWN SO REACHES GROUND First, 3 HAS less V_{0y} THAN 4 but MORE THAN 2 SO Slower THAN 4 but FASTER THAN 2.

1 takes the Most time BECAUSE IT HAS to go up BEFORE coming BACK DOWN

(9.) A man leaves his house and walks 25 m at 45° north of east. He then walks 50.0 m at 60° north of west.

(a) On the grid below, sketch the man's displacement vectors at the proper locations for finding their vector sum graphically, as well as, the vector sum. Label the vectors as $\vec{\mathbf{r}}_1$ and $\vec{\mathbf{r}}_2$ (for the first and second motions respectively). Label the vector sum as $\vec{\mathbf{R}}$. *(5pts.)*

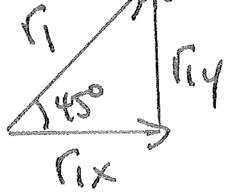


(b) From his final position after the second motion, how far and in what direction must the man walk *in order to get home*? *(5pts.)*

Notice that $\vec{R}$ points FROM Home to FINAL Position ⇒

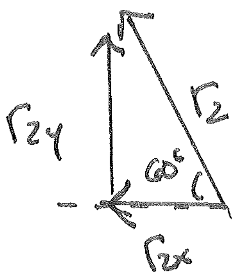
$\boxed{\text{We WANT } -\vec{R}}$

$R_x = r_{1x} + r_{2x}$ $\quad R_y = r_{1y} + r_{2y}$



$r_{1x} = r_1 \cos 45° = 25\,m \cos 45° = 17.678\,m$

$r_{1y} = r_1 \sin 45° = 25\,m \sin 45° = 17.678\,m$



r_{2x} to left $\Rightarrow$ $r_{2x} = -r_2 \cos 60^\circ = -50\text{m} \cos 60^\circ$
$= -25\text{m}$

r_{2y} up $\Rightarrow$ $r_{2y} = +r_2 \sin 60^\circ = +50\text{m} \sin 60^\circ$
$= +43.3\text{m}$

$R_x = 17.678\text{m} - 25\text{m} = -7.322\text{m}$
$R_y = 17.678\text{m} + 43.3\text{m} = 60.978\text{m}$

$R_x < 0,\ R_y > 0 \Rightarrow$ 2ND QUAD $\Rightarrow$ Calc. wrong by 180°

$R = \sqrt{R_x^2 + R_y^2} = \sqrt{(7.322\text{m})^2 + (60.978\text{m})^2} = 61.4\text{m}$

$\theta = \tan^{-1}\left(\frac{R_y}{R_x}\right) + 180^\circ$ ⟸ of course, we actually want $-\vec{R}$

which is $\theta + 180^\circ$ $\Rightarrow$ $-\vec{R}$ at $\tan^{-1}\left(\frac{R_y}{R_x}\right) + 180^\circ + 180^\circ = \tan^{-1}\left(\frac{R_y}{R_x}\right) + 360^\circ$

So for $-\vec{R}$ Do nothing to Calc. value

$\tan^{-1}\left(\frac{60.978}{-7.322}\right) = -83.2^\circ$