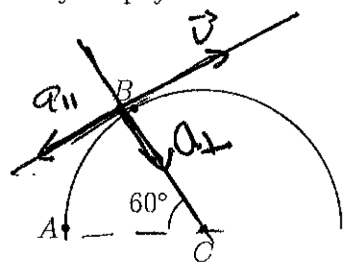
Blue

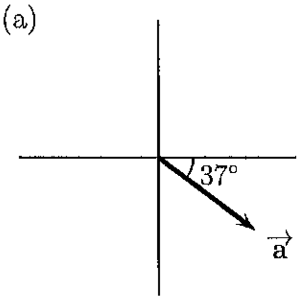
1. Your physics instructor starts from rest at the point labeled A on a half-circular track with center at point C. Being very out of shape, your physics instructor soon tires, and so when he arrives at point B his speed is decreasing. Which of the following vectors is a possible acceleration for your physics instructor at point B?



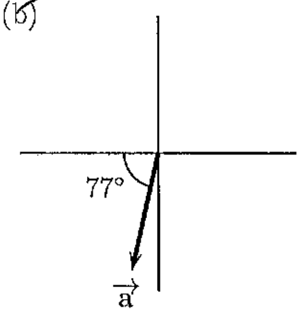
slowing down so $a_{\parallel}$ opposite to $\vec{v}$

$a_{rad} = a_{\perp}$ towards center

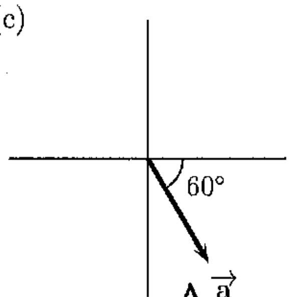
(a)



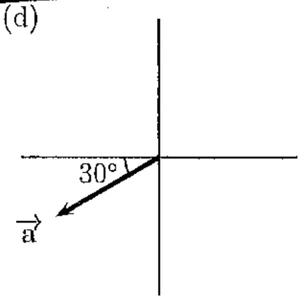
(b)



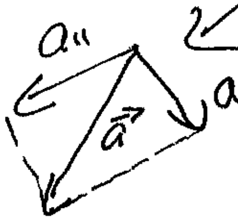
(c)



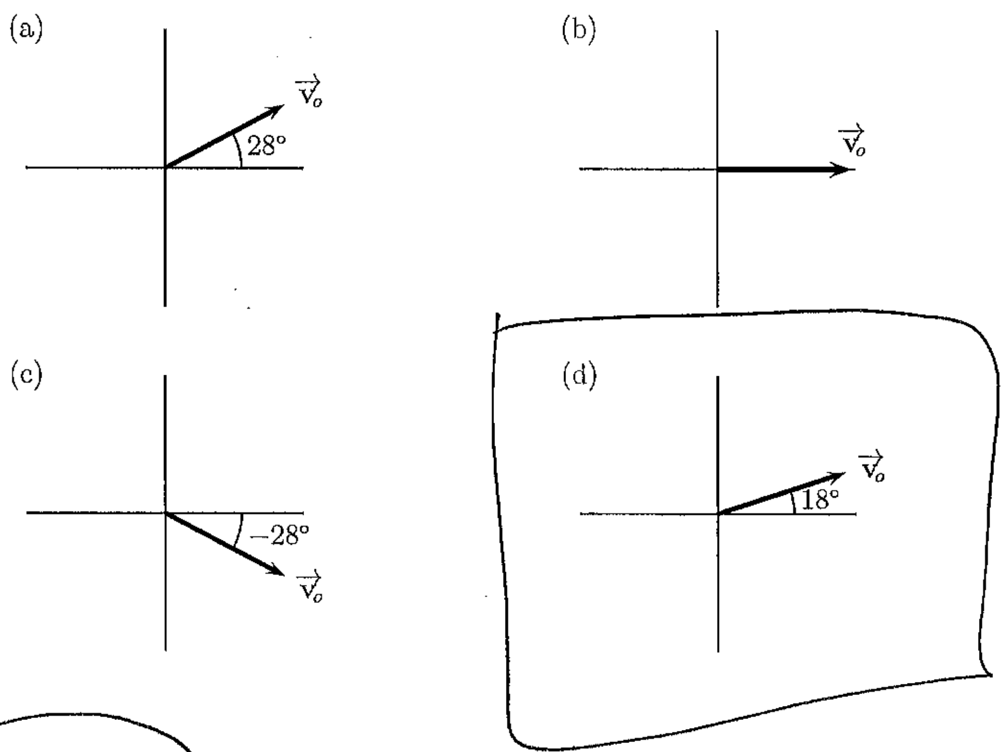
(d)

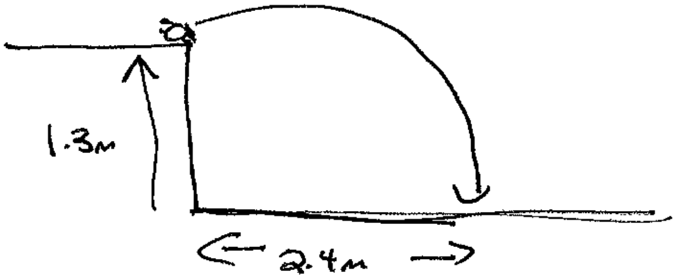


this one is just a_{rad}



2. A grasshopper launches itself from the top of a table that is 1.3 m high. Its time of flight is 0.65 s and its range is 2.4 m. Assuming air resistance was negligible, at what angle did the grasshopper launch itself?





$t = .65s$

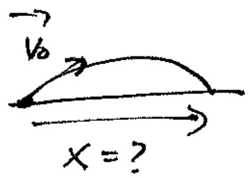
$X = X_0 + V_{0x}t \Rightarrow V_{0,x} = \frac{X - X_0}{t} = \frac{2.4m}{.65s} = 3.6923$

$y = y_0 + V_{0,y}t - \frac{1}{2}gt^2 \Rightarrow 0 = 1.3m + V_{0,y}(.65s) - 4.9m/s^2(.65s)^2$

$\Rightarrow 0 = -.77025m + V_{0,y}(.65s) \Rightarrow V_{0y} = 1.185 m/s$

$\alpha = \tan^{-1}\left(\frac{V_{0y}}{V_{0x}}\right) = \tan^{-1}\left(\frac{1.185}{3.6923}\right) = 17.79° \approx 18°$

3. What is the range of a projectile that is launched from ground level with a speed of $35\,m/s$ and at a $54°$ angle? Ignore air resistance.



$y_0 = y = 0, \quad X_0 = 0$

(a) $119\,m$	(b) $35\,m$	(c) $250\,m$	(d) $202\,m$

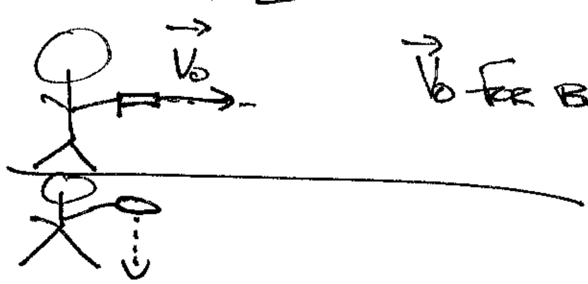
$y = y_0 + V_{0,y}t - \frac{1}{2}gt^2 \Rightarrow 0 = V_{0,y}t - \frac{1}{2}gt^2 = t(V_{0y} - \frac{1}{2}gt)$

$\Rightarrow t = \frac{2V_{0y}}{g} = \frac{2(35m/s)\sin 54°}{9.8m/s^2} = 5.779s \qquad X = X_0 + V_{0,x}t = (35m/s)\cos 54°(5.779s)$

$= 118.882m = 119m$

4. One day, in the name of science, your instructor goes to the middle of Kansas with a gun and an egg. He fires the gun horizontally with speed $125\,m/s$ at the same instant he drops the egg, both from a height of $1.8\,m$. Ignoring air resistance and assuming Kansas is so flat and empty that the bullet hits nothing on the way down, which of the two objects hits the ground first?

(a) The egg	(b) The bullet
(c) They hit at the same time	(d) There is not enough information to determine



$\vec{V_0}$ for Bullet is HORIZONTAL $\Rightarrow V_{0,y} = 0$

$y = y_0 + V_{0,y}t - \frac{1}{2}gt^2$

$\Rightarrow 0 = 1.8m - \frac{1}{2}(9.8m/s^2)t^2$

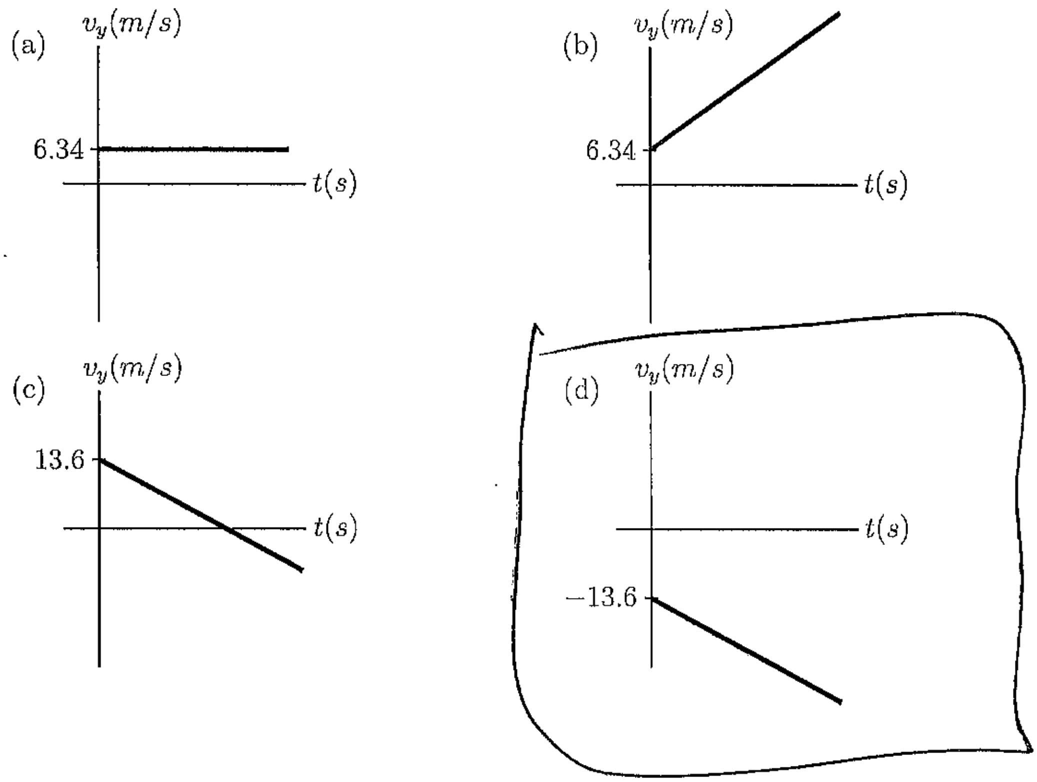
$\Rightarrow t = .606s$ to hit ground

For egg: $V_0 = 0, \quad y = y_0 + V_{0,y}t - \frac{1}{2}gt^2$

$y = 0, \; y_0 = 1.8m \Rightarrow t = .606s$

BUT NO NUMERICAL CALCULATIONS WERE NECESSARY

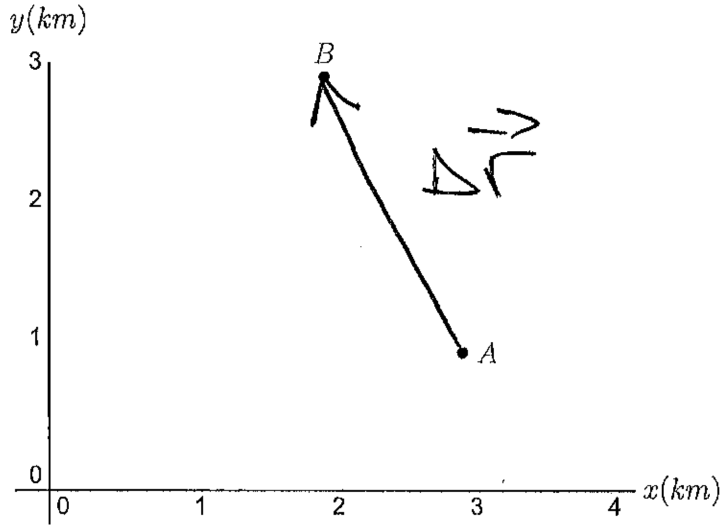
5. One day finds your physics instructor hiking the La Luz trail up to Sandia Peak. At one point in his hike, very near the top of the mountain, his boot dislodges a large rock. If the rock is kicked out at $15.0\,m/s$ and at an angle of $-65.0°$, which of the following is the correct v_y vs. t graph, if we ignore air resistance?



$$V_{0,y} = -V_0 \sin 65° = -15\,m/s \sin 65°$$
$$= -13.6\,m/s$$

$V_y = V_{0,y} - gt \Rightarrow$ DOWNWARD LINE

6. One day while shopping for physics supplies at Walmart, your instructor tries to park his 1973, orange-colored Gremlin. He enters the parking lot at the point labeled A on the graph below and then parks at the point B. If driving from point A to B takes $2.5\,min$, what is the magnitude and direction of the average *velocity* for the motion from A to B? All angles are given as standard angles.



(a) $1.3\,km/min$ at 72°	(b) $1.4\,km/min$ at 56°
(c) $0.89\,km/min$ at 117°	(d) $2.2\,km$ at 117°

Looking at $\Delta \vec{r}$, we see it's in 2ND QUADRANT (DIRECTION WISE) ⇒ ONLY (C) OR (d) possibly. Only (C) has correct unit.

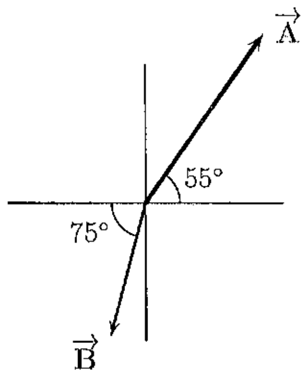
For the Completist: $\vec{V}_{AV} = \frac{\Delta \vec{r}}{\Delta t} \Rightarrow V_{AV,x} = \frac{\Delta X}{\Delta t}, V_{AY} = \frac{\Delta Y}{\Delta t}$

$\Delta X = 2km - 3km = -1km \Rightarrow V_{AV,x} = \frac{-1km}{2.5min} = -.4\,km/min$, $\Delta Y = 3km - 1km = 2km$

$V_{AV,Y} = .8\,km/min$ $\quad V_{AV} = \sqrt{V_{AV,x}^2 + V_{AV,y}^2} = .89\,km/min$ $\quad \theta = \tan^{-1}\left(\frac{V_{AV,y}}{V_{AV,x}}\right) + 180° = 117°$

2ND QUADRANT

7. What is the magnitude of the vector sum $\vec{A} + \vec{B}$ for the vectors shown below?



$A = 3.0\,m$

$B = 2.0\,m$

(a) $1.3\,m$	(b) $5\,m$	(c) $-0.68\,m$	(d) $4.9\,m$

$A_x = 3\cos 55° = 1.72m$, $A_y = 3m \sin 55° = 2.46m$

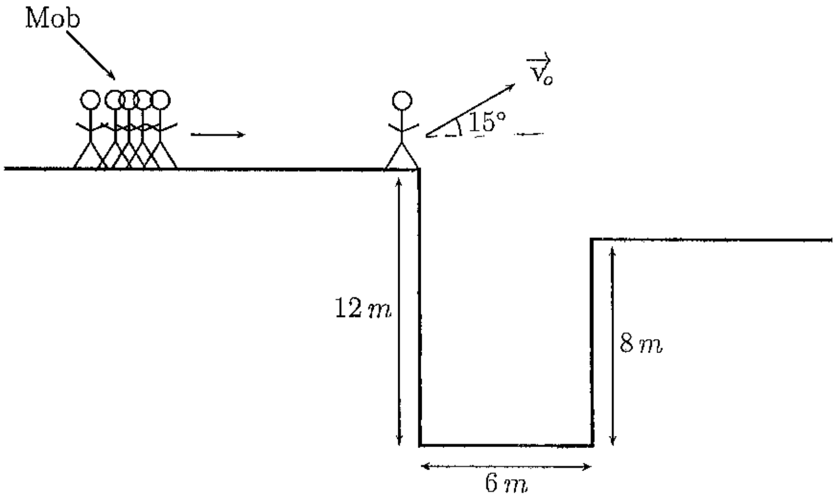
$B_x = -2m\cos 75° = -.518m$, $B_y = -2m \sin 75° = -1.93$

3RD QUAD   3RD QUAD

$A_x + B_x = 1.202m = R_x$ $A_y + B_y = .53m = R_y$

$R = \sqrt{(1.202m)^2 + (.53m)^2} = 1.3m$

8. One day finds your instructor fleeing from a mob of angry physics students. As is usually the case in situations like this, he eventually finds himself caught at the edge of a 12-m high ravine. 6.0 m away is the other side of the ravine which is only 8.0 m high. (As schematically shown below.) In desperation, your instructor launches himself with speed 5.5 m/s and angle 15°. Does he make it to the other side of the ravine? For full credit, you must do a *correct* numerical calculation.



EASIEST CALCULATION IS TO SET $X_0 = 0$, $Y_0 = 12m$ AND $X = 6m$. IF $y \leq 8m$ HE DOESN'T MAKE IT.

$$X = X_0 + V_{0,x}t \Rightarrow t = \frac{X - X_0}{V_{0,x}} = \frac{6m}{5.5m/s \cos 15^\circ} = 1.13s$$

$$y = y_0 + V_{0,y}t - \tfrac{1}{2}gt^2 = 12m + 5.5m/s \sin 15^\circ (1.13s) - 4.9m/s^2 (1.13s)^2$$

$$y = 12m + 1.6m - 6.25681m = 7.34m$$

DOESN'T MAKE IT!

YOU COULD ALSO DO THE OPPOSITE!

SET $x_0 = 0$, $y_0 = 12m$, $y = 8m$ AND FIND X

$y = y_0 + V_{0,y}t - \frac{1}{2}gt^2 \Rightarrow 8m = 12m + (5.5m/s)\sin 15° t - 4.9m/s^2 t^2$

$\Rightarrow -4m = 1.4235m/s\, t - 4.9m/s^2 t^2$

$\Rightarrow 4.9m/s^2 t^2 - 1.4235m/s\, t - 4m = 0$

$\Rightarrow t = \dfrac{1.4235m/s \pm \sqrt{(1.4235m/s)^2 - 4(4.9m/s^2)(-4m)}}{2(4.9m/s^2)} = \dfrac{1.4235m/s \pm 8.968m/s}{9.8m/s^2}$

$\Rightarrow t = 1.06s$, OR ~~$-.7698s$~~

$\therefore X = \cancel{X_0} + V_{0,x}t = 5.5m/s \cos 15° (1.06s)$

$= 5.63m < 6m$

SO DOESN'T MAKE IT.