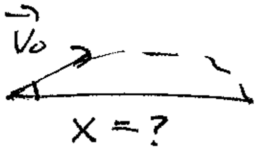
green

1. What is the range of a projectile that is launched from ground level with a speed of $25\,m/s$ and at a $29°$ angle? Ignore air resistance.



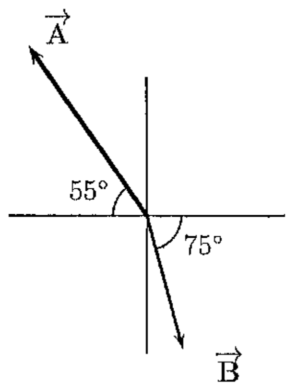
$Y = Y_0 = 0, \; X_0 = 0, \; X = ?$

(a) $123\,m$	(b) $112\,m$	(c) $54\,m$	(d) $25\,m$

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

$t = \frac{2(25\,m/s)\sin 29°}{9.8\,m/s^2} = 2.47\,s \qquad X = X_0 + V_{0x}t = (25\,m/s)\cos 29°(2.47\,s) = 54\,m$

2. 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) $4.9\,m$	(b) $5\,m$	(c) $-0.68\,m$	(d) $1.3\,m$

2ND QUAD $\Rightarrow A_x = -3m\cos 55° = -1.721\,m, \; A_y = +3m\sin 55° = 2.457\,m$

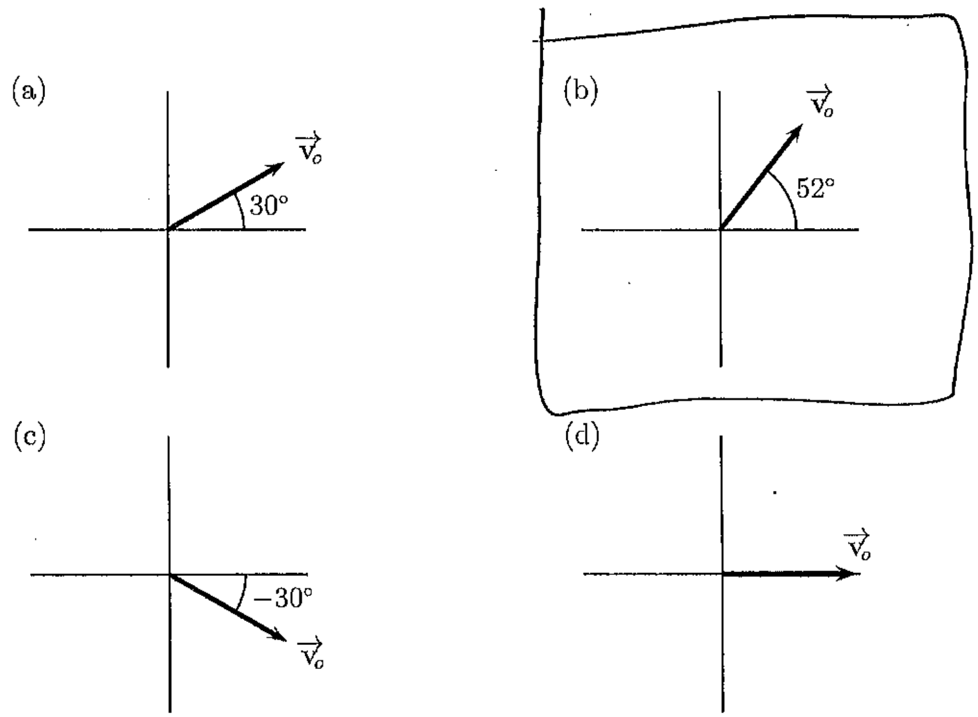
4th QUAD $\Rightarrow B_x = +2m\cos 75° = .5176\,m, \; B_y = -2m\sin 75° = -1.932\,m$

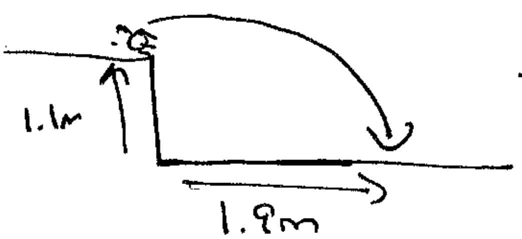
$R_x = A_x + B_x = -1.721\,m + .5176\,m = -1.2034\,m$

$R_y = A_y + B_y = 2.457\,m - 1.932\,m = .525\,m$

$R = \sqrt{R_x^2 + R_y^2} = \sqrt{(1.2034\,m)^2 + (.525\,m)^2} = 1.3\,m$

3. A grasshopper launches itself from the top of a table that is $1.1\,m$ high. Its time of flight is $0.85\,s$ and its range is $1.9\,m$. Assuming air resistance was negligible, at what angle did the grasshopper launch itself?





$t = .85s$ $\qquad \alpha = ?$

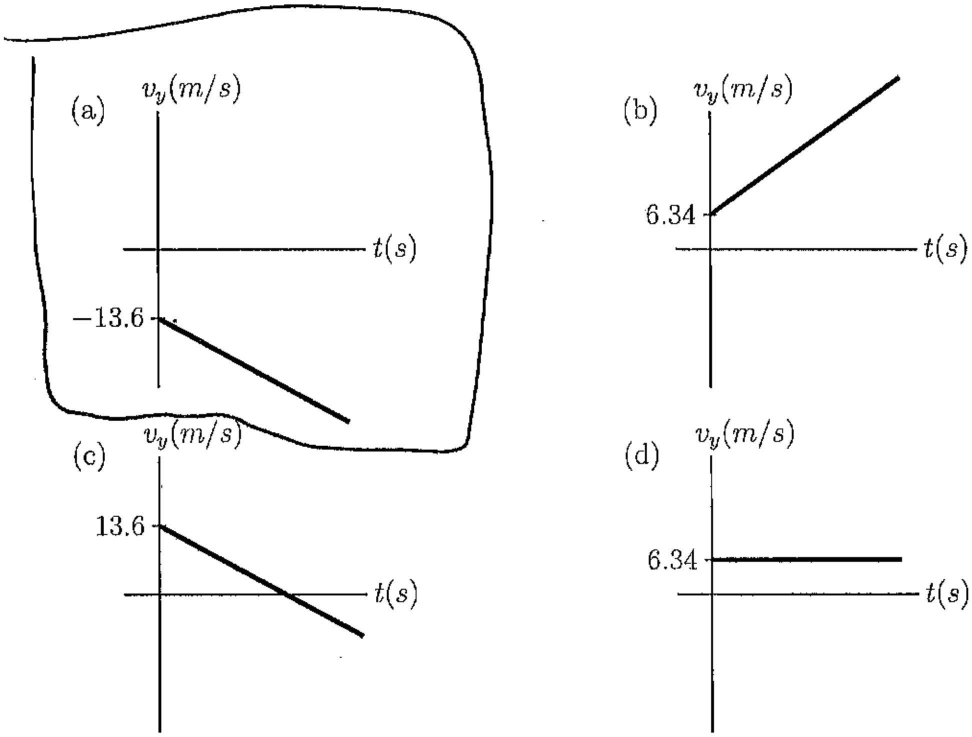
$X = X_0 + V_{0,x}t \Rightarrow V_{0,x} = \frac{X - X_0}{t} = \frac{1.9m}{.85s} = 2.235 m/s$

$Y = Y_0 + V_{0,y}t - \frac{1}{2}gt^2 \Rightarrow 0 = 1.1m + V_{0,y}(.85s) - 4.9m/s^2(.85s)^2$

$\Rightarrow 0 = 1.1m - 3.54025m + V_{0y}(.85s) \Rightarrow 0 = -2.44025m + V_{0y}(.85s)$

$\Rightarrow V_{0y} = \frac{2.44025m}{.85s} = 2.87 m/s \qquad \alpha = \tan^{-1}\left(\frac{V_{0y}}{V_{0,x}}\right) = \tan^{-1}\left(\frac{2.87}{2.235}\right) = 52°$

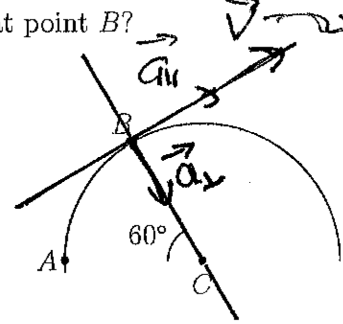
4. One day finds your physics instructor hiking the La Luz trail up to Sandia Peak. At one point in his hike, very near the top of the mountain, his boot dislodges a large rock. If the rock is kicked out at $15.0\,m/s$ and at an angle of $-65.0°$, which of the following is the correct v_y vs. t graph,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

5. Your physics instructor starts from rest at the point labeled A on a half-circular track with center at point C. He does fairly well, and so when he arrives at point B his speed is increasing. (It won't last!) Which of the following vectors is a possible acceleration for your physics instructor at point B?



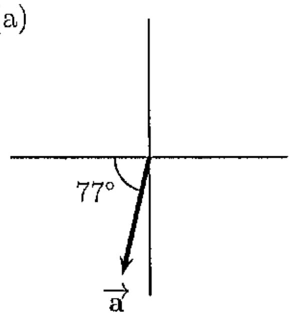
$\vec{a}_\perp$ towards center of circle

$\vec{v}$ → velocity at B

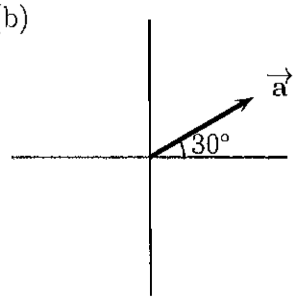
Speed increasing ⇒ $\vec{a}_\parallel$ in same direction as $\vec{v}$

$\vec{a}_\parallel$ at 30°

(a)

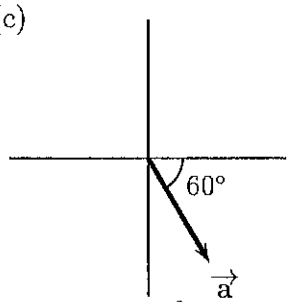


(b)

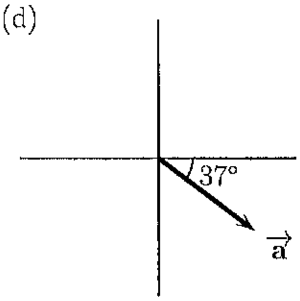


just $\vec{a}_\parallel$

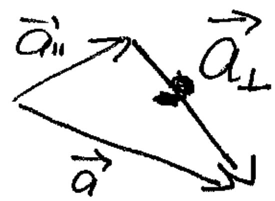
(c)



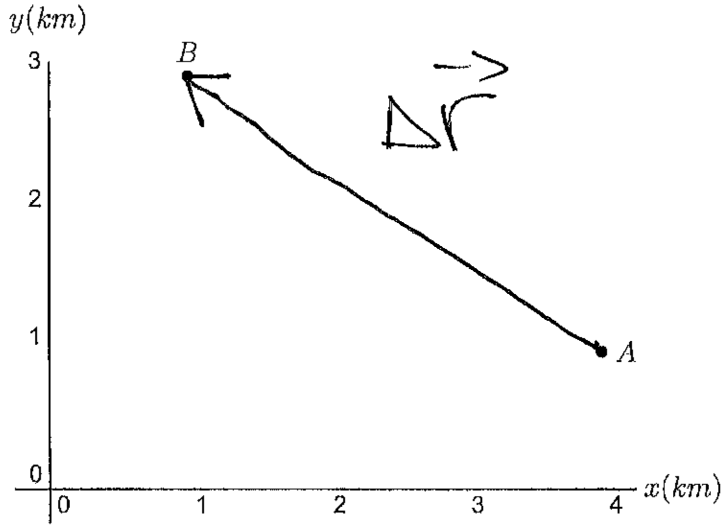
(d)



just $a_\perp$



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.



EASY WAY! $\vec{\Delta r}$ IS IN 2ND QUADRANT (DIRECTION-WISE) SO ONLY (C) AND (d) ARE possible ANSWERS. ONLY (C) HAS Correct unit

(a) $1.6\,km/min$ at 14°	(b) $1.3\,km/min$ at 71.6°
(c) $1.4\,km/min$ at 146.3°	(d) $3.6\,km$ at 146.3°

FOR THE Completist: $\vec{V}_{AV} = \frac{\vec{\Delta r}}{\Delta t} \Rightarrow V_{AV,x} = \frac{\Delta x}{\Delta t}$, $V_{AV,y} = \frac{\Delta y}{\Delta t}$

$\Delta x = 1km - 4km = -3km \Rightarrow V_{AV,x} = \frac{-3km}{2.5min} = -1.2 km/min$

$\Delta y = 3km - 1km = 2km \Rightarrow V_{AV,y} = \frac{2km}{2.5min} = .8 km/min$

$V_{AV,x} < 0$, $V_{AV,y} > 0$ $\Rightarrow$ 2ND QUAD.

$V_{AV} = \sqrt{V_{AV,x}^2 + V_{AV,y}^2} = 1.4 km/min$

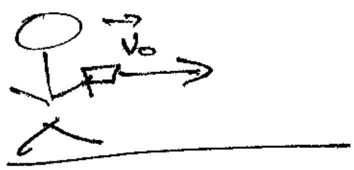
$\theta = \tan^{-1}\left(\frac{V_{AV,y}}{V_{AV,x}}\right) + 180° = 146.3°$

2ND QUAD

7. 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

Bullet



$\vec{V}_0$ Horizontal $\Rightarrow V_{0,y} = 0$

Hit ground $\Rightarrow y = 0,\ y_0 = 1.8m$

$y = y_0 + V_{0,y}t - \frac{1}{2}gt^2 \Rightarrow 0 = 1.8m - 4.9m/s^2\,t^2$

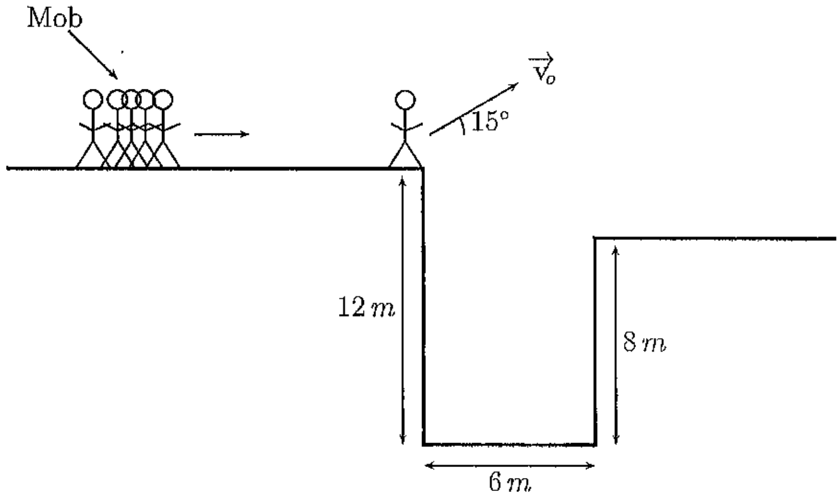
$\Rightarrow t = .606s$

For egg: $V_0 = 0 \quad y = y_0 + V_0 t + \frac{1}{2}at^2 \quad y = 0,\ y_0 = 1.8m$

$a = -9.8m/s^2 \Rightarrow t = .606\,s$

But no numerical calculations were necessary. Same y_0, y, $V_{0y} = 0$ is enough to tell us same time.

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 6.5 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.



PROBABLY THE EASIEST WAY IS TO SET $X_0 = 0$, $X = 6m$, $Y_0 = 12m$ AND SOLVE FOR Y. IF $Y < 8m$, HE DOESN'T MAKE IT.

$$X = X_0 + V_{0,x} t \Rightarrow t = \frac{X - X_0}{V_{0,x}} = \frac{6m}{6.5m/s \cos 15°} = .9556s$$

$$Y = Y_0 + V_{0,y} t - \frac{1}{2} g t^2 \Rightarrow Y = 12m + 6.5m/s \sin 15° (.9556s) - 4.9m/s^2 (.9556s)^2$$

$$\Rightarrow Y = 12m + 1.608m - 4.475m = 9.133m$$

MAKES IT! (IF YOU PREFER: $\Delta Y = -2.867m > -4m$)

YOU COULD ALSO REVERSE THIS BY SETTING $y_0 = 12m$, $y = 8m$, $X_0 = 0$ AND FINDING X.

$$y = y_0 + V_{0,y} t - \frac{1}{2} g t^2 \Rightarrow 8m = 12m + 6.5m/s \sin 15° t - 4.9m/s^2 t^2$$

$$\Rightarrow -4m = 1.682m/s\, t - 4.9m/s^2 t^2$$

$$\Rightarrow 4.9m/s^2 t^2 - 1.682m/s\, t - 4m = 0$$

$$\Rightarrow t = \frac{1.682m/s \pm \sqrt{(1.682m/s)^2 - 4(4.9m/s^2)(-4m)}}{2(4.9m/s^2)} = \frac{1.682m/s \pm 9.013m/s}{9.8m/s^2}$$

$$\Rightarrow t = 1.09s \text{ OR } \sout{-.748s}$$

$$\therefore X = \cancel{X_0} + V_{0,x} t = (6.5m/s) \cos 15° (1.09s) = 6.84m$$

6.84m > 6m SO MAKES IT!