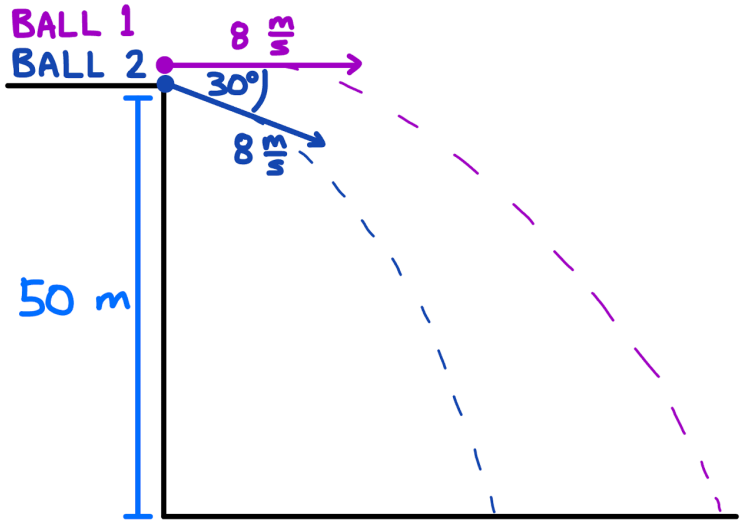
Bob walks 500 m 25° east of south, then 600 m north. What is his total displacement?

A car is initially 6 km east of home. Thirty minutes later, it is 3 km south of home. What is the displacement of the car during the 30 minutes?

A plane travels with an airspeed of 600 km/h and aims 40° west of north. An 80 km/h wind blows south. What is the velocity of the plane relative to the ground?

Two balls are launched from a 50 m high cliff as shown. Determine the range and impact velocity of each ball.

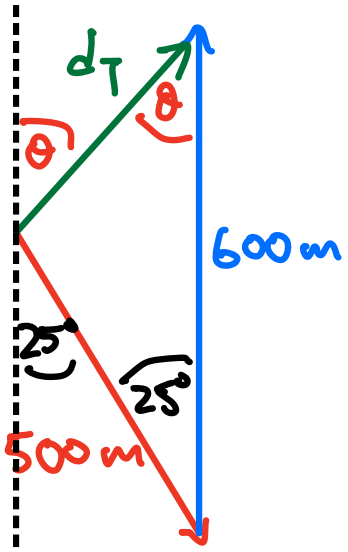


A ball is launched from level ground at a velocity of 10 m/s 50° above the horizontal. Determine…

a) the maximum height
b) the range
c) the impact velocity

Bob walks 500 m 25° east of south, then 600 m north. What is his total displacement? $\vec{d}_T$ $\vec{d}_1$ $\vec{d}_2$

$\vec{d}_T = \vec{d}_1 + \vec{d}_2$



$d_T^2 = (500)^2 + (600)^2 - 2(500)(600)\cos 25°$

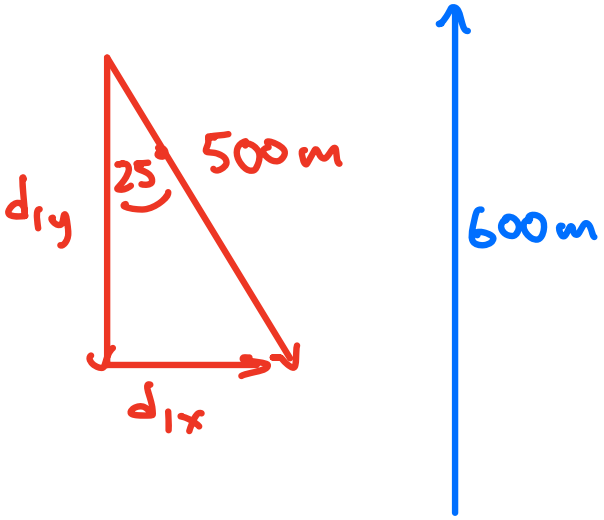
$d_T = 257$ m

$\frac{\sin\theta}{500} = \frac{\sin 25°}{257}$

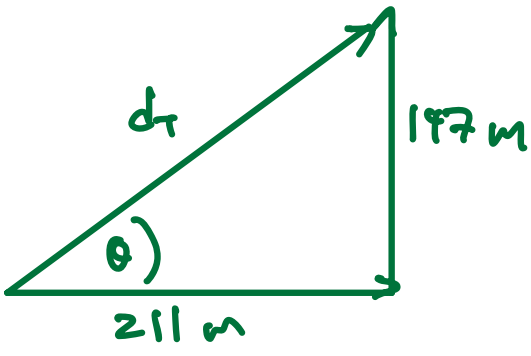
$\theta = \sin^{-1}\left(\frac{500}{257}\sin 25°\right) = 55.2°$

257 m 55.2° E of N

= **257 m 34.8° N of E**



x	y
$d_{1x} = +500\sin 25°$ $= +211$ m	$d_{1y} = -500\cos 25°$ $= -453$
$d_{2x} = 0$	$d_{2y} = +600$
$d_{Tx} = +211$ m	$d_{Ty} = +147$ m



$d_T = \sqrt{(211)^2 + (147)^2} = 257$ m

$\theta = \tan^{-1}\left(\frac{147}{211}\right) \approx 34.8°$

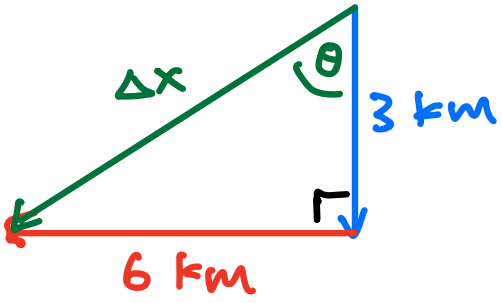
257 m 34.8° N of E

A car is initially 6 km east of home. Thirty minutes later, it is 3 km south of home. What is the displacement of the car during the 30 minutes?

$\vec{x}_i$ $\vec{x}_f$ $\Delta\vec{x}$

$$\Delta\vec{x} = \vec{x}_f - \vec{x}_i$$

$$\Delta\vec{x} = \vec{x}_f + (-\vec{x}_i)$$



$$\Delta x = \sqrt{(3)^2 + (6)^2}$$

$$= 6.71 \text{ km}$$

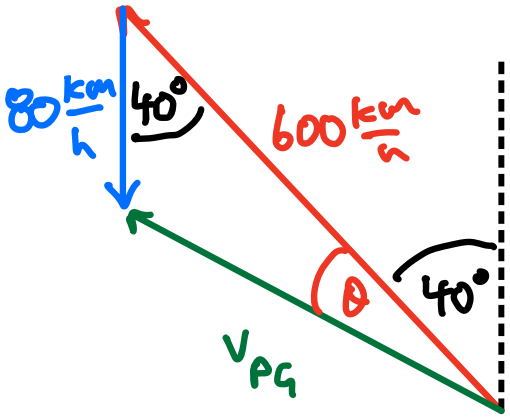
$$\theta = \tan^{-1}\left(\frac{6}{3}\right) = 63.4^\circ$$

6.71 km 63.4° W of S

$$= \boxed{6.71 \text{ km} \quad 26.6^\circ \text{ S of W}}$$

A plane travels with an airspeed of 600 km/h and aims 40° west of north. An 80 km/h wind blows south. What is the velocity of the plane relative to the ground?

$\vec{V}_{PA} + \vec{V}_{AG} = \vec{V}_{PG}$



$V_{PG}^2 = (600)^2 + (80)^2 - 2(600)(80)\cos 40°$

$V_{PG} = 541 \frac{km}{h}$

$\frac{\sin\theta}{80} = \frac{\sin 40°}{541}$

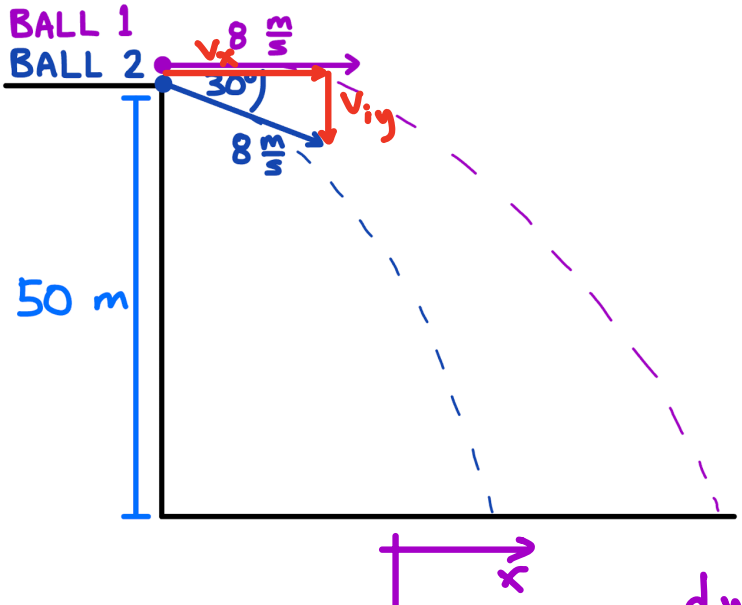
$\theta = \sin^{-1}\left(\frac{80}{541}\sin 40°\right) = 5.5°$

$45° + 5.45° = 45.5°$

$541 \frac{km}{h}$ 45.5° E of N

$= \boxed{541 \frac{km}{h} \quad 44.5° \quad N \text{ of } E}$

Two balls are launched from a 50 m high cliff as shown. Determine the range and impact velocity of each ball.



x	y
$v_x = 8\ \frac{m}{s}$	$v_{iy} = 0$
$t = ?$	$a_y = +9.8\ \frac{m}{s^2}$
$d_x = ?$	$d_y = +50\ m$
	$t = ?$
	$v_{fy} = ?$

$$d_y = v_{iy}t + \frac{1}{2}a_y t^2$$

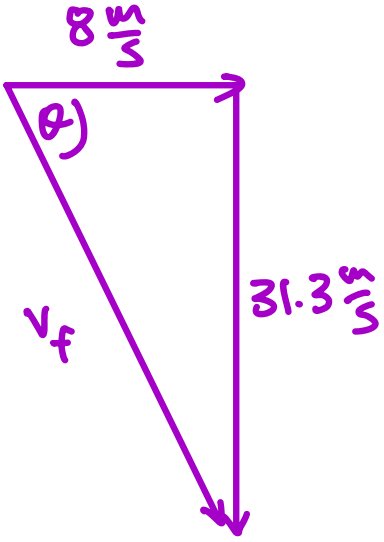
$$t = \sqrt{\frac{2d_y}{a_y}} = \sqrt{\frac{2(50)}{9.8}} = 3.19\ s$$

$$d_x = v_x t$$

$$= (8)(3.19) \approx \boxed{25.6\ m}$$

$$v_{fy}^2 = v_{iy}^2 + 2a_y d_y$$

$$v_{fy} = \sqrt{2(9.8)(50)} = 31.3\ \frac{m}{s}$$

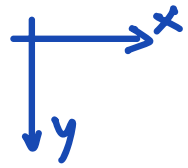


$$v_f = \sqrt{(8)^2 + (31.3)^2}$$

$$= 32.3\ \frac{m}{s}$$

$$\theta = \tan^{-1}\left(\frac{31.3}{8}\right) = 75.7^\circ$$

$\boxed{32.3\ \frac{m}{s} \quad 75.7^\circ \text{ BELOW THE HORIZONTAL}}$



x	y
$v_x = 8\cos 30^\circ$	$v_{iy} = +8\sin 30^\circ$
$= 6.93 \frac{m}{s}$	$= +4 \frac{m}{s}$
$t = ?$	$a_y = +9.8 \frac{m}{s^2}$
$d_x = ?$	$d_y = +50\,m$
	$t = ?$
	$v_{fy} = ?$

$$d_y = v_{iy}t + \frac{1}{2}a_y t^2$$

$$50 = 4t + \frac{1}{2}(9.8)t^2$$

$$0 = 4.9t^2 + 4t - 50$$

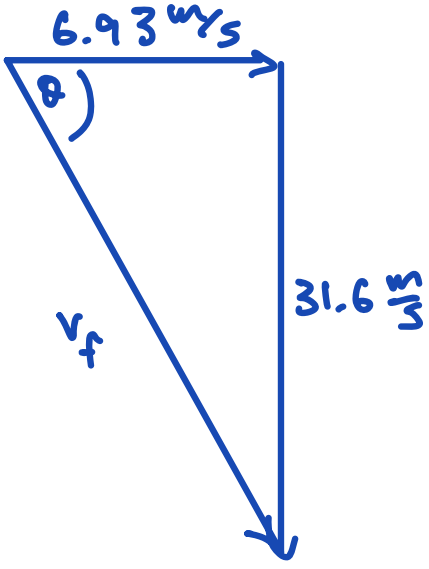
(a, b, c)

$$t = \frac{-4 \pm \sqrt{(4)^2 - 4(4.9)(-50)}}{2(4.9)}$$

$$= -3.63\ s,\ 2.81\ s$$

$$d_x = v_x t$$

$$= (6.93)(2.81) = \boxed{19.5\ m}$$



$$v_{fy}^2 = v_{iy}^2 + 2a_y d_y$$

$$v_{fy} = \sqrt{(4)^2 + 2(9.8)(50)}$$

$$= 31.6 \frac{m}{s}$$

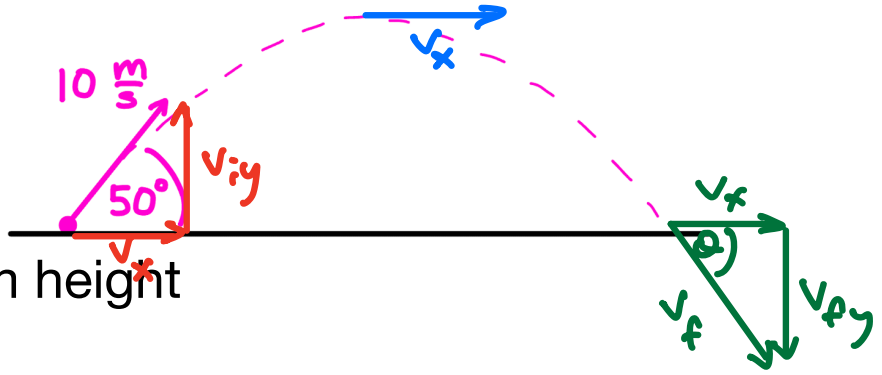
$$v_f = \sqrt{(6.93)^2 + (31.6)^2}$$

$$= 32.3\ m/s$$

$$\theta = \tan^{-1}\left(\frac{31.6}{6.93}\right) = 77.6^\circ$$

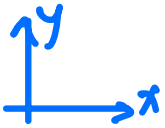
$\boxed{32.3 \frac{m}{s} \quad 77.6^\circ \text{ BELOW THE HORIZONTAL}}$

A ball is launched from level ground at a velocity of 10 m/s 50° above the horizontal. Determine…



a) the maximum height
b) the range
c) the impact velocity

a)



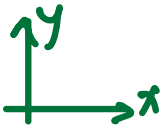
x	y
$v_x = 10\cos 50°$	$v_{iy} = +10\sin 50°$
$= 6.43 \frac{m}{s}$	$= +7.66 \frac{m}{s}$
	$a = -9.8 \frac{m}{s^2}$
	$v_{fy} = 0$
	$d_y = ?$

$$v_{fy}^2 = v_{iy}^2 + 2a_y d_y$$

$$d_y = \frac{-v_{iy}^2}{2a_y} = \frac{-(7.66)^2}{2(-9.8)}$$

$$= \boxed{2.99\ m}$$

b)



x	y
$v_x = 10\cos 50°$	$v_{iy} = +10\sin 50°$
$= 6.43 \frac{m}{s}$	$= +7.66 \frac{m}{s}$
$t = ?$	$a = -9.8 \frac{m}{s^2}$
$d_x = ?$	$d_y = 0$
	$t = ?$
	$v_{fy} = ?$

$$d_y = v_{iy}t + \frac{1}{2}a_y t^2$$

$$0 = t\left(v_{iy} + \frac{1}{2}a_y t\right)$$

$$v_{iy} + \frac{1}{2}a_y t = 0$$

$$t = -\frac{2v_{iy}}{a_y}$$

$$= -\frac{2(7.66)}{-9.8}$$

$$= 1.56\ s$$

$$d_x = v_x t$$
$$= (6.43)(1.56)$$
$$= \boxed{10.0\ m}$$

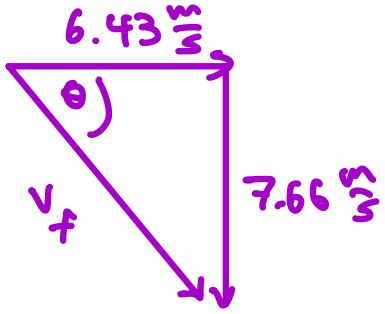
c)

x	y
$v_x = 10\cos 50^\circ$	$v_{iy} = +10\sin 50^\circ$
$= 6.43\ \frac{m}{s}$	$= +7.66\ \frac{m}{s}$
$t = 1.56\ s$	$a = -9.8\ m/s^2$
$d_x = 10.0\ m$	$d_y = 0$
	$t = 1.56\ s$
	$v_{fy} = ?$

$$v_{fy}^2 = v_{iy}^2 + 2a_y d_y$$

$$v_{fy} = \pm v_{iy}$$

$$= \pm 7.66\ \frac{m}{s}$$



$$v_f = \sqrt{(6.43)^2 + (7.66)^2}$$
$$= 10\ m/s$$

$$\theta = \tan^{-1}\left(\frac{7.66}{6.43}\right) = 50^\circ$$

$\boxed{10\ \frac{m}{s} \quad 50^\circ \text{ BELOW THE HORIZONTAL}}$

COULD ALSO SIMPLY USE SYMMETRY