2. A plane attempting to head due north is experiencing a westward crosswind. The resultant velocity is that the plane is heading 40.0° north of west at a speed of 300. m/s.

   a) Draw the resultant velocity vector using the scale of 1.0 cm = 50. m/s.

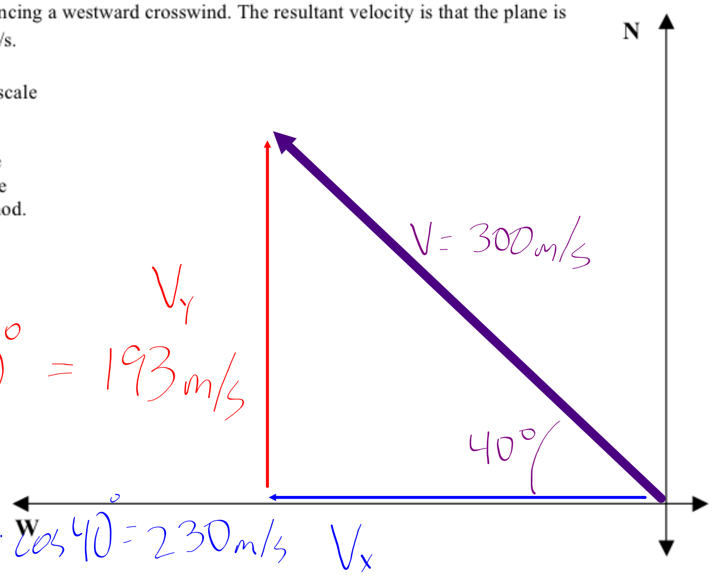
   b) Determine the component velocities (i.e. the plane's speed and the wind's speed) using the graphical method and the mathematical method.

$V_y = V \sin\theta$

$= 300.\,m/s \cdot \sin 40^\circ = 193\,m/s$

$V_x = V \cos\theta$

$= 300.\,m/s \cdot \cos 40^\circ = 230\,m/s$



3. A cannonball is launched with a speed of 450 m/s at an angle of 35° above the horizontal.

a) Sketch an appropriate vector diagram showing the resultant velocity and its horizontal and vertical components.
(Diagram does not need to be drawn to scale but should be roughly to scale.)

b) Calculate the horizontal and vertical components of the cannonball's velocity.

4. A person drags a crate across the floor with a force of 200. N at an angle of 20.°above the horizontal as shown (not to scale).

   a) Sketch an appropriate vector diagram showing the horizontal and vertical components of the force.

   b) As the angle of the force increases, what will happen to the:

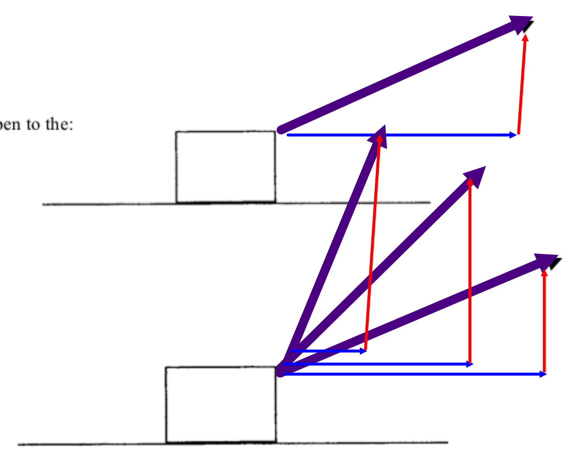
      i) resultant force?

      ii) horizontal component of the force?

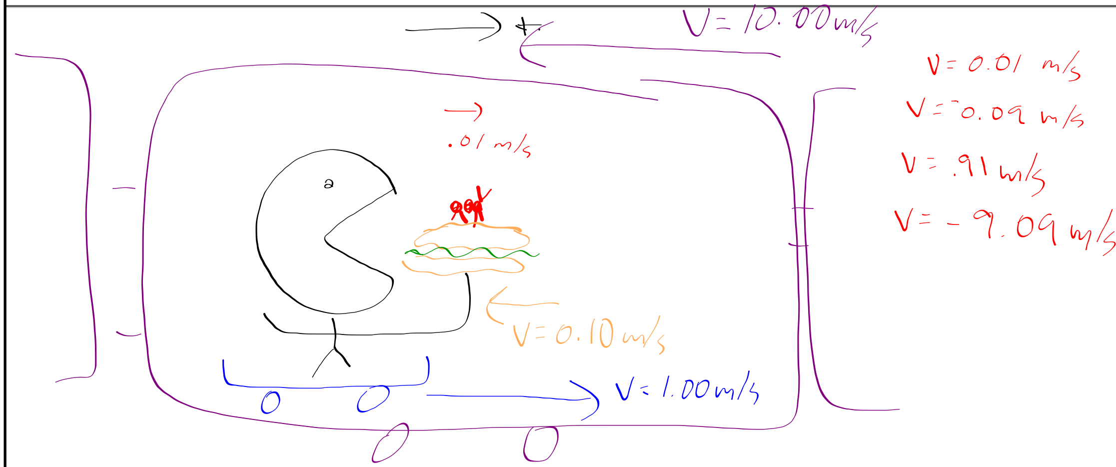
      ↓

      iii) vertical component of the force?

      ↑



Relative Velocity



General Rule: opposite directions - add

same direction - subtract

1. Two cars are 400 meters apart and traveling toward each other on a long straight road. One car is moving at 30 m/s and the other at 50 m/s. How long will it take before they meet?

Independence of Vectors

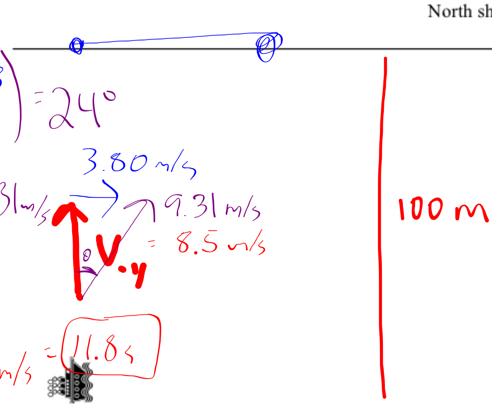
2. A motorboat travels at 8.50 m/s, north straight across a river that has a current of 3.80 m/s east.

North shore

$\theta = \tan^{-1}\left(\frac{3.8}{8.5}\right) = 24°$

a) Determine the boat's resultant velocity.

$V = \sqrt{V_x^2 + V_y^2} = \sqrt{(3.8\,m/s)^2 + (8.5\,m/s)^2} = 9.31\,m/s$



b) If the river is 100. m wide, how long it will take the boat to cross the river?

$d_y = V_{oy} t + \frac{1}{2} a_y t^2$ $\quad t = d_y / V_{oy}$

$= 100.\,m / 8.5\,m/s = 11.8\,s$

c) How far downstream will the boat be when it reaches the opposite shore?

South shore

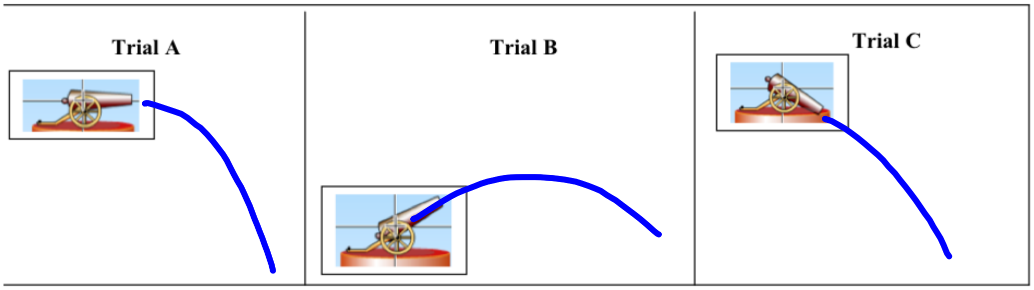
$d_x = V_{ox} t + \frac{1}{2} a t^2 = 3.8\,m/s \cdot 11.8\,s = 45\,m$

d) How far will the boat actually travel?

Projectile: objects that are thrown or launched into the air and are subject only to the force of gravity (neglecting air resistance)

Trajectory: the path of a projectile

1. Predict the trajectory of the cannon ball after it leaves the cannon in each trail, then sketch in its actual trajectory after the demonstration.



Describe the shape of the trajectory of the cannon ball.

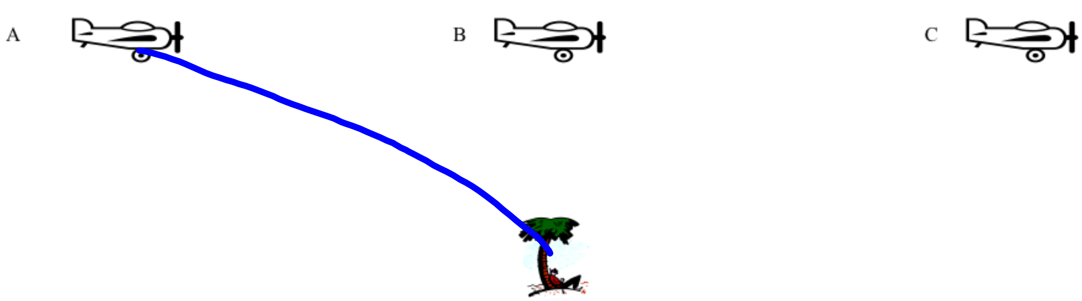
parabolic

Conclusions:

An object projected horizontally will hit the ground at the same time as an object dropped from the same height

The horizontal motion of the cannon ball does not affect its vertical motion – the two motions are independent

3. An airplane must drop a rescue package to a person stranded on a desert island. In which position should the airplane be when it drops the package? Sketch the trajectory of the package as it drops.



If you were in the airplane watching the package drop from above, how would you describe the trajectory of the package?

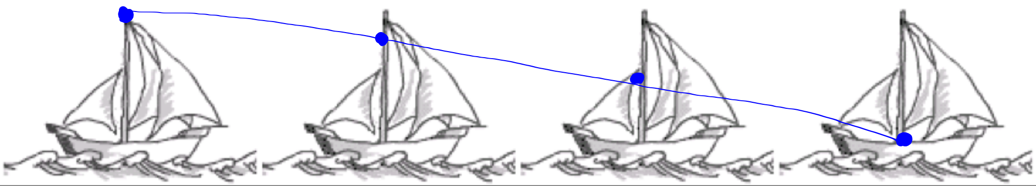
package drops straight down

4. A sailor drops a ball from the top of the mast of a ship sailing to the right at a constant speed.

   a) Where does it land?

   b) Describe the ball's trajectory as seen by the sailor.

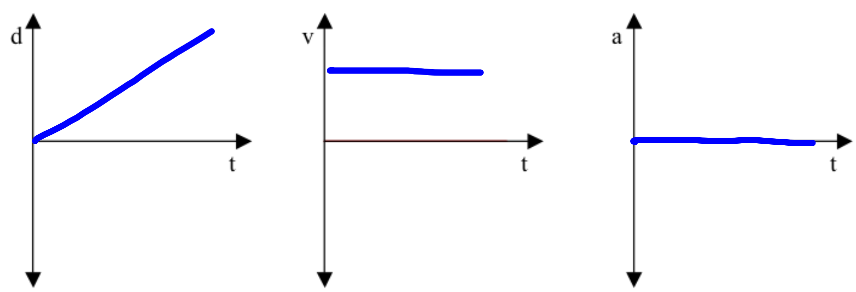
   c) Describe the ball's trajectory as seen by an observer on the shore. Sketch it below.



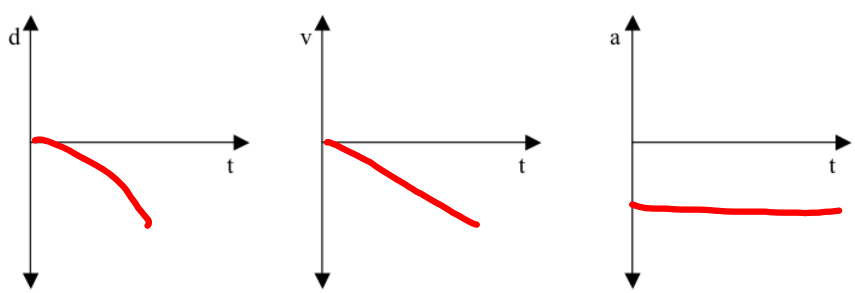
Conclusion:

Projectile motion is the resultant of two independent component motions – horizontal and vertical

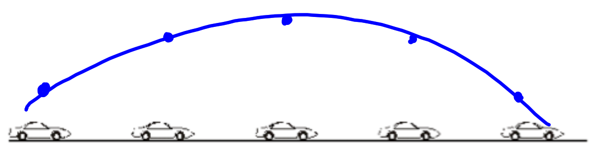
Horizontal Motion



Vertical Motion



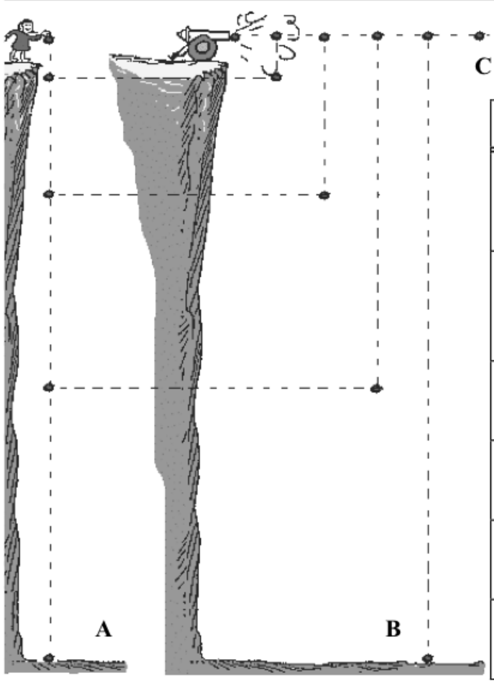
5. A car fires a flare straight upward while traveling at a constant speed. Sketch the position of the flare at each instant.



Where is the flare at each instant? Why?

directly above the car

Horizontal Projectiles



Ball A is dropped over the edge of the cliff. Ball B is shot horizontally from the same height at 50. m/s. Ball C can be imagined to be the path of ball B if gravity were "turned off."

Characteristic	A	B	C
Horizontal motion			const. vel
Vertical motion	const accl		
Initial horizontal velocity		←	50. m/s
Initial vertical velocity	0 →		
Horizontal acceleration			← 0
Vertical acceleration	$-10 \, m/s^2$ →		

January 8, 2020

1. If it takes both balls 4.0 seconds to hit the ground, determine:

a) the height of the cliff.

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

$= \frac{1}{2}(-10\,m/s^2)(4s)^2 = -80\,m$

b) the distance from the base of the cliff that ball B lands.

$d_x = V_{ox}t + \cancel{\frac{1}{2}a_x t^2}$

$= 50.\,m/s \cdot 4s$

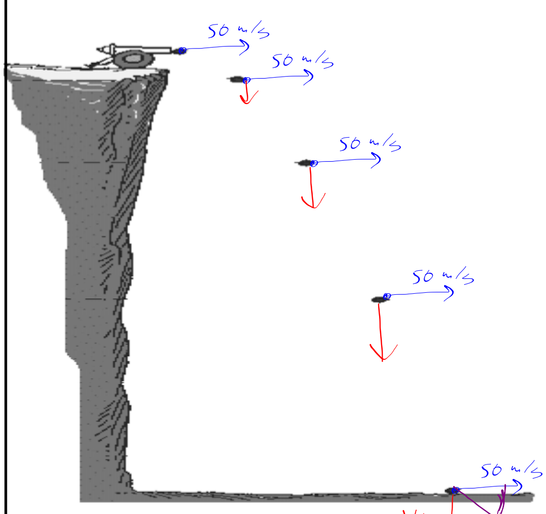
$= 200.\,m$

c) the impact velocity of ball A.

$V_{f,y} = \cancel{V_{oy}} + a_y t = -10\,m/s \cdot 4s$

$= -40\,m/s$

e) Sketch in the instantaneous velocity vectors for ball B at each instant as well as its horizontal and vertical component velocities.



f) Calculate the impact velocity of ball B. How does it compare with that of ball A?

$V = \sqrt{V_{fx}^2 + V_{fy}^2}$

$= \sqrt{(50\,m/s)^2 + (-40\,m/s)^2} = 64\,m/s$

$\theta = \tan^{-1}\left(\frac{40}{50}\right)$

$= 39°$