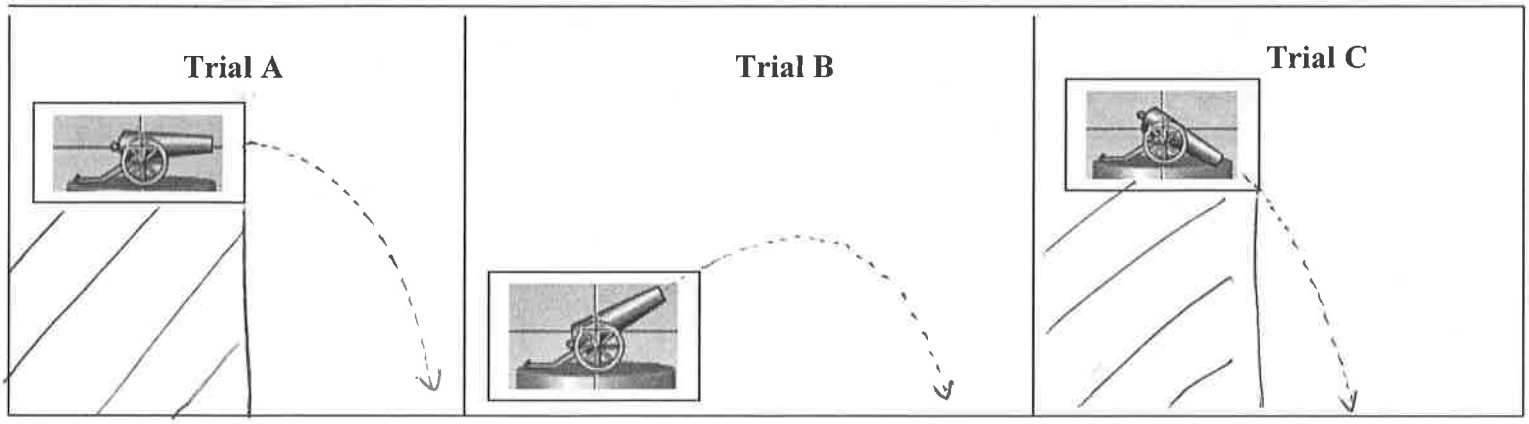
Projectile Motion

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

Trajectory: path of 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.



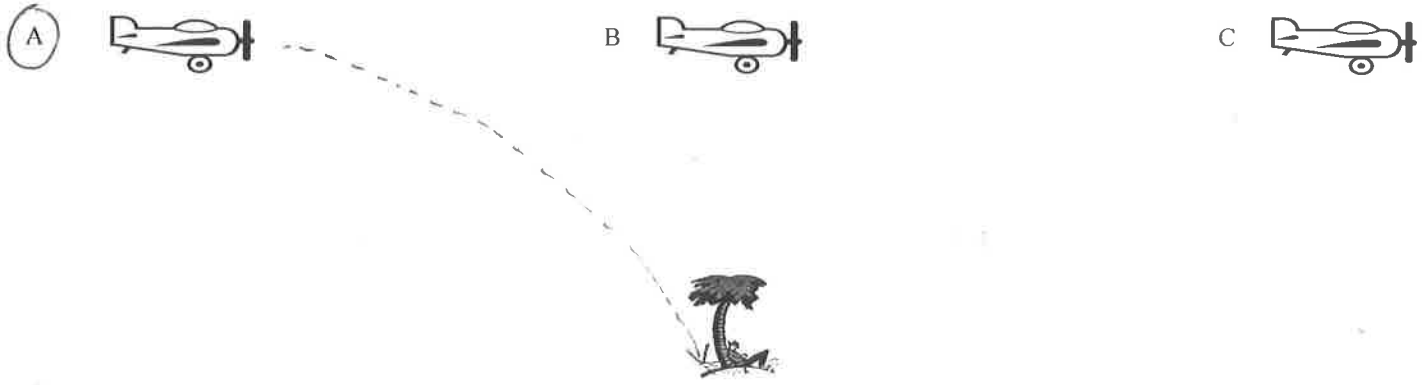
Describe the shape of the trajectory of the cannon ball.

All parabolic

Conclusions:

a) horizontal and vertical motions are independent
b) objects projected horizontally will hit the ground at the same time as an object dropped vertically from the same height

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?

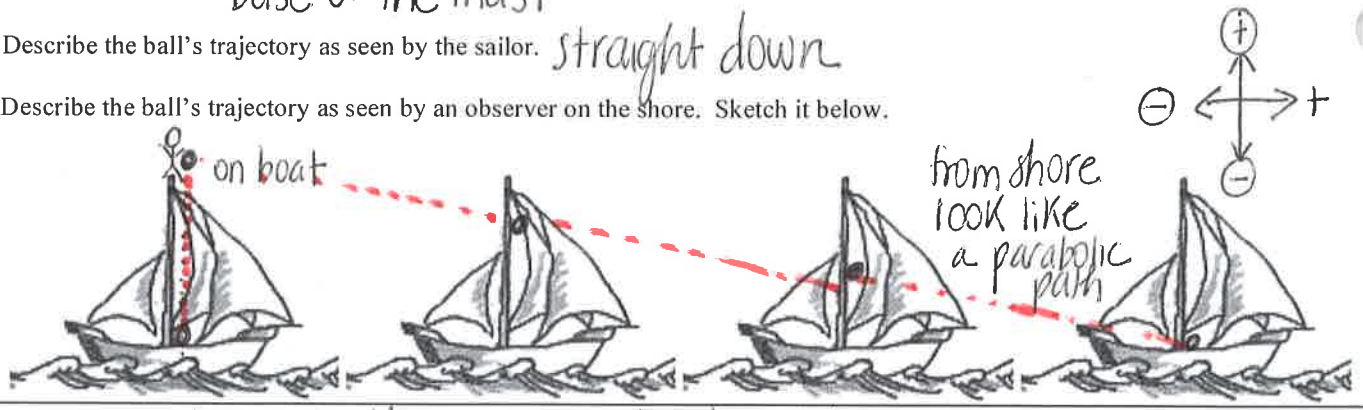
Appears as though the package drops straight down.

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? base of the mast

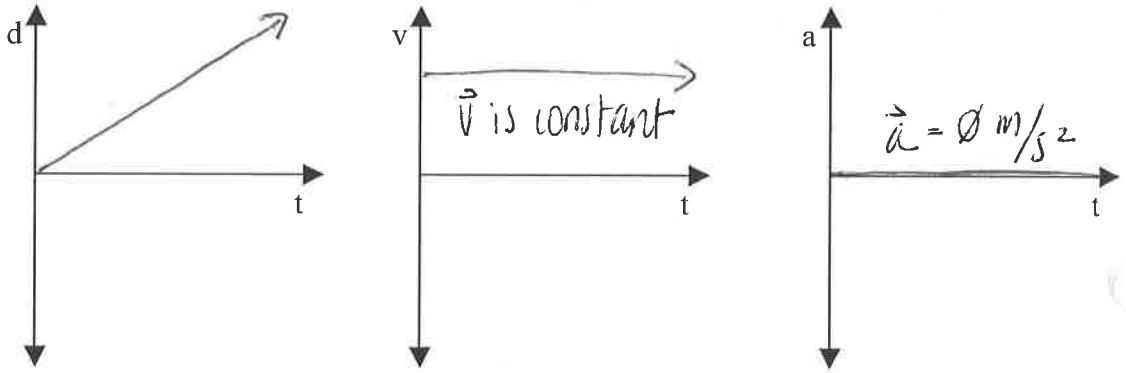
b) Describe the ball's trajectory as seen by the sailor. straight down

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

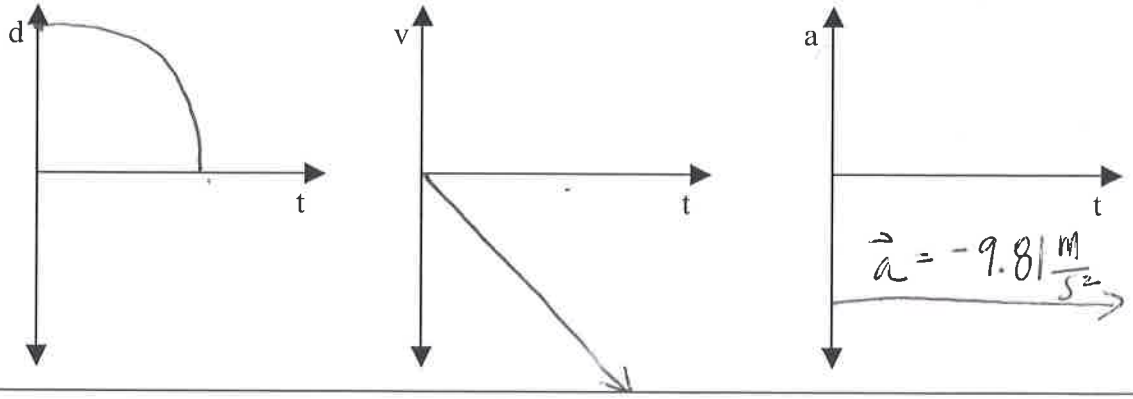


Conclusion: projectile's path is a resultant of the two components

Horizontal Motion



Vertical Motion

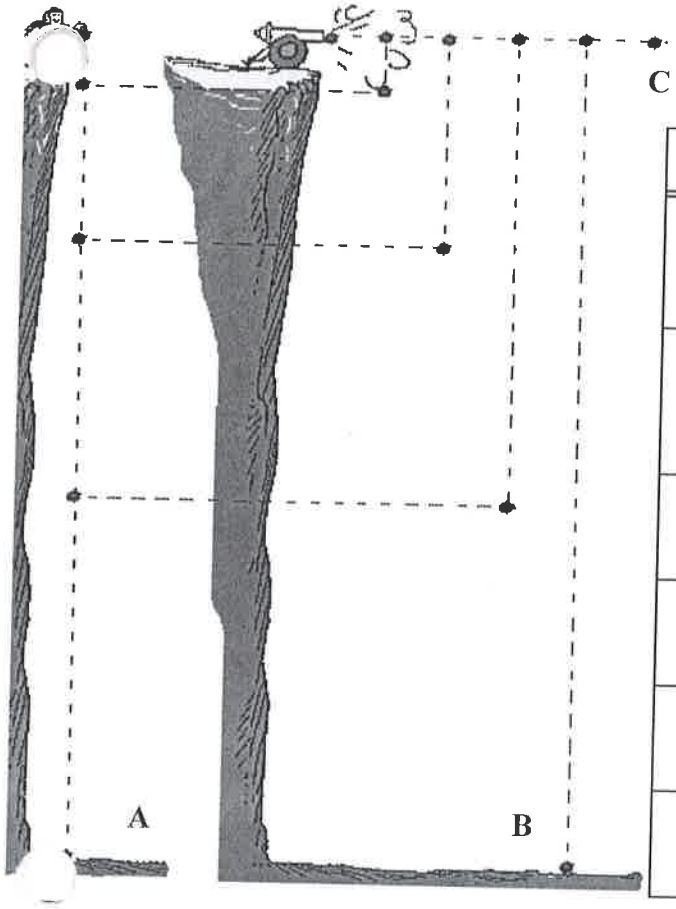


5. A car fires a flare straight upward while traveling at a constant speed. Sketch the position of the flare at each instant.

Where is the flare at each instant? Why?

At each instant the flare is right above the car because it retains the initial horizontal velocity.

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	Ø	50. m/s constant $\vec{V}$	50. m/s
Vertical motion	constant $\vec{a} = 9.81\ m/s^2$ ↓		Ø m/s^2 none
Initial horizontal velocity	Ø	50. m/s →	
Initial vertical velocity	Ø m/s →	→	none
Horizontal acceleration	Ø m/s^2 →	none →	
Vertical acceleration	$-9.81\ m/s^2$	↔	Ø

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

a) the height of the cliff.

(+) ↑ ↓ (−)

$\vec{d}_y = \cancel{\vec{V}_y t}^{\ \text{Ø m/s}} + \frac{1}{2}\vec{a}t^2$

$\vec{d}_y = \frac{1}{2}\left(-9.81\frac{m}{s^2}\right)(4.0s)^2$

78m = height or $\vec{d}_y = -78m$

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

$d_x = V_x t + \cancel{\frac{1}{2}at^2}^{\ \text{Ø m/s}^2}$

$\vec{d}_x = (50.\ m/s)(4.0s) = 2.0\times10^2\ m$

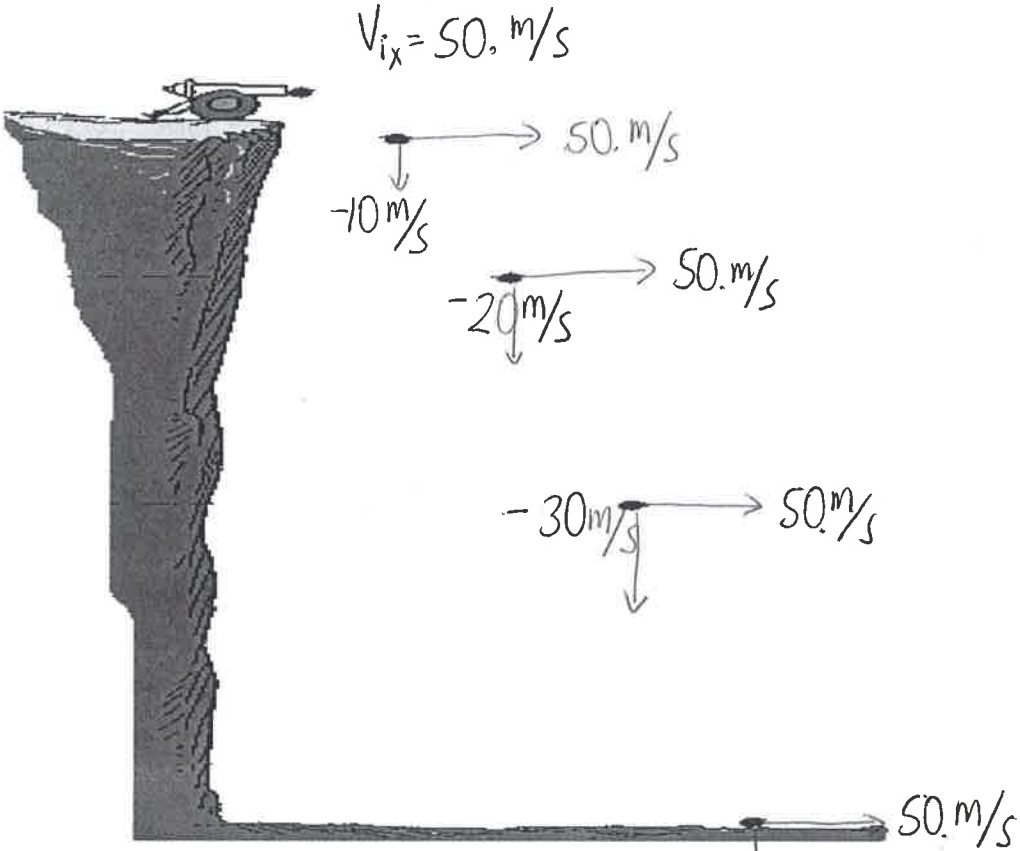
c) the impact velocity of ball A.

$\vec{V}_{fy} = \cancel{\vec{V}_{iy}}^{\ \text{Ø m/s}} + \vec{a}t$

$\vec{V}_{fy} = \left(-9.81\frac{m}{s^2}\right)(4.0s) = -39\frac{m}{s}$

d) Sketch in the trajectory and the displacement of ball B.

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



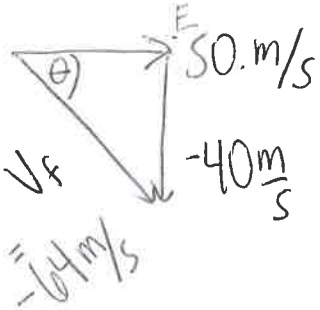
f) Calculate the impact velocity of ball B. How does it compare with that of ball A?

$$V_f^2 = V_{fx}^2 + V_{fy}^2$$

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

$$V_f = 64\frac{m}{s}$$

or $-64\frac{m}{s}$



$= -64\ m/s$

$$\tan^{-1}\left(\frac{40}{50}\right) = 39^\circ$$

$$\tan\theta = \frac{40\frac{m}{s}}{50.\frac{m}{s}}$$

The impact velocity of ball B is $64\frac{m}{s}$ at 39° below the horizontal.