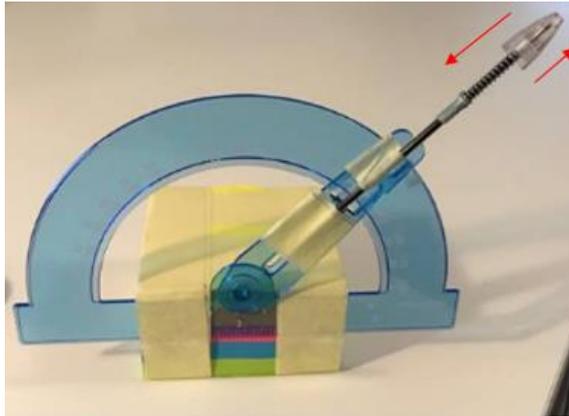


Build a flare launcher to study motion and angles

Materials

- › Swing arm protractor (or use a protractor and Blu Tack/tape to stick the pen to it at the angles mentioned)
- › Sticky note cube
- › Retractable ballpoint pen
- › Masking tape or Blu Tack
- › Scissors
- › Measuring tape



Normal

Activity Overview

- › This task is all about projectile motion, an engineering principle used heavily in the design of a number of firing mechanisms. In our case, we are going to be measuring the ideal projection for a red parachute flare. At Babcock, we are involved in designing and making a range of emergency products, both on land and sea. If a stranded boat fired the red parachute flare too low, our rescue boats wouldn't be able to see it to rescue them. Projectile motion follows a parabolic trajectory where the flare can be resolved into two components – horizontal and vertical velocity. It is important to study projectile motion to ensure the flare is fired high enough in the sky that passing ships can see it.
- › Try the experiment below to find out the flare's flight duration and travel distance.

Activity Plan

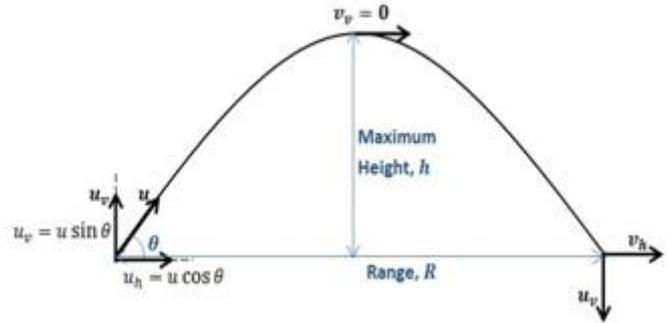
- › Secure the swing arm protractor onto the sticky note cube with masking tape or Blu Tack.
- › Secure the ink refill from the retractable ballpoint pen to the swing arm with masking tape.
- › Slot the spring over the top end of the ink refill and secure the bottom edge in place with a small piece of masking tape.
- › Place the nozzle from the retractable ballpoint pen over the top end of the ink refill.
- › Launch the flare by pulling back the nozzle until the spring has fully retracted, let go and watch it soar into the air. This is our makeshift flare launcher.
- › How does changing the angle affect the flight duration and range?

Angle	Duration	Range
15°		
30°		
45°		
60°		
75°		

Extra Activity

A prototype flare was launched at an angle of 45°. The time that the flare was in the air was 1.36 seconds and it travelled a distance of 3 metres.

- > What speed did the flare travel?
- > What is the maximum height that the flare reached?
- > Calculate the initial velocity?



Learning Objective

- > Ability to predict what happens to the flight path when you change launch angle.
- > Ability to apply Trigonometry, Pythagoras and the Equations of Motion to determine the maximum height and initial velocity of the flare.
- > Understand that a flare is only influenced by the downward force of gravity.

Reflection Questions



- > What is the optimum angle to fire the flare at to travel the furthest distance? Why is this the optimum angle?
- > What effect would increasing or decreasing the mass of the flare have on the flight path?
- > In reality, what effect would air resistance have on the range and velocity of the flare?

Extra Activity – SOLUTIONS

- > What speed did the flare travel?

$$V_h = \frac{d}{t} = \frac{3}{1.36} = 2.2 \text{ m/s}$$

- > What is the maximum height that the flare reached?

$$V_v = \tan \theta \times V_h = \tan 45 \times 2.2 = 2.2 \text{ m/s}$$

$$S = \frac{1}{2}(u + v)t = 0.5 \times (2.2 + 0) \times 1.36 = 1.5 \text{ m}$$

- > Calculate the initial velocity?

$$V_i = \sqrt{V_h^2 + V_v^2} = \sqrt{2.2^2 + 2.2^2} = 3.1 \text{ m/s}$$

Introduces

- Trigonometry
 - SOH CAH TOA
- Pythagoras
 - $a^2 + b^2 = c^2$
- Equations of Motion
 - SUVAT

