Build a flare launcher to study motion and angles

1-2 HOURS

Materials

› Swing arm protractor (or use a protractor and Blu Tack/tape to stick the pen to it at the angles mentioned)

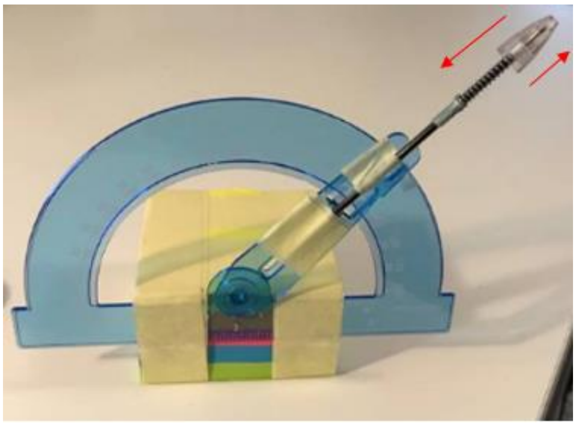
› Sticky note cube

› Retractable ballpoint pen

› Masking tape or Blu Tack

› Scissors

› Measuring tape



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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.

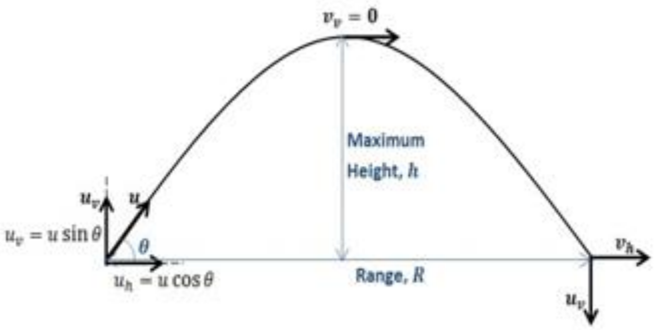
› How does changing the angle affect the flight duration and range?

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

Extra Activity

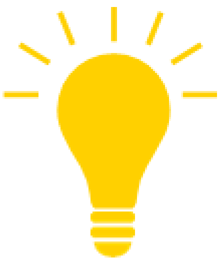
A prototype flare was launched at an angle of 45º.
The time that the flare was in the air was 1.36 seconds and it travelled a distance of 3 metres.

- 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?

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

- What is the maximum height that the flare reached?

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

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

- Calculate the initial velocity?

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

<u>Introduces</u>

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