

D3: Pocket Rocket

- Preparation time 30-60 minutes
- Demonstration time less than 5 minutes

Important note

This is NOT covered by the model (general) risk assessments adopted by most education employers. Before conducting this experiment you should go through whatever procedure your employer has laid down for obtaining a special risk assessment.



see important
note at start



eye protection
must be worn

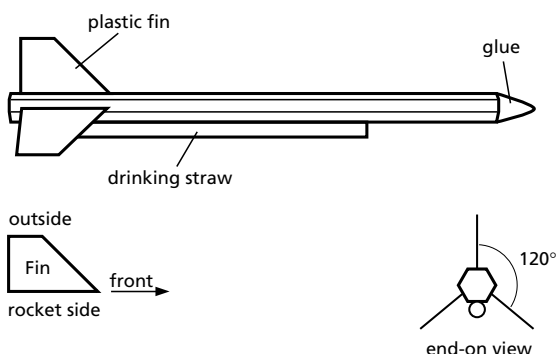
Requirements

- | | |
|--|--|
| 1 ball pen (Bic or similar make with hexagonal cross section) | 3 g zinc powder (preferable to dust, which is finer) |
| a pair of scissors | 1 g sulphur powder |
| safety match | |
| nichrome wire | eye protection |
| 12 V d.c. power supply, adequate extension cable and props to hold windows or doors open | |
| 1.5 cm x 2 cm piece of paper | |
| ~1m steel rod for launching | |
| pestle and mortar | |
| plastic lid (margarine or ice cream tub) | |
| glue gun (checked for electrical safety and safe to use in schools) | |
| large diameter plastic drinking straw ~8 cm long | |
| heat proof mat with hole drilled in the centre (must not be asbestos) | |
| access to a fume cupboard | |
| outdoor launch site | |

Method

Construction of the rocket

1. Remove the plug from the end and the ink tube from the inside of the ball pen, so that all you are left with is a hollow plastic tube.
2. Using a pair of scissors, cut out three fins from the plastic lid. See diagram below. Ensure that the fins are all the same size.
3. Using the glue gun, fill the nib end of the pen with glue. The glue should extend about 1 cm up the tube. Try to ensure that the glue at the end of the ball pen casing is slightly rounded to increase the aerodynamic efficiency.



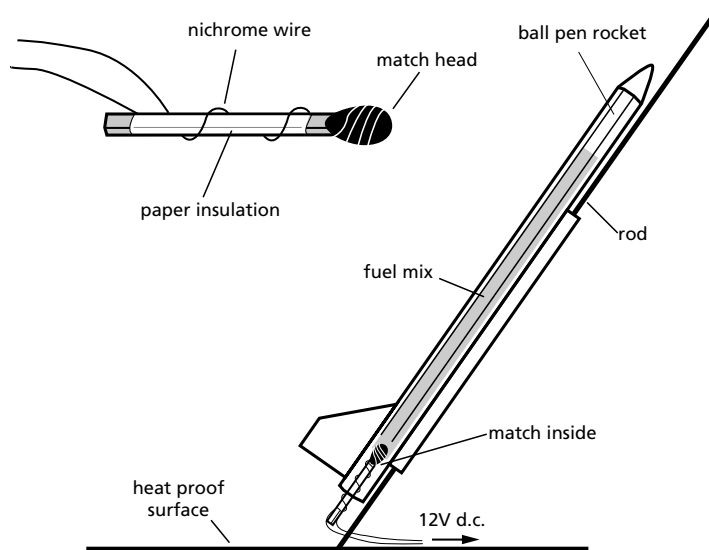
Glue a plastic fin on alternate sides of the end of the ball pen. When looking straight down the length of the ball pen, the fins should be straight and at an angle of 120° to each other. On one side, in between two of the fins and about 1 cm from the end, glue the plastic drinking straw. See diagram.

D3: Pocket Rocket (contd)

4. Construction of the ignition system

Wrap the nichrome wire carefully, in a spiral, around the wooden shaft of the match. Leave about 2 cm of wire free. The wire should go through 1 or 2 complete turns before reaching the match head (see diagram below). Wrap the wire tightly a few times around the match head.

Twist the small piece of paper around the shaft of the match. Wrap the rest of the nichrome wire back down the shaft from the head. The paper should insulate the two wires from one another and prevent a short circuit when the ignition is switched on. The twisted wire should also stop the paper unwinding. The two ends of the nichrome wire should be free. Make sure that the match head and shaft fit freely into the back end of the ball pen tube, with the ends of the wire free;



5. Mixing the rocket fuel

Grind 1 g of sulphur to a fine powder in a fume cupboard. Place 3 g of zinc powder on to a piece of paper. Pour the sulphur on to this zinc powder. Pour the mixture on to another piece of paper and repeat the procedure carefully until the powders are well mixed. Do not grind the two powders together. Pour the fuel into the ball pen case from the bottom end. Tap the pen case to pack the fuel. Insert the ignition system (see diagram).

6. Guidance system

Place the heat proof mat in the centre of the launch site. Insert the steel rod through the hole drilled in the centre and stick it into the ground. You can angle the rod to give some directional control.



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D3: Pocket Rocket (contd)

7. Launching the flight

Find a launch site that is free of people and objects that could be damaged.

Place the straw of the ball pen rocket on to the steel guidance rod.

Lower the rocket gently on to the heat proof mat. Do not worry if some fuel leaks out. Carefully attach the insulated copper wires to the ends of the nichrome wire. This can be done by a simple twist.

Run the wires back to the power supply and connect to the 12 V output. It is advisable to have a screen between the rocket and the power supply. Ensure that electrical cable does not get 'nicked' in slammed doors or windows by using props to hold them open.

When there is no wind, the launch and flight area are free of objects that could be damaged, and all observers are standing at least 10 m away from the launch site and outside the flight area, then stand back and switch on the power pack.

This is best done at the mains switch rather than the 12 V d.c. power pack.

It takes about 2 seconds for the nichrome wire to heat up enough to ignite the match, which in turn ignites the fuel and your rocket should fly!

If the rocket does not lift off, turn off the power supply and wait several minutes before approaching the rocket. Assess whether the match has ignited.

If the match has not ignited, then there is a problem either with the wires or the ignition system. Carefully check all contacts along the wires.

For the ignition system check that parts of the nichrome wire aren't touching each other. Also ensure that there is nichrome wire wrapped around the match head.

If the match has ignited, but has failed to ignite the fuel, then carefully replace the ignition system. Gently tap the rocket to ensure that the fuel falls down the biro and is in contact with the match head.

If the flight is successful, collect the rocket and check for any stress fractures, or distortion. If there is no damage it is safe to reuse with caution (to date the maximum number of flights undertaken by any one ball pen is three). Otherwise, it is best not to use the rocket again.



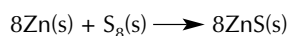
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Chemical background

Zinc and sulphur react when heated by the burning match head. The reaction is:



The reaction is exothermic and explosive. When the reaction is confined inside the ball pen case the pressure is released out of the open end forcing the rocket skywards.