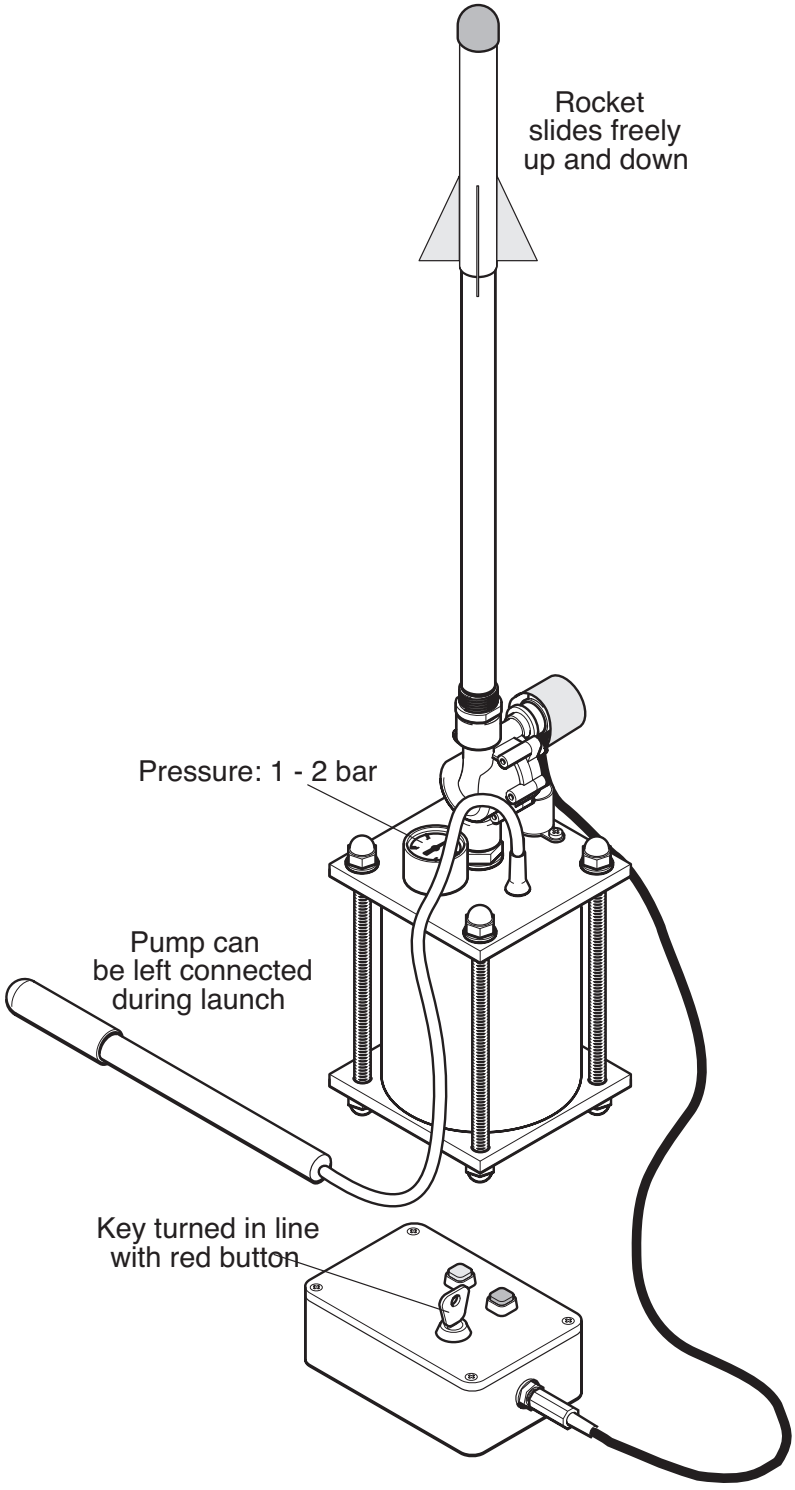
THE ROCKET FACTORY



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PROGRAMME

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Design and layout by Daniel Taylor

Line illustrations by James Wilkinson

Series Editor

John Cave
Middlesex University

IMPORTANT NOTE
As an additional safety precaution, the main valve used for the Rocket Fact a leaky type. This ensures that the system cannot be left pressurised for any length of time - leading to an accidental discharge. The performance of the valves varies slightly according to batch, but they will maintain full pressure for firing providing that this is not unduly delayed after pressurising.

1. THE ROCKET FACTORY

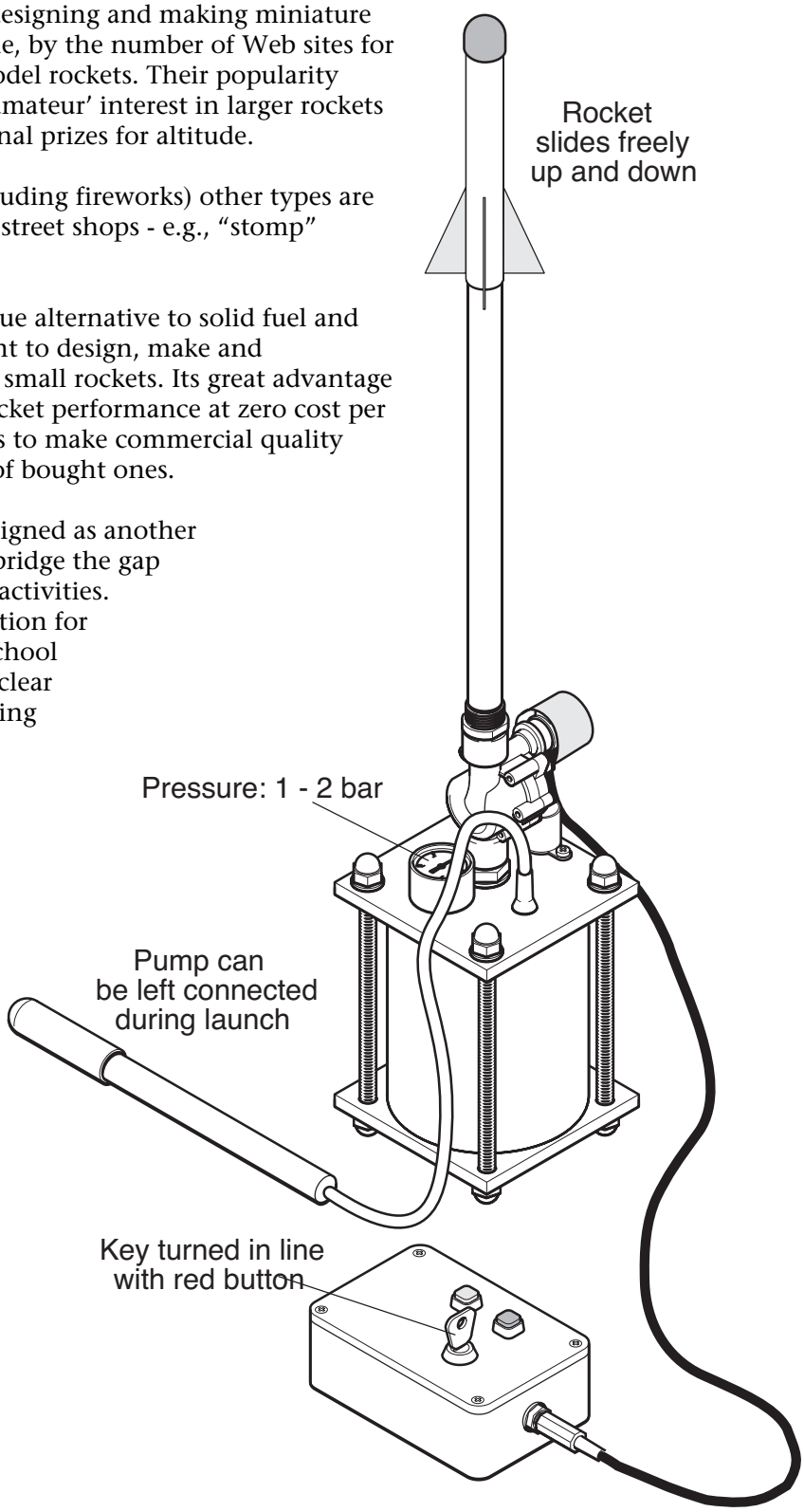
There is world-wide interest in designing and making miniature rockets as evidenced, for example, by the number of Web sites for the brand leader in solid fuel model rockets. Their popularity coincides with a resurgence of 'amateur' interest in larger rockets with potential to win international prizes for altitude.

As well as solid fuel rockets (including fireworks) other types are now widely available from high street shops - e.g., "stomp" rockets, water rockets etc.

The Rocket Factory offers a unique alternative to solid fuel and other systems for those who want to design, make and investigate the characteristics of small rockets. Its great advantage is that it offers near solid fuel rocket performance at zero cost per launch - and provides the means to make commercial quality rockets at a fraction of the cost of bought ones.

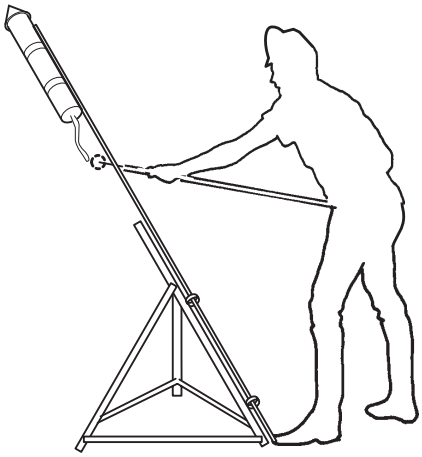
The Rocket Factory has been designed as another *Magic of Engineering* resource to bridge the gap between curriculum and leisure activities. It is already offers a major attraction for after schools clubs and special school funding-raising events, and has clear potential for designing and making in design and technology.

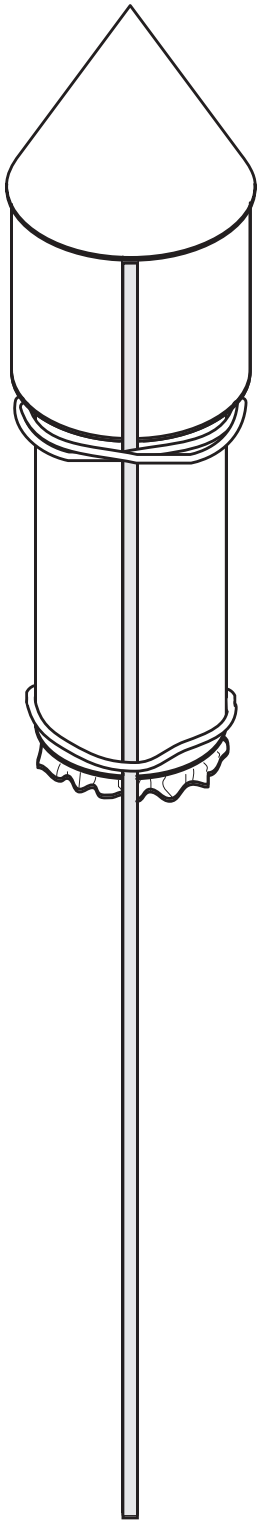
The system must only be used under direct adult supervision but has several in-built safety mechanisms including orientation safeguard, and key operated "firing" switch. The Rocket Factory can be purchased as a complete package or as component parts.



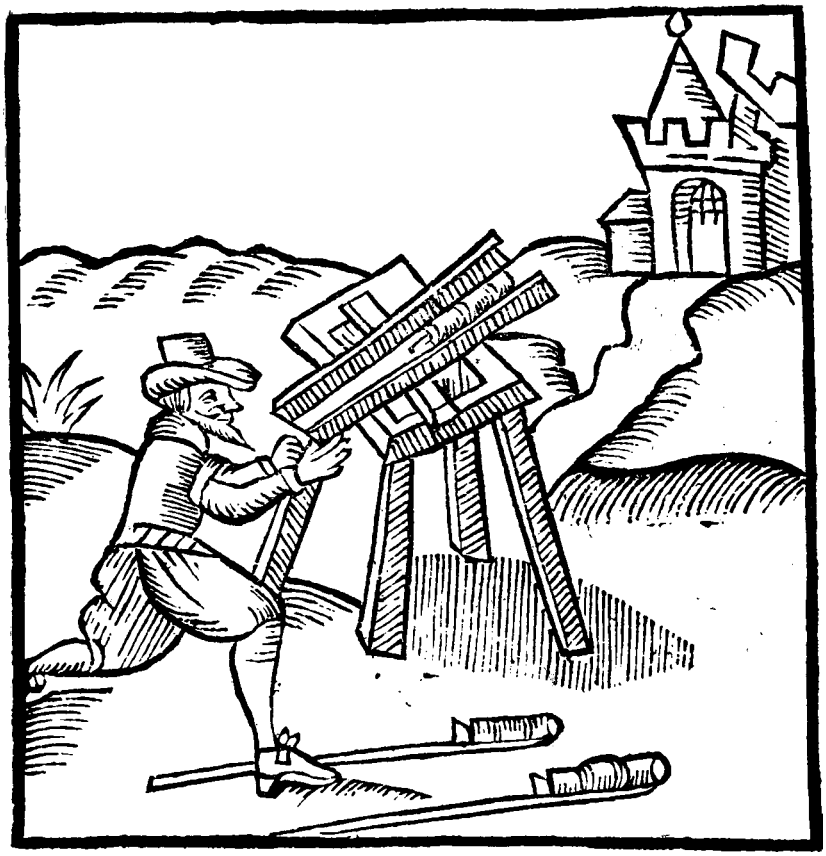
2A. THE ROCKET IN HISTORY

Rockets have a long history stretching back to origins in China at the beginning of the 13th Century - or earlier. These early rockets, brought to Europe from China by the Arabs, used gunpowder as fuel and were used as weapons but more commonly as fireworks.



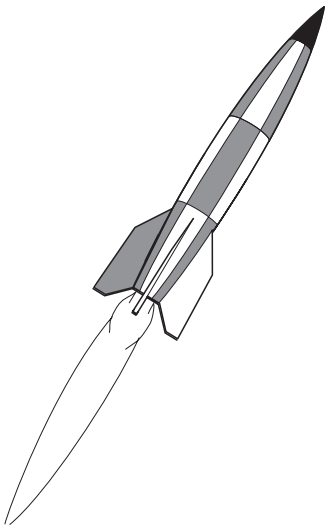


In the 19th Century, a British inventor called Sir William Congreve, designed the first effective long distance (3 Kilometre) rockets for use in warfare.

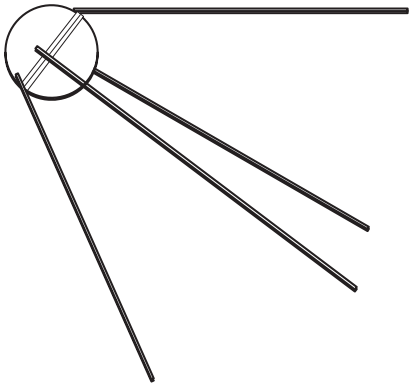


2B. THE ROCKET IN HISTORY

Until the 20th Century rockets, used solid fuel such as gunpowder - as do modern fireworks. In the 1920s the American Scientist Robert Goddard pioneered the use of liquid propellants (e.g. hydrogen and oxygen) to create rockets that had a far greater range.



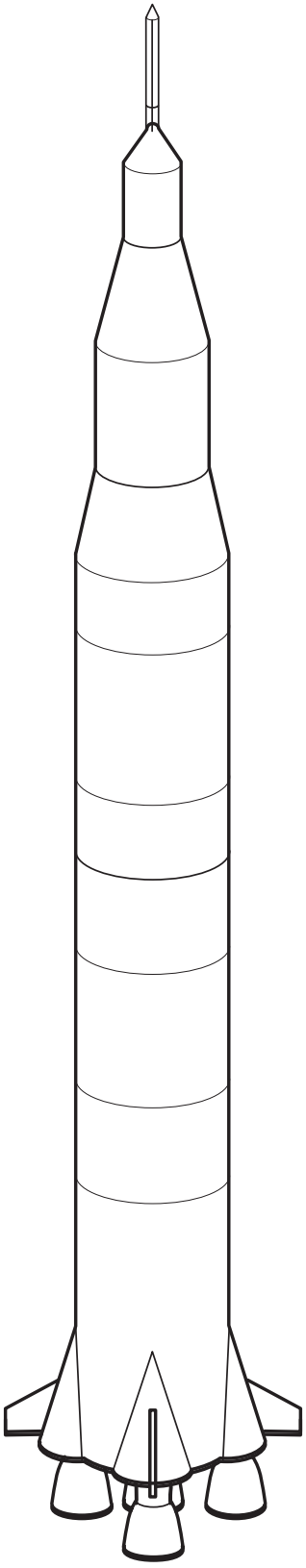
The V2 rockets used during the second world war used liquid oxygen and alcohol and had a range of 200 miles. Von Braun, who headed the V2 rocket programme was recruited after the war to assist in developing launch vehicles for the American space programme. Rocket development for military applications was rapid during the 1950s.



The first satellite was launched into space in 1957 by Russia - followed in 1961 by the first person to orbit the earth. Since 1969 - the year of the first person to land on the moon - rockets have been used routinely to launch satellites, space vehicles and offensive weapons.

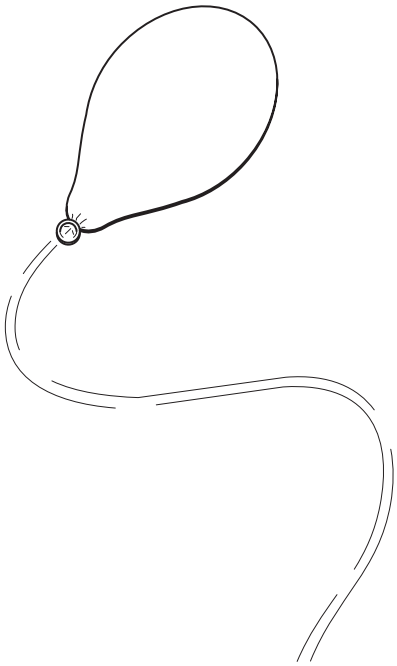
The history of rockets is also the history of guidance and control systems and materials. Early (guided) rockets relied of gyroscopes and mechanical control systems. Modern rockets rely heavily on electronics and on-board computers for guidance.

For the future, scientists are now working on the design of micro rockets which will be less than the size of a matchbox. Such rockets can be built using the construction methods used for silicon chips, but they will give far more thrust for their weight than larger rockets. These micro-rockets might be used to position satellites in space.

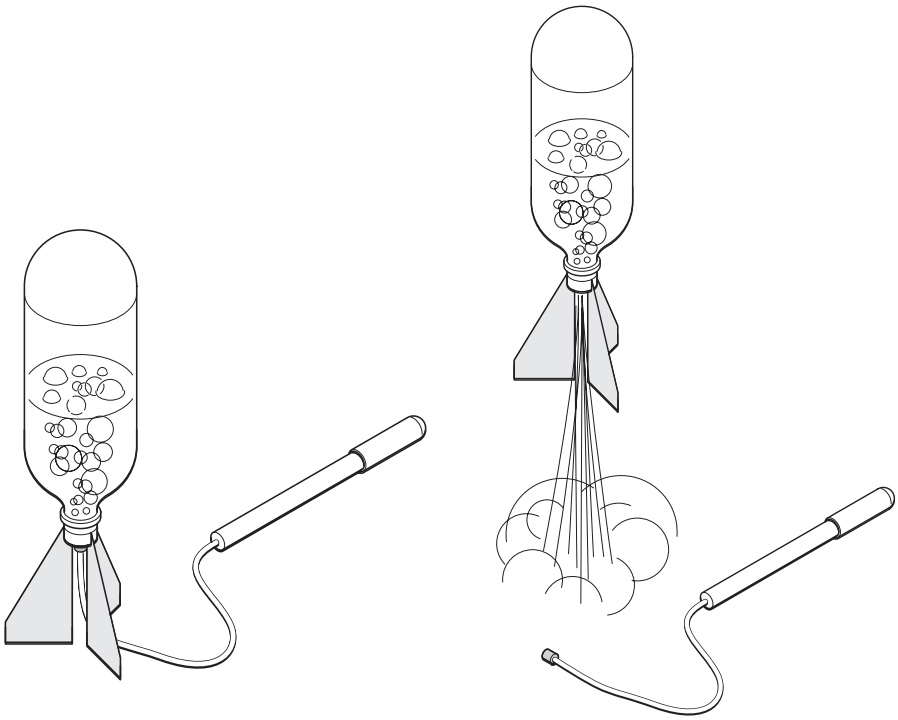


3A. HOW DO ROCKETS WORK?

All rockets - whether fireworks or the space shuttle - work in the same basic way. They contain a mass of material (called the reaction mass) which is expelled at high speed. The mass of gunpowder in a firework rocket is expelled when it is turned into gas by burning. Rockets obeys Newton's Third Law of Motion: **for every action, there is an equal and opposite reaction**. As the gas is pushed out, the rocket moves in the opposite direction.



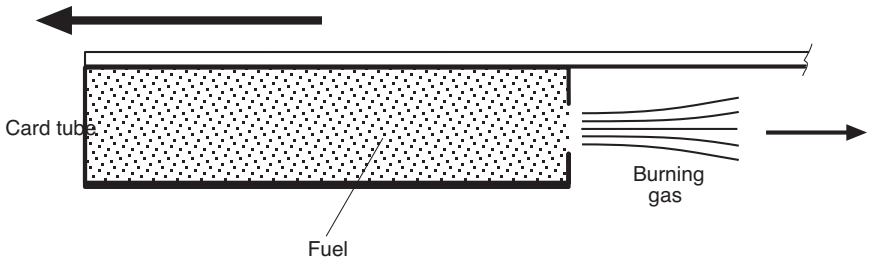
This is similar to a blown-up balloon which flies forward when air is suddenly released. Another example is the fizzy drinks bottle water rocket. The bottle is part-filled with water and air is pumped into the top of the bottle. When released, the air pushes out the water very quickly and the bottle moves rapidly in the opposite direction.



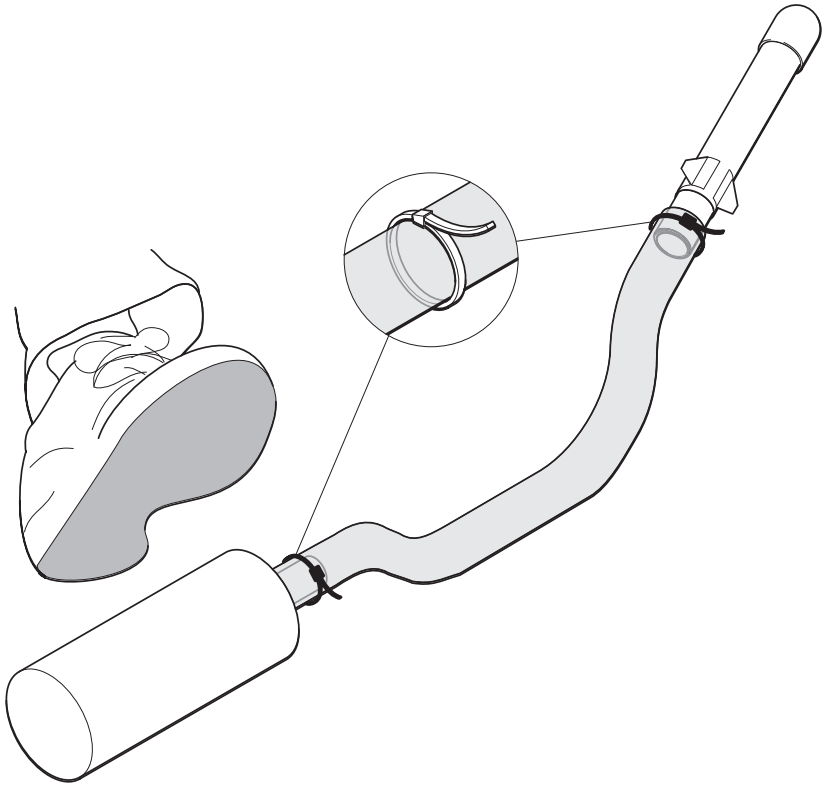
The reaction mass (or fuel) can be quite small providing it can be pushed out quickly enough. Ideally, in a rocket, it should be as small as possible and pushed out as rapidly as possible. This is because the burning fuel has to move the unburnt fuel mass as well as the rocket itself.

3B. HOW DO ROCKETS WORK?

The reaction mass of model solid fuel rockets and fireworks is a fast burning powder such as gunpowder contained in a strong card tube. Such rockets accelerate to high speeds very quickly.

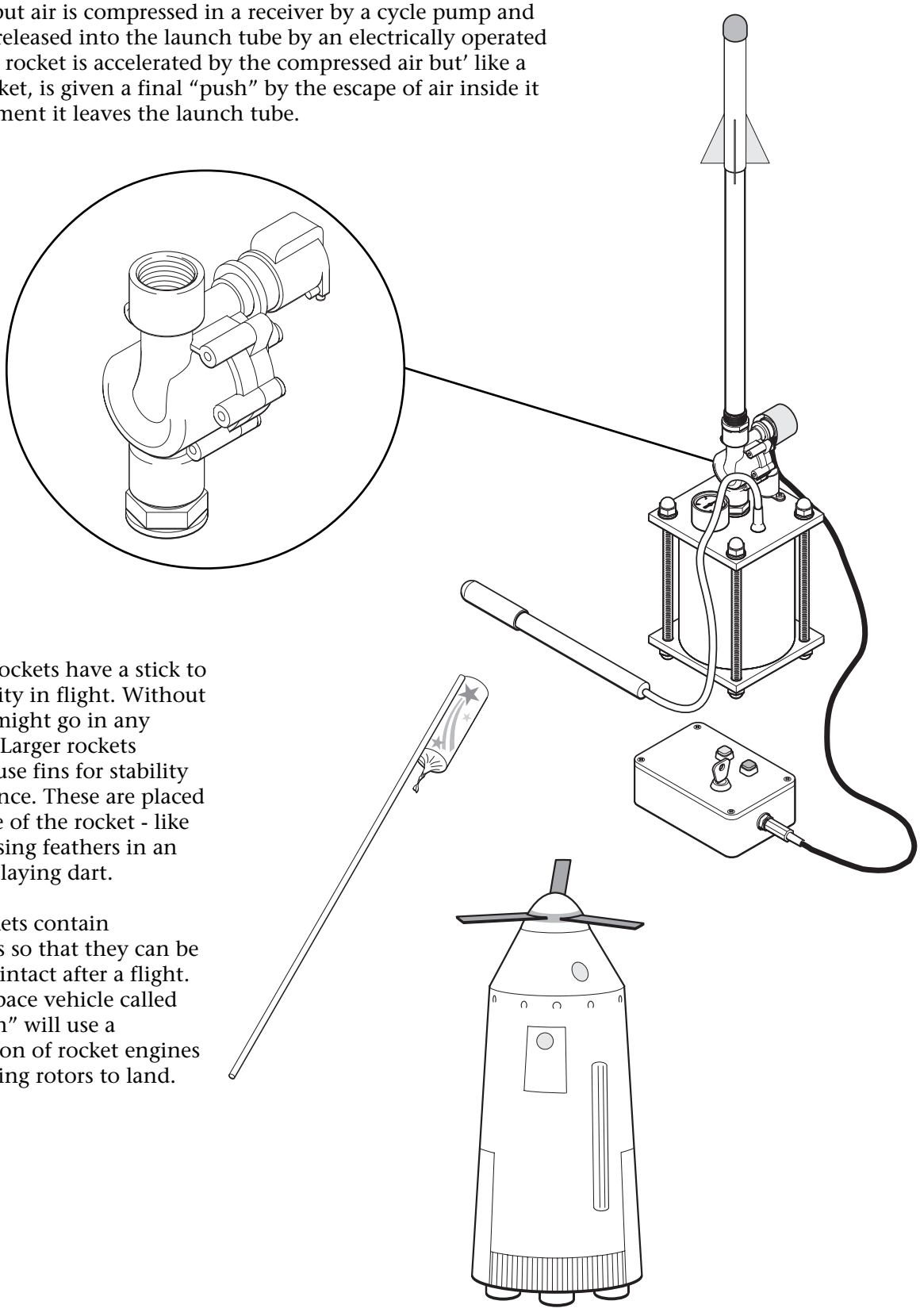


The popular ‘,stomp” rocket uses air which is suddenly compressed by jumping onto a plastic sac. This type of rocket is accelerated off the launch tube by the compressed air but as soon as it leave the tube, the small amount of compressed air inside the rocket acts as a reaction mass and gives the rocket an additional instant “push”.



3C. HOW DO ROCKETS WORK?

The rocket factory launcher is similar to a “stomp” rocket launcher but air is compressed in a receiver by a cycle pump and suddenly released into the launch tube by an electrically operated valve. The rocket is accelerated by the compressed air but’ like a stomp rocket, is given a final “push” by the escape of air inside it at the moment it leaves the launch tube.



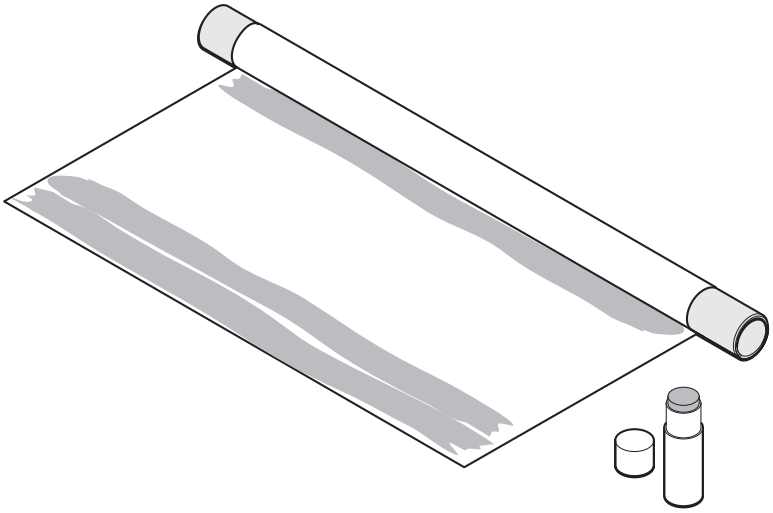
Firework rockets have a stick to give stability in flight. Without this they might go in any direction. Larger rockets normally use fins for stability and guidance. These are placed at the base of the rocket - like the stabilising feathers in an arrow or playing dart.

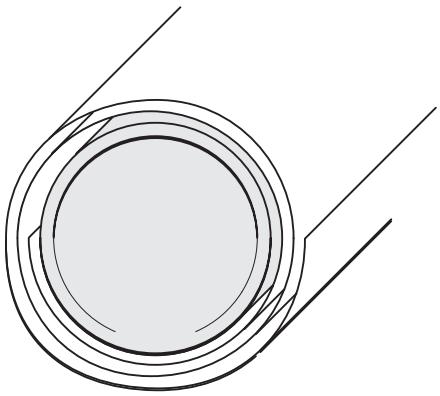
Some rockets contain parachutes so that they can be recovered intact after a flight. A future space vehicle called the “Roton” will use a combination of rocket engines and spinning rotors to land.

4A. MAKING A ROLL-TUBE ROCKET

Many small rockets are made from paper rolled tightly into a tube. For its weight, paper has high tensile strength (strength in tension) and resists bursting apart. Also, when made into a tube, it becomes stiff. A paper rocket can be rolled from a single A4 sheet of 80g/100g paper (the "weight" used for photocopying). It is formed by rolling over a mandrel - a tube with the same diameter as the Rocket Factory launch tube. The outer edge of the paper is seamed with "pritt Stick", "Changing Glue" or similar so that the tube holds together when rolled.

It is also a good idea to lay down a seam of glue after the first roll of paper around the mandrel. (This prevents compressed air from the launch tube forcing itself inside the spiral of paper and expanding it so that it sticks to the launch tube).

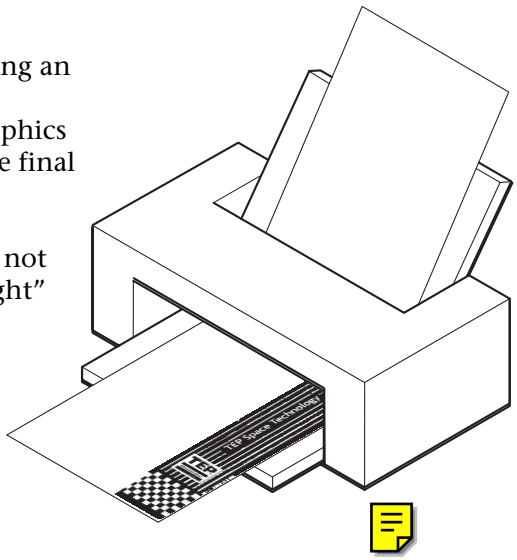




Compressed air
can open up spiral of paper
and make rocket
stick to mandrel

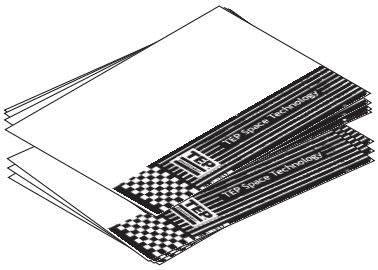
4B. MAKING A ROLL-TUBE ROCKET

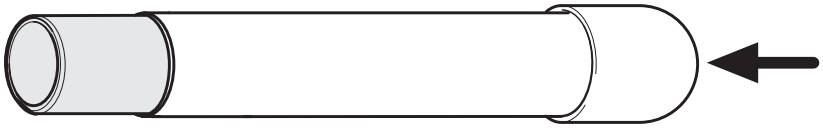
Every rocket can be given a very distinctive look by designing an image on a PC and then printing out on a laser printer. Alternatively, existing designs can be photocopied. The graphics need only cover the part of the paper which shows after the final roll around the mandrel.



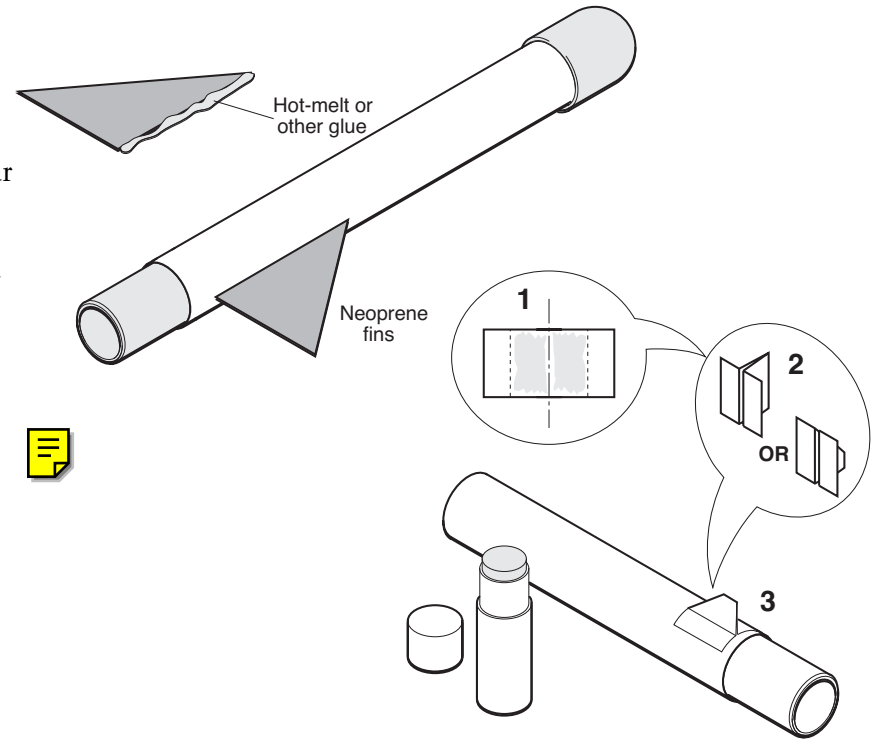
The tube should not be rolled too tightly or the rocket will not leave the launch tube as fast as it should. It should be a "light" fit and easily run up and down. A rocket made in damp or humid conditions will shrink when it becomes drier.

Before the tube is taken off the mandrel, the nose cap and fins should be attached. You can use plastic nose cones supplied or make your own (see card 5). If you use the nose cone supplied, apply glue around the top of the tube and slip the nose cone over. You might also need to add Sellotape or hot-melt glue to prevent the nose cone coming off during a launch.





Before fitting the fins, the rocket can be covered in a clear self-adhesive plastic film like that used for covering books. This improves appearance and adds strength. The fins can be made either from paper or neoprene plastic sheet. If neoprene is used, the fins are cut out with a craft knife and glued to the rocket with hot-melt glue. If paper is used, the fins can be formed with glue-on tabs and applied with "Pritt-Stick" or equivalent.



5. MAKING A NOSE CONE

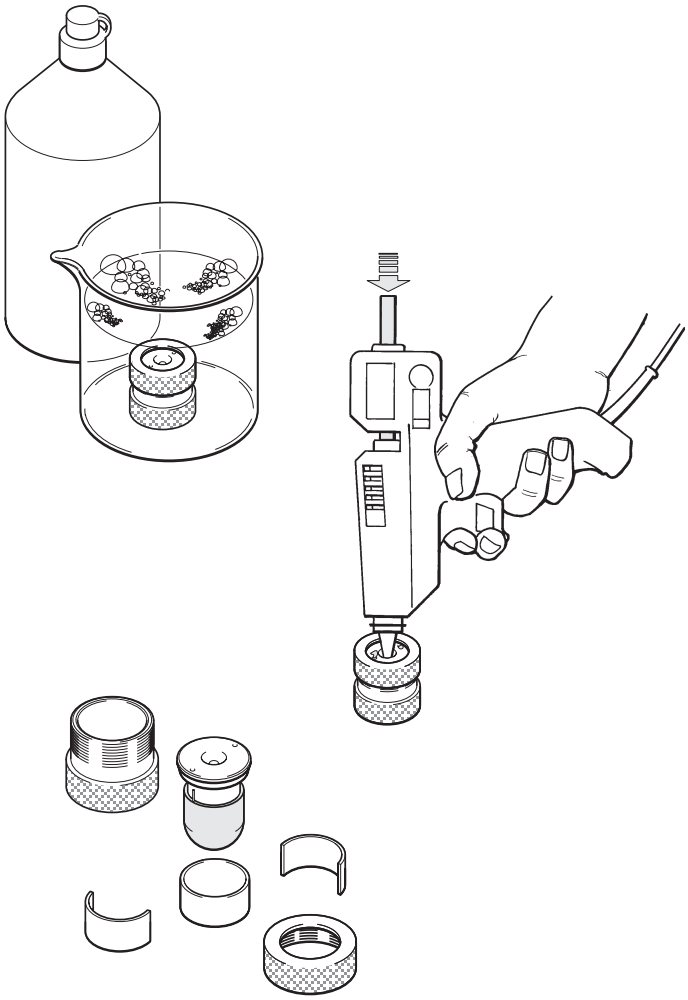
The Rocket Factory comes with a nose cone mould which is filled with fused plastic by injection moulding. This is one of the most common production processes for making consumer products and usually involves a large automatic machine that injects plastic into a mould under very high pressure. The rocket nose cone mould is filled using a hot-melt glue gun as the injection moulding machine. The coloured glue is quite tough and forms an excellent moulding.

Step 1.
Assemble the mould parts after first dipping and covering them in soapy water (a strong detergent washing-up solution).

Step 2.
After leaving it to warm up for at least 10 minutes, use a suitable glue gun to fill the mould. “Pump” the glue gun trigger slowly and press on the end of the glue stick. When the mould is full, plastic will show at the small indicator holes.

Step 3.
Unscrew the mould top and lift out the inner part. Pull off the rounded bottom section followed by the two ring halves. Finally, prise the moulding from the inner core.

Step 4.
Re-assemble for the next moulding only after dipping again in the soapy water.



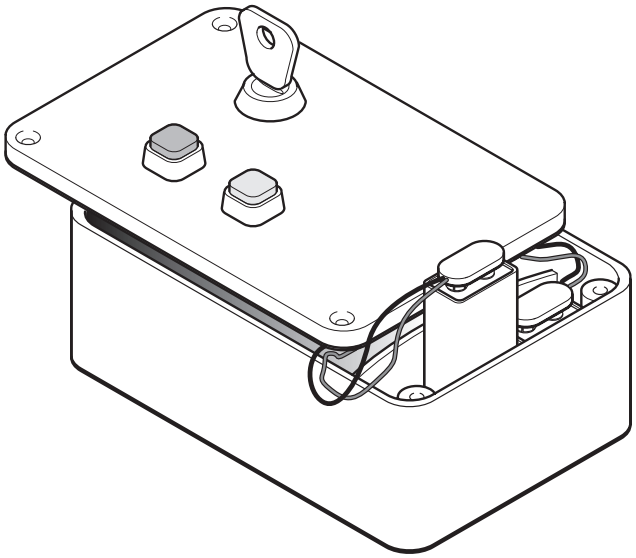
If the mould does not fill completely first time, it may be because it is too cold (although it will fill from cold), or because the glue gun is not hot enough. After two mould fillings, the glue gun should be left for 2/3 minutes to warm up again.

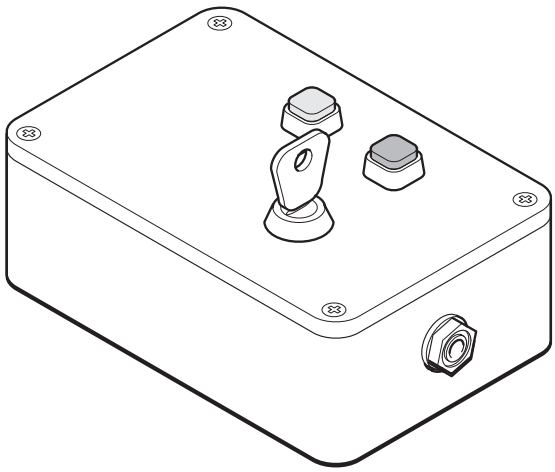
After trimming any excess plastic, the nose cone is fitted to the paper rocket tube **while it is still on the mandrel** (to give it support). The top of the rocket tube may be pre-glued, but the nose cone must be fitted quickly before it hardens.

6A. LAUNCHING THE ROCKET

THE ROCKET LAUNCHER MUST ONLY BE USED UNDER ADULT SUPERVISION

First, unscrew the four retaining screws on the firing unit and insert 2 PP3 size alkaline batteries between the end of the unit and the plastic divider. (This divider will bow out but hold the batteries very tightly.) After inserting the batteries, do a check to make sure the unit and launcher are working. With the launcher unpressurised, plug the lead into the firing unit and turn the key to "on". This is the position when the key lines up with the green switch. Press the green switch firmly for a second and let go. (This charges a capacitor.) Then press the red switch. The Launcher's valve should "click". If this does not happen, check that the batteries are correctly inserted.





The rocket launcher must be set up on a table with the launch tube vertical and its top above eye height for any user or spectator. The launcher should be used strictly in the following sequence:

1. Slip the rocket over the top of the launch tube so that it moves freely up and down.

2. Pressurise the launcher using a cycle pump such as the one illustrated. The pressure should not exceed 2/3 bar on the gauge.

3. Plug the launcher lead into the firing unit making sure that the key switch is in the "off" position.

4. Stand at the lead's length from the launcher and turn the key to the "on" position. Firmly press the green switch for one second and let go. Press the red switch and the rocket will take off with a loud "pop".

6B. LAUNCHING THE ROCKET

If the launch fails, turn off the key and disconnect the firing unit. Reduce the launcher pressure and try again in the above sequence. As the batteries weaken, they will not be able to open the valve at higher pressures (i.e., battery output is roughly proportional to operating pressure).

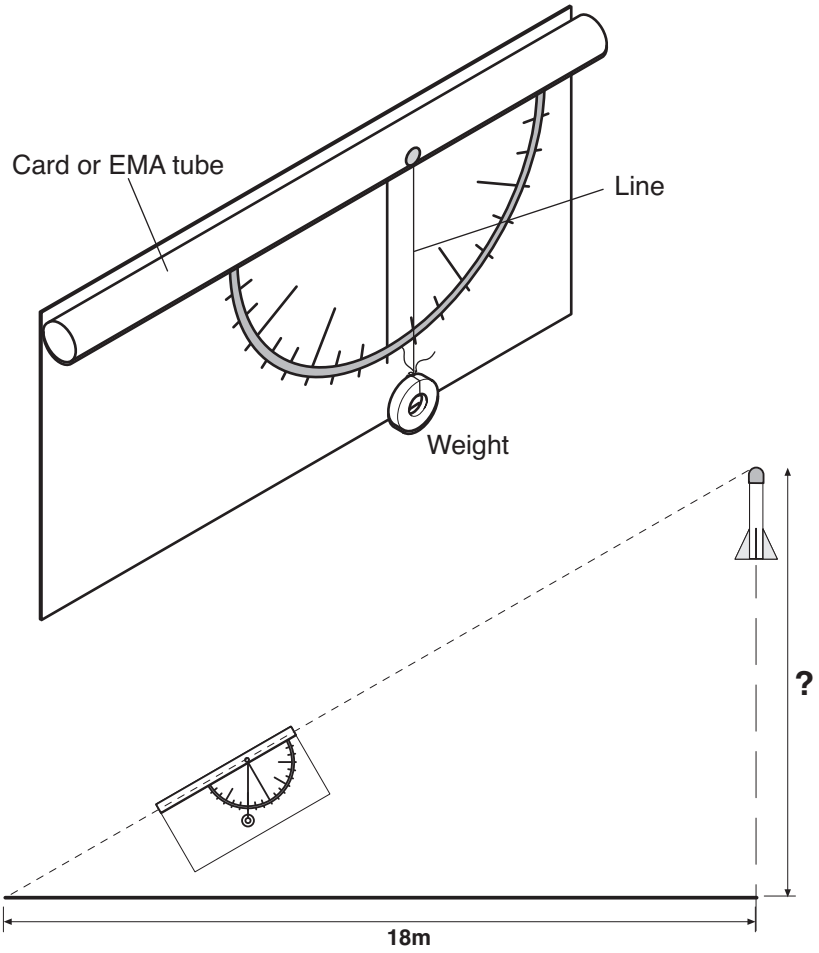
Safety features:

- A tilt switch on the launcher prevents firing if angled to more than 35°.
- A safety valve releases at approximately 4 bar.
- Air leakage between the blue container and end plates occurs at approximately 6 bar.

Water may accumulate in the launcher due to the compression of air. If this becomes noticeable - i.e., can be heard when the launcher is moved - it can be drained after carefully removing the pressure gauge. This must be replaced using a sealant such as the original PTFE tape.

7A. TRACKING THE ROCKET

The altitude of the rocket can be measured with a simple instrument called an inclinometer. Surveyors use a complex version of this, but you can make one with a piece of card as illustrated. In use, you keep the ascending rocket in view through the sighting tube and press the weight against the card at the rocket's highest point. This gives you an angle from where you are standing. If you know this angle and the distance from the rocket launcher, you can calculate the height using trigonometry. Most calculators have a "trig" function making the maths very easy.



Example calculation: You are standing 18 metres away from the rocket and measure an angle of 30°.

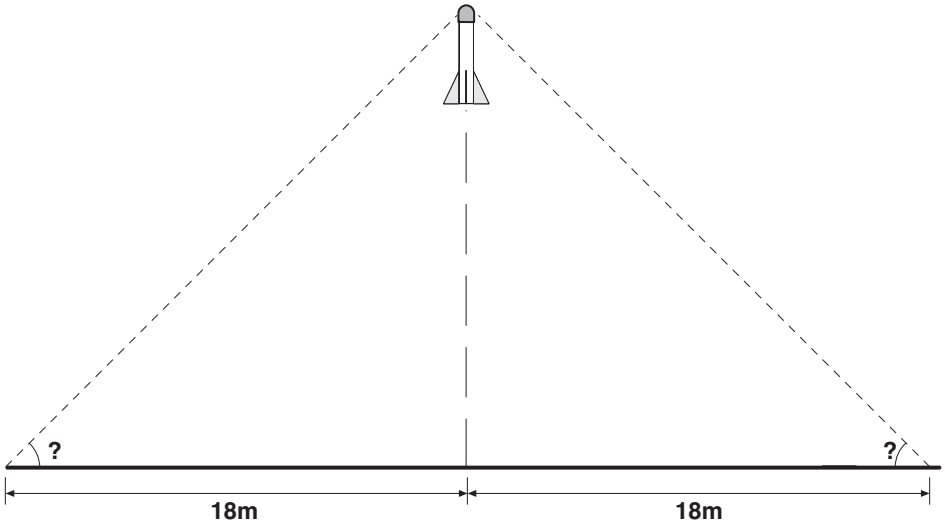
Altitude = "tan" key x angle x length from launcher

Altitude = "tan" key x 30° x 18m

Altitude = 0.577 x 18m = 10.4 m

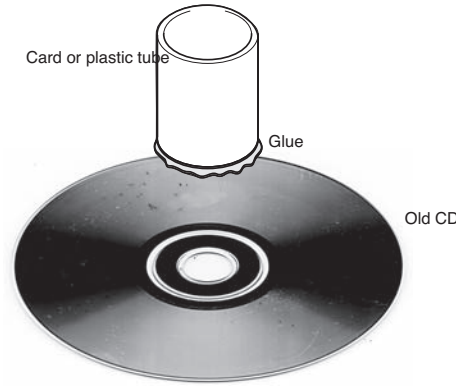
7B. TRACKING THE ROCKET

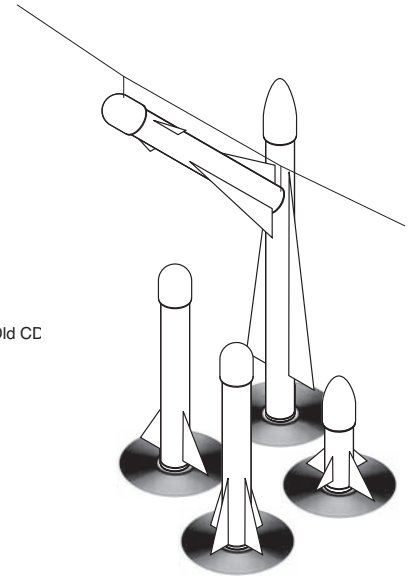
To make the measurement more accurate, two or more people using inclinometers should stand at a set distance from the launcher. They then average their recorded angles and do the above calculation.



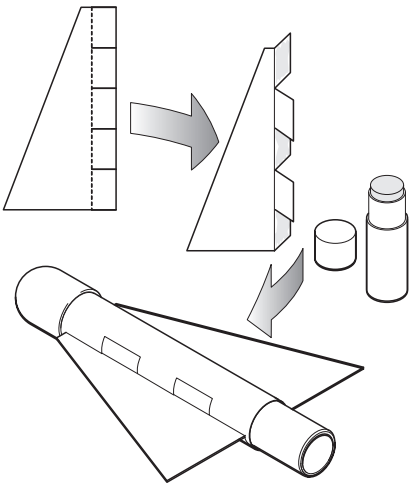
8. MORE THINGS TO DO

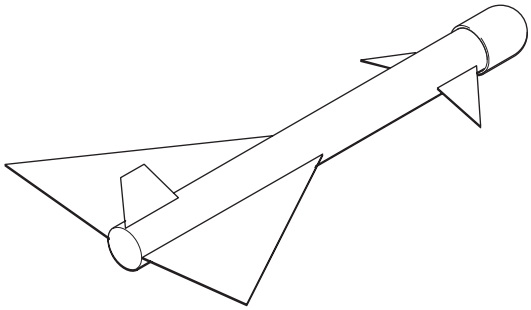
Making a basic paper rocket is just the start! You can make, collect and display a large number of rockets. A piece of tubing glued onto an old CD makes an ideal rocket base.





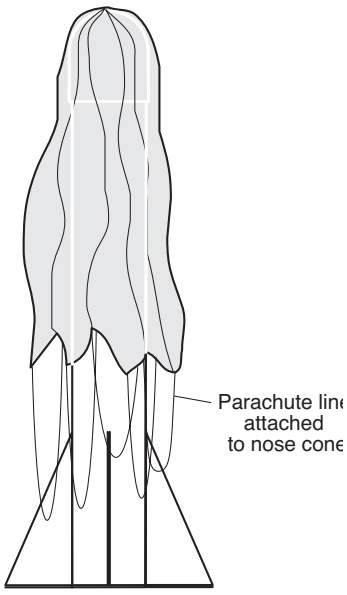
If you do not have access to the Rocket Factory Launcher, they can be flown out my blowing off the mandrel - or a piece of newspaper rolled into a tight tube. **But REMEMBER: you should not point the rocket at people if you do this.**





Rockets can be designed to fly back to earth if you give them wings as well as fins. You can throw rockets like gliders to try out the effectiveness of different designs.

You can also experiment with parachutes. One way of doing this is to make a parachute using very thin plastic bag material and draping it over the rocket at launch. Can you think of a better way ?



It might also be possible to attach flexible rotors to a rocket so that they are vertical at take-off but open out when the rocket has reached maximum altitude. This would enable the rocket to start spinning like a sycamore seed and descend slowly.

FURTHER SUPPLIES

The Rocket Factory and component parts can be obtained from:

Middlesex University
Teaching Resources
Unit 10
The IO Centre
Lea Road
Waltham Cross
Herts
EN9 1AS

Tel: 01992 716052
Fax: 01992 719474
Web: www.mutr.co.uk

Complete launcher and key switch firing unit
Supplied without pump or batteries. Uses any cycle or car foot pump and requires 2 PP3 alkaline batteries.

Code: ROC 006

Nose cone mould for use with hot melt glue gun injection moulding system

Code: ROC 007

Rocket rolling mandrel
For rockets to fit 21.5mm diameter launch tube

Code: ROC 008

Pack of 30 assorted coloured soft plastic nose cones
To fit rockets made using above mandrel.

Code: ROC 009

Complete rocket factory starter pack
Supplied without pump or batteries. Uses any cycle or car foot pump and requires 2 PP3 alkaline batteries. Comprises ALL items above and a hot melt glue gun.

Code: ROC 010A