



Keiron McGeever takes a month off robotics articles to remind us about the possibilities of the TEP Rocket Factory and the things we can do when the weather gets warmer.

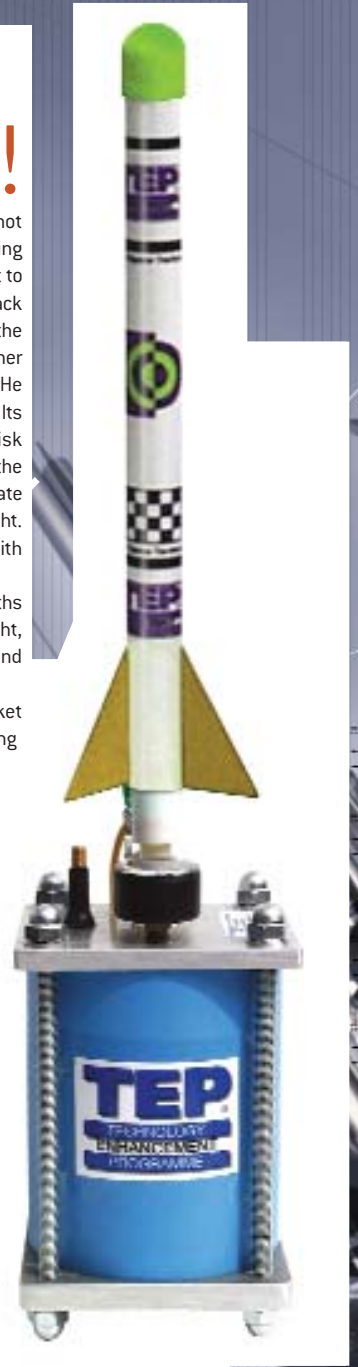
This IS Rocket Science!

I was excited the first time that Frank Muraca demonstrated the TEP Rocket Factory to me and I could not wait to try it out for myself. Firing rockets 30, 40, 50 metres into the air is great fun and highly motivating to children for the first few goes, but for any real learning to take place there needs to be another element to

the work. What it reminded me of were my Maths lessons at school (way back in the middle of the last century). I was lucky and went to school before the National Curriculum was invented and even luckier to have a maths teacher with a bit of imagination when it came to teaching formulas and graphs. He introduced the topic by getting the class to fire rocks into the air from catapults (think of the health and safety issues around that today and the risk assessment!) and then he showed how, by timing how long the rock was in the air, we could plot graphs of the flight of the rock from which we could calculate the height the rock got to and the maximum speed it achieved during the flight. The Rocket Factory allows you to do this much more safely and I came up with the idea for a competition called Rocket Day.

Rocket Day was intended to show that Technology can not only make Maths and Science relevant but also FUN. There are three elements to a Rocket Day competition, the highest flight, the longest flight and the most stylish rocket. Teams of up to four pupils are formed and they design and make rockets for each of the three events.

Many schools already have the Rocket Factory and can 'fire up' integrated maths and science into a Rocket Day activity. The Rocket Factory comes complete and ready to use and is available only from Teaching Resources.



3. How high can you fly?

At first sight the problem seems easy. Making a rocket for the TEP Rocket Launcher is simple, wrap a sheet of A4 paper round a plastic tube, stick a nose cone and some fins on it, and there you are. The difficulty starts when you try to make the rocket go as high as possible, you have to balance out the weight of the rocket versus the power applied to it and the drag of it flying through the air.

2. How long can you go?

Trying to get the rocket to stay in the air as long as possible has so far proved to be almost impossible, as can be seen from an actual table of results on the next page. No team has managed to get their rocket to stay in the air for longer than the highest rockets time. This was due to the fact that devices added to the rocket to make it come down slowly also made it go up slowly, resulting in very little height gained, therefore a very short flight time. So this is a problem still to be solved.

1. How smart are you?

The Best Looking Rocket event is mainly a bit of fun, but the rocket still has to be launched, and this can result in some of the funniest happenings of the day as a lot of the fancy add-ons don't stay on. There can be a lot of flying debris. The most difficult part of this event is deciding who has made the best-looking rocket and it can result in a lot of controversy.

Liftoff - Getting the total right

At the end of the competition the overall winner is decided on the total points scored for all the events and is done using a spread sheet. See the example at the end of the article. The spread sheet is set up so that it not only calculates the total number of points, but it also works out the height a rocket has reached and the maximum speed it achieved during its flight.

Doing the Maths and Science

Tracking the Rocket

The altitude of the rocket can be measured directly with an inclinometer (see fig 1).

To do this, do the following:

- ✦ Keep the ascending rocket in view through the sighting tube.
- ✦ Lock the angle of the inclinometer at the highest point. (Angle a)
- ✦ Measure the distance from you to the rocket launcher. (Distance d)
- ✦ Use the formula $\tan a \times d = h$ (h is the height of the rockets flight).

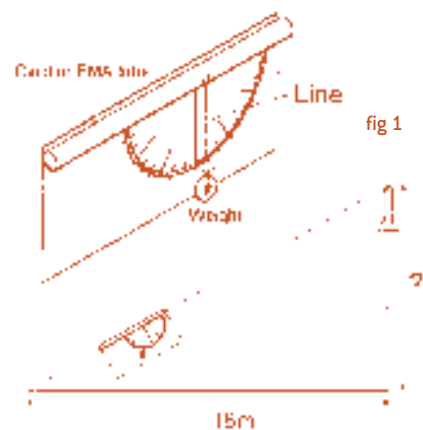
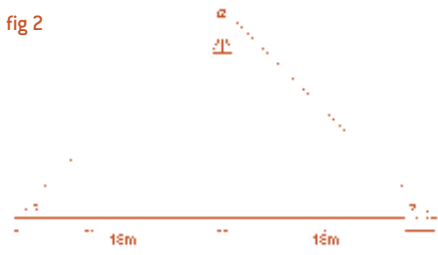


fig 2



For greater accuracy it might be a good idea to use more than one inclinometer and to average the results [see fig 2]. This method is quick and simple but susceptible to a lot of errors; it also gives only the height that the rocket achieved and not its speed. For a more reliable method you have to delve deeper into the science.

Notes on Gravity, or “Why things fall down.”

But first, acceleration and velocity

Acceleration is the rate of change of velocity (speed) with respect to time and Velocity is the rate of change of distance with respect to time. For example a car travelling at 5m per second will travel 5m for every second it is moving, its velocity is constant. A car accelerating at 5m per second per second will have its velocity increase by 5m/s for every second that it is moving, its velocity is not constant it gets faster and faster.

Gravity

Gravity is a force of attraction between any two bodies that have a mass. I am attracted to the Earth by the Earth's gravity and the Earth is attracted to me by my gravity (please note the two masses are vastly different!). The greater the mass of an object the greater the gravitational attraction it has to another body. It is gravity which gives an object weight, not to be confused with mass.

Gravitational attraction between two bodies causes them to come together with a greater and greater speed, it accelerates them. On Earth the effect of gravity is expressed as the letter g and $1g = 10\text{m/s/s}$ (approx.) This means that if a ball is dropped from the top of a high building after 1 second the ball will be travelling at 10m/s, after 2 seconds 20m/s and so on [see fig 3]. After 3 seconds the ball will be travelling at 30m/s which equals 108km/hr which equals 68m/hr, therefore gravity out performs a Ferrari.

The effects of gravity on a Rocket

When the rocket is going up, gravity works in reverse slowing the rocket down until it reaches a velocity of 0m/s and then it falls back to earth. This means the flight of the rocket is symmetrical and that half of the flight is the same, mathematically, as if the rocket had been dropped from a great height.

Therefore the simple way to work out how high and how fast your rocket has travelled is to use the formulas for the effects of gravity on an object and to do that you need to time the length of flight of the rocket from when it leaves the launch pad to when it hits the ground again by using a cheap stop watch. You can then substitute T divided by 2 for t in any of the formulas. (T equals the time of the flight in seconds).

Calculating the effects of gravity on a Rocket

Speed

To calculate the maximum speed your rocket achieved during its flight use the formula $v_f = g \times t$. This gives the speed (v_f) after t seconds. A free falling object accelerates at $1g$ (the accurate figure for this is 9.8m/s/s).

Distance

Similarly the distance (d) a free falling object travels can be found from the formula $d = 0.5 \times g \times t^2$

Simply calculating the effects of gravity on a Rocket

The simple way to calculate the effects of gravity on the rocket is to use a spreadsheet such as Excel and to set it out as shown in the example below. You can put any of the formulas into the spread sheet, depending on how you want to calculate the height of the rocket and it will work out the results. I have used this many times with groups from different schools, but it can be done just as well with a class group even spreading the event over several lessons. Projecting the spread sheet onto a screen adds to the atmosphere of the event by allowing the teams to see how they are progressing.

Organisation

As an inter-school event the way I have organised it in the past is to take a whole day to do it in, spending the morning instructing and then experimenting and the afternoon testing and judging. But, I am sure that with a little ingenuity an event can be adapted to suit your own environment. It would be great to do during an Ofsted inspection, properly prepared and set up. If you want any more help or advice, a copy of the Excel spreadsheet file, or a power point presentation on how to get organised, contact kmcgeever@cercot.demon.co.uk

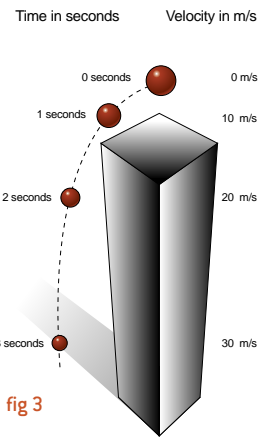


fig 3



School	Team Name	Best	Longest	Highest Height		Speed	Total
		Looking	Flight/secs	Secs	Mtrs		
Harrogate Grammar School	The Avengers	8	3.55	7.28	64.57	35.57	118.95
Rossett School	Nimbus	9	3.17	6.07	58.51	34.15	117.80
St Aidan's C.E.	Rockin' Rockets	9	1.01	6.12	46.88	29.89	98.03
Harrogate Grammar School	Ravin' Rocketeers	9	3.87	5.67	39.38	27.78	85.51
King James' Knaresborough	Northern Lights	11	1.7	4.73	27.41	23.18	68.01
King James' Knaresborough	Rodger Rocket	8	2.99	1.81	28.31	23.57	67.11
King James' Knaresborough	Bombers	9	1.86	4.78	27.78	23.32	68.70

Results chart