Rough Science 4

Teacher's Notes

UPD8 Rough Science 4 Programme 1: Water for Death Valley Scientists

Topics: Solvents and solutions [QCA 7H]; microbes and disease [QCA 8C]

Students pick up on the excitement of reality TV by becoming back-up teams for the scientists challenged in the BBC/Open University Rough Science TV series. They are asked to make dirty water palatable and safe to drink just as the Rough Scientists had to. The activity exploits students knowledge of separation techniques, as well as their ingenuity, the equipment they have is basic and limited. You may like to inject an element of competition into the activity; students can score their clean water sample against those of their peer group and the Rough Scientists.

Try the activity

Download the file from http://www.open2.net/schools_pack.html. You will need Acrobat Reader installed.

Water For Death Valley Scientists

Curriculum link

11-14 (KS3)
Scientific enquiry
Solvents and solutions [QCA 7h] separating solvents from solutes
Microbes and disease [QCA 8c] some microbes cause disease and can be transmitted through water

Running the activity

The best way to start all the Rough Science activities is to show the beginning of the Rough Science programme where Kate Humble sets the challenges, and the five scientists come up with ideas. Then you can set the same challenge to your students. After they have completed the activity, you can compare the students' solutions with those of the TV scientists by showing the end of the programme (alternatively explain the scenario to the students).

In this **starter** and **main** activity, pupils are challenged to make dirty water safe to drink using limited equipment.

Page 1 sets the context and the challenge. It also shows what equipment is available to the students. At this stage, encourage students to think of as wide a range of ideas as possible.

Page 2 allows groups of students to record their plans. Dialogue prompts from the scientists suggest ways of tackling the challenge. Each group will need a photocopy of this sheet. Page 3 is to show students after they have cleaned their water. Each group will need a copy. This page graphically describes what the Rough Scientists did, and provides a simple scoring system for their own results.

Possible extension activities include:

- Each group making a poster of their practical set-up, and later presenting their ideas to the class as if being interviewed/on TV.
- Investigating what can be added to dirty water to clear it, e.g. chopped straw, crushed egg shells, clay, wine finings and so on
- Internet research about water cleansing in situations where a water purification station is not possible, as well as statistics on water usage.

Resources needed

Each group needs:
Two night lights or a candle
Sheet of polythene or other plastic about 70 cm by 100cm
Sellotape or masking tape (to make plastic sheet into a bag.)
Kitchen foil
60 cm x 60 cm cloth
Clean plastic cup to collect clean water.
Made up Muddy water solution, with some coloured food dye (to represent dissolved solids)
clamp stand
filter funnel - but no filter paper
one boiling tube
one hole bung (to fit boiling tube) with glass tube fitted
60 cm of plastic or rubber tube

Summary of Programme 1

The series begins with our team of 5 Rough Scientists making a dramatic helicopter arrival at their new base an abandoned silver mine on the edge of Death Valley in the United States. Kate introduces the theme of the series; it's going to be all about space exploration! Each week they will pit their improvisational science skills against a different set of space related challenges.

Staying with the theme of exploration, Iain and Ellen have to use their geological and botanical skills to search for water in the desert. Death Valley and the deserts around it are some of the driest places on the planet, so they're going to have their work cut out.

Assuming they find some water, Kathy and Mike are going to have to find a way of purifying it to make it safe for drinking. The ability to purify water would be crucial on any space mission. And just to make it a bit harder, not only are they going to have to purify it, they're going to have to make it taste good as well. Because at the end of day 3 we're going to have a blind tasting session where we compare their purified water with drinking water.

Ellen and Iain aim to find water using the same principles that NASA use to search for water on other planets they look for features in the landscape where water has left its mark. Iain spots a gully with signs of a recent flash flood, so they follow it in the hope that somewhere along its course water will have been trapped in the rocks or in the soil. Along the way Ellen finds plants which indicate that water isn't too far below the surface. And then they come across a tiny desert oasis just a few straggly trees. But even though the soil is moist here, when they dig down they find that the damp layer isn't very thick. So Ellen sets up a solar still to evaporate water out of the soil. At the same time she wraps plastic sheets around a branch to collect the water that transpires off the leaves. Next day they have miraculously collected 2 small jars of rather mucky looking water. Not much for Kathy and Mike to purify. But on the way back to base Iain uses his geological knowledge to find one more source of water.

Kathy and Mike have a two pronged strategy for cleaning the water. Mike makes activated charcoal to filter out contaminants and to absorb some of the dissolved particles that would make the water unsuitable for drinking it's exactly the same way that NASA clean water on the space shuttle. But to be extra safe Kathy makes a solar cooker to boil the water, to remove microscopic bugs that might have crept through the filters.

UPD8 Rough Science 4 Programme 2: Communication

Topics: KS3 QCA SoW Year8, 8K Light

Programme 2 clip from script opening to set the scene.

"Now your next set of challenges are going to be all about communication a vital part of any space mission, I think you'll agree.

Ellen and Mike, over a million pounds and 2 years were spent developing a space pen, a pen that could work in zero gravity. We're not going to give you any money at all and just 3 days to do exactly the same thing. Thank you.

Now Kathy and Jonathan sound waves don't travel in space, but we need some sort of communication device a kind of Rough Science walkie talkie that doesn't rely purely on sound to relay a message, ok so that's your challenge.

And Iain, when NASA sent up their deep space probe, Pioneer it had a plaque on it with information about the human race for any aliens that might one day come across it, could you design a plaque with information about the Rough Science team for any aliens that might be interested. Ok, you've got 3 days, all the stuff around here and in the workshop of course and what is in the magic trunk........"

This activity is a challenge requires the pupils to make a 2- D reflector of the best possible shape and direct a light beam across 1.5 meters and concentrate the light onto a detector (5cm x 5cm screen) at the focus of the receiver
reflector dish.

Try the activity

Download the file from http://www.open2.net/schools_pack.html. You will need Acrobat Reader installed.

Communication

Curriculum link

YTOs Energy Yr 8
Recognise that when light travels from a source it is transferring energy; use this idea to:

- describe the nature and propagation of light;
- explain the behaviour of light, including reflection and absorption.

Year 8 Unit 8K Light unit (and Sound unit 8L)
- to apply understanding of reflection to everyday situations

KS4: Physics, Waves: using waves to transmit information (higher tier)
Waves from point sources
Waves and curved reflectors

Running the activity

1. Use the intro part of the Rough science Programme 2 to set the scene.
Or explain the scenario to the pupils
2. Explain the challenge to the pupils. They need to 'assist' the Rough Scientists in producing a beam of light to carry the sound signal. This light beam could be used in darkness or deep shadow. Hence the blacked out lab situation.
The idea is to shine the ray box onto the 'transmitter' reflector to produce a nearly parallel beam of light.
Ideally this should be a parabolic reflector hence the clue graph of $y=x^2$.
This beam of light is collected by the 'receiver' dish, and concentrated onto a detector. The brightness of the 5cm x 5cm white card screen can then used to judge the intensity. Alternatively, the pupils themselves can use an analogue light sensor or multimeter/LDR combination.
3. Let the pupils sketch and discuss designs for 5 - 10 minutes. Remind them that they will need to produce an explanation of their solution based round an annotated diagram.
4. Let the pupils trial possible ideas. Set a time limit, 15 minutes before the end of the session, for measurement and judging. Use the same light meter for all the measurements.

Technicians notes

Equipment

Blackout the room

Ray box - 12 volts 21 watts bulb
Low voltage lab supply 12volts
Receiver screen: 5cm x 5cm piece of white card mounted on wooden block or the like.

Material to make reflectors

Kitchen foil) to make 2 dimensional reflector dishes
Flexible card)
Glue)
Or you could use the DIY reflective material for behind radiators or other sorts of reflective sheet.

For teachers use in judging the best reflector:
Light meter or ESMI meter (these were produced by British Gas for schools)
Any sort of ANALOGUE light measuring device will do including a computer data logger.
You can make a simple light measuring device out of a Light Dependent Resistor (LDR) e.g. an ORP12 or the like, connected to a multimeter set on a suitable resistance scale.

Summary of Programme 2

No space mission can succeed without communication, so our second set of Rough Science space challenges are all based around communication. Sound waves don't travel in space, so Jonathan and Kathy have to come up with a way of communicating that doesn't use sound waves.

It took two years and a million pound to develop a space pen, a pen that would work in zero gravity (note: space pen is a registered trademark, we cannot refer to the RS pen as a space pen). Ellen and Mike have no money and just 3 days to come up with their own version a pen that will work in zero gravity.

Iain's challenge is very different, he has to find a way to communicate with aliens! NASA faced this problem when they sent the Pioneer probe out into deep space. They put a plaque on the probe with crucial information about the human race in case any aliens came across it. So Iain has to come up with a plaque that would communicate information about the Rough Science team to aliens.

Kathy and Jonathan come up with a truly extraordinary Rough Science way of communicating without sound waves. They find a way to carry a voice on a sunbeam! Their technique involves getting a voice to wiggle a light beam, then reflecting the wiggling light beam to a receiver which turns the light beam back into sound.

Down on earth, pens rely on gravity to deliver ink to the nib. But in space there's no gravity, so Mike and Ellen need some other force to push ink to the nib. Although we can't take them into space to test their pen, there is another way to find out if they've succeeded; if their pen can write upside down then it will prove it isn't using gravity to make the ink flow. Mike comes up with two designs; a pen that uses capillary action, and a ballpoint pen with a balloon inside it to put pressure on the ink. And Ellen goes hunting amongst the plant and animal communities in her quest to make a workable ink.

Iain's plaque to communicate with aliens is inspired by the local geology he decides to make it out of plaster of paris because there should be gypsum in the hills around the mine, and gypsum is the raw material for plaster of paris. The trouble is, his geology lets him down; what he thinks is gypsum turns out to be something else. He has to rely on some clever chemistry to get his challenge back on track. But he eventually comes up with a rather clever idea for the design of his plaque.

UPD8 Rough Science 4 Programme 3: Spacesuit Challenge

Topics: Heating and Cooling [QCA 8i]; Energy [QCA 9i]

Students pick up on the excitement of reality TV by becoming back-up teams for the scientists challenged in the BBC/Open University Rough Science TV series. In programme 3, the Rough Scientists have to design a spacesuit to keep one of them cool in the 50°C+ temperatures of Death Valley. The activity gets pupils to look critically at some design ideas for spacesuits. They then plan what to say, and produce an energy transfer diagram, to explain on TV how the Rough Scientists' spacesuit works.

Try the activity

Download the file from http://www.open2.net/schools_pack.html. You will need Acrobat Reader installed.

Spacesuit challenge

Curriculum link

11-14 (KS3)
- Scientific enquiry
- Heating and cooling [QCA 8i]: energy transfer is the result of temperature difference.
- Heating is a process where energy is transferred. Conduction and radiation.
- Energy [QCA 9i]: energy conservation. Explaining energy transfers.

Running the activity

The best way to start all the Rough Science activities is to show the beginning of the Rough Science programme where Kate Humble sets the challenges, and the five scientists come up with ideas. Then the students can discuss possible solutions to the challenge. After they have completed the activity, you can compare the students' solutions with those of the TV scientists by showing the end of the programme.

In this **starter** and **main** activity, pupils are presented with one of four possible solutions to the spacesuit challenge. They explain how their suit will keep the person cool, and then discuss the relative merits of each suit, and predict the solution that will work the best.

Page 1 sets the scene and suggests science ideas that pupils could use to start to discuss possible solutions. It can be printed onto a transparency or projected.

Page 2 sets the task. **Pages 2 and 3** then show 4 possible solutions to the challenge. There are two ways of running this part of the activity:

- Groups explain for a TV audience how each of the suits will keep the person cool, discuss their relative merits and predict the solution that will work the best

OR

- Each group of pupils is given one possible solution. They prepare a short talk to explain how it keeps the person cool, and then say how well they think it will work.

Page 4 shows the Rough Scientists suit and explains how it works. Pupils are asked to draw an energy transfer diagram to support their own explanations of the Rough Scientists suit for a TV audience.

Summary of Programme 3

Spacesuits are designed to protect astronauts from these extremes of temperature. So for this weeks challenge the Rough Scientists have to collectively design a cooling system for their very own spacesuit. And to test it out, at the end of day 3, they're going to have to go to Death Valley and do a mock moon walk in their spacesuit, and stay deliciously cool.

They decide that they need to make a portable Rough Science fridge. Ellen creates a copper pipe system that will go from the fridge to the spacesuit, carrying cool water from the fridge to the astronaut. Jonathan devises a pump to keep the water moving through the system.

Kathy suggests that the fridge should use the principle of evaporation, the same principle that cools us when we sweat. She needs to get water evaporating inside the fridge. And the best way to do that is to lower the pressure; this speeds up evaporation and therefore cooling. But there's a problem all that evaporating water is trapped inside the fridge, and unless they can get it out then it will destroy the vacuum. Fortunately there's a magic mineral called zeolite that has a special property, it adsorbs water vapor. So if they can find zeolite and put it in the fridge it will suck up the water, vapor preserving the vacuum. Mike attempts to extract zeolite from washing powder, whilst Iain tries to find naturally occurring zeolite in the rocks around the mine.

Unfortunately, all their efforts are to no avail, because Kathy fails to create an airtight container in which they can lower the pressure enough to create cooling. Mike comes to the rescue with some clever chemistry; he manages to create cool water using nothing more than a bag of fertiliser and some table salt. Kathy's fridge isn't entirely wasted because it's produced enough of a vacuum to function as a kind of cool box, to keep Mike's cool water from warming up in the heat of Death Valley.

So at the end of day 3 the Rough Scientists decamp to Death Valley where Ellen is dressed in their spacesuit for a space walk that will reveal whether their cooling system really can keep someone cool in one of the hottest places on earth.
In a desert where the temperature gets up to 50^0C, the suit managed to keep its wearer, Ellen, down to a cool 23.6^0C.

UPD8 Rough Science 4 Programme 4: Craters Impact

Topics: Unit 9J Gravity and Space 9K Speeding Up 9M Investigating Scientific Questions

Crater Impact is a fun, easy to use investigation into kinetic and potential energy.
It is set in the context 'If a large asteroid hit the Earth, could it cause global catastrophe?'
Pupils simulate asteroid impacts on a tabletop scale by dropping objects into sand. They can investigate how the speed and mass of their 'asteroid' affects the distance that the debris travels or the size of the 'crater' produced.
The activity addresses the whole range of investigative skills. It is a specially adapted version of a popular brief from the Pupil Researcher Initiative.

Try the activity

Download the file from http://www.open2.net/schools_pack.html. You will need Acrobat Reader installed.

Crater Impact

Curriculum link

KS3 QCA Unit 9J Gravity and Space / 9K Speeding Up / 9M Investigating Scientific Questions
KS4 Single/Double Science: Forces and their effects

Running the activity

Pupils read page 1 *Crater Impact : Science fact or fiction* to set the context.
Page 2 is a help sheet.

- **Asteroid speed** Pupils are told that dropping the object from different heights gives it a different speed on impact. Speed is used (rather than height) to make it easier to predict the effect on the kinetic energy of the asteroid and thus the effect of the impact.
- **Asteroid mass** This can be varied using objects of different sizes. For a fair test, these should be made of the same material e.g. all ball bearings or Plasticine. Mass is used (rather than diameter) to make it easier to predict the effect on the kinetic energy of the asteroid and thus the effect of the impact.
- **Debris range** This is the furthest distance any sand from the 'planet surface' travels. Sprinkling powder paint over the surface with a sieve and tapping the container so it settles makes measurement easier.
- **Crater size** This is the diameter of the crater that the dropped object makes.

Pupils then plan their investigation, using the question prompts on the *help sheet,* page 2.
Knowledge of the formula for kinetic energy is needed to make predictions about how the speed or mass of the asteroid will affect the impact. Pupils are told that the bigger the kinetic energy, the bigger the crater and the bigger the debris range.
It is worth doing a trial run to check that there is enough sand/powder in the tray.

*Extension activities- **pages 3 and 4***

- These activities exploit the context of the investigation, giving it a more personal dimension. Pupils can scale up their results to estimate the effects of a real impact, and also consider ways we could protect ourselves from a collision. They get more practice of calculations and thinking about probabilities.
- Some of the activities are more appropriate for brighter pupils.
- For Activity 1, pupils will need results from an investigation into debris range for the calculation.

Extension calculation answers

2a) 5.23 x 108 m3
2b) 2.88 x 1012 Kg
2c) 2.30 x 1019 J
2d) 96 bombs
3a)i) 1m ii) 10km
3c) Approximately 1000
3d) 1.1 x 10-5
3e) 2.75 x 10-6

More ideas

Demonstrate what happens when an asteroid hits water rather than land, by dropping an object into a tray of water. Can you see waves produced? In a real collision huge tidal waves are created, which are known as tsunamis.

Web links

For more investigations set in contexts such as this, see the *Pupil Research Brief* from PRI. These were sent to all schools in 1995/96, and are now available on the PRI website: www.shu.ac.uk/pri

Technicians notes

Requirements per group

- Objects for dropping to represent asteroids. For example, marbles, ball bearings or plasticine. Pupils will need several different sizes of a particular material.
- Material to represent the Earth's surface. For example, flour, sodium hydrogen carbonate or Plaster of Paris. Pupils investigating 'debris range' will also require powder paint and a sieve to sprinkle on as a top layer.
- Plastic tray, aluminum pan, or cardboard box container. This needs to be at least 7.5cm deep and 30cm square to give room for debris to travel.
- Newspaper to put under the container to catch spilled powder.
- Metre stick to measure the drop height.
- Ruler to measure crater diameter and depth.
- Access to a balance to measure the mass of the 'asteroids'.

Safety

- Pupils should take care if they need to stand on a desk in order to achieve a big drop height.
- They should take care not to allow sand or powder to get in their eyes.

Summary of Programme 4

This weeks programme is all about meteorites and asteroids. Not too far from the Rough Science base on the edge of Death Valley is a Meteor Crater. Iain, Kathy and Mike have to work out how big the meteor was that caused this huge crater. It's not just the earth that gets hit by objects from outer space, the moon is also a target, as evidenced by its heavily cratered surface. So Jonathan and Ellen have to pick a crater on the moon, any crater will do and measure how big it is. And because they'll be doing their measurements at night, Ellen has to come up with some lights.

The Meteor Crater team decide they have to split their work. Kathy and Iain head off to the Crater itself to try and measure its diameter. This is the first essential step if they are to work out how big the meteor was that caused the crater. At the same time they are hoping to find out more about the meteor, in the hope this will give them clues about how big it was. Meanwhile Mike stays behind to try and make his own crater. He performs a series of impact experiments, dropping heavy objects into sand in an effort to work out the relationship between the size of an object and the size of the crater it forms.

Jonathan and Ellen have been given a high quality optical mirror, and so to find and measure a crater on the moon they build a reflecting telescope. Their plan is to time how long it takes the whole moon to travel across a fixed point in their eyepiece, and then time how long it takes their chosen crater to travel across that same fixed point. Because they know that the moon is 3500kms across, they can then work out how big the crater is as a proportion of this.

For her lights Ellen heads to the hills and collects pine sap. She melts it to remove some of the most volatile compounds, and then uses bark fibres as wicks, to make highly effective Rough Science candles.

UPD8 Rough Science 4 Programme 5: Survival (CO_2 scrubber)

Topics: 7F simple Chemical reactions (9M Investigating Scientific Questions)

Survival is a problem-solving challenge to teach about chemical reactions. It is set in the context of a journey to the International Space Station (ISS). Pupils are faced with a challenge and must apply scientific knowledge to solve it.

Try the activity

Download the file from http://www.open2.net/schools_pack.html. You will need Acrobat Reader installed.

Survival

Curriculum link

KS3 QCA Scheme of Work Unit 7F
How acids react with carbonates.
The evidence for a reaction, and the test for carbon dioxide.
Acids, alkalis and indicators.

The space station's CO_2 cleaner has failed, and CO_2 is rising to dangerous levels. Can pupils design and test a home made device to remove CO_2 from the air in time?

Running the activity

Introduce the context with the *Final Mission Briefing* sheet (page 1). You could stick this on the door before pupils enter the laboratory, and/or display it on the data projector or OHT.
Carbon dioxide scrubber
Page 2, pupils receive a message that the CO_2 scrubber that purifies the air is failing.

Pupils are given help to design the three different parts of a test scrubber. The challenge is to choose suitable chemicals from those available, and then test them to see how well the scrubber works. The *Mission message* sheet contains instructions to structure the challenge. You may want pupils to research the information they need. The CO2 scrubber consists of three parts, assembled using standard laboratory equipment.
Part A: CO_2 Generator. Various chemicals are made available to pupils. They should choose the ones that react together to make CO_2, for example marble chips and dilute hydrochloric acid.
Part B: CO_2 Scrubber. Various chemicals are made available to pupils. They should test the chemicals to find out which are alkali, and try them as potential scrubbing chemicals. Two forms of alkali are suggested (see *Technician Notes*). Solid forms work extremely well but are more hazardous, and solutions which are less effective but significantly less hazardous. Pupils should find that only soda lime or sodium/potassium solution will absorb .
Part C: CO_2 Tester. The pupils should choose limewater from various options provided, as a test for the gas.
Having designed their scrubber pupils should show you their plan. If they have selected inappropriate chemicals, ask them to rethink their design. Their first experiment should be a control, to see how quickly (in the absence of a scrubbing chemical) the limewater turns

milky once CO_2 is generated. It is important that the rate of production of CO_2 bubbles should be slow (particularly if you are using alkalis in solution form). This is so the scrubber has enough time with to react with the CO_2 before it passes through the tube. Pupils then repeat the experiment with each scrubbing chemical in turn. The best scrubber is the one where the limewater takes longest to go milky.

More ideas

- Give the activity a competitive element. The winner is the group that finds the solution in the shortest time (and thus prevents the crew suffocating).
- Discuss the Apollo 13 mission, where a disaster very similar to this one happened. The event was made into a very popular film.

Web links

This activity was adapted from a longer activity on the ASE Science Year CD-ROM 2 Is there Life? The activity was called Space Station Survival.
For more materials from the ASE Science Year CD-ROMs, see www.ase.org.uk and click on the 'resources' tab.

Technicians notes

Requirements per group
1 conical flask
2 boiling tubes
Bungs and glass tubing (see diagram in pupil sheets)
Litmus paper
Stopwatch/timer
Eye protection
Chemicals for A - CO_2 *generator (set out together)*
Zinc
Copper
Hydrochloric acid (0.4M)
Marble chips (large size, to give a slow production of CO_2 bubbles)
Chemicals for B - CO_2 *scrubber (set out together)*
Either provide alkali solutions from this selection (already in boiling tubes, so pupils do not handle the chemical):
Sodium hydroxide solution (1M)
Potassium hydroxide solution (1M)
Sodium carbonate solution (1M)
Or provide solid alkalis from this selection (already in boiling tubes, so pupils do not handle the chemical):
Sodium hydroxide pellets
Lithium hydroxide pellets
Sodium carbonate
Soda lime
Other possibilities for pupils to select from:
Citric acid crystals
Rock salt
Charcoal
Chemicals for C - CO_2 *tester (set out together)*
Limewater solution

Hydrochloric acid (0.4M)
Splint

Safety information for teacher and technician
You must try this activity before using it with pupils. This will allow you to decide whether they will need to use alkali solutions or the
more hazardous solid alkalis for the CO_2 scrubber. A risk assessment always encourages the use of the least hazardous material
that produces results. The slower the production of CO_2, the less concentrated alkali needed.

- 1M sodium and potassium hydroxide are corrosive and dangerous to eyes and skin. Solid sodium and lithium hydroxide are more hazardous.
- Eye protection must be worn at all times.

Summary of Programme 5

In programme one the Rough Scientists had to make a Mars Rover which could explore strange new worlds. This week Kathy and Jonathan have to go one better and design an aerial surveyor that can explore much greater areas by floating above land. Just like the rover they've been given a tiny camera which will record whatever the aerial surveyor sees. Back on earth, Mike has a very different challenge. Back in 1973 the crew of Apollo 13 faced certain death when an accident damaged their oxygen tanks. To survive they had to build a carbon dioxide filter and so Mike has to do the same. In 1872 California experienced once of the biggest earthquakes ever recorded in the United States. Ellen and Iain have to work out where the epicentre was, and how big its magnitude was.

Kathy and Jonathan decide to make a solar balloon a balloon that is heated by the power of the sun. It's made out of black bin bags stuck together, and the idea is to hang the camera below it. This is an idea that NASA are actively exploring for Mars. Unfortunately the Rough Science version encounters a series of unexpected setbacks, and on day three it is touch and go whether it will get off the ground.

For Mike to make his carbon dioxide filter he needs to make limewater. To do that he needs to find limestone, heat it up to make quicklime, and then dissolve it in water. However, making quicklime proves to be more difficult than anticipated, and on Day 3 he faces a classic Rough Science test to see if he has succeeded in making a working carbon dioxide filter.

Ellen and Iain take to the air to try and find the site of the 1872 earthquake. Their first task is to find the fault line which marks the location of the earthquake. They then set out to measure the amount of movement that occurred along the fault, to work out where the maximum displacement was. This should give them the epicentre of the earthquake, and also provide the information they need to calculate its magnitude.

UPD8 Rough Science 4 Programme 6: Rocket Lander Challenge

Topics: 7K Forces and their effects; 9J Gravity and space

Pupils find themselves working as European Space Agency engineers and follow in the footsteps of the Rough Science team. Their Challenge is to devise an egg lander, Mars Express/Beagle 2 style, using limited materials.

Try the activity

Download the file from http://www.open2.net/schools_pack.html. You will need Acrobat Reader installed.

Rocket Lander challenge

Curriculum link

KS3 Select and use a suitable strategy for solving a problem; identify strategies appropriate to different questions, including those in which variables cannot be easily controlled.

- Carry out preliminary work such as trial runs to help refine predictions and to suggest improvements to the method.
- Make sufficient systematic and repeated observations and measurements with precision, using an appropriate technique.
- Select and use appropriate methods for communicating data.
- Use scientific knowledge and understanding to make predictions and check reliability.

KS3 Forces Recognise how the effect of force depends upon the area to which it is applied and that the force acting per unit area is called pressure.

- Recognise that gravity is a force of attraction between objects, that this force is greater for large objects like the Earth.

Running the activity

The best way to start these activities is to show the beginning of the rough science programme, where Kate Humble sets the challenges, and the five scientists come up with ideas. Then you can set the same challenge to your students. After they have completed the activity, you can compare the students' solutions with those of the TV scientists, by showing the end of the programme.

Page 1 sets the scene. Pupils first think about why the mass needs to be kept to a minimum. Pupils need to appreciate that if the mass is greater more fuel will be needed each time it needs to change direction or speed. And also more fuel is needed to carry the extra fuel!

Page 2 is a work file with a list of materials. Teacher or lab technicians may want to make changes to this to take account of the materials readily available.

As a homework activity pupils could be asked to discuss in what ways their lander in the laboratory was not a good model for a real Mars lander. They could also research how gravity and arid resistance differ on Mars from Earth.

Extension

Pupils design a chemically-powered rocket using vinegar and sodium hydrogen carbonate powder, or fizzy antacid tablets and water. The body of the rocket could be made from a vitamin or film container. A standardised set of materials would be available. This could also include a lander and pupils could be challenged to keep their lander in the air for as long as possible.

Web links

The Beagle 2 lander and probe have their own site with lots of information which pupils could look at as a research homework - making comparisons with their own design. For some classes it may even be preferable to turn the scenario around and ask pupils to design an Earth bound laboratory lander informed by what they have found out about the Beagle 2 lander.
www.beagle2.com/landing/descent.htm

Mars Express pages of the European Space Agency are an excellent background to the mission as well as providing up to date information as the mission unfolds.
www.esa.int/export/SPECIALS/Mars_Express/index.html

Summary of Programme 6

Our final set of Rough Science challenges about space exploration are all about rockets. Mike, Jonathan and Kathy have to make three different rockets, but there's a catch; they're only allowed to use one thing as a fuel and that's water! They've also got to design their rockets to carry a 'passenger' a (raw) egg. And Ellen and Iain have to find a way of returning the egg safely to earth.

Each of our 3 rocketeers designs a rocket that fits their science background. Jonathan is the most ambitious, his physics background inspires him to build a steam powered rocket. Kathy, also a physicist, decides to use pressurised water, and Mike takes a chemical approach, using electrolysis to split water into hydrogen and oxygen gases, and then recombining them to form an explosive mixture. (Hydrogen and oxygen are what NASA use to fuel their rockets but the difference is that NASA use liquid fuel which can compress far more energy into a much smaller space.) What develops is a Rough Science space race, as the scientists compete to see who can get to the launch pad first, and whose rocket will be the most effective.

Meanwhile, Ellen and Iain have to find a way of putting an egg on each rocket and returning it to earth. They opt for a parachute made out of bin bags, and design a detachable nosecone for the rockets. However, the 'detachable' part proves harder to achieve than first thought.

Feedback

We hope you find this pack useful and would love to find out what you thought of it. So, why not send us your thoughts by completing our feedback form. You can find it by logging on to: http://www.open2.net/roughscience4/schools_pack_feedback.htm.