FUTURE TRAVEL

Practical Project
For Teachers **p2&3**, for Students **p4**

HEALTH AND SAFETY

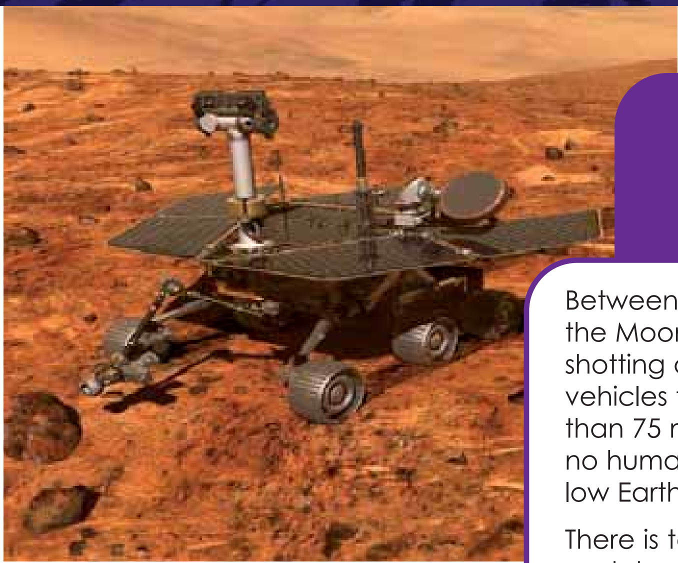
Students should be encouraged to make their own risk assessment before they carry out any activity, including surveys. In all circumstances this must be checked by a competent person. Students using specialised equipment should be supervised at all times.

Combustion of fuels requires careful risk assessment and close supervision. Students should plan and carry out their project, but all practical work must be vetted.

Students may want to set up unorthodox experiments and you may need to seek specialist advice. Organisations such as CLEAPSS and the Royal Society of Chemistry are able to help.

FUTURE TRAVEL:

Gold **Practical** Project - For Teachers



The final frontier - exciting exploration or Martian madness?

Between 1969 and 1972, twelve astronauts walked on the Moon. Since then we've sent space probes sling-shotting across the Solar System, and landed. Rover vehicles to roam the red brown surface of Mars more than 75 million kilometres away. Yet, in the past 35 years, no human has ventured further than a space station in low Earth orbit, only a few hundred kilometres up.

There is talk of astronaut missions to Mars, but can we, and should we, realise these dreams?

HAVE YOU EVER WONDERED?

...what skills you need to design a high-tech miniature mobile laboratory like a Mars Rover?

You might like to imagine yourself in a situation such as...

The European Space Agency is running a competition for the best amateur design of a mobile miniature laboratory, to explore and analyse the surface of another planet. Participants must design and build a prototype laboratory, which must be self-propelled, remotely-controlled, capable of collecting soil samples for on-board analysis and able to fit into a hemispherical 'lander' capsule, no more than one metre in diameter.

Participants are also required to suggest suitable on-board instruments for exploring and analysing the terrain. They are not expected to make or provide these, but must explain the function of each instrument and perform experiments to show how they would work.

You have decided to enter the competition, so you need to **undertake practical work** to test possible:

- methods for propelling and manoeuvring the mobile laboratory
- power sources for propulsion and for the laboratory instruments
- on-board experiments
- You must then build a prototype mobile platform for your proposed laboratory.

POSSIBLE EQUIPMENT, MATERIALS AND RESOURCES

- Manual and instrumental analytical equipment, such as spectrometer and colorimeter
- Single compounds and minerals likely to be present on a planet's surface
- Access to professional analytical techniques
- A chance to study articulated robot 'arms' in action
- Workshop facilities and materials for building their prototype platform
- Robotics kit for investigating and building a robotic arm for the platform
- Electronics components for control systems
- Experience of using sophisticated instrumental techniques may possibly be arranged through the Mentor, local company or university.

Prompts

The **Student Brief** gives some triggers to start students thinking. They should realise that each trigger implies that several ideas need to be considered. Encourage them to identify these themselves. However, if necessary, prompts such as those below might be given, to point students in suitable directions.

- Types of movement required and how these might be achieved
  - In addition to forward / reverse and cornering, what other movements would be useful?
  - How will it collect soil samples?
- Amount of power required for movement and laboratory instruments, and how this could be provided
- What would be a reasonable mass for a planetary vehicle of this size? How much power is required for propulsion?
- Communications between Mission Control and the mobile laboratory
  - What sorts of information need to be communicated?
  - Can you build-in a delay, to simulate signals being transmitted between Earth and another planet?

  [Depending on the complexity of the system, it is acceptable to control the prototype via an umbilical cable, not wireless.]
- Types of soil analyses that could be carried out, and thus the types of instrument required
  - How might compounds and their constituent elements be identified?
  - What other properties might be analysed besides chemical composition?
- Other types of on-board instruments
  - How will Mission Control determine the location and orientation of the mobile laboratory?
  - How can we take 3-D photographs of the terrain? (See marsrover.nasa.gov/gallery/3d/spirit/)
- Construction materials for the mobile platform
  - Bearing in mind conditions on the planet's surface, what are 'best' choices for the various parts?
  - These are likely to be expensive, exotic materials. So, what would be suitable substitutes for your prototype?

Suggestions for supporting students

Though primarily based on laboratory investigations and workshop activities, the Practical project will require some initial research into, for example, lunar and Martian rover vehicles, robotics and analytical instruments.

Gold Award students are required to have an external Mentor (normally a scientist or engineer) for their project. The Mentor's role is to provide guidance and support. The Mentor might be involved in …

- The construction of robot vehicles, or parts such as robotic arms
  - controlling robotic equipment, such as assembly lines or bomb disposal robots
  - satellite power systems
- developing spacecraft, robotic equipment, or components thereof, with a manufacturer
- commercial use of robotic systems
- a past, present or future space project, such as the European Space Agency's Mars Express / Beagle mission
- scientific publishing on space research or robotics

Contact your Local Coordinator for guidance.

Internet search

- UK Space Agency
  ukspaceagency.bis.gov.uk/default.aspx
- Science and Technology Facilities Council
  stfc.ac.uk
- Rutherford Appleton Laboratory Space science and technology department
  http://www.stfc.ac.uk/ralspace/default.aspx
- NASA
  www.nasa.gov/exploration
- European Space Agency
  www.esa.int

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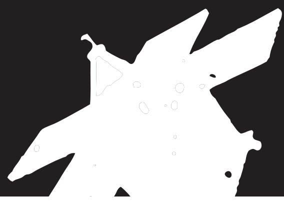

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Some things to think about...

- Types of movement required and how these might be achieved
- Amount of power required for movement and laboratory instruments, and how this could be provided
- Communications between Mission Control and the mobile laboratory
- Types of soil analyses that could be carried out, and thus the types of instrument required
- Other types of on-board instruments
- Construction materials for the mobile platform

Health and Safety

Should you decide to carry out any experiment or practical activity:

(a) find out if any of the substances, equipment or procedures are hazardous.

(b) assess the risks (think about what could go wrong and how serious it might be).

(c) decide what you need to do to reduce any risks (such as wearing personal protective equipment, knowing how to deal with emergencies and so on).

(d) make sure your teacher agrees with your plan and risk assessment.

NOTE: Your teacher will check your risk assessment against that of your school. If no risk assessment exists for the activity, your teacher may need to obtain special advice. This may take some time.

(e) if special tools or machines are needed, arrange to use them in a properly supervised D&T workshop.