

National Museums of Scotland - Connect Gallery Teachers' Notes

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Blast off As British rocket Black Knight towers above you, step into a Gemini space rocket and fire a hydrogen rocket.

Table 1 Blast Off objects

Object	Description	Background information
Black Knight Rocket	A British government research rocket designed to reach speeds of over 10,000 miles per hour. The first of these rockets was launched from the Australian desert in 1958.	<p>Rockets or rocket engines move by expelling mass in one direction, which results in movement in the opposite direction (i.e. Newton's Third Law: every action has an opposite and equal reaction). All of the 'mass' is carried within the rocket until its release and is usually fast-moving exhaust gas from a combustion engine. Rockets are particularly useful for moving in space where there is nothing for a vehicle to push against, or forces such as friction and gravity, to aid movement.</p> <p>The Black Knight rocket was designed to study the effects of re-entry on a vehicle re-entering Earth's atmosphere. The primary reason for this study was to provide information for the Blue Streak missile programme - a ballistic nuclear missile. But the information was used as part of a broader rocket research programme and after the end of the Blue Streak missile programme in 1965, the Black Knight missile was re-developed into the Black Arrow satellite launch vehicle.</p>
Gemini Space Capsule	A NASA space capsule built in the 1960s. It was designed to land in the desert instead of the ocean.	<p>The Gemini Space Programme bridged the gap between the early Mercury missions, which put an astronaut into space, and the Apollo missions that landed on the Moon. The main objective of the Gemini mission was to provide NASA with valuable information for planning the Apollo missions and develop techniques for advanced space travel.</p> <p>The Gemini capsules had a two-man crew whose tasks matched those that might come up on a trip to the moon. Flights could last as long as two weeks, compared to the hours and minutes of the Mercury flights. The capsule's design was based on the Mercury capsules, with various modifications and additions. It had small rocket engines (thrusters) around the nose of the capsule making it easy to manoeuvre and allowing it to alter its own orbit and to dock with another spacecraft.</p> <p>The capsule had to hold two astronauts and store food and scientific equipment. The supplies were carried in a service module. During the missions the astronauts' health was continuously monitored through their biosensor suits. In space, if the astronauts needed to stand up, they had to put on their space suits and open the hatch. They ate freeze dried meals, went to the bathroom using hoses and bags and cleaned up by opening the hatch; anything that was not attached was sucked into space! The first American astronaut space walk took place on a Gemini mission.</p>

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Table 2 Interactives

Interactive	Description	Background information	Learning Outcomes
<p>Rocket Power (best for 5-11 yrs)</p>	<p>You turn a handle to generate electricity, which is used to separate hydrogen from oxygen in water.</p> <p>The hydrogen generated acts as the fuel for a small rocket. You can 'fire' the rocket by pressing the ignition button and watch it rise up about 5 metres</p>	<p>Water (a liquid) consists of two oxygen atoms and one hydrogen atom joined together in a molecule. The electrical current breaks the bond between the water and hydrogen, splitting the molecule into hydrogen and oxygen ions. The separation of water into hydrogen and oxygen using electricity is called electrolysis. The hydrogen ions are positively charged and collect at the negatively charged terminal of the electrical supply. There the hydrogen ions pick up an electron-forming hydrogen gas. The oxygen atoms are negatively charged and collect at the positively charged terminal. There the oxygen ions lose an electron and form oxygen gas. The hydrogen and oxygen gas bubbles float to the surface and enter the bottom of the rocket.</p> <p>Pushing the button ignites and burns the gas in the rocket. The heat produced expands the gases, which are pushed out the bottom of the rocket at high speed. It is the gas being forced out the bottom of the rocket that provides the energy to move the rocket up the wire. This is Newton's Third Law: For every action, there is an equal and opposite reaction. For example, a person standing on the ground exerts a downwards force on the ground and the ground exerts an equal upwards force on them.</p> <p>The rocket moves up the wire because the mass of hot gas is accelerated from the rocket, producing a downwards force on the surface below the rocket. There is an equal and opposite reaction from the surface creating an upwards force on the rocket – this is called thrust or propulsion. The speed at which the rocket moves depends on the mass and acceleration (increasing the speed) of the gases. Force is equal to mass times acceleration ($F=m \times a$). Increasing the mass and or the speed of the gases being forced out the bottom of the rocket creates a greater force on the surface below the rocket and the rocket moves faster. If the rocket was in outer space it would move faster, because there would be no air resistance acting against the rocket.</p>	<p>Water molecules are made of hydrogen and oxygen atoms. Electricity can be used to separate the molecules and produce hydrogen and oxygen gas – this is called electrolysis.</p> <p>Newton's Third Law: For every action, there is an equal and opposite reaction.</p> <p>The hot gases forced from the bottom of the rocket create an equal and opposite force, called thrust, which move the rocket forward.</p> <p>Force is equal to mass times acceleration ($F=m \times a$).</p>

Interactive	Description	Background information	Learning Outcomes
Space Suit (best for 5-12 yrs)	You can step into a full-sized replica space suit, find out about how it is designed and have your photograph taken looking out through the helmet visor.	<p>Our ability to travel into space has changed the way we live on Earth and the way we think about and explore the universe. The first person to step into the harsh environment of space was Alexei Leonov, a Russian cosmonaut, on 18 March 1965.</p> <p>To function in space an astronaut needs to: breathe, move, manoeuvre, communicate, stay at constant pressure / temperature and be protected from micrometeorites and electromagnetic radiation. Like all astronauts that take part in extra-vehicular activity (EVA), Alexei Leonov was protected by his spacesuit.</p> <p>Space is a vacuum. An astronaut has to wear a spacesuit that supplies oxygen for breathing and that keeps the body at a constant pressure. If the pressure our body experiences got too low our body fluids would boil.</p> <p>Space is very cold. Spacesuits don't actually have much insulation apart from the hands and feet, because body heat can only be lost by radiation in space (because it's a vacuum) which is very slow. Spacesuits have their own cooling systems. Without the Earth's atmosphere protecting them from the full strength of the sun an astronaut could experience temperatures of over 120°C.</p> <p>The most common type of spacesuit design is the flexible pressure suit. Typically, these suits are composed of different layers which keep the suit airtight, flexible, pressurised, cooled and at a constant volume (to improve mobility). They are heavy and have a tendency to balloon up in space which makes it difficult to move. However, they do allow a wide range of movements.</p> <p>Other designs are hard-shell suits and combinations of hard-shell and flexible pressure suits.</p>	Understanding of what is needed to ensure that the human body can survive in space.

Table 3 Blast Off: Keywords , concepts and curricular links

Interactive	Keywords and concepts	Curricular links	Renfrewshire Topics (Edinburgh)
Rocket Power	Burning Electricity and Electrolysis Energy Forces Newton's Third Law Solid, liquid and Gas Thrust / Propulsion	<p>Energy and Forces: Conversion and transfer of energy Level E – give some examples of chemical energy changes [ISE5-14 EF-E2.2].</p> <p>Energy and Forces: Forces and their effects Level A – give examples of pushing [ISE5-14 EF-A3.1].</p> <p>Level B – describe the effect that a push can have on the direction and speed of an object [ISE5-14 EF-B3.1].</p> <p>Earth and Space: Materials from Earth Level C – describe the differences between solids, liquids and gases [ISE5-14 ES-C2.1].</p> <p>Earth and Space: Changing materials Level D – describe what happens when materials are burned [ISE5-14 ES-D3.1].</p> <p>Standard Grade Physics Unit 7 Space Physics Section 2: Space Travel – Rockets</p> <p>Standard Grade Chemistry Topic 1 Chemical Reactions Topic 5 Fuels Topic 7 Properties of Substances</p>	<p>P3 – Forces Give examples of pushing. Describe the effect that a push can have on the direction and speed of an object.</p> <p>P5 – Solids, liquids and gases Describe the differences between solids, liquids and gases.</p>

Interactive	Keywords and concepts	Curricular links	Renfrewshire Topics (Edinburgh)
Space Suit	Breathing Exploration Humans require protective equipment to survive in hostile environments. Oxygen Pressure Protection Space Spacesuit Temperature Vacuum	Earth and Space: Earth in space Level D – give some examples of approaches taken to space exploration [ISE5-14 ES-D1.2]. Living things and the processes of life: Processes of life Level A – describe some ways in which humans keep themselves safe [ISE5-14 LT-A2.2]. Level C – name the life processes common to humans and other animals [ISE5-14 LT-C2.1]. Level D – describe the role of the lungs in breathing [ISE5-14 LT-D2.1].	P1 – Introducing Living Things Describe some ways in which humans keep themselves safe. P5 – Living on Earth Name the life processes common to humans and other animals. P6 – The human body Describe the role of lungs in breathing. P6 – The Solar System Give some examples of the approaches taken to space exploration.