5. Making holes

Children explore the effectiveness of a variety of tools to make holes in different materials.

OBJECTIVES

- Compare and group together a variety of everyday materials on the basis of their simple physical properties
- To investigate hole-making in materials of varying hardness. Gathering and recording data to help in answering questions

RESOURCES

- Activity sheets 7 - 11
- Plastic tubs/lids
- Plasticine
- Tub of soil or mud
- Tub of sand
- Block of wood
- Cardboard
- Piece of carpet
- Piece of lino
- Clay (moist, sealed in a transparent bag)
- Needle
- Scissors
- Pencil
- Junior drill
- Hole-punch
- Hammer
- Nail
- Masonry drill (observation only)

Safety note

Children must be supervised by an adult when using tools. Consult design and technology policies on the safe use of tools with this age group.

DISCUSSION

The resources above can be laid out on a table-top to form an interactive display. At this stage, cover up the tools on the display and focus on the materials. Ask children:

- How can you describe these materials? (hard, soft, etc.)
- How could you make neat, round holes in this material (ask this for several/all materials)? What would you use?
- How will you choose which tool to make a hole in this material (ask this for several/all materials)?
- Are some tools more dangerous than others? Why?
- How can you use them safely?

TASK

Children are challenged to find how many ways there are to make neat round holes in a variety of materials. Where possible, children should draw on the knowledge from the previous task about hard and soft materials. Activity sheets 7 or 8 can be used for children to record predictions (see the section titled 'varying the task' on opposite page).

> "Children used their prior knowledge to collect their own materials, make their own suggestions and find their own tools to use."

Once children have made predictions, discuss the reasons for their choices. This will provide the opportunity to assess whether children have been able to use any of the information from the previous activity to inform their decisions (e.g. "I think I will drill a hole in the wood because it is very hard, and I couldn't even dent it with my finger.").

Children then try to make holes in each material, using their suggested methods. Decide which methods children can attempt safely, and which methods need adult supervision. Consult the school and authority design & technology policy for recommended use of tools with this age group.

VARYING THE TASK

To modify the activity for rotating groups, provide them with a different combination of tools and materials (hence the two different sample Activity sheets 7 and 8).

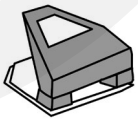
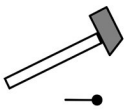
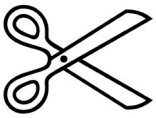
If using a different range of materials or tools, draw or stick pictures of them onto sheets similar to those provided.

Some children can be asked which tool is the 'best' for making holes in each material and why.

RECORDING

Children can use Activity sheets 7 or 8 as both recording and prediction sheets. Using a different coloured pencil for each tool, children link the tool with the material they think it will make a hole in. Each tool and material can be linked several times. Children can complete new copies of the Activity sheet once the materials have been tested, or they can write 'yes' or 'no' above each line on their prediction sheets, adding any new lines as dotted ones. Encourage children to use rulers to draw the lines, if they are able to do so.

Alternatively, prediction sheets can be prepared which have pictures of the tools in a row at the top of the sheet. Children can then stick small samples of each material under the tool they predict will make a hole. This format can also be used to make a class record. Using the data from all the groups, the chart is completed by writing, drawing or sticking tested pieces of materials beneath each tool:

 drill	 pencil	 hole punch	 hammer and nail	 scissors
plastic lid	card	plastic lid	plastic lid	plastic lid
wood	sand	card	wood	card
card		lino	lino	sand
			card	
sand			sand	

DISCUSSION

Focus the discussion with the following questions:

- Which tool could make holes in the most materials?
- Why do you think it was this tool?
- Which tool could make the least holes? Why?
- Which tools were made from hard materials? Did this make a difference to what they could make holes in?
- Which tools were made from soft materials? Did this make a difference to what they could make holes in?
- What do you think you would need to make holes in bricks or rocks?

Discuss other factors which affect the ability of each tool to make holes in the materials. Particular reference should be made to tools made from hard materials which may be limited by their design, such as the hole punch and scissors. Suitable questions to ask are:

- Could you make a hole in the wood with the hole punch? How?
- Do the scissors make any marks in the wood? Why?
- What are the scissors, hole punch and drill bit made from? Why?
- Why are they shaped differently?

Show children a drill and drill bits for making holes in masonry, and possibly for metal and wood too. Discuss the hardness and shape of these drill bits and the appropriateness for the job.

> "They related the use of the drill to the drill used for oil, but how much bigger it would be."

Using Activity sheets 9 - 11 as the stimulus, tell the children that underneath the soft sand of the sea bed there is hard rock. This hard rock must be drilled through in order to reach the oil.

Activity sheet 9 shows a 'derrick man' handling the upper end of a series of connected pipes as it is hoisted out or lowered into the hole. Activity sheet 10 shows 'rotary helpers' (also known as floor men, roughnecks or roustabouts) working on the drill floor. It is their job to add new pipe joints as the well is drilled, and to detach joints as the pipes are pulled out to change the bit. Activity sheet 11 shows both the drill bit and sections of pipe which, when connected, form the 'drill string'. The drill bit is made from toughened steel (like the masonry drill) and are about 35 cm wide (diameter) and 35 cm long. The drill head is then attached to the string which drills down to depths up to 6000 metres! This distance can be exemplified by comparing to a familiar landmark 6 km from the school. For further details on the drilling process, see the Background Information page.

Background Information

Note: *This information is provided as a reference for the teacher. Most of the information is too difficult for 5-7 year olds to understand. Some aspects can be discussed, though these must be carefully selected to provide simple and appropriate discussion points with the children.*

THE FORMATION OF OIL

Oil is formed from the remains of small sea animals and plants from 50 million years ago. Immense pressure and heat over time changes these tissues physically and chemically into crude oil and natural gas.

SEARCHING AND DRILLING FOR OIL

Nobody knows precisely where oil can be found.

Geologists gather information about rock formations to make intelligent deductions about possible locations, often under the sea. Exploratory drilling then takes place, using a drilling rig. This is a tall structure with suspended steel pipes and a strong steel drill bit. Once oil is reached (sometimes as deep as 6000 metres below the sea bed) the drilling rig is replaced with a production platform - a more permanent structure in which the crew will live and work.

The platform must be strong enough to support its community and buildings, and withstand the severest storm conditions at sea. The platform is therefore made from a combination of steel and cement.

The North Sea has many oil rigs and platforms which have been built on the North East coast of Britain, and then towed out to the place where oil production will begin.

Rigs used for exploration are quite different from those erected for long term oil extraction. There are also a variety of platform designs for extracting the oil, which depend on the sea and weather conditions. For example, floating platforms are anchored in very deep seas. Others can sit on the sea bed with the legs of the structure deeply embedded. 'Feet' for a platform can be used on dry land, but the force of the sea water would still move the platform about in the water. For the children's activities, distinctions between different types of platforms are not made.

The rate of drilling depends largely on the hardness of the rock. In ideal conditions up to 60 metres an hour can be achieved; whereas extremely hard rock can reduce this rate to 60 metres in 24 hours. A typical drill bit varies in diameter from 30 to 60 cm, depending on the drill hole and depth. In very deep holes, the diameter of the drill bit can be as small as 12.5 cm. The bit has many individual teeth which are made from steel that has been toughened by adding chips of tungsten carbide. For exceptionally hard rock, the teeth are toughened using diamond.

To weigh down the drill bit, 'collars' are used. These are each 9 metres long and weigh 1.5 tonnes. Up to 20 in a 'string' can be added. Replacement of a worn drill bit can take 24 hours - 12 hours to bring it up, and 12 to take it down again.

WORKING ON A PLATFORM

100-200 people can work on one platform, though small or 'satellite' platforms have less. Due to the difficult travelling to and from work, most staff work 1-2 weeks on the platform, followed by 1-2 weeks on shore. People usually travel by helicopter, whilst supplies can travel by boat or helicopter. One helicopter typically transports 20 people.

The platform functions as a small community, so jobs vary widely, as in a village or town. As well as the production, maintenance and drilling team, there are cooking staff (head chef, baker, cooks, and stewards), cleaning staff, medical staff, radio operators, etc.

A typical weekly 'shopping list' for the platform crew includes:

100 kg butter	500 kg vegetables
350 kg flour	1,000 kg meat
500 kg fruit	2,000 litres milk

In addition to this food, a fresh supply of water must always be available. For this reason, a platform has its own desalination plant which converts sea water into fresh water. A typical demand for fresh water can be 30,000 litres per day!

TRANSPORTING THE OIL

Tankers are used to transport oil around the world. They are categorised according to the quantity of crude oil they carry. Very large crude oil carriers (VLCCs) can carry 300,000 tonnes, whilst the cargo of ultra large crude oil carriers (ULCCs) can be 500,000 tonnes. The largest tankers are 400 metres long - approximately 5 football pitches placed end-to-end. Often the crew use bicycles to travel around the ship.

These ships are too large to travel through the Suez Canal, and so their route from the Middle East to Europe takes them around the Cape of Good Hope. This journey takes 60 days, rather than the 40 days needed to travel through the Suez.

The oil is carried in several compartments in the ship. As a cargo is unloaded (in order to maintain the ship's stability) the compartments are filled with water for the return journey.

Smaller coastal tankers sail between refineries, and usually carry loads of 20,000 tonnes or less.

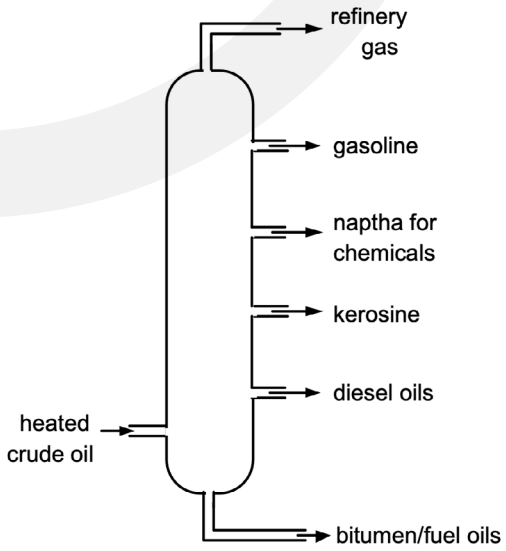
In addition to tankers, pipelines are used to carry crude oil from platforms in the North Sea to shore. Oil can be transported from several platforms to the shore by one pipeline. Pipelines are also used within the UK to transport oil products, such as petrol, to large consumers and distribution centres. For example, nearly 90% of Esso oil and gas products are transported by pipeline. A network of 1100 km of pipelines runs from the Esso refinery near Southampton to centres such as Manchester, London, Birmingham and Gatwick Airport. It is the safest means of transportation, as spillages are rare. It is also environmentally friendly, as pressures on road transport are reduced, and the only visible signs of the pipeline are small markers along its length - similar to those seen on street corners for gas pipelines.

The pipeline consists of sections of steel pipe welded together. When being laid, the newly-welded joints are cleaned, X-rayed, wrapped and waterproofed before the pipeline is covered over. To ensure no leakage occurs, the entire pipeline is regularly tested by running high pressure water through its length.

Road tank vehicles are used to carry oil products to smaller distribution centres, such as petrol stations, and to some customers. These tankers can weigh 38 tonnes and carry 35,000 litres of petrol, though smaller vehicles are used for less accessible places.

SEPARATING CRUDE OIL

Crude oil is a mixture of components which can be separated by heating. This process is called 'distillation'. The process relies on the fact that each component in the mixture changes from a liquid to a gas at a different temperature. The crude oil mixture is heated up to 400°C before being passed into a tall tower (about 80m high). Some of this mixture is now a liquid, but most of it has turned into gases. As the mixture enters the tower, the liquid falls to the bottom, and the gases rise up the tower. As the gases rise they cool down, and one by one they become liquids. As each gas becomes a liquid, it is drawn away from the tower by pipeline. The diagram overleaf shows the main components of the mixture. These components are often further distilled, or refined, to provide a wider range of products.



USES OF OIL

In the 1860s the main use of oil was as a fuel for domestic lighting (paraffin lamps). However, the demands for lubrication grew as industry developed, for lubricating wheels, pulleys and engines. In the 1960s the main use was for producing heat. Today, the main demands on oil are fuels for transportation, a wide range of lubricants, and for the production of chemicals.

A variety of oil products provide fuels, such as aviation fuels, diesel oil and petrol. Each product is tailor-made for its use, be it a heavy grade of fuel oil for use in ships, or kerosene used to heat large buildings such as hospitals, or liquefied petroleum gas (LPG) for camping gas stoves. In many countries these fuels are also used for cooking.

Similarly, products for lubrication vary - from a fine clear liquid to thick grease for the rollers in a steel mill. Paraffin wax is extracted from oil during lubricant manufacture. It is used to make candles and waxed containers for packaging.

Fine oils and greases are used in cosmetics and medicines.

Bitumen is used for road surfacing and for waterproofing roofs, dams and tunnels. This list is not exhaustive, and oil products are found in many applications - such as plastics, ointments, polishes and a wide range of chemicals. In the children's activities the distinction between crude oil and its many products is not made. It is sufficient to say that crude oil is changed in 'factories' (oil refineries) to make many types of oil and products.