Appropriate Pumps

Contents: Information, questions and discussion on appropriate technology as applied to water pumps for developing countries.

Time: 2 periods.

Intended use: GCSE Physics and Integrated Science. Links with work on pressure and pumps.

Aims:

- To complement work on pressure and pumps
- To develop awareness of the need for clean water supplies, and the problems involved in securing them in developing countries
- To introduce the concept of appropriate technology and to show its importance
- To provide opportunities to practise communication skills and problem-solving skills.

Requirements: Students' worksheets No. 708

The main task in this unit involves students attempting to deduce how the three pumps work. This task, and indeed all the questions, are best tackled by students working in groups of two or three. This will encourage students to discuss the workings of the pumps, and some of the wider issues, with one another. Explanations of the workings of the pumps are available (pages 6—7 of the students' sheets), but it is for the teacher to decide whether to duplicate and issue these, or whether to bring out the explanations through class discussion. In any case, students should be given ample opportunity to tackle the explanations before they are given the 'answers'.

Notes on some of the questions

Q.1 The translation of the poster is:

The fine well is being wrongly used:
(a) The surroundings of the well are dirty
(b) Cattle can come and drink at the well
(c) The women wash clothes near the well
(d) Nothing is done to keep out the cattle.

Avoid giving the impression that this is the condition of *all* wells: the poster is of course highlighting the common causes of contamination by reference to a single well.

Q.2 Serious water-borne diseases include typhoid, cholera, dysentry and diarrhoea. It has been estimated that in developing countries some seven million children under the age of 5 die each year from diarrhoea resulting from drinking polluted water.

Q.4 The rope pump can in principle raise water from any depth. In practice there is always some leakage between the knots and the tube. The greater the depth from which the water is raised, the higher the pressure on the lowest knots, and the faster the leakage.

Q.5 An important feature of the hose and bucket pump is the width of the hose relative to the capacity of the bucket. The hose needs to be fairly narrow so that the volume of water needed to fill the hose itself is small compared to the capacity of the bucket.

Q.6 The displacement pump can in principle raise water to any height. In practice, the height to which it can be raised is limited by the leakiness of the valves: the higher the column of water in the rising main, the greater the pressure on the valves, and the more they leak.

Q.8 (c) The machine would use expensive electricity, would require imported plastic (or home-produced plastic made from imported oil) and would create unemployment. Hand-made leather sandals might be more appropriate.

However, students might like to discuss the broader aspects of development. For example, it is often argued that without advanced technology, developing countries will stay underdeveloped and never break out of the cycle of poverty.

Q.9 Examples that could be discussed might include cars versus bicycles and public transport, garden machinery (for example, lawnmowers) microwave cookers and dishwashers.

Further resource material

The PLON physics project from The Netherlands includes a unit, *Water for Tanzania,* on which much of this unit is based. *Water for Tanzania* includes full background information on the pumps, practical work and geographical details on Tanzania and the water problem. It is available from: PLON, Physics Education Department, State University of Utrecht, PO Box 80-008, 3508 TA Utrecht, The Netherlands.

Earthscan publish a number of books relating to water supply in developing countries. Details from: Earthscan, 3 Endsleigh Street, London WC1H ODD.

Acknowledgements Figures 1 and 4 supplied by UNICEF; Figure 9 supplied by World Health Organisation; Figures 2, 5, 6, 7, 8, 10, 11 and 12 reproduced by permission from *Water for Tanzania,* PLON, The Netherlands.

APPROPRIATE PUMPS

When you turn on the tap, you assume the water that comes out will be clean and safe to drink. But hundreds of millions of people in developing countries have no taps — let alone clean water to come out. In many parts of Africa, Asia and South America, people have to walk miles to get water, and even then it may be dirty and carry disease. In developing countries, 30 000 people die *every day* because of contaminated water supplies.

The United Nations has declared 1981-1990 to be International Drinking Water and Sanitation Decade. The aim is to provide safe, clean water supplies and sanitation for everyone by the year 1990. It is estimated the programme will cost £44 million for *every day* of the decade.

Figure 1 The symbol of the International Drinking Water and Sanitation Decade

Many developing countries have hot climates. This often makes water difficult to find. In many places, the only source of drinking water is a pool. Often the pool is used for washing as well as drawing water. The water can easily get infected and can be a major source of disease.

One way round the problem is to draw water from below the ground. This **groundwater** is usually clean and uncontaminated. But to draw groundwater needs a pump. In this unit we will be trying to decide the most suitable pumps for the job.

Figure 2

Questions

1 *The poster in Figure 2 comes from Tanzania. It warns people about the danger of polluting drinking water. What do you think the words might say?*

2 *Name two or more diseases that are spread through drinking water.*

3 *Water-carried diseases were common in Britain as little as fifty years ago. Why are they very rare today?*

What makes an appropriate water pump?

Pumps are used everywhere. They are used for pumping water supplies, pumping sewage, pumping oil and pumping air. Your house may have a pump like the one in Figure 3 to send water round the central heating. If you have a car it will have a pump to send petrol from the tank to the engine.

We do not often notice pumps in Britain, because they are usually driven by electricity and quietly switch themselves on and off. They are usually made from high quality materials and rarely break down.

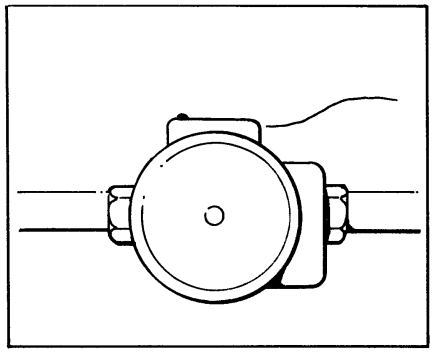

Figure 3 A central heating pump

A water pump for a developing country needs to be rather different. Electricity is often not available. Petrol and diesel fuel are expensive, so the pump must usually be operated by hand. The pump must be cheap. It needs to be easy to maintain and repair by local people. This means it must be simple, and made from local materials. It is no use having to send for parts from abroad when the pump breaks down.

This 'checklist' gives the main features needed in a water pump for a typical African village:

- Does not need electricity or fuel
- Needs little maintenance
- Cheap
- Made from local materials
- Must raise water from a well at least 5m deep
- Must be able to pump enough water for all the members of the village
- Must be built so the well water cannot become contaminated.

Figure 4 A village handpump in Nigeria

Three pumps

We will now look at three different kinds of pumps that could be appropriate for a developing country. In each case you will be asked to try to explain how the pump works. You will find it helpful to work with another student or students to discuss how the pumps work.

1 The rope pump

Look at Figures 5 and 6, then answer question 4.

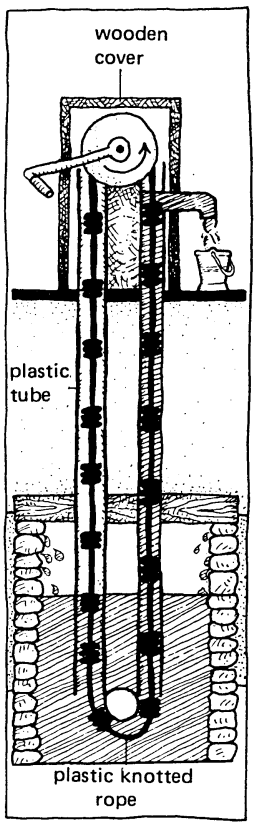

Figure 5 The rope pump

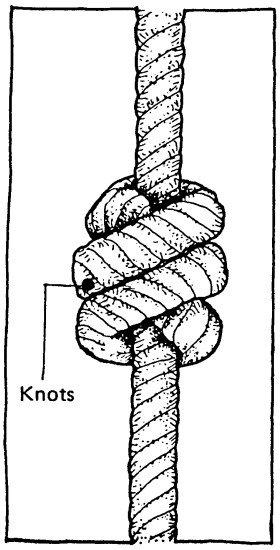

Figure 6 The special knot for the rope pump

Question

4 Write a few words beginning 'When the handle is turned . . .', to describe how you think the pump lifts water.

2 The hose and bucket pump

Look at Figures 7a and 7b, then answer question 5.

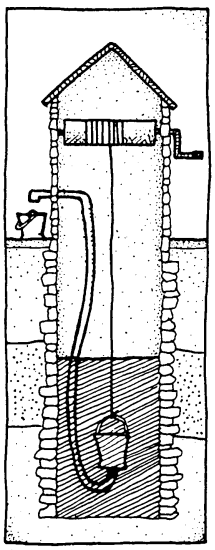

Figure 7a

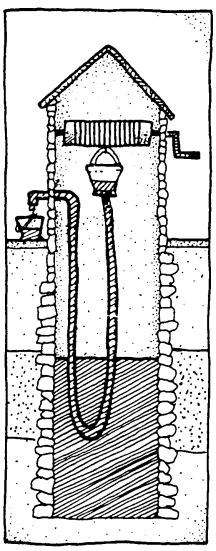

Figure 7b

Question

5 Write a few words, beginning 'When the handle is turned to raise the bucket . . .', to describe how you think the pump lifts water.

3 The displacement pump

Look at Figure 8, then answer question 6.

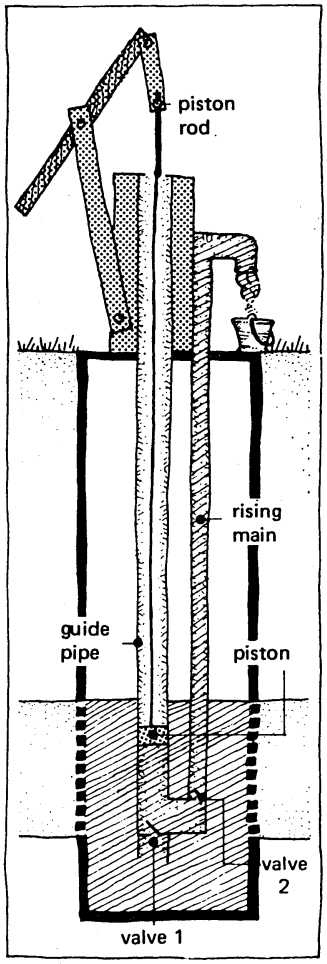

Figure 8

Question

6 *Write a few words, beginning 'When the handle is pushed down . . .', to explain how you think the pump works.*

Appropriate technology

The pumps we have been looking at are examples of **appropriate technology**. In a village in a developing country, there is often no mains electricity. So electric pumps would not be appropriate technology in this case. A much simpler technology would be for each person to lower their own bucket into the well on the end of a rope. But this would not be appropriate technology either. It would be slow, and it might help spread disease from one family to another. Appropriate technology fits people's needs *and* what they have available to make the technology work.

Advanced technology like computers and tractors is often not appropriate for developing countries. Some of the difficulties with advanced technology machines are:

- They are often expensive, and have to be imported from developed countries like Britain, USA and Japan.
- They usually require energy in the form of electricity or oil. Energy is often expensive or difficult to obtain in developing countries.

- They need skilled technicians to maintain and repair them. A supply of spare parts is also needed, and these usually have to be imported.
- They replace human workers and create unemployment, which is often already very high.

Appropriate technology uses *local* materials, *local* energy sources and *local* workers to meet the needs of the *local* people.

More questions for discussion

7 *Choose* one *of the three pumps which you think would be particularly appropriate for a village in a developing African country. Say* why *you think it would be appropriate. (Look back at the checklist on page 2.)*

8 *For each of the following, explain why the technology given would* not *be appropriate. Suggest a more appropriate technology in each case.*

(a) *A diesel tractor for ploughing fields around a remote African village*

(b) *A microwave cooker for a household in a village in Peru, South America*

(c) *A machine to make plastic-soled sandals for an Indian footwear manufacturer.*

9 *Is all the technology used by you and your family appropriate? Could you manage with less advanced technology in some cases? Give some examples.*

10 *Advanced technology needs energy supplies, spare parts and qualified engineers. Why are these things easier to provide in Britain than in developing countries?*

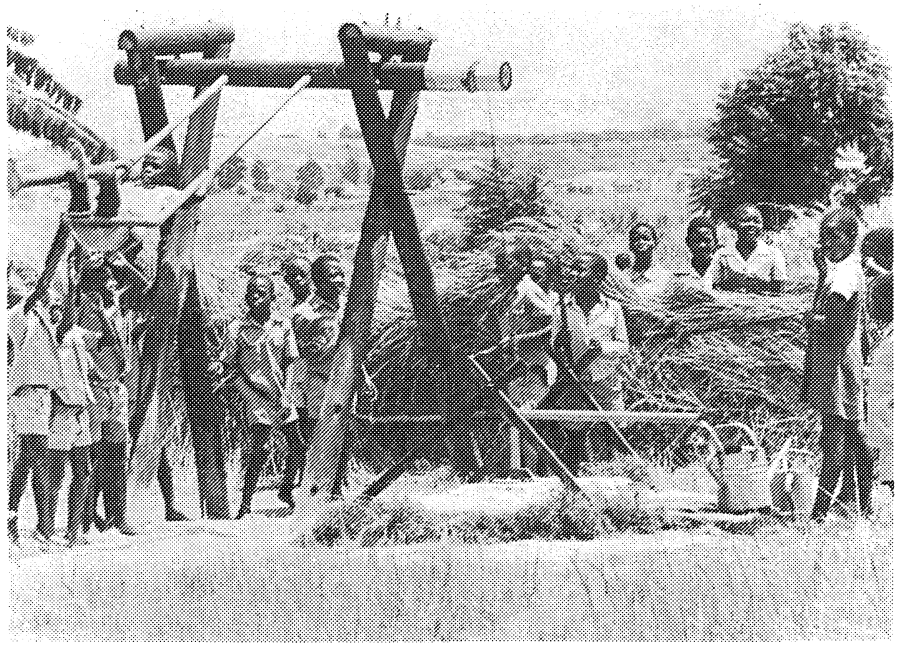

Figure 9 This children's swing in Zimbabwe also operates a water pump.

How the pumps work

1 The rope pump (Figure 10)

When the handle is turned, the knots raise the water in the right-hand tube. When the water reaches the outlet it flows out. Some water flows back because it leaks past the knots. This can be improved by fitting rubber discs (cut from old tyres) as seals in front of the knots.

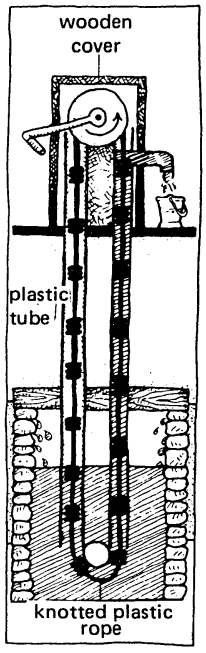

Figure 10

2 The hose and bucket pump (Figure 11)

When the bucket is under the water, it will fill completely with water. When the handle is turned to raise the bucket, some of the water in the bucket flows into the hose. The water level in the left-hand side of the hose is always exactly the same as the water level in the bucket. By the time the bucket has been raised to the outlet level, the hose is full of water up to this level. When the bucket is raised higher, water flows from the outlet. The arrangement acts as a siphon. Water continues to flow until the water level in the bucket has fallen to the same level as the outlet. Then it will stop, and the bucket will have to be lowered again for a refill.

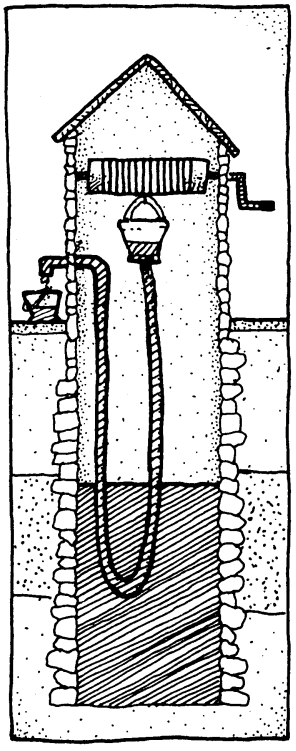

Figure 11

3 The displacement pump (Figure 12)

When the handle is pushed down, the piston rises in the guide pipe. The pressure of the water under the piston drops slightly. This makes valve 1 open, and valve 2 closes. Water flows into the guide pipe.

When the handle is pulled up, the piston is pushed down in the guide pipe. The pressure of the water under the piston rises slightly. This makes valve 1 close, and valve 2 open. Water flows into the rising main, and through the outlet.

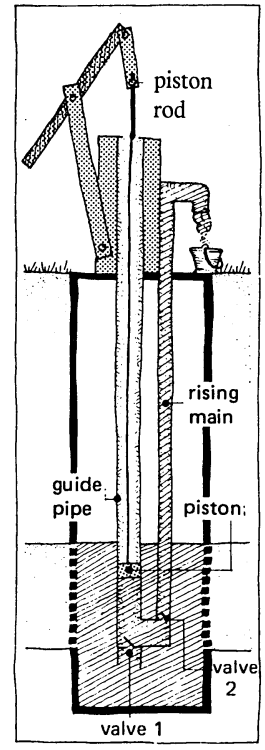

Figure 12