The Technology of Toilets

Contents: Reading, diagrams, pictures and questions about alternative solutions to the design of toilets.

Time: 2 periods, or more, depending on number of parts attempted. Homework time could be used. Part 1 is particularly suitable for homework, so the unit could be started for homework, then completed in class.

Intended use: GCSE Biology, Physics, Technology and Science courses.

Aims:

- To complement work on sanitation, hygiene and the control of disease
- To complement work on control systems, water pressure and domestic water supply
- To develop awareness of the history of the design of a common appliance (the toilet)
- To provide an opportunity to evaluate alternative design solutions to a practical problem
- To provide an opportunity to practise skills in reading and comprehension.

Requirements: Students' worksheets No.803

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This unit is in three parts which can be used independently if required:

Part 1 History
Part 2 Toilet designs
Part 3 The development of the water closet.

Part 3 is more demanding than the first two parts, particularly the questions on page 6 concerning cistern design.

Notes on some of the questions

Q.5 Problems with soiling the pan and the valve due to the lack of a method for flushing and the shape of the pan. Modern pans are shaped to reduce the possibility of soiling. The valves wore out and let in smells from the drains.

Q.6 The flush water is trapped under the rim and runs around the top of the pan to clean all of the surface. The wash-out pan was only cleaned where the jet of water fell at the front.

Q.7 To provide a water seal to prevent smells rising from the drains.

Q.8 Because of the bend in the trap.

Q.9 Adults could adopt a more natural position for evacuation of the bowel. Small children could use the toilet more easily.

Q.10 The floating ball.

Q.11 The valve opens as the float falls.

Q.12 The rising ball moves the slider which presses the washer against the inlet pipe.

Q.13 As more water enters the cistern the rising float makes the water flow less. Positive feedback would create a flood.

Q.14 Cisterns are fitted with an overflow pipe which empties outside the house or into the toilet pan.

Q.15 The rising piston in the wide cylinder pumps water up to fill the flush pipe. The water then siphons out, because the outlet is at a lower level than the inlet.

Q.16 The high level cistern has a more forceful and effective flush because of the increase of water pressure with depth.

Acknowledgements Figures 1 and 6 based on illustrations in the official guide to the Jorvik Viking Centre, York, by permission of York Archaeological Trust; Figures 2, 3, 4 and 12 cartoons by Laurie Fahy; Figures 5 and 7 supplied by the Wellcome Institute Library, London.

THE TECHNOLOGY OF TOILETS

Imagine what life would be like if no one had invented toilets. Good sanitation is essential for our health. In this unit you are asked to think about the ways technology has been used to solve the problem of getting rid of our everyday waste products.

Part 1 History

Wild animals do not use toilets. There are many small animals which carry away and digest other animals' dung. Bacteria also help break down wild animals' excrement.

Disposing of human excrement is not a difficult problem for small rural communities. The filth and stench of decomposing excreta can become a problem when people live in crowded towns and cities.

The toilet was invented to solve the problem. Archaeologists have found remains of ancient toilets in the Middle East. They were high-seat toilets that were flushed by pouring water into them. All of them were in palaces. No evidence has been found that ordinary people had toilets. The oldest known toilet was discovered in India. It dates back to 3000 BC.

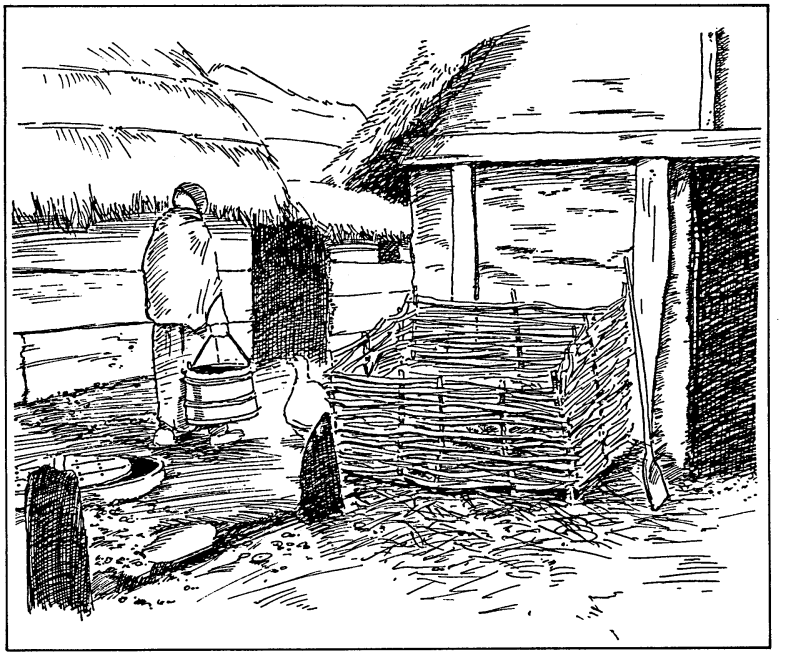

Figure 1 A model of a latrine in Viking times, in the Jorvik museum in York. The latrines were just by the houses. They were holes in the ground near the wells.

The Romans brought toilets and sewers to Britain. Sitting on a toilet could be a sociable activity. A toilet built in Northumberland could seat 20 soldiers together. However, in their private houses the Romans used chamber pots and had slaves to empty them.

Answer questions 1 to 3.

Questions

1 *Use a dictionary to make sure you know the meaning of words used in this unit including: excrete, excrement, cesspit, latrine, closet, cistern, flush.*

2 *Why is it important to keep clean the cages of pets such as hampsters or budgerigars?*

3 *What happens to the excretment of wild animals?*

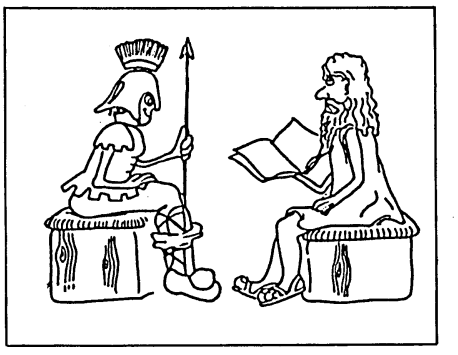

Figure 2

Unfortunately, the technology of toilets vanished along with the Romans. The only sanitary requirement in medieval England was to 'retire a bow's shot away'.

In the Middle Ages, London stank from cesspits and open drains. Rivers were choked with sewage and waste.

Even after the Great Fire of 1666, when London was rebuilt, chamber pots were emptied out of the windows into the streets. Sometimes people gave a warning shout of 'Gardez-loo'. This was meant to be French for 'beware of the water'. That is why the toilet is sometimes called the 'loo'.

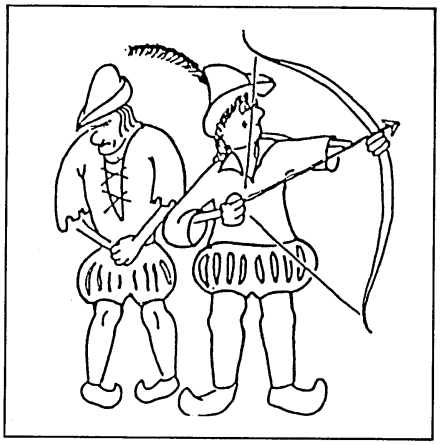

Figure 3

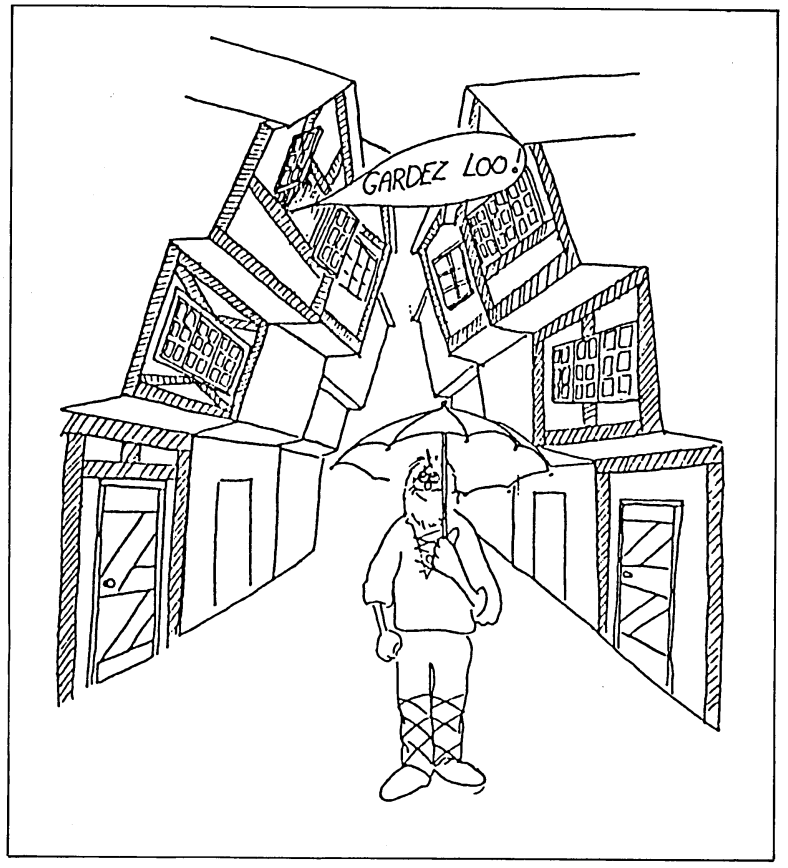

Figure 4

Major outbreaks of diseases such as cholera and typhoid were common in big cities during the nineteenth century. They spread quickly because of poor sanitation. It was a luxury for a family to have a toilet of their own. All the people in a row of houses might have to share one outdoor toilet.

Some landlords provided no sanitation when new houses were built. The families had to use chamber pots. They emptied them on the nearest piece of waste ground, or in the street. Even in homes with their own toilet, it might be in an unventilated cupboard. It would drain into an outdoor cesspit likely to overflow.

Water closets were introduced towards the end of the nineteenth century. But there was still the problem of where the waste would go.

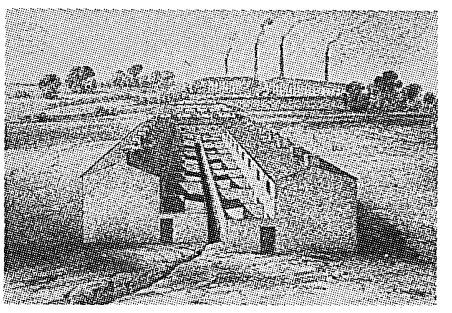

Figure 5 Terrace houses in Preston in 1844. The toilets at the end of the yards emptied into a trench running down the gap between the yards. The waste in the trench was cleaned out once a year and piled nearby.

Part 2 Toilet Designs

What makes a good toilet? A satisfactory toilet should:

- Collect excrement
- Dispose of excrement, to prevent the spread of infectious diseases
- Be comfortable and pleasant to use
- Prevent smells from spreading
- Be easy to clean
- Not become infested with flies and maggots

There is often more than one way of solving a practical problem. On this page and page 4 you can see some designs which have been tried. Look at the pictures and then answer question 4 on page 4.

Figure 6 A pit latrine in Jorvik. (See also Figure1.)

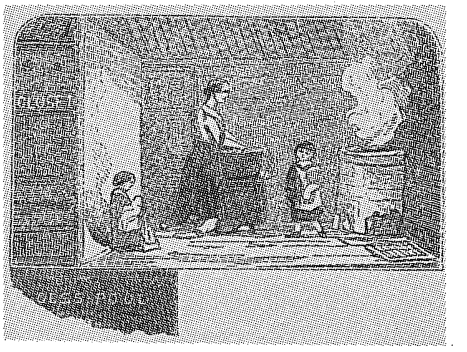

Figure 7 This drawing shows a closet in the washroom of a London house in the nineteenth century. There is a cesspit directly below the closet.

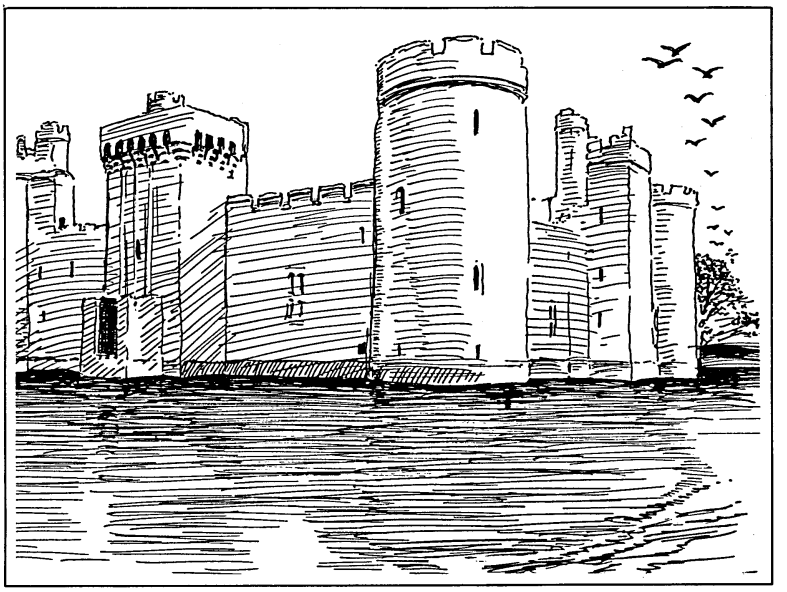

Figure 8 In castles they built small latrines (called garderobes) into the thick outer walls. In some cases the open shafts emptied into the castle moat. Inside the castle they emptied into pits which could be dug out from time to time.

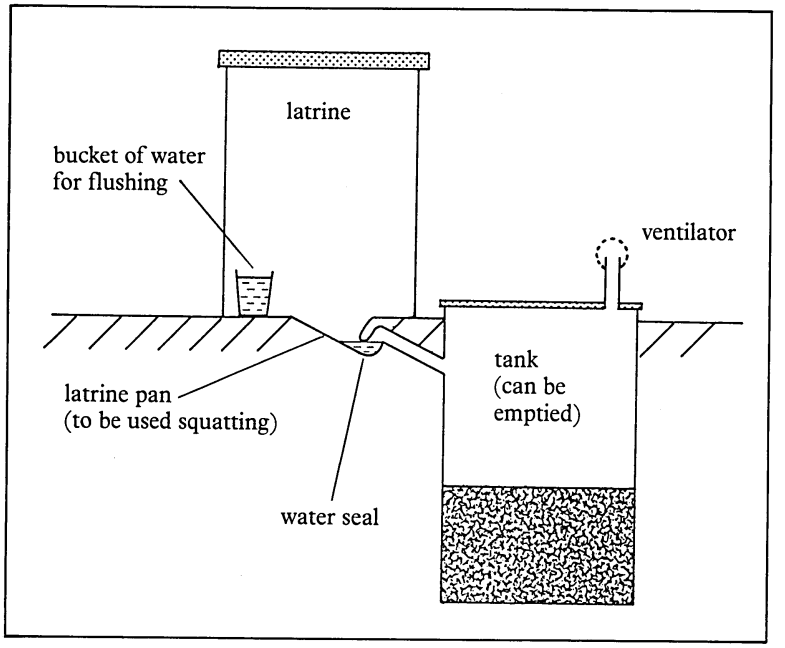

Figure 9 This improved pit latrine is designed for use in parts of the world where rainfall is low and water purification is expensive.

Question

4 Think about the types of toilet described in words and pictures on this page and on page 3. You can also include Figure 5 on page 2. Make a copy of the chart below. For each design, put ticks or crosses in the chart.

	Figure						
	5	6	7	8	9	10	11
• Collects excrement							
• Disposes of excrement to prevent disease							
• Comfortable and pleasant to use							
• Prevents smells							
• Easy to clean							
• Will not become infested with flies and maggots							

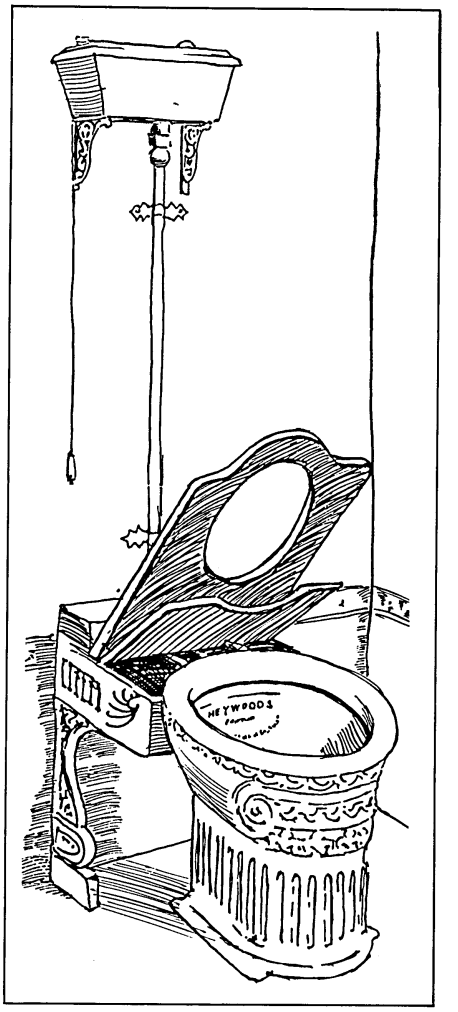

Figure 10 This type of water closet was on sale in 1889. There was still the problem of where to pipe the waste when the toilet was flushed.

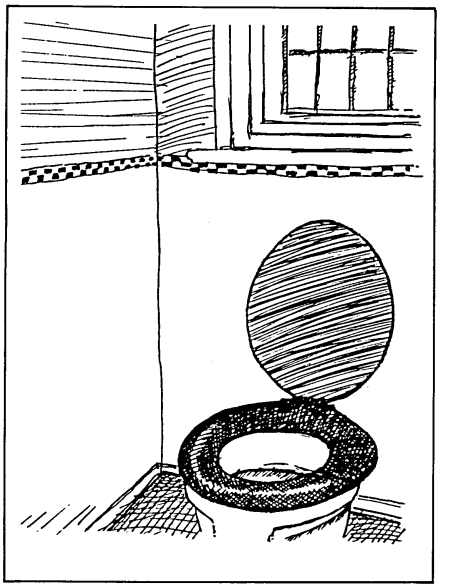

Figure 11 This toilet has a high flush cistern which is not shown. The toilet is in a small room built for the purpose.

Part 3 The development of the water closet

The design of the water closet (WC) has been changed and improved many times. The first Englishman to build a flushing water closet in his home was Sir John Harrington in 1596. His solution to the problem of smells was to use a leather covered valve. The valve had to be opened to empty the contents of the toilet into the sewer. The toilet was cleaned by turning on a tap which flushed water from his fish tank!

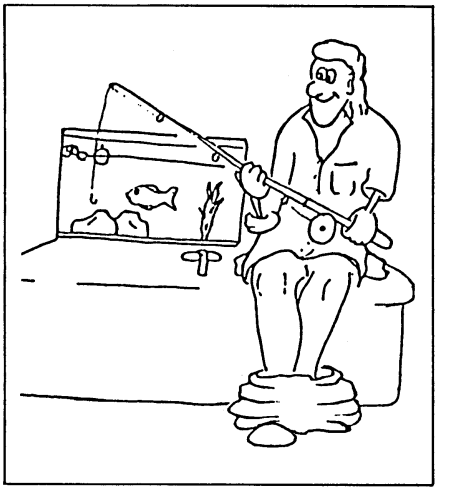

Figure 12

Sir John Harrington's invention did not catch on. Interest in designing water closets did not reappear until the eighteenth and nineteenth centuries. Again, designers used a valve to cut off the toilet from the drains. But there was no satisfactory method of flushing them. This made it difficult to keep the toilets clean. As the valves became worn, water ran away form the pan and smells leaked back from the sewers.

Eventually a Victorian plumber called P.J. Davies designed a water closet without a valve at the bottom. Instead a water seal was left after each flush to stop smells from the drains. This was the forerunner of the modern wash-down water closet.

Answer questions 5 to 9.

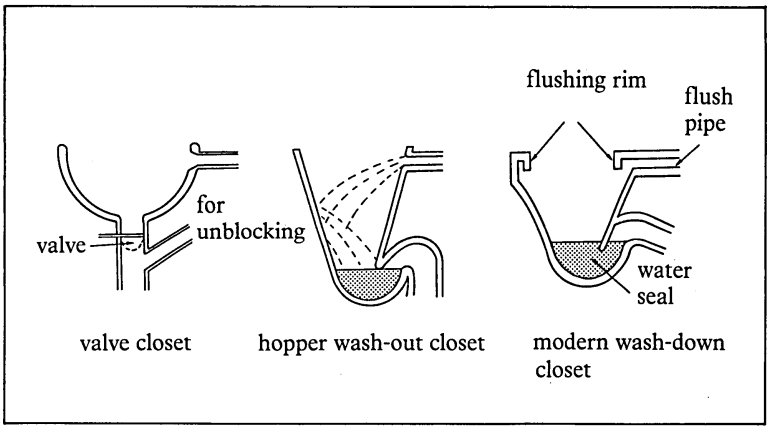

Figure 13 Types of toilet pan

Questions

5 *What were the main problems with valve closets ? Do you think a satisfactory valve closet could be designed today using new materials?*

6 *How is the rim on a modern pan an improvement on the older wash-out design (see Figure 13)?*

7 *What is the purpose of the water seal?*

8 *Why does water remain in the trap after flushing?*

9 *Some doctors suggest that toilets should be made with lower seats. Why do you think that doctors give this advice?*

The water closet could not come into common use until a public water supply was available to flush it. Early designs of flushing cisterns were unreliable and many Victorians still preferred the earth closet.

How does the toilet cistern work?

A cistern has to release its water into the toilet, and refill itself automatically.

Automatic refilling is usually controlled by a ball-valve. This valve is a kind of tap. It is turned on and off by a floating ball on a lever. (See Figures 14 and 15). Flushing is started by a piston which forces water up over the top of a flush pipe. The water then siphons out (see Figure 16).

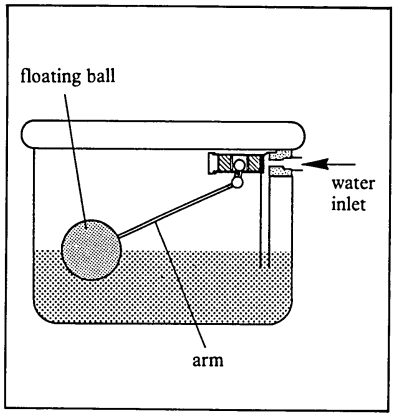

Figure 14 Simplified diagram of a toilet cistern showing just the ball-valve

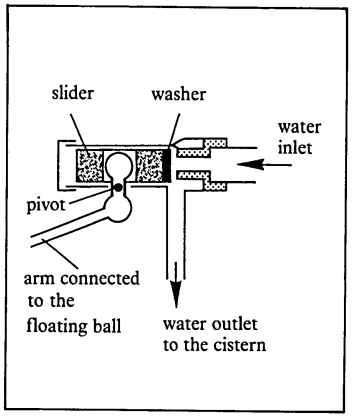

Figure 15 Detail to show how the ball-valve works

The cistern is kept full of water by a system of control which uses *feedback* of information about the water level. Look at figures 14 to 16. Try to work out what happens as the cistern is flushed and then refills. If possible look inside your toilet cistern at home.

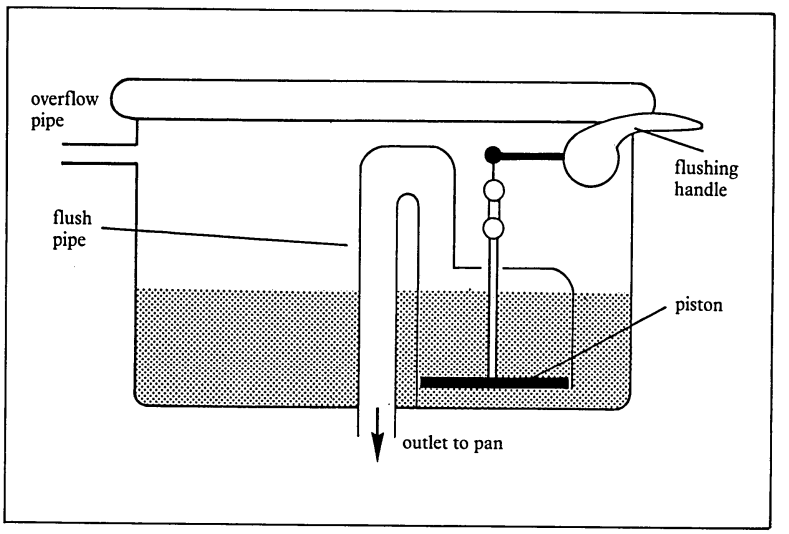

Figure 16 Toilet cistern showing the flushing mechanism

The modern designs of water closet and cistern had been developed by the beginning of this century. The names of the early pioneers are still well known today. They include Twyfords, Doultons and Shanks.

Now answer questions 10 to 16.

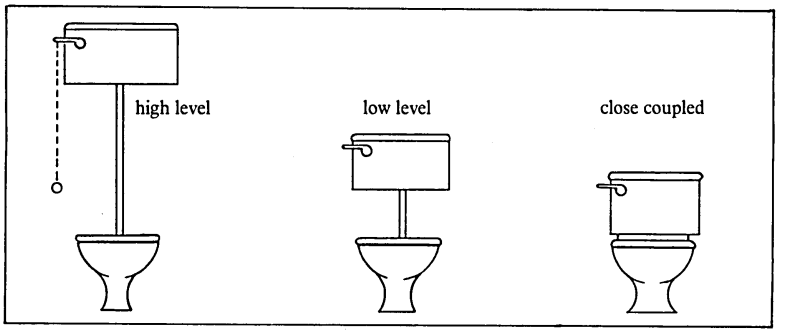

Figure 17 Types of toilet suite

Questions

10 When the toilet is flushed, what acts as the sensor *in the cistern to detect that the water level has dropped?*

11 What happens to put the water back to its original level?

12 How does the sensor detect when to shut off the water supply?

13 The flow of water into the system is controlled by feedback. Information is fed back from the sensor to the valve. This is an example of **negative** *feedback. Why negative? What would be the result of* **positive** *feedback in a toilet cistern?*

14 What happens if the ball-valve goes wrong and does not shut off the water flow? How is the cistern designed to cope with this failure?

15 Explain how water is made to siphon out of a toilet cistern.

16 Public toilets and school toilets usually have high level cisterns. Many modern homes have more expensive low level, or close coupled cisterns. Which type washes out the pan with greater force? Are the more expensive cisterns more effective?