Telling the time: the story of clocks

Approach: Station *Level:* Year 4 and year 8

Resources: A story in four parts presented on 2 laminated sheets. Four sets of questions, one for each part of the story.

Instructions

After reading each part, do the questions for that part on the answer sheet

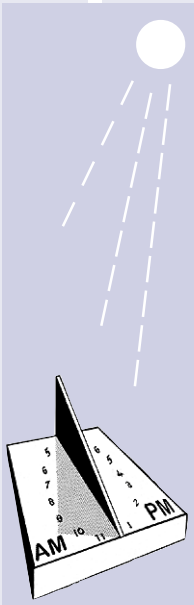
PART 1

How do you tell the time? You need to have a good clock or a watch. What would it be like if we did not have clocks and watches? How would we know when to get up in the morning, or when to go to school, or when to meet our friends?

Many workers on the job have to tell the time. They may need to know how long it took them to do a job. Then they will know how much people have to pay them. Train drivers and bus drivers and airline pilots need to know what time to begin their journey. And we need to know what time it is if we are to catch them before they start the journey. Also, referees need a good watch, so that they know when to start and stop a sports match. So clocks and watches are very important for all of us. We all need to tell the time.

Many years ago, there were no clocks. People had to guess at the time by looking up to see where the sun was. If the sun was in the east, they knew it was still morning. If it was high up in the sky, it must be near midday. If the sun was in the west, it must be in the afternoon. This was a very rough and ready way to tell the time. It would not be accurate enough for us today.

Do questions 1 to 5 on your answer sheet now.



PART 2

Many people in the olden days noticed that the sun made shadows. Tall trees and towers made long shadows, while people and animals made short shadows. But as the sun moved across the sky, the shadows changed. In the early morning, a tall tree had a long shadow, which pointed towards the west, away from the sun. As the sun rose higher in the sky, people noticed that the shadow became shorter. Then, in the afternoon, the shadow moved around to the other side of the tree, and pointed east. Gradually it became longer, as the sun set in the west.

Over 4000 years ago, the people of Babylon worked out a clever way to use these changes in shadows to help them tell the time. They made a sundial. This was a kind of chart or dial for helping them work out exactly where the sun

Circle the letter alongside the best answer.		% responses y4	% responses y8
1. The passage said that telling the time is important for school pupils because they need			
a to learn how clocks work			
b to learn how to make clocks			
c to know when to start school	c	71	90
2. Telling the time is important for airline pilots because they need to know			
a when to begin their journey	a	76	95
b when to land			
c how to read dials properly			
3. Where is the sun at midday?			
a In the east			
b In the west			
c Overhead	c	64	92
4. What do you think the writer will tell us next?			
a How to read clocks			
b How to make clocks			
c What the first clocks were like	c	49	67
5. What was wrong with telling the time by looking to see where the sun was? (Write an answer in your own words.)			
2 or more valid responses		1	3
1 valid response		23	72

Now read Part 2 of the story.

was. Once they knew that, they could tell the time.

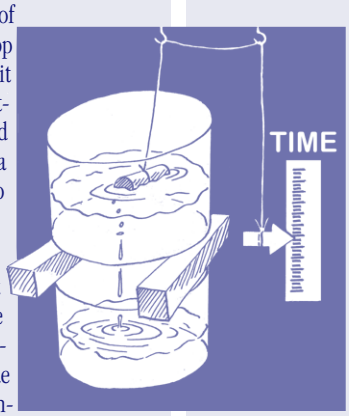
What does a sundial look like? Most of them had a stick or pointer that made a shadow. They also had a dial, or set of numbers which were used to tell the time. They started at 5 a.m., and then 6 a.m., 7 a.m. ... and up to 12, then 1 p.m., 2 p.m., 3 p.m. up to 7 p.m. The picture shows one example of a sundial. You can see that when the sun is shining on the pointer, it casts a shadow on the dial of numbers. In the early morning, the shadow points to 5 or 6 a.m. At sunset it would point to 6 or 7 p.m. When the sun shone overhead, the shadow pointed to 12. This way, the people of Babylon were able to tell the time much better than before. It was a very clever invention.

However, it was not perfect. There were many times when it was not very helpful. How could they tell the time when the sun did not shine - on wet days, or at night? Also, the sun changes its position in the sky according to the seasons. In summer, it rises earlier in the morning, and sets later in the evening. This was another problem.

Do questions 6 to 11 on your answer sheet now.

PART 3

Several other methods of telling the time were in common use before the modern clock was invented. The ancient Egyptians, for instance, developed a water clock. This was a neat device which consisted of two cans, placed one on top of the other. At first, the top can was full of water, and it had a tiny hole in the bottom. The water leaked through this hole at a steady rate, and fell into the empty can below.



The Egyptians were able to estimate how long it took for the water in the top can to run into the bottom one. Then they made a dial, with a series of numbers on it, and attached it to a block of wood which floated on the surface of the water in the top can. As the water level went down, the pointer moved down the dial, and showed the people how far the water had dropped. So, let us say that it took 6 hours for the water to leak out of the top can, and there were 6 numbers on the dial - from 1 to 6. Then it would take exactly one hour for the pointer to drop from one number to the next. The diagram shows how this would work.

The water clock was a great improvement on the sundial, and the principle of it has been copied in the sand glass. Instead of water, people put sand in a container. This container had two parts with a narrow neck between them, through which the sand could pass, very slowly. Such a device is still often used as an egg timer, to tell when an egg has been boiling for 3 minutes.

A burning candle can be used in the same way. It is possible to put notches in the side of the candle, at regular intervals, and to number them. Those notches will indicate how much time has elapsed since the candle was first lit, and the wax started to melt.

None of these systems was perfect. Most were not precise enough for scientists and technicians to use; others were clumsy to operate, and not easily moved about. So the search for an efficient, accurate, mobile clock went on.

Do questions 12 to 16 on your answer sheet now.

		% responses y4	% responses y8
6. At 7 o'clock in the morning, the shadow of a tree points towards a the east b the west c the north	b	51	72
7. What are the two main parts of the sundial? a The base and the pointer b The dial and the base c The dial and the pointer	c	52	67
8. At what time would the shadow on the sundial point to the middle of the dial? a At midday b At 6 a.m. c In the middle of the afternoon	a	44	78
9. Why is there no place on the dial for midnight? a It would not fit on the dial b Most people are asleep then c The sun does not shine then	c	66	92
10. How useful would a sundial be for timing a 400 metre running race? a Almost as good as a watch with a second hand b Would be good if the sun was shining c Would not be accurate enough	c	38	81
11. What was a big problem with sundials? (Write an answer in your own words)			
2 or more valid responses		1	14
1 valid response		64	72

Now read Part 3 of the story.

		% responses y4	% responses y8
12. Who invented the water clock? a Modern scientists b The people of ancient Egypt c The people of Babylon d The story does not say	b	48	88
13. How did the water escape from the top can? a It leaked through a tiny hole b It flowed down the dial c It was pushed out by pressure from the block d It leaked through a pipe once it warmed up	a	54	90
14. Why was the water clock better than the sundial? a It was more modern b It did not need sunshine c It could work over several days d It would last longer	b	41	79
15. What do you think the next part of the story will tell us? a How to tell the time b The splitting of the atom c Improvements made in the sand glass d The invention of the first mechanical clock.	d	36	72
16. Why are the notches placed on the candle?			
Clear comprehensive response		5	15
Fuzzy or partial response		15	49

Now read Part 4 of the story.

PART 4

Better progress was made in the development of a modern clock with the invention of the coiled spring in the 15th Century A.D. This was a spring that unwound very very slowly, at a constant rate. It was linked up to a small drive wheel which was able to turn the hands of the clock face, as we know it.

If you look inside a modern watch you can see a complex array of cogwheels and springs. However, such a watch really has only two main parts - a drive wheel which causes the hands to turn, and an escapement, which ensures that the mechanisms move at exactly the right speed.

In large timepieces, such as a grandfather clock, the escapement role is played by a pendulum, or long rod with a weight on the end. The pendulum swings back and forth at a regular rate, thus ensuring a regular beat and accurate time keeping. In a small watch with hands, there is insufficient space for a pendulum, so this role is served by a tiny balance wheel.

Today, many people prefer to wear small digital watches, which do not have the traditional hands on the face of the watch, but reveal the time in actual numbers. Like some other watches, these digital watches have an integrated circuit on a tiny silicon chip. This chip regulates the vibrations that occur in a small crystal of quartz, located inside. These vibrations are extremely consistent, enabling the digital watch to keep very accurate time.

How do watches keep going? Some require regular winding by hand to keep their mainspring operating. By contrast, self-winding watches depend on a little rotor that swings as the wearer's wrist moves. This ensures that the mainspring is constantly wound up. Another type, an electric watch, contains a tiny battery, which provides power to drive the watch, making a mainspring unnecessary. Some electronic watches also contain a battery which activates a tuning fork that

vibrates at a constant rate.

The development of time-telling has come a long way since the early Babylonians experimented with sundials. No doubt there will be further technical developments in the future to ensure that we have no excuse for being late for school.

Do questions 17 to 21 on your answer sheet now.

		% responses y4	% responses y8
17. How was the coiled spring helpful in developing the first clocks?			
a It unwound fast and consistently			
b It unwound at a slow constant rate	b	26	71
c It was easy to construct and check			
d It was useful for making electronic clocks			
18. What is the pendulum for?			
a It provides a steady beat	a	25	67
b It links directly to the clock hand			
c It supports the mainspring			
d It supports the clocks escapement			
19. What are the two main parts of a watch's mechanism?			
a Watch face and drive wheel			
b Battery and cogwheels			
c Pendulum and watch face			
d Drive wheel and escapement	d	16	51

		% responses y4	% responses y8
20. What provides the escapement in a digital watch?			
a Regular winding by hand			
b Vibrations in a crystal of quartz	b	18	59
c A tuning fork and coiled spring			
d Numbers on the dial			
21. Where does the self-winding watch get its energy from?			
2 points made		1	15
1 of the 2 points made		9	28

Commentary

The incremental complexity of ideas and vocabulary from the first part to the last part is reflected in the results. The constructed response questions required students to compose a written answer rather than choose from a range of options. Results show that only a small number of students were able to give full answers to the constructed response questions.