

General Certificate of Education
January 2003
Advanced Level Examination



GENERAL STUDIES (SPECIFICATION A)
Unit 5 Science, Mathematics and Technology

GSA5

Friday 24 January 2003 Afternoon Session

In addition to this paper you will require:

- an objective test answer sheet;
- an 8-page answer book;
- a blue or black ball-point pen.

Time allowed: 1 hour 30 minutes

Instructions

- Use a blue or black ball-point pen. Do **not** use pencil.
- Write the information required on the front of your answer book for Question 2. The *Examining Body* for this paper is AQA. The *paper reference* is GSA5.
- Answer **both** Question 1 (1.1 to 1.25) using the answer sheet provided **and one** question from Question 2.1 to 2.6 in a separate answer book.
- For each item in Question 1 there are several alternative responses. When you have selected the response which you think is the best answer to a question, mark this response on your answer sheet.
- Do all rough work in your answer book, **not** on your answer sheet.

Information

- The maximum mark for this paper is 50.
- This paper consists of **two** questions.
Question 1 contains 25 objective test questions based on a variety of exercises in spatial and mechanical relations. Each question carries 1 mark. No deductions will be made for wrong answers.
- **Question 2** consists of six alternative essay questions (2.1 to 2.6).
25 marks are allocated to each of Questions 2.1 to 2.6.

Advice

- Attempt Questions 1.1 to 1.25 before you do **one** from Questions 2.1 to 2.6.
- Spend approximately equal amounts of time on Questions 1 and 2 as a whole.
- Do not spend too long on any item in Question 1. If you have time at the end, go back and answer any question you missed out.
- Make sure that you hand in **both** your answer sheet **and** your essay answer book at the end of the examination.

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QUESTION 1**Answer questions 1.1 to 1.25**

For each of Questions 1.1 to 1.25 choose the answer you consider the best of the alternatives offered in A, B, C and D.

Questions 1.1 to 1.6

An engine converts heat energy into mechanical work. Often a piston moves to and fro (called reciprocating) in a cylinder and this is turned into rotary motion by a crank. The steam engine is called an external combustion engine because the fuel is not burned inside the cylinder. The heat energy reaches the cylinder as pressurised steam applied to both sides of the piston in turn in this double acting engine shown in Figure 1.

The transmission of power from the piston is effected through the cross head which joins the connecting rod to the piston rod. The other end of the connecting rod is fixed to the circumference of a wheel or crank of the crankshaft. Rotary motion is produced. A flywheel at one end of the crankshaft smooths out any jerkiness.

The internal combustion engine burns the fuel inside the cylinder. A common petrol engine is the “four-stroke” as shown in the diagrams of one cylinder in Figure 2. This works in a cycle of four movements of the piston, each of which have a different effect on the gases inside. A typical car engine has 4 cylinders and the power stroke occurs at different times for each. The valves are opened and closed at the right time by cams on a camshaft. This is linked to the piston motion via the crankshaft.

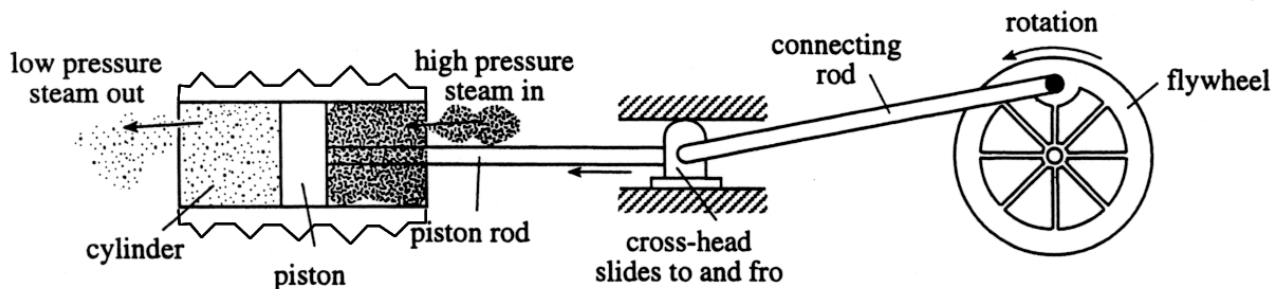


Figure 1 Mode of operation of a steam engine

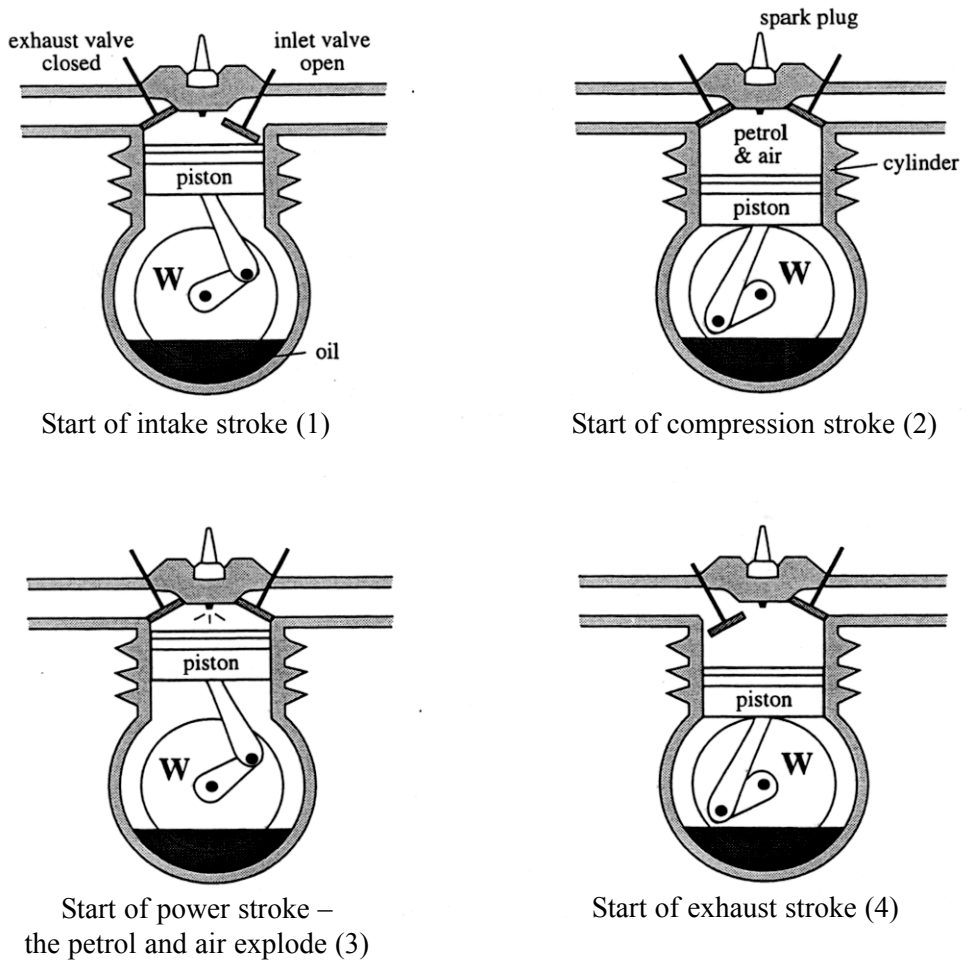


Figure 2 Four stroke engine

1.1 The exhaust valve (Figure 2) opens for the exhaust stroke to let the

- A** petrol and air mixture in.
- B** burned gases in.
- C** gases produced out.
- D** petrol and air mixture out.

1.2 The pistons are connected via the connecting rods to the part marked **W** in **Figure 2** which is the

- A** camshaft.
- B** crankshaft.
- C** universal joint.
- D** valves.

Turn over ►

1.3 The spark is timed to occur

- A** as soon as the cylinder is full of petrol and air.
- B** to clear out the exhaust gases.
- C** to open the inlet valve.
- D** when the petrol and air are compressed.

1.4 The purpose of the spark is to

- A** complete the electrical circuit.
- B** ignite the fuel.
- C** recharge the battery.
- D** start the starter motor.

1.5 The oil is there (Figure 2) to

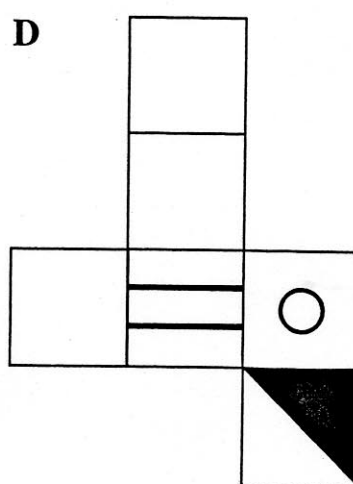
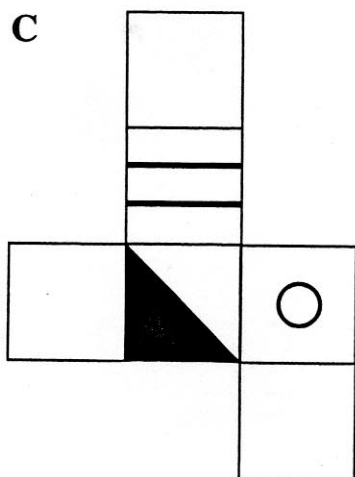
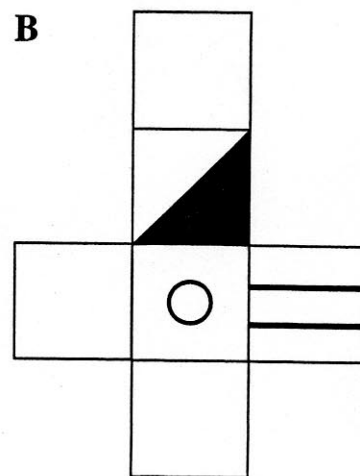
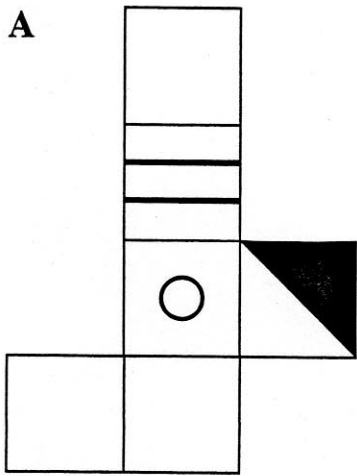
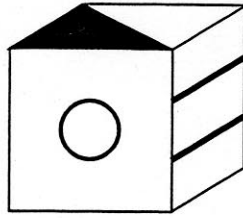
- A** burn as fuel.
- B** increase friction.
- C** lubricate.
- D** provide heat.

1.6 The outside of the cylinder (Figure 1) has metal “fins” sticking out. This is to

- A** keep heat in.
- B** let heat escape.
- C** let the mechanic service it.
- D** trap oil and dirt.

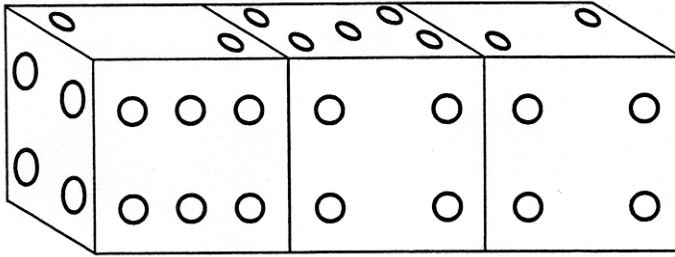
Questions 1.7 to 1.12

1.7 The cube has been formed by which net?



Turn over ►

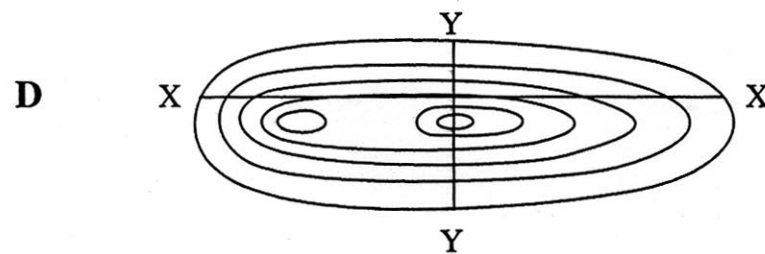
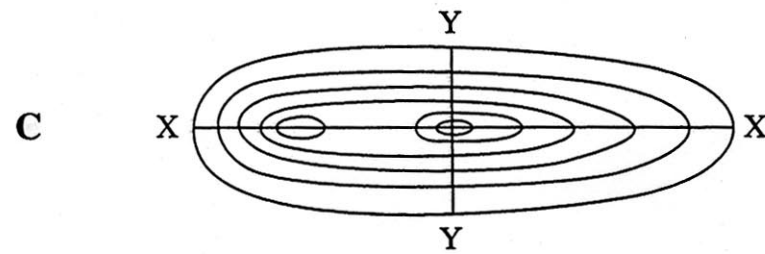
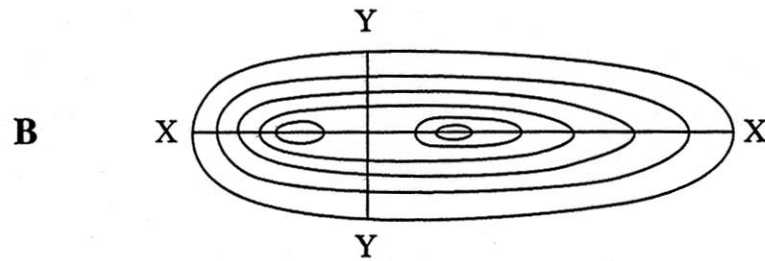
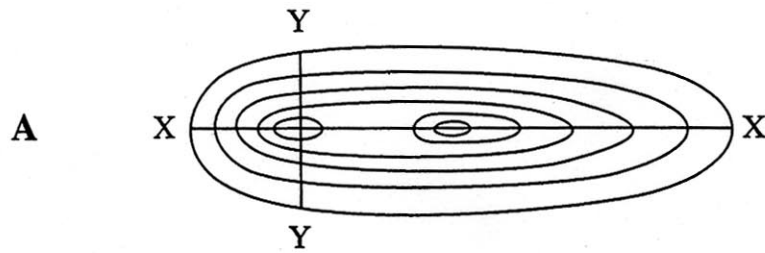
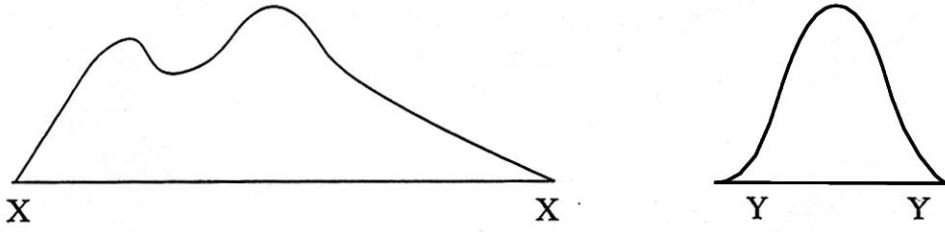
1.8



If opposite faces of each dice total seven and the dice are identical, what is the sum of the numbers on the four faces that are stuck together?

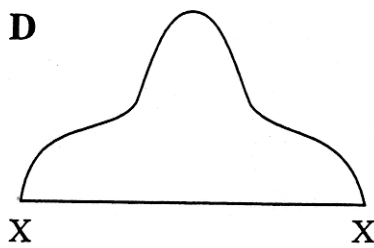
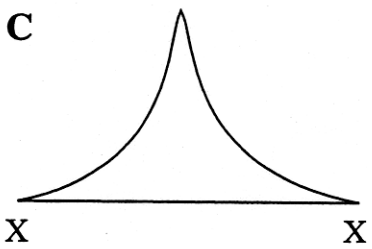
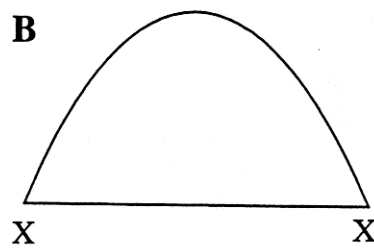
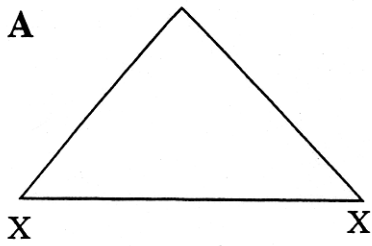
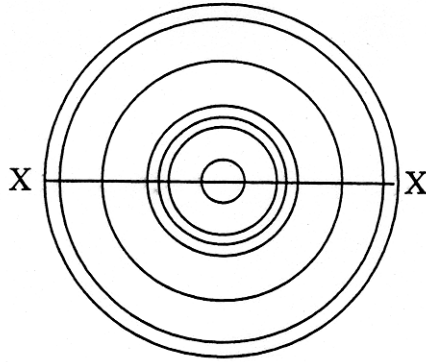
- A 9
- B 11
- C 14
- D 16

1.9 The two elevations shown correspond to which set of contours?

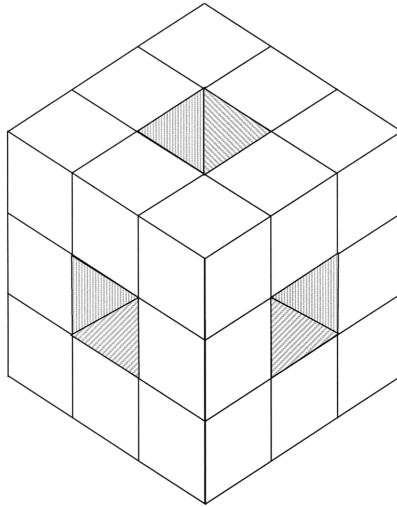


Turn over ►

1.10 Which of the hill elevations corresponds to the contour map?

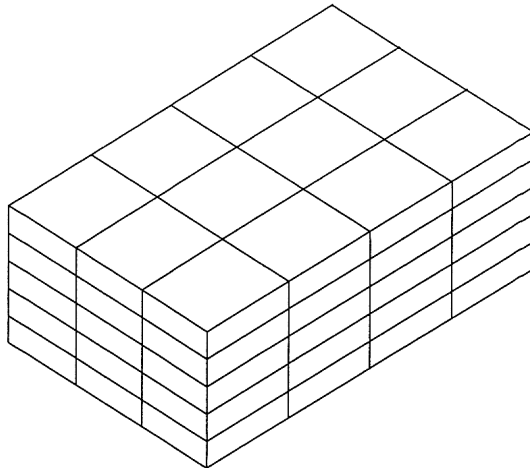


- 1.11** The following isometric drawing is symmetrical and made from 20 cubes. The shaded areas represent empty spaces.



The number of cubes with three non-touching faces only is

- A** 8
B 12
C 16
D 20
- 1.12** This isometric drawing shows a stack of wooden blocks stacked in uniform layers on a horizontal surface.



The number of blocks where exactly one face is not touching another face is

- A** 11
B 18
C 22
D 26

Turn over ►

Questions 1.13 to 1.18

Beet-harvesting machine

The beet harvesting machine (Figure 3) cuts off the top of the beet (this operation is called “topping”), lifts the beet out of the ground, cleans the earth off it, and delivers it to a hopper or to a wagon travelling along with the machine. Topping is performed by a knife (Figure 5). A spiked roller moves along the ground. When it travels over a beet, the topping knife is automatically set to the correct height. The cut-off beet head with the leaves is fed by the action of the spiked roller to an elevator and is discharged into a hopper (not shown) or is deposited in a windrow beside the machine (as in Figure 4).

The lifting mechanism operates on the adjacent row of beet, already dealt with by the topping device. The guide skids keep the lifting fork at the correct pre-set working depth. The fork seizes the beet below its point of greatest girth, loosens it from the ground, and passes it to the cleaning wheel which flings the beet against a surrounding cage and there removes adhering earth.

The beet is then delivered to an elevator which conveys it to the beet hopper. From time to time the contents of this hopper are emptied into a wagon. This is done by means of the discharging conveyor which forms one side of the beet hopper and which can be swung down to deliver the beet into the wagon. In addition, the hopper can (by hydraulic power) be tilted about the axis *A-A* in Figure 3. The lifting mechanism can be swivelled by the operator, if necessary, in order to seize any beet that may be somewhat out of the row.

The power for driving the beet harvesting machine is supplied through a drive shaft from the tractor that tows it. The machine may be provided with two sets of rubber beater arms to follow up the topping device. The beet can then be cut off at a somewhat higher level above ground (see Figure 6); the short leaves that are then still left standing on the beet top are removed by the beater arms, which revolve in opposite directions.

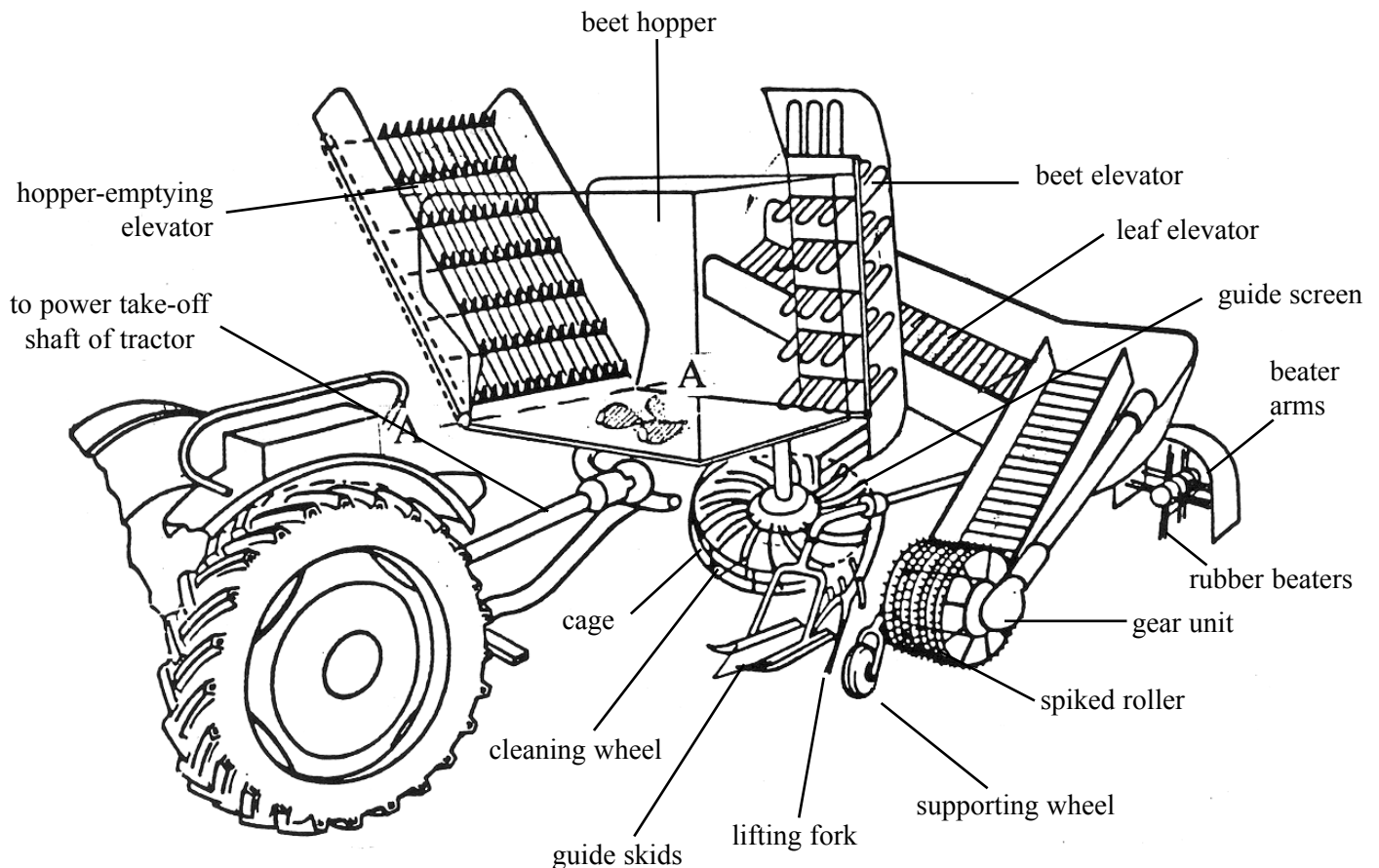


Figure 3

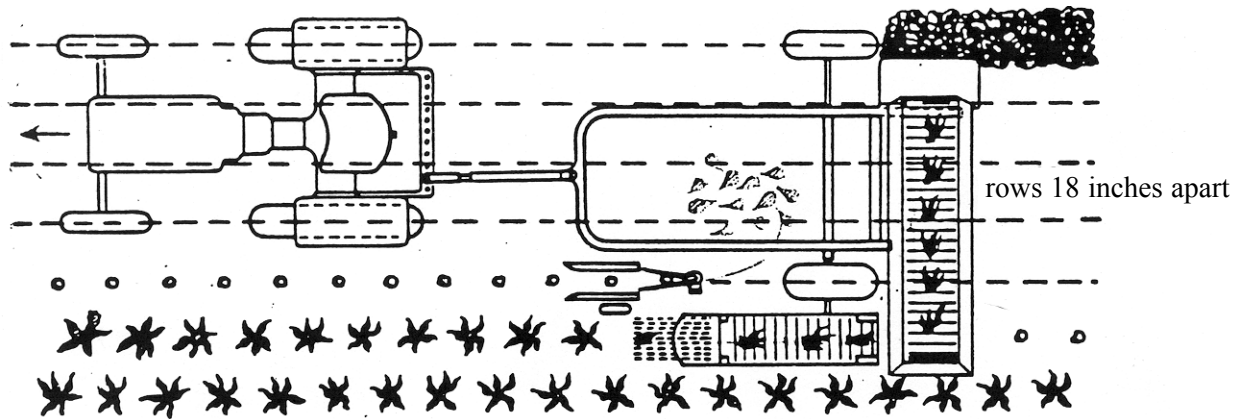


Figure 4

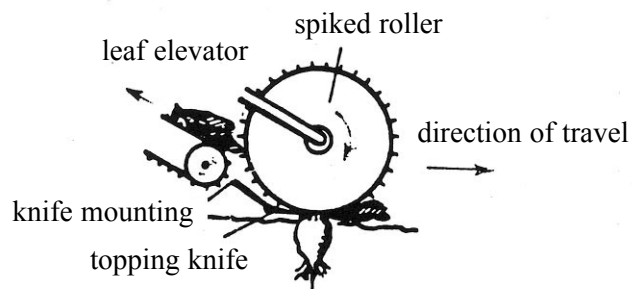


Figure 5 Topping Device

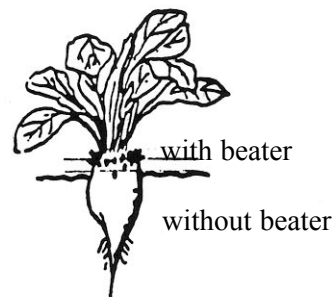


Figure 6 Cutting levels with and without beater arms

1.13 The main purpose of the spiked roller is to

- A aerate the ground.
- B stabilise the harvester.
- C pick up tops.
- D loosen the beets.

1.14 The main purpose of the rubber beater arms is to

- A loosen the beets.
- B clean the beets.
- C pick up beets which are difficult to remove.
- D make leaf removal more effective.

1.15 When harvesting the last row of beet, which one of the following will be used in the way shown in Figure 4?

- A beater arms
- B spiked roller
- C beet elevator
- D leaf elevator

Turn over ►

1.16 If the beet in the hopper still has earth attached to it then it is most likely that

- A** harvesting occurred on a dry day.
- B** the cage cleaning wheel is turning too slowly.
- C** it is too early in the season to harvest.
- D** the beet elevator is moving too quickly.

1.17 The main purpose of the supporting wheel is to

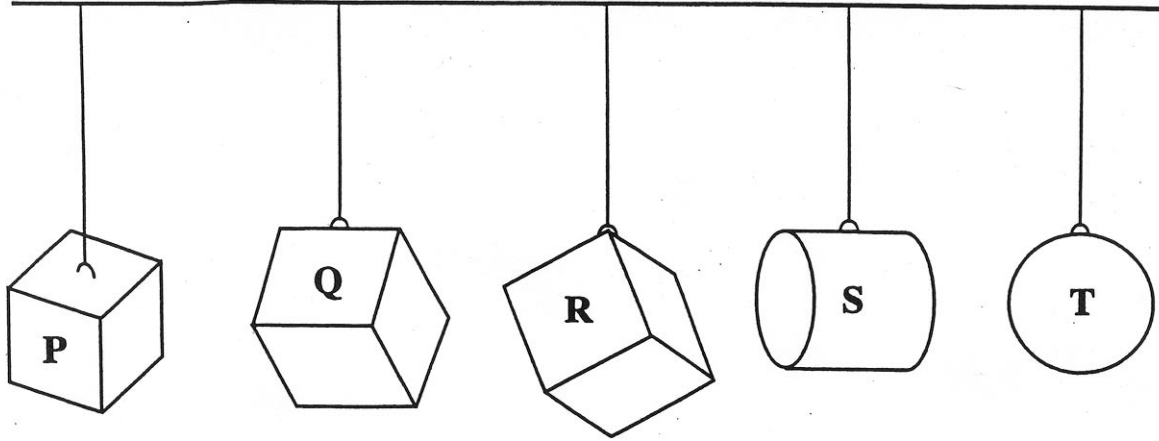
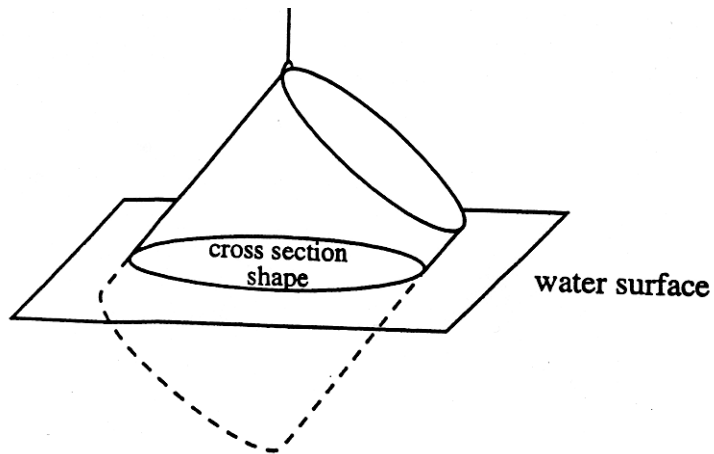
- A** keep the harvester in a straight line.
- B** prevent the roller from digging into the ground.
- C** indicate direction to the tractor driver.
- D** control the direction of the roller.

1.18 A similar system of harvesting would **not** work for

- A** parsnips.
- B** turnips.
- C** carrots.
- D** peas.

Questions 1.19 to 1.25

To help children familiarise themselves with shapes, the apparatus in Figure 7 was constructed. There are 3 cubes, a cylinder and a sphere suspended as shown. They are lowered slowly into a bowl of water (as in Figure 8).

**Figure 7****Figure 8**

1.19 Which part of shape P will touch the water first?

- A** a face
- B** an edge
- C** a corner
- D** none of these

1.20 Which part of shape Q will touch the water first?

- A** a face
- B** an edge
- C** a corner
- D** none of these

1.21 Which part of shape R will touch the water first?

- A** a face
- B** an edge
- C** a corner
- D** none of these

1.22 What is the cross-section shape in the plane of the water surface, as in Figure 8, when shape P is $\frac{1}{4}$ of the way down?

- A** hexagon
- B** rectangle
- C** square
- D** triangle

1.23 What is the cross-section shape in the plane of the water surface when shape Q is $\frac{1}{4}$ of the way down?

- A** hexagon
- B** rectangle
- C** square
- D** triangle

1.24 What is the cross-section shape in the plane of the water surface when S is $\frac{1}{4}$ of the way down?

- A** circle
- B** oval
- C** rectangle
- D** square

1.25 What is the cross-section shape in the plane of the water surface when T is $\frac{1}{4}$ of the way down?

- A** circle
- B** oval
- C** square
- D** triangle

END OF QUESTION 1

TURN OVER FOR THE NEXT QUESTION

Turn over ►

QUESTION 2

Answer **ONE** of Questions **2.1** to **2.6**.

Each Question is worth 25 marks.

This question must be answered in a **separate** answer book which must be clearly labelled **GSA5 Question 2**. Include relevant science wherever appropriate. Write as if you are addressing the intelligent general reader.

The assessment of your answer will take account not only of content but also of your use of English, including spelling, punctuation, vocabulary, sentence construction and the organisation of your essay.

2.1 It is just over one hundred years since the first transatlantic radio transmission by Guglielmo Marconi.

Explain the scientific principles behind the transmission and reception of radio signals.

Discuss the extent to which you consider the radio to be the most important invention of the last century.

2.2 What is sleep and why is it needed?

Describe the conditions for good sleep. To what extent do you consider sleeping well contributes to quality of life?

2.3 It has been suggested that because of the journey times and the distances involved, the only way we will successfully colonise other planets is to send large groups of people into space.

What are the challenges involved in setting up such a venture? How far do you agree that we will need to do it?

2.4 The number of British house sparrows is reported to have fallen from seventeen million in 1972 to around ten million in 1996.

How would these estimates have been established? What could be the reasons for the reduction and why should it concern us?

2.5 The Commission for Integrated Transport (CFIT) is proposing a scheme to charge motorists for motorway travel. Similarly, Ken Livingstone, the Mayor of London, has proposed a scheme for congestion charging in central London.

Outline the technological systems involved in the identification and charging of motorists in such schemes.

Indicate the need for an integrated transport policy and identify the main problems in its introduction.

2.6 Explain why there is conflict between Creationism and Darwin's Theory of Evolution.

A similar conflict between science and the establishment view was Galileo's defence of a heliocentric system.

Explain how the scientific method has encouraged acceptance of Darwin's and Galileo's accounts.

END OF QUESTIONS