General Certificate of Education
June 2005
Advanced Level Examination

ASSESSMENT and QUALIFICATIONS ALLIANCE

GENERAL STUDIES (SPECIFICATION A) GSA5
Unit 5 Science, Mathematics and Technology

Wednesday 15 June 2005 Afternoon Session

In addition to this paper you will require:
- an objective test answer sheet;
- an 8-page answer book;
- a black ball-point pen.

You may use a calculator.

Time allowed: 1 hour 30 minutes

Instructions
- Use a black ball-point pen for recording your answers to Questions 1.1 to 1.20 on your objective test answer sheet.
- Use blue or black ink or ball-point pen for answering **one** question from Questions 2.1 to 2.6.
- 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 Question 1 (1.1 to 1.20) using the answer sheet provided **and one** question from Questions 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.
- Make sure that you hand in **both** your answer sheet **and** your essay answer book at the end of the examination.

Information
- The maximum mark for this paper is 45.
- This paper consists of **two** questions.
  Question 1 contains 20 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 your essay.

Advice
- 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.

QUESTION 1

Answer Questions 1.1 to 1.20

For each of **Questions 1.1** to **1.20** choose the answer you consider the best of the alternatives offered in **A, B, C** and **D**.

Questions 1.1 to 1.8

The Falkirk Wheel

The wheel is the world's first rotating boat lift, standing almost 40 metres high and linking the Forth & Clyde and Union canals between Glasgow and Edinburgh. Opened in May 2002, it forms the centrepiece of the £84.5 million Millennium Link project, which will restore a coast-to-coast waterway link running right across the Scottish lowlands.

Chief Engineer George Ballinger stated "A flight of 11 locks originally linked the two canals, but we decided we needed something special there, something really modern." £17 million later it has been achieved.

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The excluded item was a photograph of the Falkirk Wheel.

Boats are loaded into two giant gondolas at the top and bottom of the wheel (see Figure 1). The wheel then rotates 180° so that the two gondolas swap places. Each gondola weighs 50 tonnes and can hold up to 250 tonnes of water and four average-sized canal boats. Together with the rest of the wheel, the whole thing weighs in at a massive 1 800 tonnes, yet it takes only the same amount of power as two electric showers (about 20 kilowatts) to shift it.

"It's possible because it's perfectly balanced", says Ballinger. And because any boat displaces its own weight in water, the system always remains balanced. "Archimedes sorted it all out for us" he says. "It wouldn't matter if you had an aircraft carrier at the top and a canoe at the bottom."

The rotation takes less than five minutes, although the entire period for loading and unloading takes more like 15. This compares with several hours to get through the original flight of locks. Locks also have the disadvantage of using a lot of water and are liable to leak. "The Union Canal is not particularly well-endowed with water. The wheel, of course, doesn't consume any water at all."

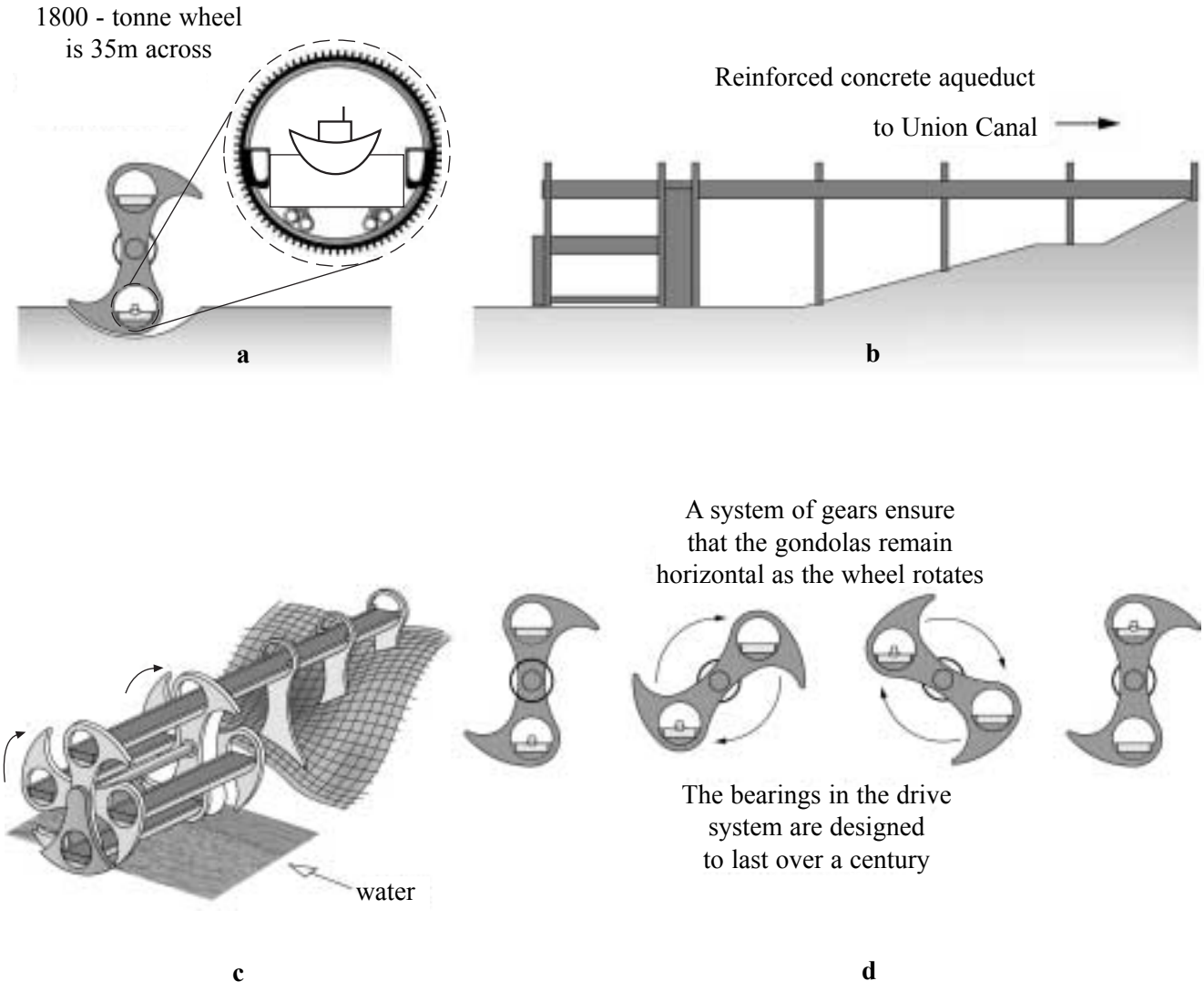

1800 - tonne wheel
is 35m across
a
Reinforced concrete aqueduct
to Union Canal
b
water
c
A system of gears ensure
that the gondolas remain
horizontal as the wheel rotates
The bearings in the drive
system are designed
to last over a century
d

Figure 2

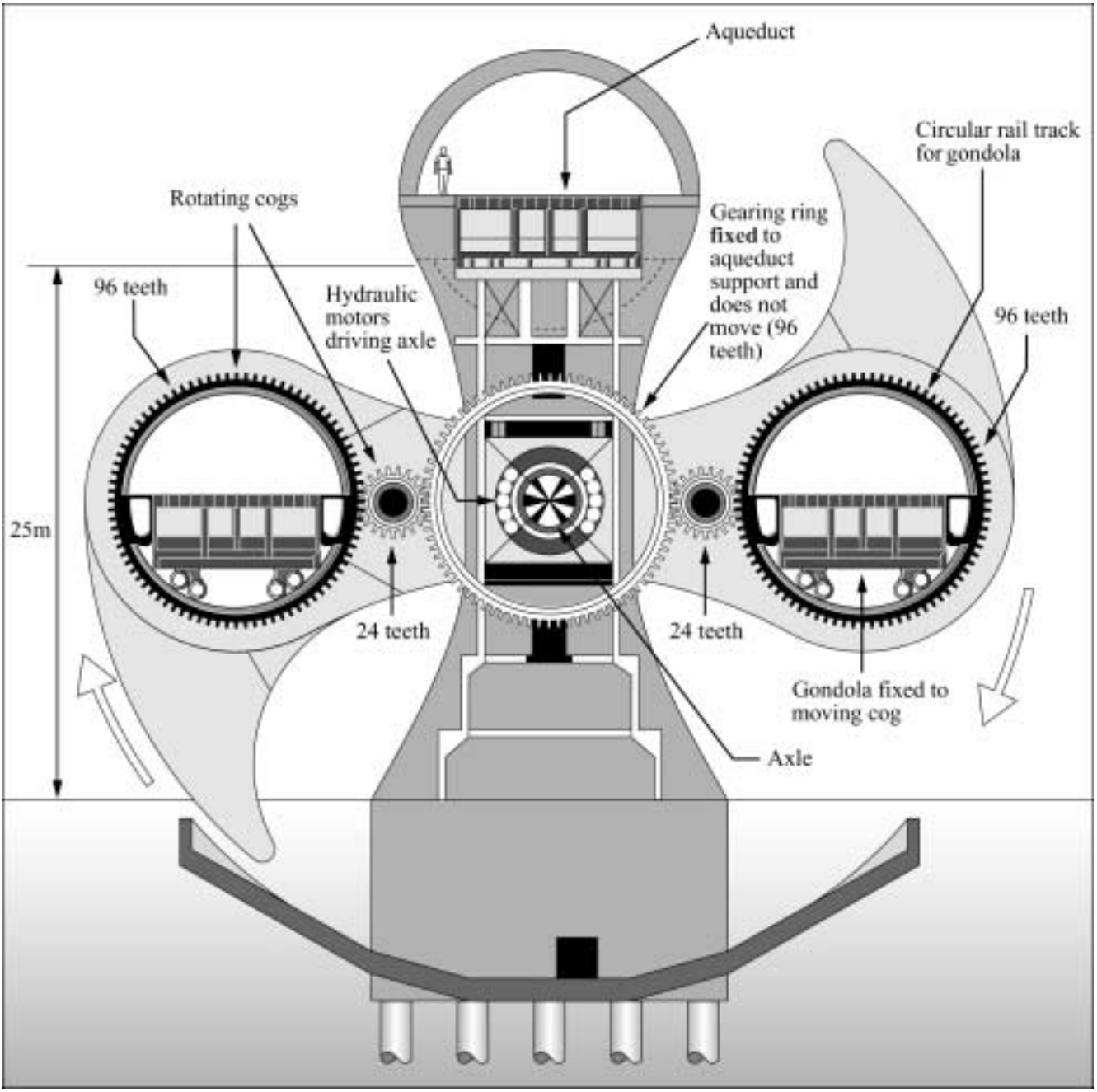

Aqueduct
Circular rail track for gondola
Rotating cogs
Gearing ring **fixed** to aqueduct support and does not move (96 teeth)
96 teeth
Hydraulic motors driving axle
96 teeth
25m
24 teeth
24 teeth
Gondola fixed to moving cog
Axle

Figure 3

1.1 The Falkirk Wheel is preferred to eleven locks because

1 it does not consume water.
2 it is quicker to use.
3 it is cheap to run.
4 it behaves in a balanced manner.

Answer

A if **1**, **2** and **3** only are correct.
B if **2**, **3** and **4** only are correct.
C if **1**, **3** and **4** only are correct.
D if all of them are correct.

1.2 The flight of eleven locks had the following disadvantages

1 using it could take hours
2 it was liable to leaks
3 it was relatively cheap to build
4 water from the Union Canal was used

Answer

A if **1**, **2** and **3** only are correct.
B if **2**, **3** and **4** only are correct.
C if **1**, **2** and **4** only are correct.
D if all of them are correct.

1.3 If the Falkirk Wheel rotates clockwise as shown in Figure 3, the cogs fixed to the gondolas will

A remain stationary.
B both turn anticlockwise.
C turn in opposite directions - one on left turning clockwise.
D turn in opposite directions - one on right turning clockwise.

1.4 When the Falkirk Wheel has made half a turn, each of the small rotating cogs will have turned

A once.
B twice.
C four times.
D eight times.

1.5 The weight acting on the reinforced concrete aqueduct (Figure 2b) is

A increased when a boat is present.
B further increased when two boats are present.
C unchanged when a boat is present.
D decreased when a boat is present.

1.6 If the lower gondola contained four boats and the upper gondola contained none, turning the Falkirk Wheel would have the effect, compared to a fully-loaded operation, of

A being harder to start - more electricity needed.
B the lower gondola liable to tilt.
C not turning because of imbalance.
D no change.

1.7 If half a turn of the Falkirk Wheel takes five minutes this represents an angular mean speed of

A 0.1 rpm
B 0.4 rpm
C 2.0 rpm
D 5.0 rpm

1.8 The gondola could tilt in operation if

1 there is excessive friction with the circular rail track.
2 there is a loss of adjacent teeth in any of the moving cogs.
3 moving cogs are enmeshing and sticking.
4 there is an electricity power cut.

Answer

A if **1**, **2** and **3** only are correct.
B if **2**, **3** and **4** only are correct.
C if **1**, **3** and **4** only are correct.
D if all of them are correct.

TURN OVER FOR THE NEXT QUESTION

Questions 1.9 to 1.15

The Crossbow

In the medieval crossbow, Figure 4, a bow was mounted across the front of a stock of wood called a tiller. If the bow were sufficiently powerful a device for drawing it (e.g. a cranequin as shown in Figure 5) was built into the tiller.

The crossbow was superior to the handbow in its range (typically 400 m versus 250 m) and as the firing mechanism was partially mechanical, less effort and skill were needed to use the weapon. Its main disadvantage was its slow rate of fire compared to the handbow.

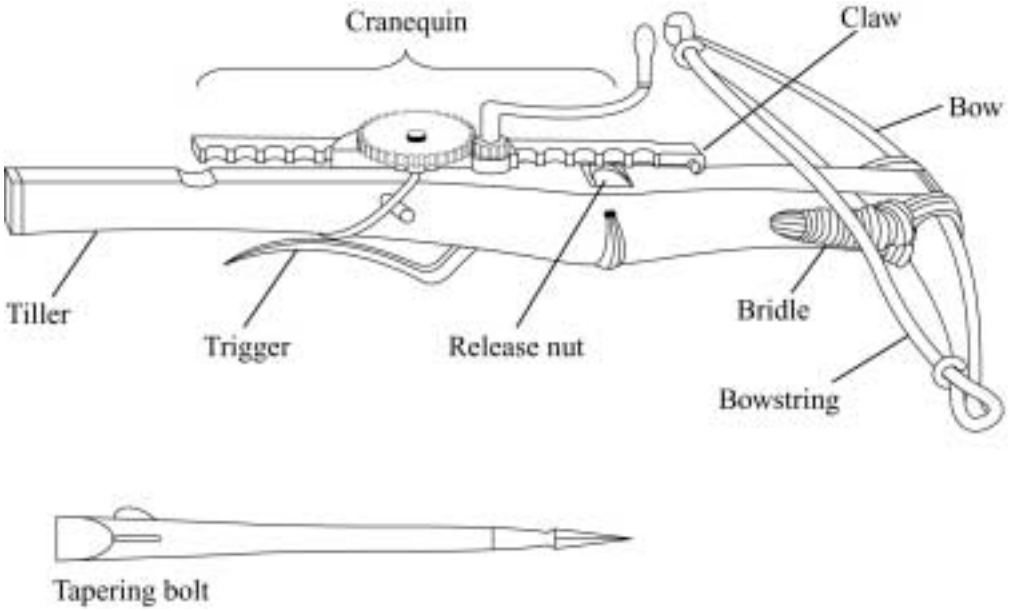


Figure 4: Crossbow

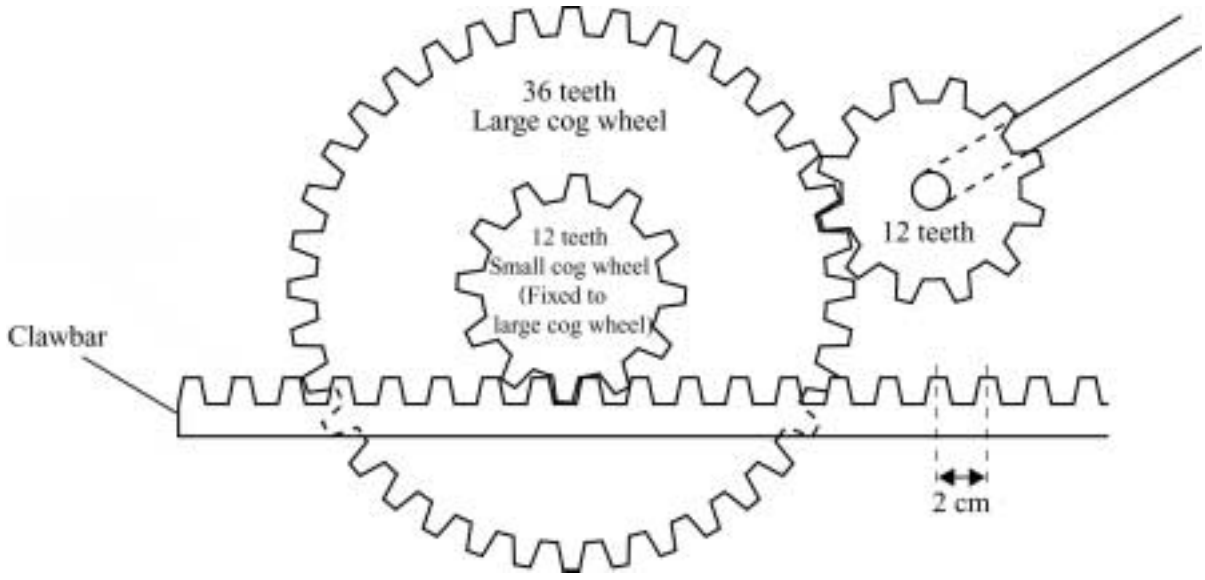


Figure 5: Cranequin viewed from underneath

1.9 Each of the following is correct **except**

A the crossbow can achieve a greater range than a handbow.
B the crossbow requires less effort in use than a handbow.
C the crossbow requires less skill to use than a handbow.
D the crossbow has a faster rate of fire than a handbow.

1.10 When a crossbow is drawn the energy supplied by the archer is stored and subsequently released when the trigger is pulled. Where is most of the energy stored before firing?

A in the bolt
B in the trigger
C in the cranequin
D in the bow and string

1.11 In the cranequin (Figure 5) through how many degrees does the large cog wheel turn when the cranequin handle is turned through two revolutions?

A 60°
B 120°
C 180°
D 240°

1.12 In Figure 5, through how many degrees must the large cog rotate if the claw is to move through 12 cm?

A 30°
B 90°
C 150°
D 180°

1.13 In Figure 5, how far does the claw move when the handle is turned through a complete revolution?

A 4 cm
B 6 cm
C 8 cm
D 16 cm

1.14 In Figure 5, each of the following is correct **except**

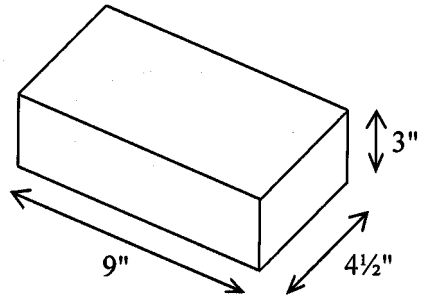
A when the handle is rotated clockwise the large cog rotates anticlockwise.
B when the handle is rotated anticlockwise the claw bar moves to the right.
C the claw moves through 2 cm when the large cog rotates through 30°.
D when the handle is moved through 90° the large cog rotates through 30°.

1.15 The flight path of a bolt, assuming negligible air resistance, is best described as

A elliptical.
B hyperbolic.
C parabolic.
D linear.

Questions 1.16 to 1.20

Brickwork



Including the mortar a brick takes up $9 \times 3 \times 4\frac{1}{2}$ inches. As laid the long side is called the 'stretcher' and the end face is called the 'header'. If the wall is a multiple of 4½ or 9 inches long it saves cutting bricks. Each course (row of bricks) will raise the wall by 3" and the thinnest a wall can be is 4½". A more usual width for a solid wall is 9".

For strength, the vertical joints in one course must not be directly above those in the course below but should be directly above those in the row below that. Bricks are laid in a pattern called a bond.

Stretcher bond is the simplest and will produce a 4½" wall. Other bonds use the brick turned so that the 'header' shows.

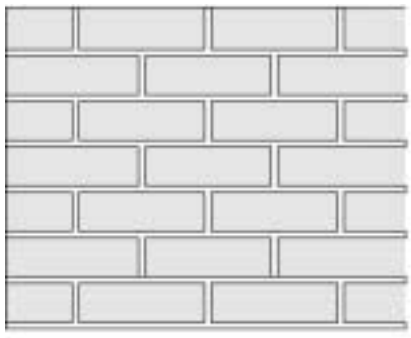


Figure 6a

Stretcher bond

Identical courses with the long 'stretcher' faces laid end to end. Half length bricks (called '½ bats') are needed at the end of a course to achieve joint staggering.

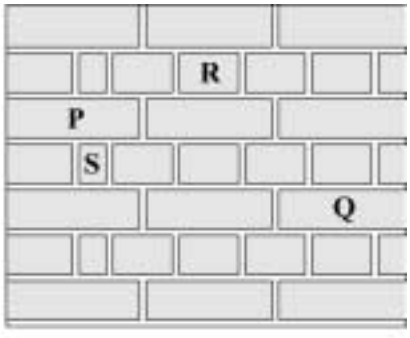


Figure 6b

English bond

Consists of a course of headers alternating with a course of stretchers. A brick cut down its length (a 'closer') completes the joint staggering.

Another bond used for 9" walls is called Flemish. Courses are identical with two stretchers parallel to each other along their lengths, alternating with a header except at the end of a wall.

Bricks designed to stand the weather are called Facing bricks. If a brick is not going to be exposed then a type called Commons may be used which is cheaper.

1.16 A '½ bat' (Figure 6a) will have measurements of approximately

A 3" × 3" × 4½"
B 3" × 4½" × 4½"
C 1½" × 4½" × 9"
D 2¼" × 3" × 9"

Questions 1.17 and 1.18 refer to the same wall.

1.17 To build a 4½" wide wall 36" long by 18" high in stretcher bond (Figure 6a), the number of courses would be

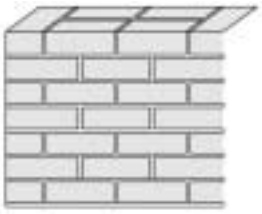
A 2
B 4
C 6
D 8

1.18 If the bricks in Question 1.17 are cut in half to complete the wall, the minimum number of bricks needed is

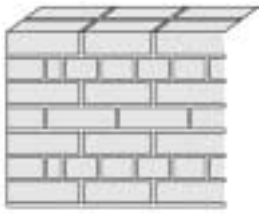
A 12
B 24
C 36
D 48

1.19 From the description given (see introduction - *Brickwork*) the wall which is built with Flemish bond is

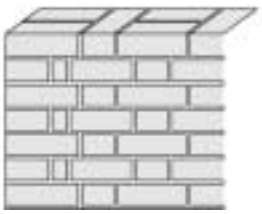
A



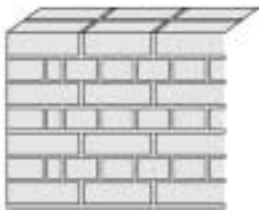
B



C



D



1.20 In Figure 6b the brick which is a 'closer' is

A P
B Q
C R
D S

END OF QUESTION 1

TURN OVER FOR QUESTION 2

QUESTION 2

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

Each question carries 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 Discuss how science and technology have made intensive farming an efficient way of producing food.

Examine the concerns that have arisen as a consequence.

2.2 The skin is the body's biggest organ.

Explain the function of skin and the scientific principles involved in steps taken to protect it.

2.3 Explain what is meant by nanotechnology.

Discuss the possible future of this technology and comment upon why its impact on society appears to have provoked so little public reaction.

2.4 The Sony Walkman, the Sony Discman and the Apple iPod illustrate analogue to digital progression in mobile music listening.

Explain the scientific principles underlying **one** of these devices.

Discuss how analogue to digital progression has made recorded music more accessible.

2.5 Explain the concept of biodiversity.

Discuss whether the initial loss of a small number of species would ultimately lead to mass extinction.

2.6 Discuss ways in which the study of mathematics is critical to the growth of a thriving technological society.

END OF QUESTIONS

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