General Certificate of Education
January 2003
Advanced Subsidiary Examination

ASSESSMENT and
QUALIFICATIONS
ALLIANCE

GENERAL STUDIES (SPECIFICATION A)   GSA2
Unit 2   Science, Mathematics and Technology

Tuesday 14 January 2003 Morning Session

In addition to this paper you will require:
- an objective test answer sheet;
- a data booklet for Questions 1-25 (enclosed);
- a blue or black ball-point pen.

You may use a calculator.

Time allowed: 1 hour 15 minutes

Instructions
- Use blue or black ball-point pen. Do **not** use pencil.
- Answer **both** Section 1 (Questions 1 to 25) **and** Section 2 (Question 26 to 50) using the answer sheet provided.
- Answer **all** questions.
- For each question 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.
- Mark all responses as instructed on your answer sheet. If you wish to change your answer to a question, follow the instructions on your answer sheet.
- Do all rough work in this book, **not** on your answer sheet.

Information
- This paper consists of **two** Sections.
  Section 1 contains 25 objective test questions (Questions 1 - 25) based on material provided in a separate data booklet.
  Section 2 contains 25 objective test questions (Questions 26 - 50) testing mathematical reasoning and its application.
- Each question carries 1 mark. No deductions will be made for wrong answers.
- 2 mm graph paper is available from the Invigilator.

Advice
- Do not spend too long on any question. If you have time at the end, go back and answer any question you missed out.

SECTION 1

Answer Questions 1 to 25

Each of the 25 questions carries 1 mark.

Read the passage entitled GEOPHYSICAL PROSPECTION IN ARCHAEOLOGY which is printed in the separate data booklet.

Each of questions **1** to **22** consists of a question or an incomplete statement followed by four suggested answers or completions. You are to select the most appropriate answer (**A** to **D**) in each case.

Questions 1 to 22

1 Which method detects the hearth best? (Figure 1)

    A   resistivity
    B   magnetometer
    C   magnetic susceptibility
    D   phosphate analysis

2 The survey (Figure 1) that gives the position of the midden most accurately is

    A   resistivity.
    B   magnetometer.
    C   magnetic susceptibility.
    D   phosphate analysis.

3 Which method detects only material that is already magnetised? (Figure 1 and paragraphs 9 and 13)

    A   resistivity
    B   magnetometer
    C   magnetic susceptibility
    D   phospate analysis

4 Which method depends mainly on water content? (Figure 1)

    A   resistivity
    B   magnetometer
    C   magnetic susceptibility
    D   phosphate analysis

5 Study Figure 2 and paragraph 6. The resistivity anomalies are positive under both the Roman house and the kiln because

    A   these are the most recent features.
    B   of the heat from these features.
    C   they both had stone foundations.
    D   of water-logging.

6   In the resistivity probe (Figures 3 and 4) the

   1   current is measured between C and C.
   2   current is measured between C and P.
   3   potential difference is measured between C and P.
   4   potential difference is measured between P and P.

   Answer

   A   if **1** and **3** only are correct.
   B   if **1** and **4** only are correct.
   C   if **2** and **3** only are correct.
   D   if **2** and **4** only are correct.

7   The current would also spread sideways on its way from probe to probe (Figure 3) so there would be a horizontal circle explored of radius

   A   22.5 cm.
   B   45 cm.
   C   90 cm.
   D   180 cm.

8   When conducting in water on chalk the negative electrode (paragraph 7) will

   A   attract the calcium ions and negative ions.
   B   repel the calcium ions and the negative ions.
   C   attract the negative ions but repel the calcium ions.
   D   repel the negative ions but attract the calcium ions.

9   The expected moisture content (low to high) of different materials (paragraph 6) would be

   A   nonporous rock, porous rock, clay.
   B   clay, nonporous rock, porous rock.
   C   porous rock, nonporous rock, clay.
   D   nonporous rock, clay, porous rock.

10   The greatest range of resistivity measurements (Table 1) would occur in
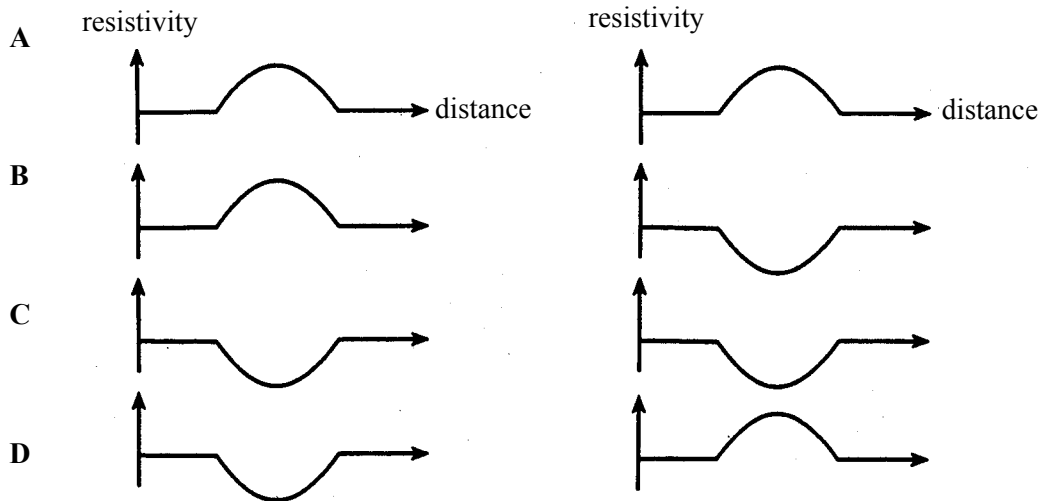
   A   chalk.
   B   clay and soil.
   C   porous rock.
   D   nonporous rock.

Turn over ▶

11   The increasing resistivity shown in Table 1 is mainly due to

    A   depth.
    B   density.
    C   moisture.
    D   temperature.

12   The resistivity survey shown in Figures 5a and 5b respectively is carried out moving from X to Y in each case. The results would look something like

13   The magnetometer is called a 'passive' device (paragraph 9) because it

    A   sends a signal into the ground.
    B   only receives signals.
    C   is very sensitive.
    D   cannot be used near power cables.

14   As well as helping to detect an object, magnetism after baking (Figure 6) may also tell us about

    A   the moisture content of the soil.
    B   the climate long ago.
    C   the Earth's magnetic field in times past.
    D   whether animals were kept on the piece of ground.

15   The subsoil generally has less magnetism than the topsoil (paragraph 10) because it

    A   contains no heated material.
    B   is wetter than the topsoil.
    C   is unploughed.
    D   is nearer the centre of the Earth.

16   Approximately how many readings per hour can you take with the magnetometer (paragraph 11)?

    A   5
    B   12
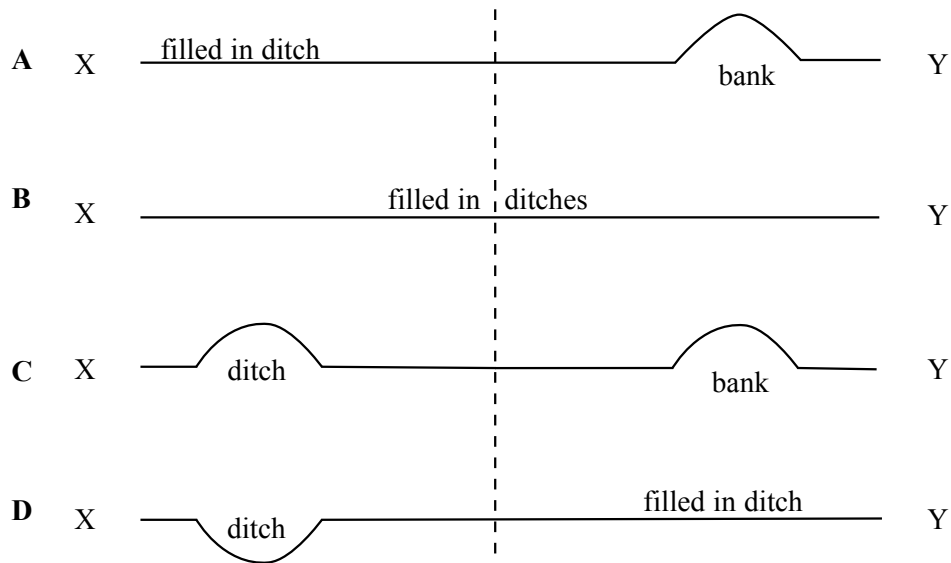   **C**   70
    D   700

17 Referring to Figures 7a and 7b. Which diagram best shows the arrangement of magnetic field lines with the arrows showing the way a north pole of a compass would point?
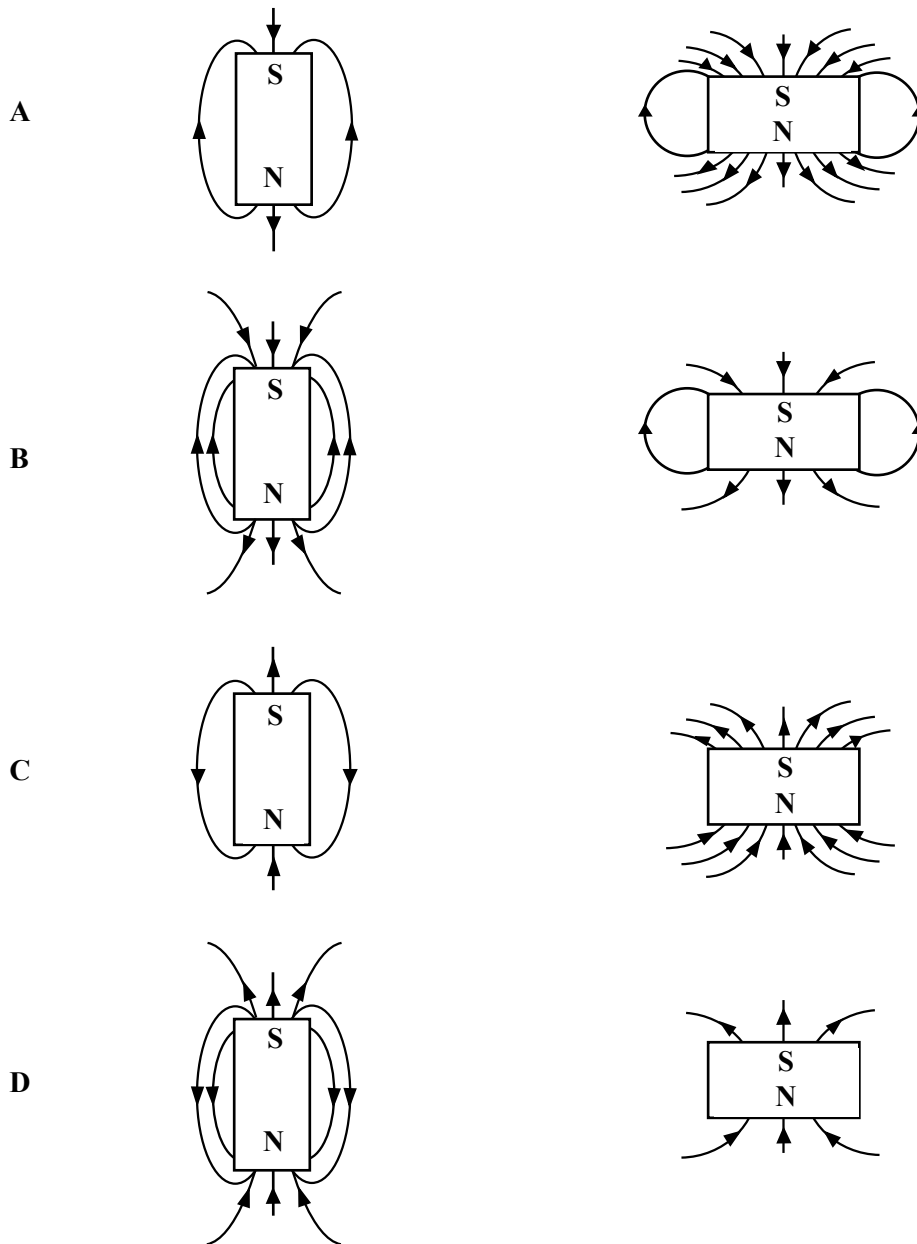
18 In Figure 8, each line is displaced slightly to produce a 3D effect but the vertical scale is 15 units per line interval. The pit C shows a maximum variation of roughly

A   15 units.
B   30 units.
C   60 units.
D   90 units.

19   If you looked across the site in Figure 8 the approximate profile of the ground from X to Y would be

A X   filled in ditch ─────────────────────────⌒ bank ──── Y

B X ──────── filled in ¦ ditches ──────────── Y

C X ─⌣─ ditch ──────────⌒ bank ──── Y

D X ─⌣ ditch ──── filled in ditch ──── Y

20   From the commentary for Figure 8 you understand that

1   A, B, C are pits which could be dangerous as you might fall into them.
2   A, B, C will be filled with material which gives a magnetic anomaly.
3   D, E, F are sudden high readings showing there is buried iron.
4   D, E, F are iron bars sticking out of the ground.

Answer

A   if **1** and **3** only are correct.
B   if **1** and **4** only are correct.
C   if **2** and **3** only are correct.
D   if **2** and **4** only are correct.

21   Refer to Figure 8. The original circle probably consisted of how many stones?

A   4
B   6
C   8
D   12

22 A geoprospection is taking place near an underground electrical supply cable. The most useful methods are likely to be

1 magnetometer.
2 magnetic susceptibility.
3 phosphate survey.
4 resistivity survey.

Answer

A if **1** and **2** only are correct.
B if **2** and **3** only are correct.
C if **3** and **4** only are correct.
D if **1** and **4** only are correct.

Questions 23 to 25

In each of Questions **23** to **25** one or more of the responses is/are correct.

P, **Q**, **R**, **S** and **T** below are prospecting methods used in archaeology (Figure 1).

P examining the surface
Q measuring the resistance to electrical current
R measuring the magnetic field
S measuring magnetic susceptibility
T chemical analysis of the soil

Decide which of the responses to the question is/are correct and mark **A**, **B**, **C** or **D** on the answer sheet as follows.

A if **P** alone is correct.
B if **R** and **S** only are correct.
C if **Q**, **R** and **T** only are correct.
D if **T** alone is correct.

Which of the methods, **P**, **Q**, **R**, **S**, **T**, would be likely to provide evidence of

23 building foundations?

24 animal grazing?

25 burning?

Turn over ▶

SECTION 2

Answer Questions 26 to 50

Each of the 25 questions carries 1 mark.

For each of Questions **26** to **50** choose the answer you consider the best of the alternatives offered in **A, B, C** and **D**. You are reminded that graph paper is available on request from the Invigilator.

Questions 26 to 28

Telephone bills, not including VAT, consist of a standing charge plus a charge that is directly proportional to the number of units used.
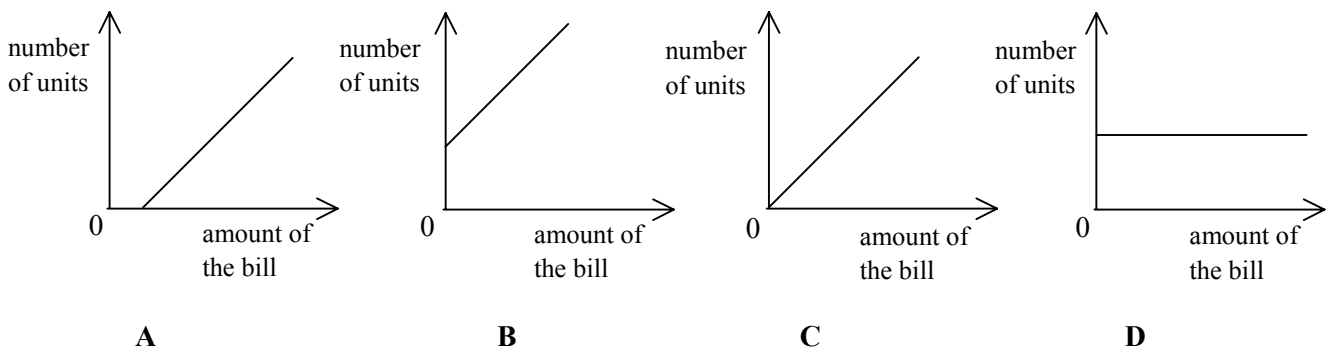
26 When the bill was £25.19, 60 units had been used.

When the bill was £25.99, 80 units had been used.

The standing charge is

    A 4p
    B 80p
    C £4
    D £22.79

27 The graph showing the number of units used against the telephone bill is of the form

28 If the standing charge were decreased, the effect on the graph showing the number of units used against the telephone bill would be to

    A make it steeper.
    B make it less steep.
    C move the graph to the right.
    D move the graph to the left.

29   Three of the following lines pass through the point (2,4). Which line does not?

A $y = \dfrac{x}{2} + 3$

B $y = 2x$

C $y = 8 - 2x$

D $y = 6 - \dfrac{x}{2}$

30   The diagram shows a cumulative frequency graph for the marks of 200 students in an examination.
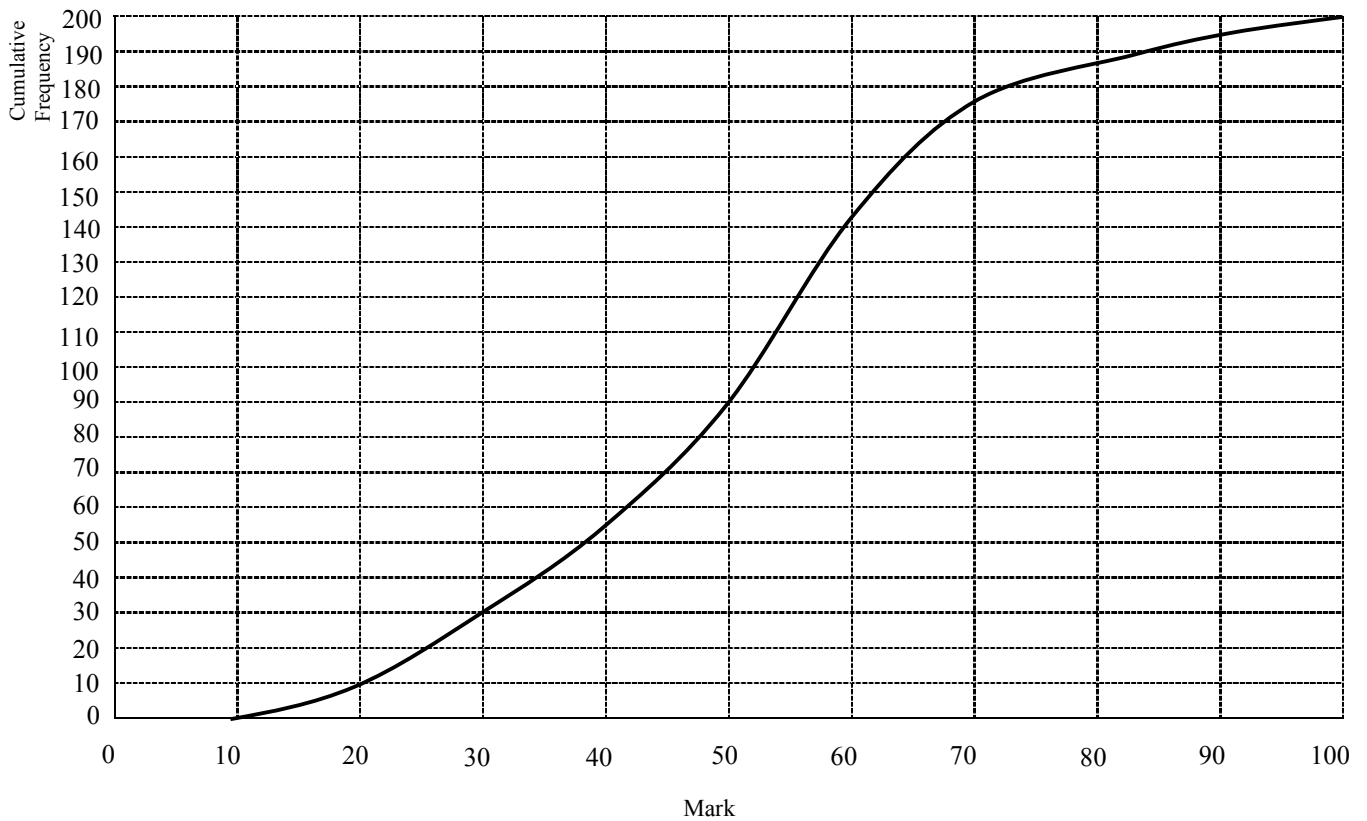
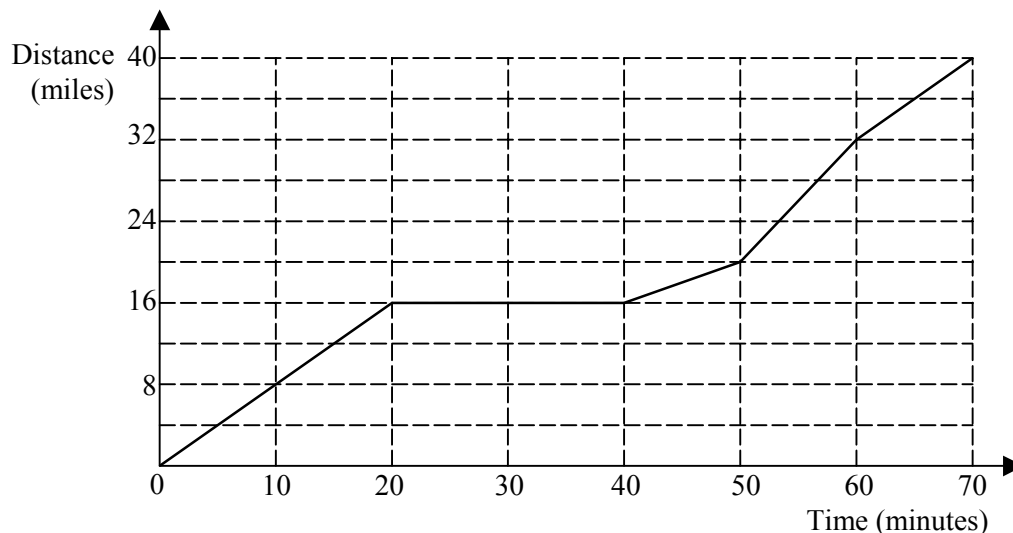What was the pass mark if 40% of the students failed?

A   33
B   42
C   47
D   56

Questions 31 and 32

A vehicle starts a journey at 9.00 am.

The distance-time graph is shown below.

31 What is the vehicle's average speed, in miles per hour, for the first 20 minutes?

A $\frac{4}{5}$ mph

B   8 mph

C   16 mph

D   48 mph

32 Which statement best describes the motion of the vehicle between 9.20 am and 9.40 am?

A   The vehicle is stationary.
B   The vehicle is travelling with a constant speed of 16 mph.
C   The vehicle is travelling with a constant speed of 48 mph.
D   The vehicle travels 16 miles at a constant speed.

33 Taking 1 kilometre to be 0.6 miles and 1 gallon to be 4.5 litres, a petrol consumption of 30 miles per gallon is equivalent to K kilometres per litre where K is

A $6\frac{2}{3}$
B   9
C $11\frac{1}{9}$
D   15

34 Temperatures in the Celsius (*C*) and Fahrenheit (*F*) scales are related by the formula
$F = \frac{9}{5}C + 32$.

Which of the following sketch graphs illustrates this relationship?

A

B

C

D
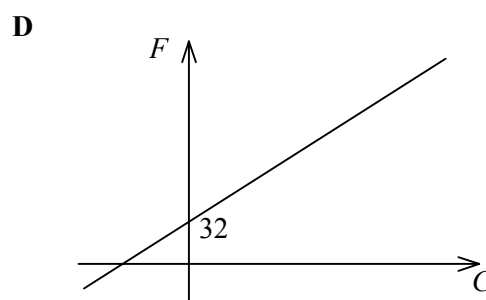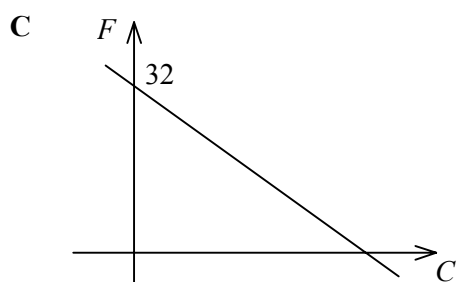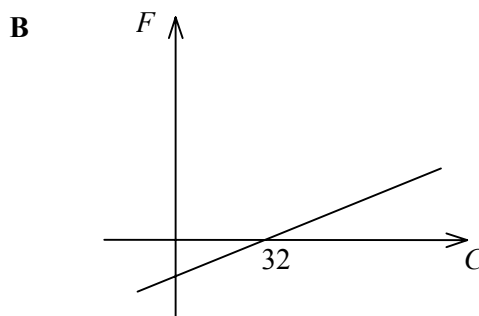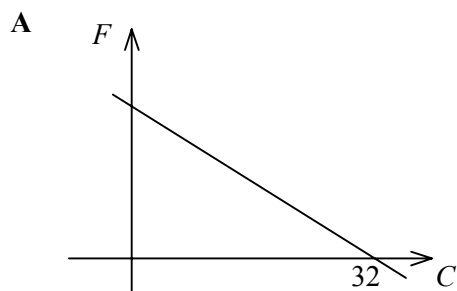
35 Some time ago a book of 20 postage stamps contained only 17p and 22p stamps. The total value of the stamps was £4.   The number, *n*, of 22p stamps can be found by solving the equation

$$22n + 17(20 - n) = 400.$$

How many 22p stamps were there in a book?

   A   12
   B   14
   C   16
   D   18

36 The following table shows the scores obtained by a group of 31 children in a competition.

Score	6	8	9	10	12	13	14	15	16	17	18	19	20
Frequency	2	2	2	2	3	2	1	3	4	3	2	3	2

When the mean, median and mode of this distribution are listed in **increasing** order of size, the result is

   A   mean, median, mode.
   B   median, mean, mode.
   C   median, mode, mean.
   D   mean, mode, median.

37 4 people working individually for 8 hours a day claim that they can paint 2000 lamp-posts in about 15 days. If 3 of them were to work at the same rate for 10 hours a day, how long (to the nearest day) would it take to paint 1200 lamp-posts?

A 5 days
B 10 days
C 15 days
D 27 days

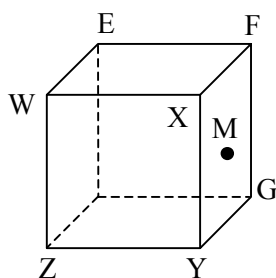**Questions 38 and 39**

The nth term of a sequence is $n^2 - 2n$.

38 The sum of the first four terms of the sequence is

A 8.
B 10.
C 12.
D 15.

39 The $(n + 1)^{th}$ term of the sequence is

A $n^2 - 2n$.
B $n^2 - 2n + 1$.
C $n(n - 2)$.
D $(n + 1)(n - 1)$.

40

The diagram shows a cube of edge 2 cm. M is the centre of the face XYGF. The length of the straight line WM is

A 3 cm.
B $\sqrt{5}$ cm.
C 4 cm.
D $\sqrt{6}$ cm.

Questions 41 and 42

There is a lucky dip at a charity fair. The lucky dip contains a selection of bags of sweets, key rings, pens, digital watches, staplers and empty boxes.

Each individual object in the lucky dip has an equal chance of being picked.

The probabilities of picking the different objects in the lucky dip at the start of the fair are

Sweets	Keyrings	Pens	Digital Watches	Staplers	Empty Boxes
$\dfrac{23}{60}$	$\dfrac{1}{4}$	$\dfrac{1}{12}$	$\dfrac{1}{30}$	$\dfrac{1}{12}$	

41   What is the probability that the first person picks an empty box?

    A $\frac{7}{60}$

    B $\frac{1}{6}$

    C $\frac{5}{6}$

    D $\frac{53}{60}$

42   What is the probability that the first person picks either a pen or a digital watch?

    A $\frac{1}{360}$

    B $\frac{1}{60}$

    C $\frac{1}{21}$

    D $\frac{7}{60}$

43   A type of pond weed doubles its mass every three days. The mass of pond weed on the 10th June is $250\,g$. What is the mass of pond weed on 10th July?

    A $7.5\,kg$
    B $256\,kg$
    C $2.6 \times 10^{5}\,kg$
    D $2.7 \times 10^{8}\,kg$

44   A rectangle has a fixed area.

Which of the following is **not** true?

    A   The length and the width of the rectangle are inversely proportional.
    B   The perimeter of the rectangle is fixed.
    C   As the length increases the width decreases.
    D   The perimeter will be least when the rectangle is a square.

45   A box is to be made from a sheet of card 50 cm by 40 cm. Squares of side x cm are removed from the corners so that the remainder of the card will fold into an open box.
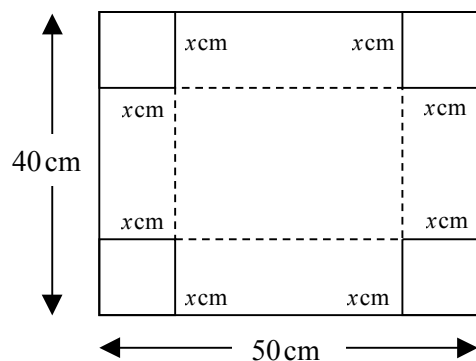
The volume v cm^3 of the box is given by $v = 4x^3 - 180x^2 + 2000x$.

A sketch of the graph of v for $0 \leq x \leq 20$ is shown below:
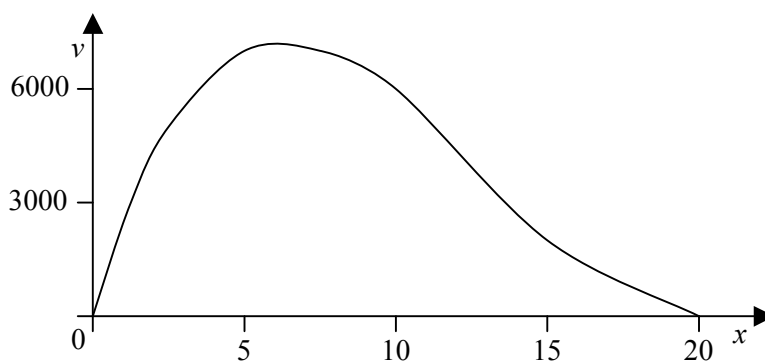
Which of the following can be deduced from the graph?

1   The maximum volume is when x is approximately 7.
2   The minimum volume is when $x = 0$ and when $x = 20$.
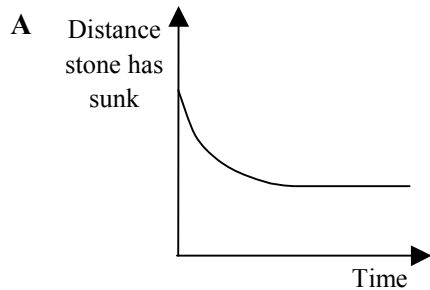**3**   As x increases, the volume also increases.

A   **1** only
B   **1** and **2** only
C   **1**, **2** and **3**
D   none of the above

46 $4x^3 - 180x^2 + 2000x$ is equivalent to

A $x\,(40 - 4x)\,(50 - x)$
B $x\,(40 - 2x)\,(50 - x)$
**C** $x\,(100 - 4x)\,(20 - x)$
D $x\,(100 - 2x)\,(20 - 2x)$

47 A stone falls into still water. Assume that once the stone enters the water it slows down at a steady rate before sinking at a constant speed until it rests at the bottom.

Which graph best shows how the distance the stone has sunk in the water varies with time?

A Distance stone has sunk / Time

B Distance stone has sunk / Time

C Distance stone has sunk / Time

D Distance stone has sunk / Time
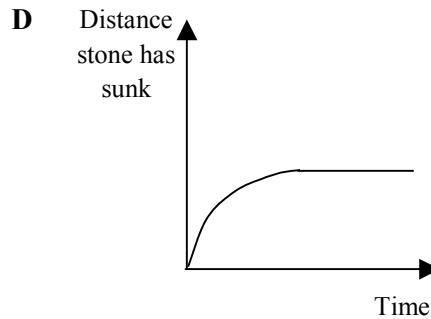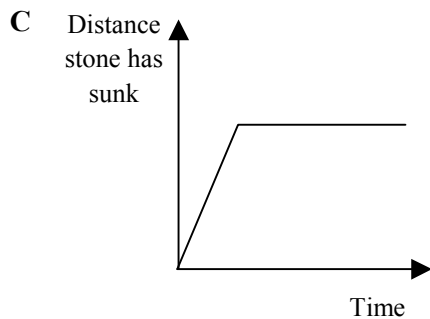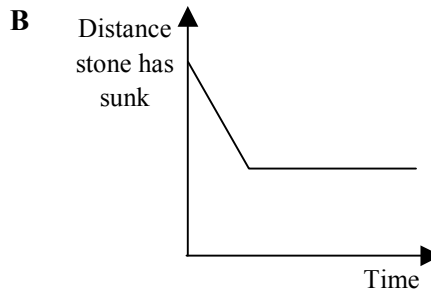
48 A building materials supplier offers a variety of roof tiles suitable for roofs of different pitch as shown in the table.

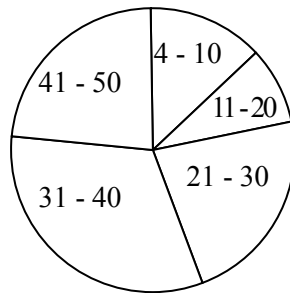| TILE	ROOF PITCH '$p°$'
Redland	$17\frac{1}{2}° < p° \le 25°$
Sandwood	$12° < p° \le 22\frac{1}{2}°$
Textured	$22\frac{1}{2}° < p° \le 70°$

4ft 6in

$p°$

11ft
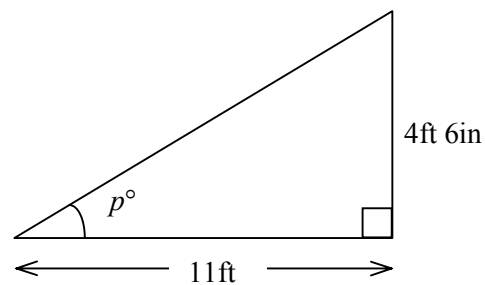
Which of the tiles would be suitable for the roof shown in the diagram?

A Sandwood only
B Redland or Sandwood
C Textured only
D All three

Questions 49 and 50

The pie chart below shows the distribution of ages (in years) for a group of people on a particular holiday.

49   Which, if any, of the following statements may be true?

1   The range of their ages is 50 years.
2   The median age is 25.
3   The inter-quartile range of their ages is 25 years.

A   Statement **1** only
B   Statement **2** only
C   Statement **3** only
D   None of the statements can be true.

50   The percentage of people under 21 years old is approximately

A   10%.
B   20%.
C   40%.
D   80%.

END OF QUESTIONS

General Certificate of Education
January 2003
Advanced Subsidiary Examination

GENERAL STUDIES (SPECIFICATION A)   GSA2
Unit 2   Science, Mathematics and Technology

Data Booklet

Tuesday 14 January 2003   Morning Session

Data booklet for use with **Section 1 Questions 1 - 25**.

Language Modified
For Hearing
Impaired Candidates
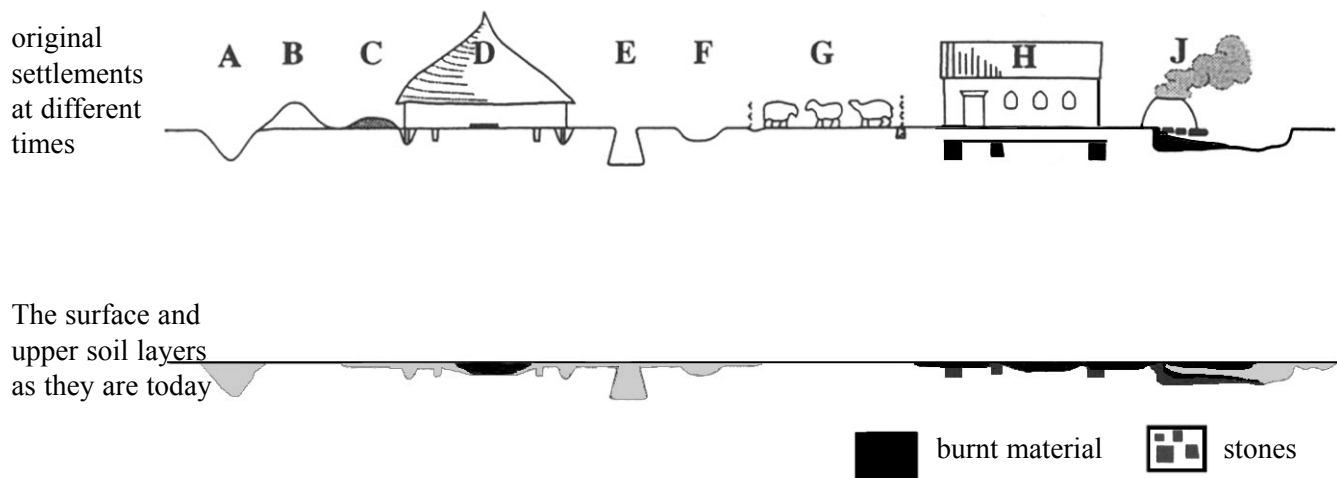
PASSAGE AND FIGURES FOR QUESTIONS 1 TO 25

Consider the following passage, and Figures 1-8, about Geophysical Prospection in Archaeology.

GEOPHYSICAL PROSPECTION IN ARCHAEOLOGY

(1)   Archaeologists use a variety of prospecting methods to 'see' what is underneath the surface of a site, before they begin to dig. Buried objects, ground that has been disturbed, or different soils affect the electrical or magnetic properties of the site. These properties can be detected without damage to archaeological remains.

Figure 1 and Figure 2 give an overview of the results that might be obtained from the survey of a typical site, using a range of methods. These methods are described later in separate sections.

Figure 1

original settlements at different times

The surface and upper soil layers as they are today

burnt material   stones

The first line shows the original settlements.

A and **B** are a medium size ditch and bank surrounding the settlement.

C is a midden (dump of domestic waste).

D is an iron age round house with a central surface hearth; the outer posts are set in a trench and the inner posts in individual holes.

E is a bell-shaped storage pit.

F is a shallow pit.

G is a fenced animal compound.

H is a small roman building with substantial outer wall foundations.

J is a pottery kiln made from baked clay with a stoke-hole.

The second line shows these features as they appear now, after prolonged ploughing. Ditch **A** has loose 'fill' but it would be silty if the surrounding soil was gravel. The bank **B** protected the 'natural' (undisturbed ground) from erosion. You can detect where a bank has been because less soil has been broken-up and the topsoil is shallower. Stone that was above the ground has been taken away. The kiln has collapsed.

Figure 2: **4 SURVEYS OF THE SITE**

Method 1
Resistivity
survey
results -
(shows
changes in
electrical
resistance)

Method 2
Magnetometer
survey -
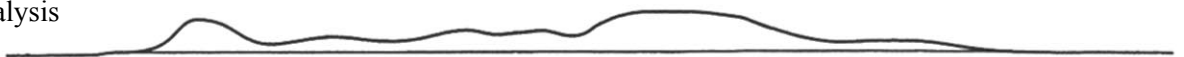
(shows changes
in magnetic field)

Method 3
Magnetic susceptibility
survey -

(the response to a
magnetic field)


Method 4
(Phosphate analysis
of the topsoil)

On the resistivity survey (Method 1) the continuous line is the result expected if the ditch is cut in chalk, clay or loam. The dotted line is the result expected if the ditch is cut in gravel or well-drained types (the two extremes).
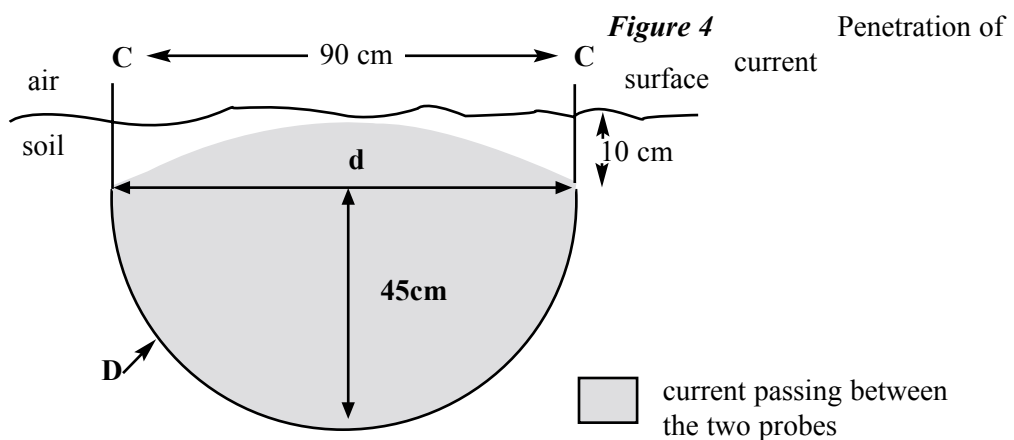
(3)   **Method 1 - Electrical Resistivity survey**

Measuring the resistance of the soil to electric current can often reveal what is under the ground. Four conducting probes, about 1 metre apart in total, are pushed about 10 cm into the ground.

Figure 3

C   P   P   C
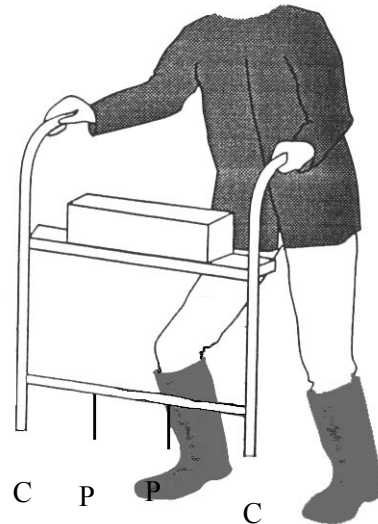
(4)   The two outer probes **C-C** are connected to a power supply and electric current travels between them. The current spreads to a maximum depth of about half the separation of these probes.

Figure 4   Penetration of current

C ←———— 90 cm ————→ C

air   surface
soil   10 cm
           d
        45cm
    D

☐ current passing between the two probes

(5)   The two inner probes **P-P** sense the electric potential (voltage) at their positions. The change in potential with distance (the potential gradient) is calculated. A large potential gradient and a small current means the soil between the probes has high resistivity. A small potential difference but a large current means much lower resistivity.

(6)   The resistivity is affected most by water content. Moisture conducts well and has low resistivity. A reading lower than normal is called a negative anomaly. Dry material is a poor conductor and the resistivity is high. A reading higher than normal is called a positive anomaly.

(7)   Ions in the water conduct the current, for example on chalk (calcium carbonate) where the following reaction occurs

$$CaCO_3 + CO_2 + H_2O = Ca^{2+} + 2HCO_3^-$$

Table 1 Typical values are:
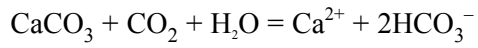
Material	Resistivity /ohm m
Clay and soil	1-10
Porous rock	100-1000
Nonporous rock	10^3-10^6

(8) The best results are obtained after a long hot dry spell of weather, e.g. in July. Results from filled pits depend both on the nature of the fill and of the surrounding soil.
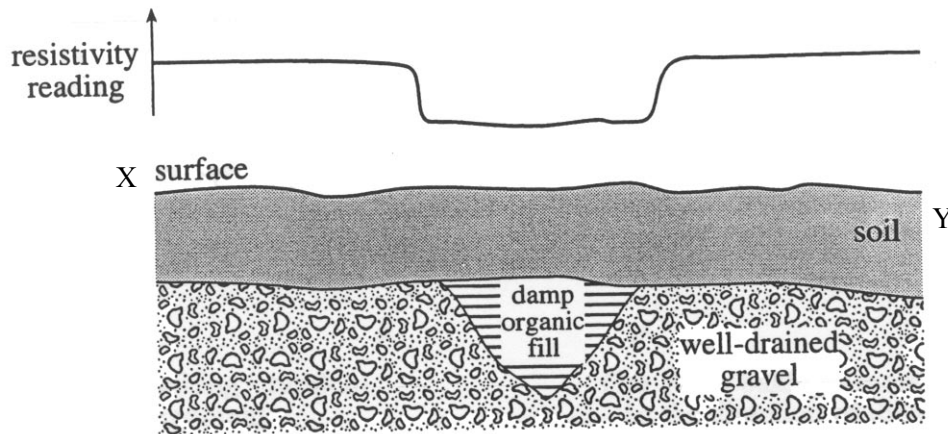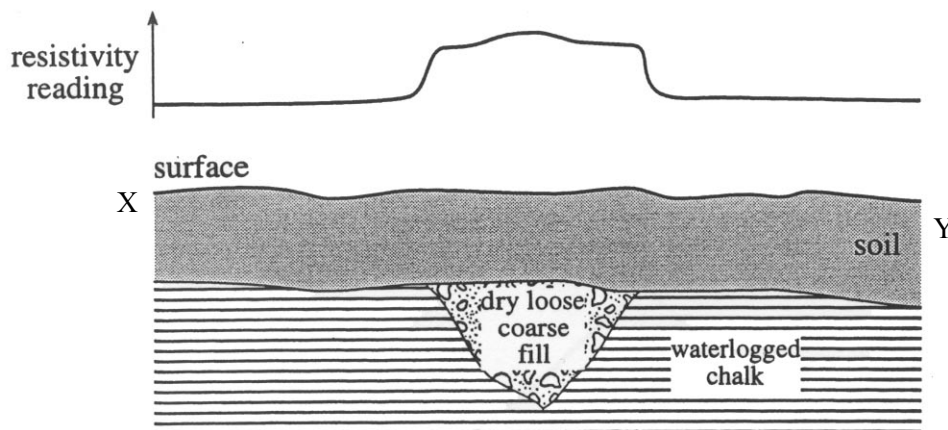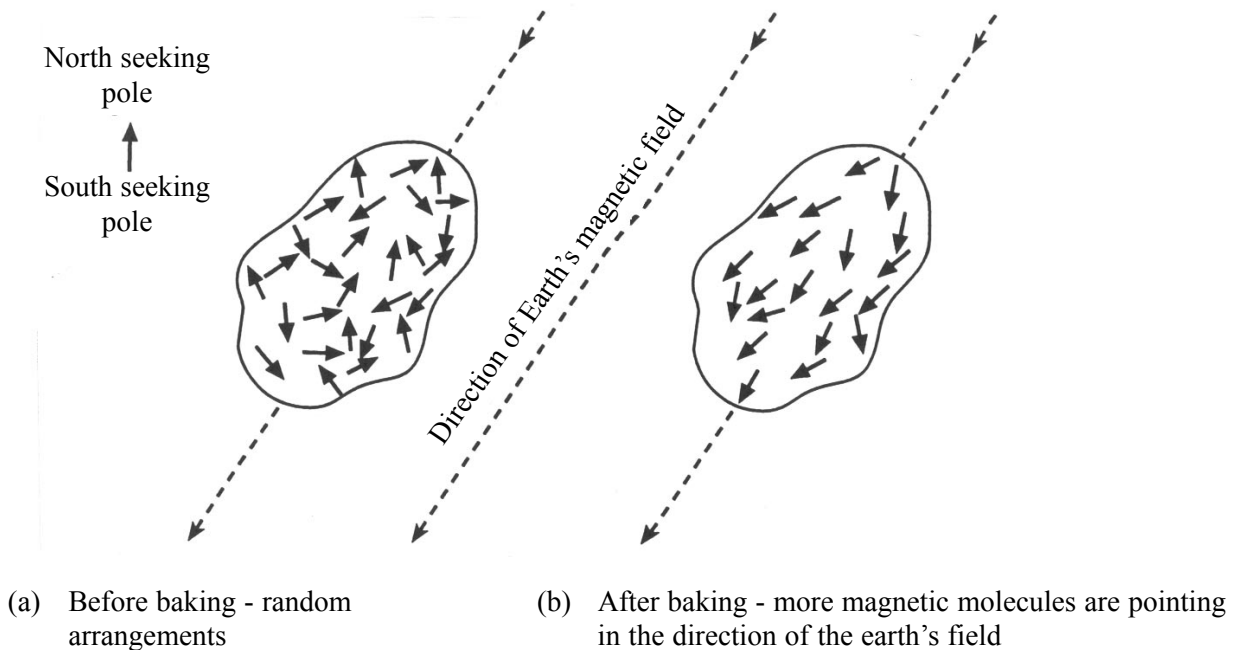
Figure 5a

Figure 5b

Resistivity measurements may be used near metal objects and power lines which produce magnetic fields and interfere with many other methods. The current between the probes is not affected.

Turn over ▶

Method 2 - Magnetometers - passive devices for detecting changes in magnetic fields

(9)   These instruments are sensitive to small sharp differences in the Earth's magnetic field. They detect not only buried objects containing magnetised iron but any burning. Burning shows evidence of occupation. When iron oxide (often found in clay) is heated the magnetic molecules tend to align with the Earth's field. This makes the object become permanently weakly magnetised. As pottery is the most commonly found material this is a very useful technique.

Figure 6   The alignment of magnetic molecules with the Earth's magnetic field

(a)   Before baking - random arrangements

(b)   After baking - more magnetic molecules are pointing in the direction of the earth's field

(10)   Kilns and hearths give an increased magnetic field. Even filled pits may be detected, the effect of deep pits being greatest. The sub-soil is generally less magnetic than the topsoil. Magnetometers can detect deeper changes than other methods. Very small changes, down to 2×10^{-5} % of the earth's field, can be detected.

Figure 7a A deep pit filled with magnetic material is like a bar magnet and gives a strong signal
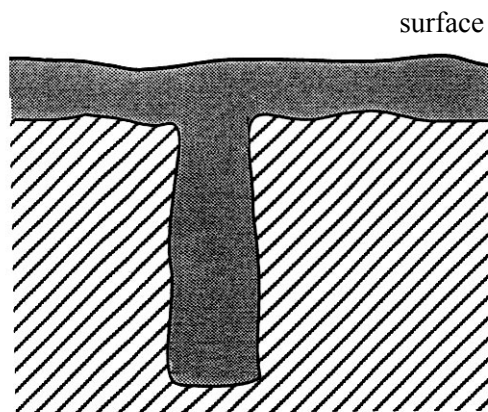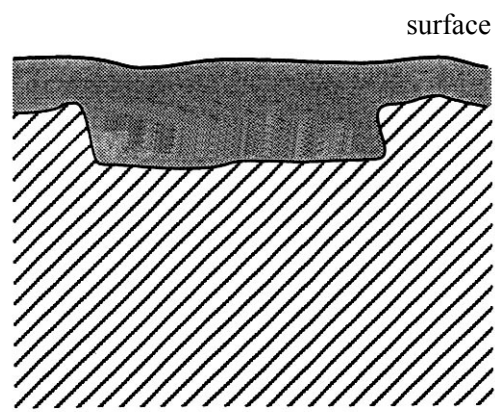
Figure 7b In a shallow pit the flux cancels except at the edges

S   **South seeking pole**
N   **seeking pole**

(11)   Measurements are quick (1 every 5 seconds) and easy but the operator must remove all buckles or buttons etc. containing iron from themselves. Electric trains, power cables, wire fences and corrugated iron are all a problem when measuring magnetic fields.

(12)   The following diagram shows the result of a magnetic survey carried out on a ring of standing stones. The obliterated parts of the surrounding ditch show as an anomaly reaching 50 units. Existing parts of the ditch are magnetically weaker as they contain less of the magnetic soil. **A**, **B** and **C** are filled pits. **D**, **E** and **F** are iron 'spikes' (sudden high readings caused by a piece of iron). Regions labelled **G** are natural variation. There are five stones still standing.

Figure 8 Magnetic survey of ring of standing stones - 15 units per line interval
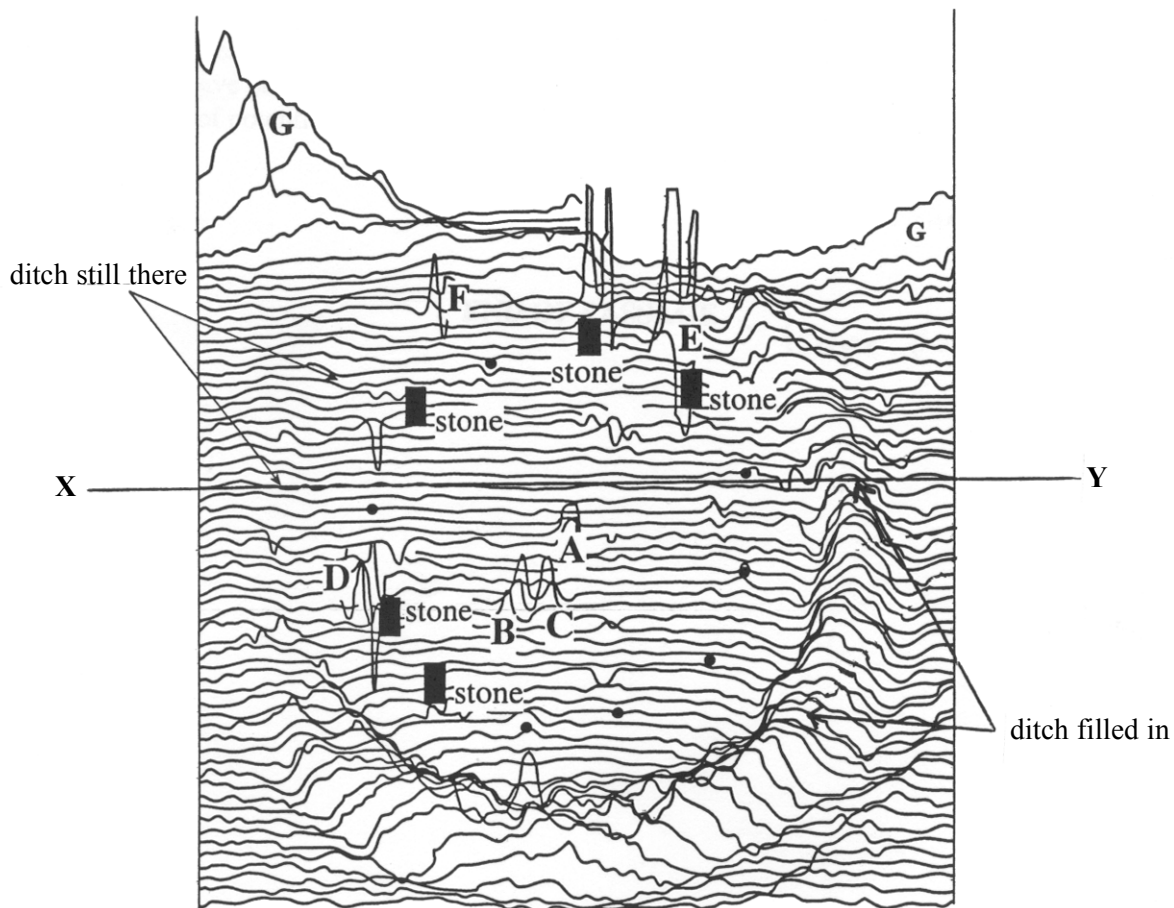
(13)   **Method 3 - Measurement of the susceptibility of soil to a magnetic field (magnetic susceptibility)**

A magnetic field is passed into the ground and a sensor measures the size of the returning signal. Unlike the magnetometer, this is an active method. This method does not detect deeply buried objects, as the weakened signal has to travel back again after reflection (similar to a metal detector). The incoming magnetic field can be increased by magnetic molecules rotating to align with the field. An object does not need to be magnetised to produce a higher or lower reading than the background. Human activity, especially burning, increases the magnetic susceptibility of soil. Iron has a very high magnetic susceptibility and as it is insoluble in water, often accumulates. The topsoil has a greater susceptibility than the sub soil or bedrock. Rubble in the topsoil diminishes the magnetic susceptibility. The readings can show erosion of topsoil and re-deposition elsewhere e.g. when forest clearance has taken place.

Turn over ▶

(14) **Method 4 - Geochemical analysis**

A close correlation has been found between the phosphate content of soil and ancient settlements. Phosphates are taken in by living things and concentrate in their bodies and excreta. The phosphate binds to the particles of the soil and remains there. It is a good idea to test the topsoil, in situ, before removal in a dig.

(15) The survey methods indicate different materials below the ground surface. Because of this archaeologists use the results from a range of surveys to plan the dig. They do this so that it can be carried out efficiently while at the same time protecting valuable archaeological evidence.

END OF PASSAGE