General Certificate of Education
June 2003
Advanced Subsidiary Examination

ASSESSMENT and QUALIFICATIONS ALLIANCE

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

Wednesday 21 May 2003 Afternoon Session

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

You may use a calculator.

Time allowed: 1 hour 15 minutes

Instructions
- Use black ball-point pen.
- 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 to 25) based on material provided in a separate data booklet.
  Section 2 contains 25 objective test questions (Questions 26 to 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 **DATING** which is printed in the separate data booklet.

Each of Questions **1** to **23** 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 23

1 Which of the following explains how scientists were able to tell that the central stump at Seahenge was cut down in late spring?

A The middle ring had thin-walled cells.
B The rings were unusually wide.
C The outermost ring was incomplete.
D The bark was still present.

2 The trees of the ring at Seahenge (paragraph 1) are estimated by archaeologists to have been felled

A 4050 years ago.
B in autumn 2050 BC.
C in spring 2049 BC.
D in summer 2051 BC.

3 Which of the following represents the order of tissues from the centre to the outer bark in a two-year old tree (paragraph 2)?

A pith-xylem-pith-xylem-bark
B pith-xylem-cambium-xylem-bark
C pith-cambium-xylem-cambium-bark
D pith-xylem-cambium-bark

4 Which of the following represents the order of thin and thick-walled cells of xylem in a ring (paragraph 2)?

A pith – thick cells – thin cells – cambium
B bark – pith – thin cells – thick cells – cambium
C pith – thin cells – thick cells – cambium
D pith – thin cells – thick cells – bark

5 In Figure 1a, which of the labels show the earlywood (paragraph 2)?

A i, ii, iii, iv
B i, iii, v
C i, ii, iv, v
D ii, iii, iv, v

6 The term 'locally absent' (Figure 1) means

A not in the area around the tree.
B not on the same slope.
C not found throughout the trunk.
D away from the area.

7 Using Figure 2, which of the samples was alive when William the Conqueror invaded England in 1066?

1 dendroarchaeological sample
2 living tree sample
3 dead wood sample

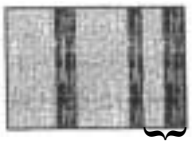
Answer

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

8 In Figure 2, in the dead wood sample, the ring X represents the year

A 1494.
B 1495.
C 1496.
D 1505.

9 Diagram of rings in a sample



Which of the following conditions is most likely to have given rise to the ring at X?

A drier than average
B above average warm temperature
C above average sunlight
D moister than average

10 Diagram of tree rings in a sample

Which of the following conditions represents the last two years' growth rings?

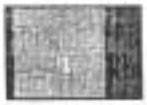
A Year 1 moist; Year 2 moist
B Year 1 moist; Year 2 dry
C Year 1 dry; Year 2 moist
D Year 1 dry; Year 2 dry

11 If last year the climate was moist and this year it is dry, the best match of rings would be

centre ← SAMPLE → bark

A

B



C

D

12 In Figure 3, the plots of the unknown sample show that it lived for

A 20 years.
B 19 years.
C 18.5 years.
D 18 years.

13 A series of tree rings for bristlecone pines extends back 9000 years. It is hoped that recently obtained samples will take this back 10 000 years. This will be interesting to scientists because

A it proves they are long-lived trees.
B it gives indications of past weather.
C it shows there has been no human interference.
D scientists like to gather trivial data.

14 Which of the following represents the proportion of Carbon-14 in a plant (Figure 4 and paragraph 7)?

A 10 000 000 000 %
B 1 000 000 000 %
C 0.000 000 000 1 %
D 0.000 000 001 %

15 Out of 300,000 atoms which is the best estimate of the number of Carbon-12 and Carbon-13 atoms (Figure 4)?

A 2.94×10^5
B 2.99×10^5
C 3.03×10^3
D 9.99×10^2

16 Using the information in paragraph 8, in order to produce 10^7 Carbon-14 atoms, how many cosmic ray neutrons would be needed?

A 70
B 100 000
C 1 000 000
D 10 000 000

17 Using the information in paragraph 10, if Carbon-14 content was 5.5 g, how much would remain after 16,704 years?

A 0.055 g
B 0.69 g
C 1.38 g
D 2.75 g

18 Using Figure 5, if a sample has an activity ratio of 0.5, its estimated age is

A younger than Hemaka.
B older than Zoser, younger than Hemaka.
C older than Hemaka.
D younger than Zoser and Sneferu.

19 Using Figure 5, if A = 0.7 and Ao = 1.15, then the age of the item would be

1 the same as the Boat.
2 younger than the Zoser.
3 younger than the Taymat.
4 younger than the Hemaka.

Answer

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

20 During which time period was the Redwood living (Figure 5)?

A 2800-2000 BCE
B 2400-2300 BCE
C 1000-500 BCE
D 400-300 BCE

21 Tree rings from living specimens can be counted by boring into the tree and removing a narrow cylinder of wood. If the trunk is very thick it may not be possible to reach to the centre. Which of the following methods might best be used to estimate the age of the tree?

A Match the ring pattern with those of younger trees.
B Cut the tree down and count all the rings.
C Work out average ring width and extrapolate from trunk radius.
D Use Carbon-14 dating of the tree bark.

22 To establish the age of Seahenge, both tree-ring dating and Carbon-14 dating were used. Why were two methods needed?

A to ensure that there was no contamination
B in case one was wrong
C because Carbon-14 is more accurate
D because neither can give an accurate answer alone

23 A stalagmite recently found in a cave in Bermuda indicates that more than 20 000 years ago there were dramatic shifts in Carbon-14 concentration, which may mean that early dates are up to 5 000 years out.

This information means that dates earlier than 18 000 BCE

A are all incorrect.
B are probably inaccurate.
C should be ignored.
D are sufficiently correct to use.

Questions 24 and **25**

For Question **24** and **25** you are given an assertion followed by a reason. Consider the assertion and decide whether, on its own, it is a true statement. Consider the reason and decide if it is a true statement. If, and only if, you decide that *both* the assertion and the reason are true, consider whether the reason is a valid or true explanation of the assertion. Choose your answer as follows and indicate your choice on the answer sheet.

Select

A if both the assertion and the reason are true statements and the reason is a correct explanation of the assertion.

B if both the assertion and the reason are true statements but the reason is not a correct explanation of the assertion.

C if the assertion is true but the reason is a false statement.

D if the assertion is false but the reason is a true statement.

Directions summarised			
	Assertion	**Reason**	**Argument**
A	True	True	Reason **is a correct** explanation of assertion
B	True	True	Reason **is not a correct** explanation of assertion
C	True	False	Not applicable
D	False	True	Not applicable

	ASSERTION		**REASON**
24	1890s wood was used for absolute radiocarbon standard	because	1890 was before the release of excessive carbon dioxide.
25	The sample in Figure 1a is dateable by ring counting alone	because	there is one locally absent growth ring per year.

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

Data Booklet

Wednesday 21 May 2003 Afternoon Session

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

PASSAGES AND FIGURES FOR QUESTIONS 1 TO 25

Consider the following passage, and Figures 1 to 5, about Dating.

DATING

(1) Henges are ceremonial sites from the Bronze Age. The most famous is probably Stonehenge on Salisbury plain. Seahenge in Norfolk was a remarkable ring of 55 oak timbers uncovered on a beach. This particular henge had a ring of timbers with an upturned oak stump in the centre. Using modern dating techniques scientists have convinced the archaeologists that the ring is about 4050 years old. They can even say that the central oak was felled or died between April and June 2050 BC. The other trees were cut down in the spring of the following year.

(2) Two methods were used to date the find. The first was dendrochronology, which matches the growth rings in wood to known historical climate data. Rings are made of xylem. Pith is found at the centre of the tree stem followed by the xylem. Between the xylem and the rough bark is a layer of dividing cells (cambium), which form the xylem cells. Each year a new layer of xylem may be formed; thin-walled cells are formed as earlywood and thicker walled cells later in the year as latewood. The thicker walled cells appear as a darker band, before the next year's spring growth (Figure 1).

(3) An annual ring is from the beginning of the earlywood to the end of the latewood. Tree rings are never identical but the general patterns are similar. When the climate is particularly moist it will produce wide rings and in dry years narrow rings.

(4) Scientists use a crosscheck system to verify data. In order for this to be reliable four factors must be present:

- Species studied must produce only one ring per growing season or year.
- Only one dominant environmental factor can be the cause of reduced growth.
- The main environmental factor should be different each year, so changes are easily seen between different annual rings.
- The same pattern should be evident over a fairly wide geographic area, so comparisons can be made.

(5) Factors which may affect tree ring growth are slope gradient, temperature, snow accumulation, soil properties, sun and wind. In some years there may be no growth ring locally, due to severe weather (Figure 1).

Figure 1

(a) Single Locally Absent Ring:
- Bottom part of this photo has 4 full rings
- Top part of this photo has only 3 full rings
- Wedging ring is "locally absent" from that part of the sample
- This sample is crossdateable, but not by mere ring counting

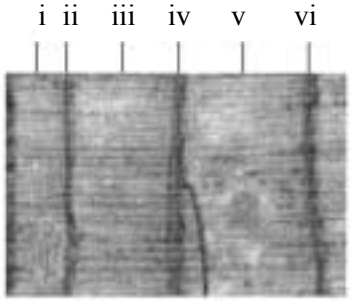


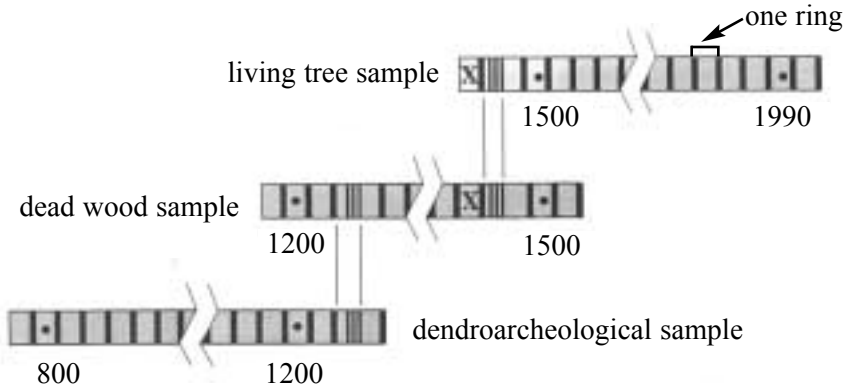
Photo provided by P.R. Sheppard

(b) Many Locally Absent Rings:
- This photo of a coast redwood sample has many rings that are wedging out
- This sample is probably not crossdateable
- Important point: Not all tree-ring samples are crossdateable

Photo provided by H.C. Fritts

Figure 2 (below) shows how three samples can be compared to find the common overlap. From this the years that the tree was alive can be found.

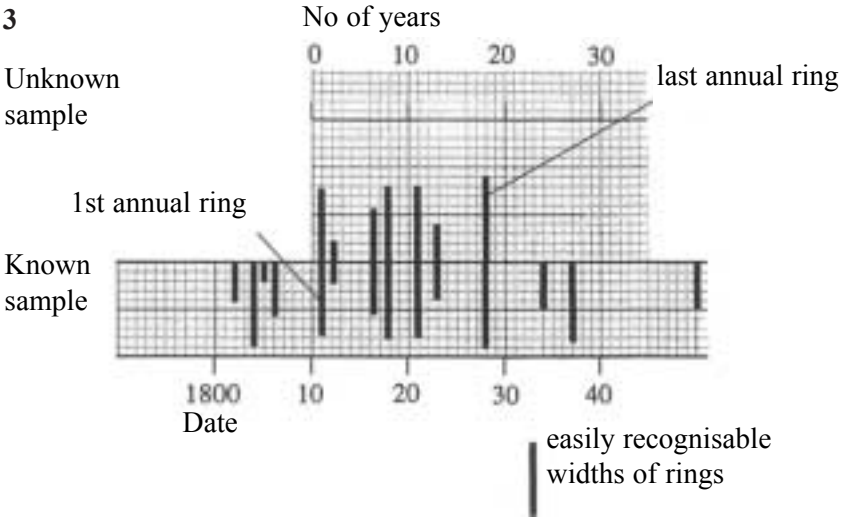
Figure 2



After crossdating, dendrochronologists can:
- Assign the true year of formation for every ring of each sample
- Analyse past environmental and/or human events.

Crossdated samples overlap in time. Using plotting this can be graphed out to find matching patterns.

Figure 3



(6) Unfortunately in the case of Seahenge's trees the oak rings matched many parts of Britain's weather spectrum.

(7) The second method is radiocarbon analysis. There are three principal isotopes of carbon which occur naturally: Carbon-12 and Carbon-13 are both stable. Carbon-14 is unstable or radioactive. These are present in varying amounts.

Figure 4

Type of Carbon	Percentage
12	98.89
13	1.11
14	1.0×10^{-10}

This means that one Carbon-14 atom exists in nature for every 1,000,000,000,000 Carbon-12 atoms in living material.

(8) The method depends on the rate of decay of the Carbon-14, which is formed in the upper atmosphere by cosmic ray neutrons acting on Nitrogen 14.

Nitrogen-14 + n => Carbon-14 + p where n = neutron and p = proton

The Carbon-14 is changed to carbon dioxide by reacting with oxygen. The carbon dioxide can then be taken up by plants in photosynthesis and converted to sugar. When animals eat the plants the Carbon-14 is transferred to animals. The proportion of Carbon-14 in the living system is therefore the same as in the atmosphere.

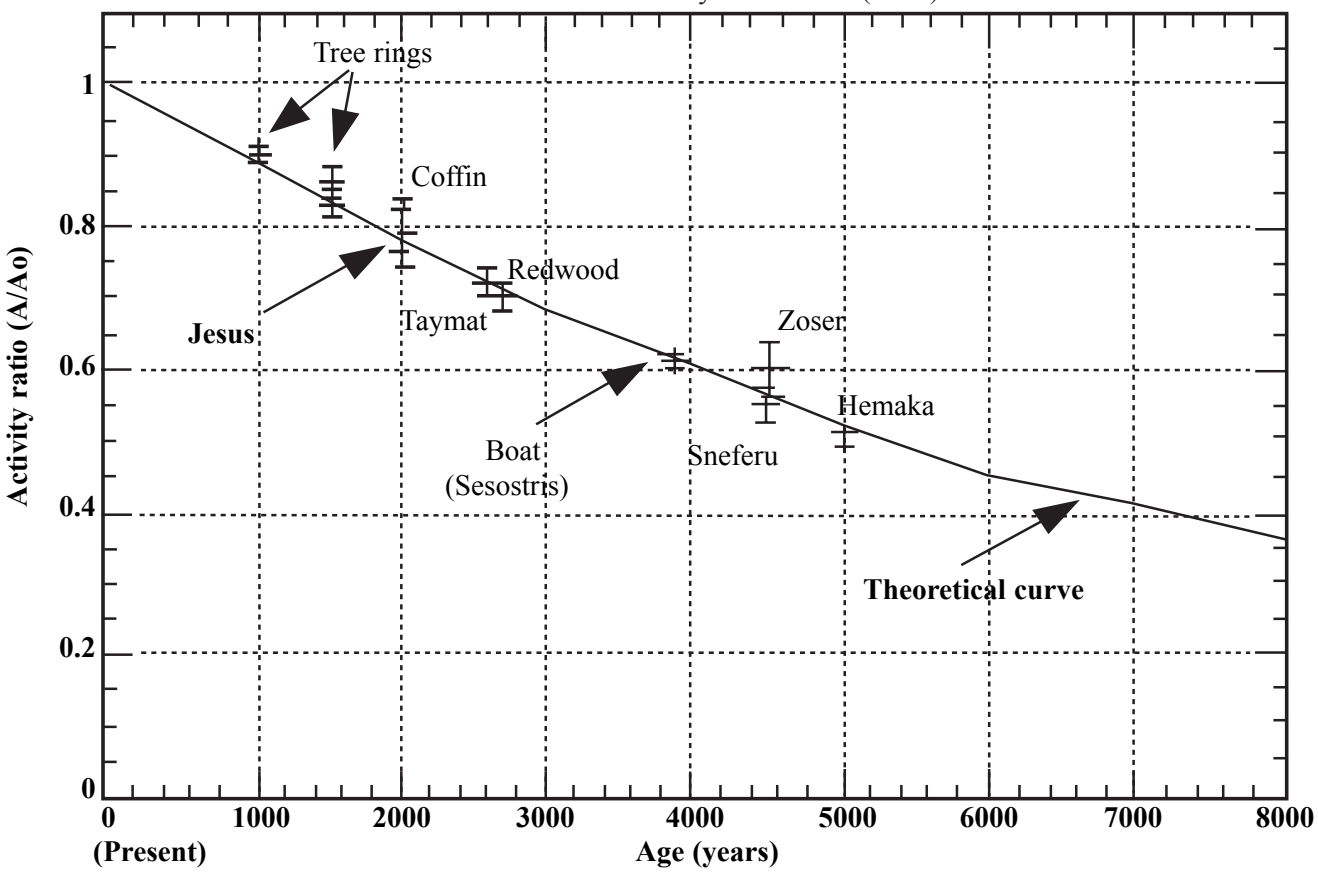
(9) When the plant or animal dies, no more carbon dioxide is taken up but the tissue is decayed by decomposing bacteria. However, where tissue is fossilised, it will contain the remains of the carbon which has not yet radioactively decayed.

(10) Libby, Anderson and Arnold first discovered that the radioactive decay of Carbon-14 occurs at a constant rate. They found that after 5568 years, half the Carbon-14 in the original sample will have decayed and after another 5568 years, half of that remaining material will have decayed. The half-life is the name given to this value which was measured to 5568 years with an allowance for error of ± 30 years. The Carbon-14 present in an unknown sample can then be compared with the Carbon-14 in similar oak tissue today. Then by using the half life the age at which the fossilised remains died can be calculated. This can then be compared with the Curve of Knowns (Figure 5).

(11) The new method was tested against radiocarbon dating of known age samples, mainly from Egypt. The Egyptian Kings' names are given next to the corresponding ages obtained. The ages are shown as vertical lines. The theoretical curve was constructed using the half-life of 5568 years. The activity ratio plotted on the y-axis is the ratio of the activity of the sample (A) against modern activity (Ao).

Figure 5

The "Curve of Knowns" after Libby and Arnold (1949)



(12) Later the half life was adjusted to 5730 ± 40 years and this became known as the Cambridge half-life. Since then carbon dating has advanced to use better technology, where much smaller samples of the tissue are required. However, in tissue over 50 000 years old, the level of Carbon-14 would be too small to measure, so any item older than this needs to use other radioactive elements with longer half lives.

(13) The modern standard is taken to be the measured Carbon-14 activity of oxalic acid in a crop compared to the absolute radiocarbon standard of 1890 wood. 1890 wood is used because it was growing before the fossil fuel effects of the Industrial Revolution. As the ratio of activity of the oxalic acid can be worked out compared to the 1890 wood, the oxalic acid can be used by scientists to compare an unknown sample to the activity in a sample of the oxalic acid.

(14) For the Seahenge timbers, even more complex statistical tests have been used to combine the dates for the dendrochronology and Carbon-14 methods to give the exact dates mentioned in paragraph 1.

END OF PASSAGE

SECTION 2

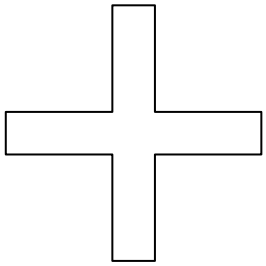
Answer Questions 26 to **50**

Each of the 25 questions carries 1 mark.

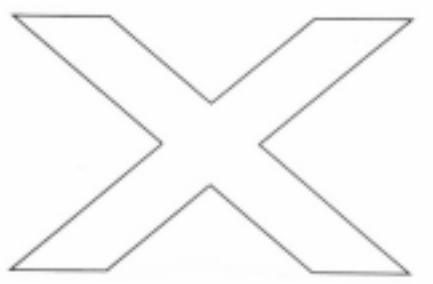
For each of Questions **26** to **50** choose the answer you consider the best of the alternatives offered in **A, B, C** and **D**. You are reminded that graph paper is available on request from the Invigilator.

26 Which of the following crosses has **exactly** 2 axes of symmetry?

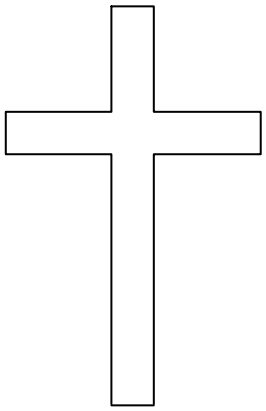
A



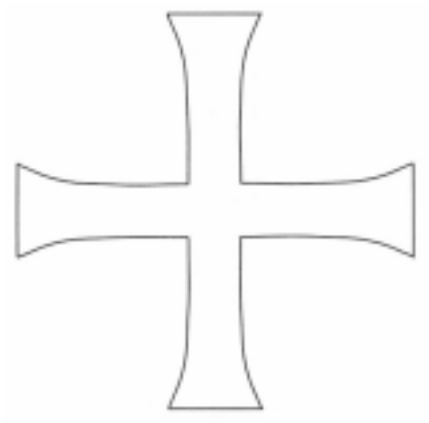
B



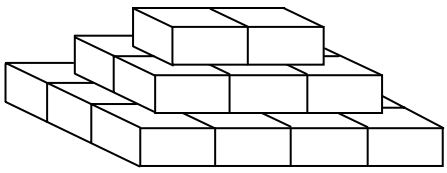
C



D



27 A type of pyramid is made of blocks as shown so that there are 2 blocks on the top layer, 6 blocks on the second layer, 12 blocks on the third layer, 20 blocks on the fourth layer, and so on.



Continuing the same pattern, how many blocks will be in the n^{th} layer?

A $2n$
B $4n - 2$
C $n^2 + n$
D $2n^2$

Questions 28 and 29

A mobile phone company used to have a tariff which charged customers 25 p per minute for the first two minutes of calls of any one day, and 15 p per minute for any further use that day. Calls were charged by the second.

28 What was the cost for using the phone for 4 minutes 20 seconds on one day?

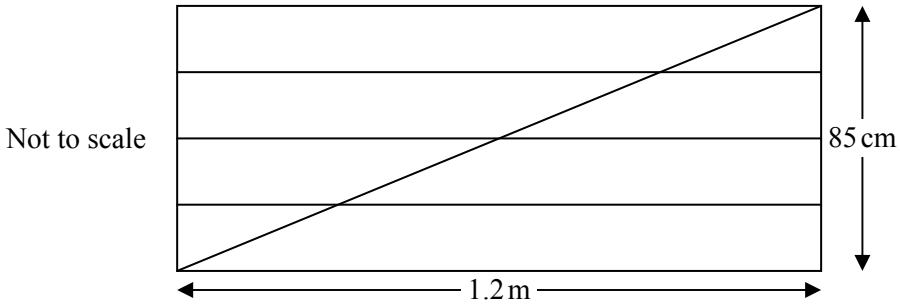
A 65 p
B 66 p
C 83 p
D 85 p

29 The charge for one day's use was £ 1.76. How long was the phone used for on this day?

A 8 min 40 sec
B 10 min 24 sec
C 10 min 40 sec
D 11 min 44 sec

Questions 30 and 31

The diagram shows a gate made from metal rods. The gate measures 1.2 m by 85 cm.



30 The length of metal, correct to the nearest 10 cm, needed to make the gate is

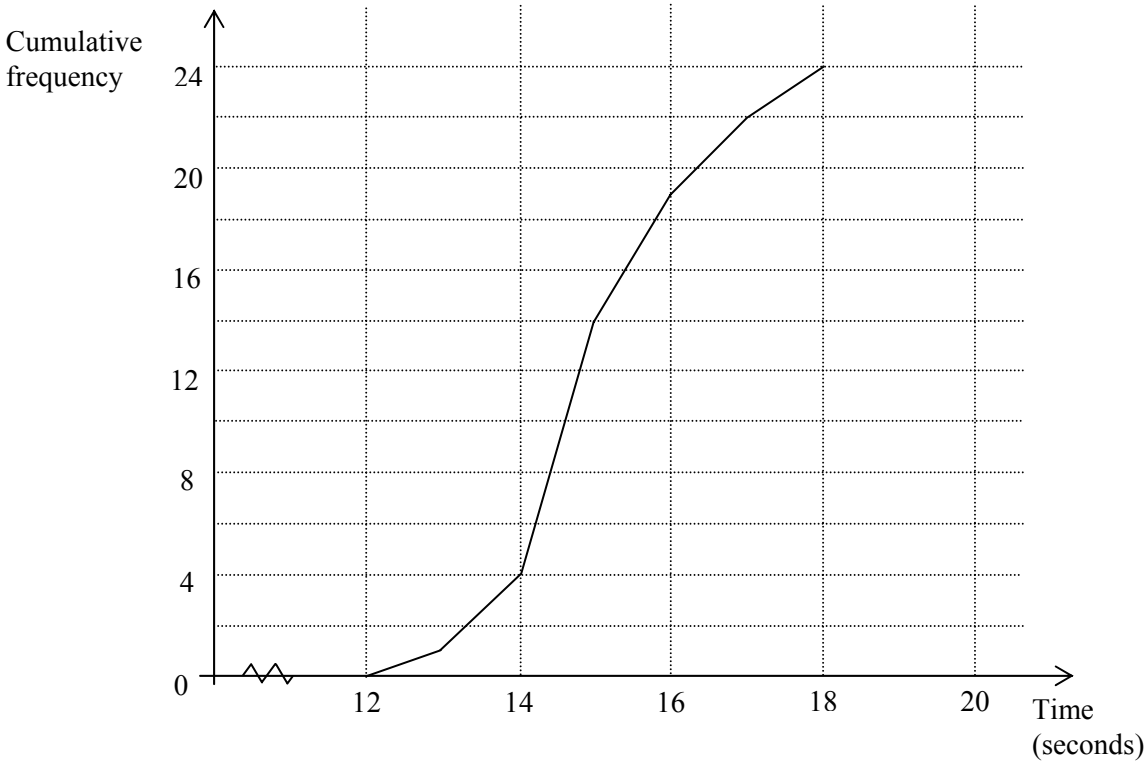
A 7.7 m
B 9.1 m
C 9.2 m
D 9.9 m

31 What is the angle made by the diagonal of the gate with the horizontal?

A 35.3°
B 44.9°
C 45.1°
D 54.7°

Questions 32 to 34

The cumulative frequency graph shows the time taken by each person in a class to run 100 metres.



32 Which time interval includes the result for the slowest member of the class?

A 11-12 seconds
B 12-13 seconds
C 17-18 seconds
D 23-24 seconds

33 What is the approximate value for the interquartile range of the times?

A 1.5 seconds
B 3 seconds
C 6 seconds
D 12 seconds

34 Statement **1** The median time of the fastest 12 students is approximately half the median time for the whole class.
Statement **2** The range of times for the fastest 12 students is approximately half the range of times for the whole class.

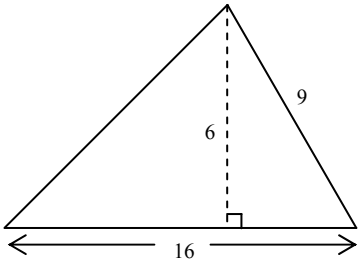
Which of the above statements is/are correct?

A Both **1** and **2**
B **1**, but not **2**
C **2**, but not **1**
D Neither **1** nor **2**

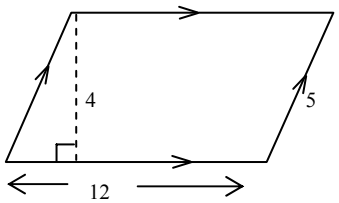
35 Three of these shapes have the same area. Which does not?

All diagrams not to scale

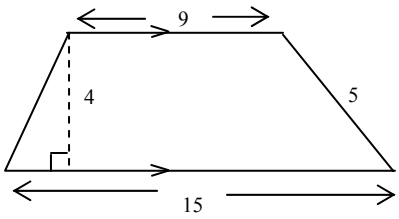
A



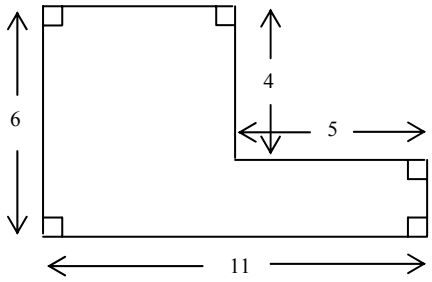
B



C



D



36 A tank with a capacity of 100 litres can be filled from either of two taps. The first tap takes 5 minutes and the second takes 10 minutes. With both taps running, how many minutes will it take to fill the tank?

A $2\frac{1}{2}$

B $3\frac{1}{3}$

C $3\frac{3}{4}$

D $7\frac{1}{2}$

37 An estate agent gives the length of a plot of land as 60 m correct to one significant figure. The shortest possible length of the plot is

A 50 m
B 54.5 m
C 55 m
D 59.5m

38 The area of Angola is approximately 1.2×10^6 square kilometres; the area of Botswana is approximately 5.8×10^5 square kilometres. The difference between these two areas in square kilometres is approximately

A 4.6×10^{-1}
B 4.6×10^{1}
C 6.2×10^{5}
D 6.2×10^{6}

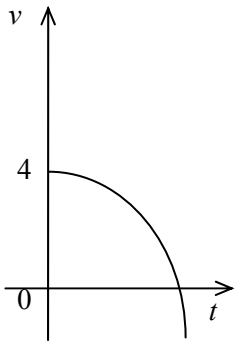
Questions 39 to 41

A particle travels between two points M and N on a straight line.
The particle starts at a point between M and N. t seconds later the velocity, $v\,\text{m s}^{-1}$, of the particle in the direction of N is given by

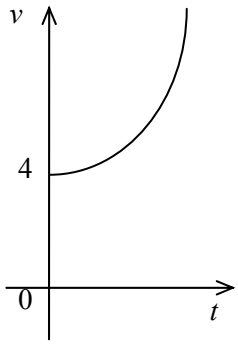
$$v = 3t^2 - 4$$

39 A graph showing the relationship between v and t for $t \geq 0$ is

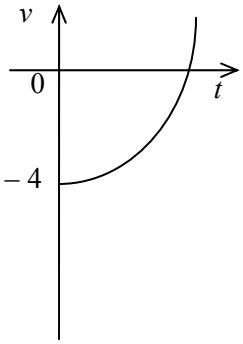
A



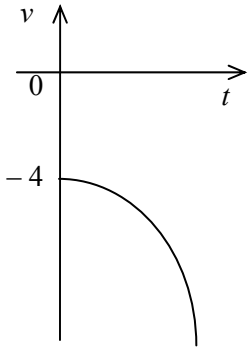
B



C



D



40 A rearrangement of $v = 3t^2 - 4$ to give an equation for t in terms of v is

A $t = \sqrt{\dfrac{v+4}{3}}$

B $t = \dfrac{\sqrt{v+4}}{3}$

C $t = \sqrt{\dfrac{v}{3}+4}$

D $t = \sqrt{\dfrac{v}{3}}+4$

41 Using the equation $v = 3t^2 - 4$, $v = -1$ when $t = 1$. This means that after one second

A the equation cannot be used.
B the particle is not between M and N.
C the particle has not yet started to move.
D the particle is moving towards M.

42 A tourist went to Australia with £1000 to spend. The exchange rate was £1 = A$2.681. He spent A$1500. He then went to New Zealand where the exchange rate was £1 = NZ$3.217.
The number of NZ$ he had to spend was

A 367.
B 984.
C 1417.
D 3799.

43 After taking part in a competition, each contestant was given a grade from 1 (the lowest) to 6 (the highest). The table shows the results of the competition.

Grade	1	2	3	4	5	6
No. of contestants	10	15	25	20	15	5

What is the probability that a randomly chosen contestant achieved a grade higher than the modal grade?

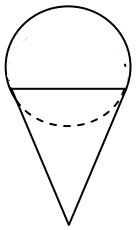
A $\frac{4}{9}$

B $\frac{1}{2}$

C $\frac{5}{9}$

D $\frac{13}{18}$

44 The volume, V, of a sphere of radius r is given by $V = \frac{4}{3}\pi r^3$



The volume of ice-cream needed to fill a cone is modelled by a sphere of diameter 5 cm. The number of such cones which can be filled from 1 litre of ice-cream is approximately

A 2
B 15
C 65
D 520

45 A set of five numbers is reported as having the following characteristics:

Mode = 3 Median = 4 Mean = 5 Range = 6

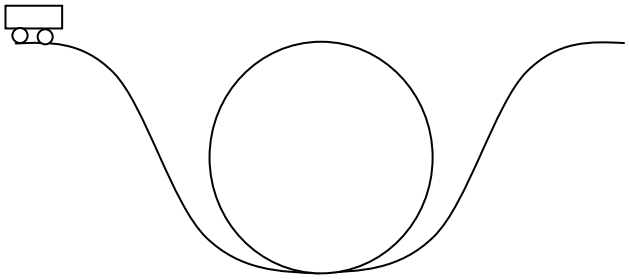
Which one of the following can be deduced?

A No set of numbers exists that satisfies these statements.
B There is a unique set of numbers that satisfies these statements.
C There are exactly two sets of numbers that satisfy these statements.
D There are more than two sets of numbers that satisfy these statements.

Turn over ▸

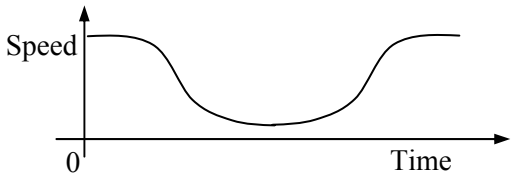
Questions 46 and 47

On a ride at a theme park a car performs a vertical loop as shown below.

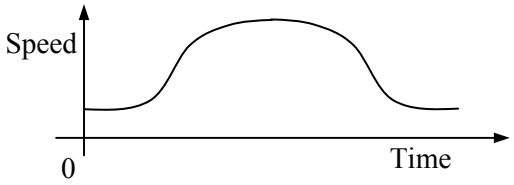


46 Which graph best shows the speed of the car during the ride?

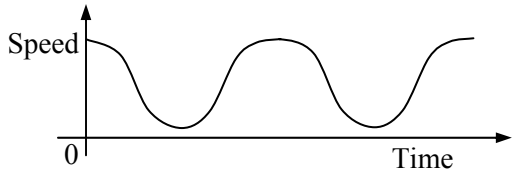
A



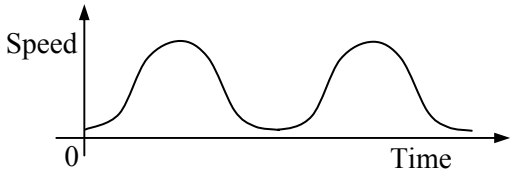
B



C



D



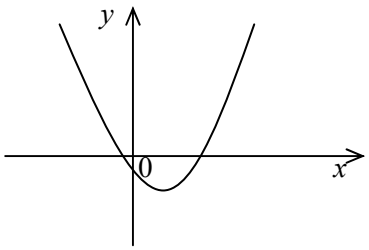
47 The times 60 customers spent waiting in the queue for the ride are shown in the table.

Time in queue	Number of customers
Up to 10 minutes	2
10 minutes up to 20 minutes	7
20 minutes up to 30 minutes	18
30 minutes up to 60 minutes	33
Over 60 minutes	0

The best estimate of the mean waiting time is

A 25 minutes.
B 30 minutes.
C 35 minutes.
D 40 minutes.

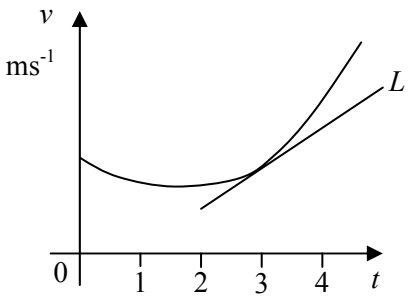
48 The diagram shows the graph of the function $y = 2x^2 - 7x - 15$.



The graph is used to solve the equation $2x^2 - 7x - 15 = 5$. Which of the following statements is true of the solutions to this equation?

A The equation has no solutions.
B The equation has one solution only.
C The equation has two non-negative solutions.
D The equation has one positive and one negative solution.

49

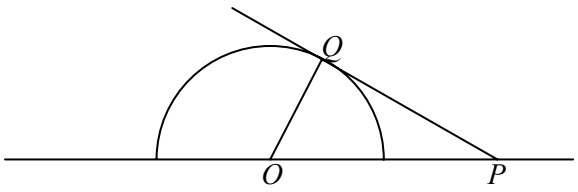


L is the tangent to the velocity-time graph at $t = 3$.

The gradient of L gives

A the acceleration at $t = 3$.
B the distance travelled in the first three seconds.
C the speed at $t = 3$.
D the velocity at $t = 3$.

50 A semi-circle, centre O, is drawn on a straight line. A second line is drawn from a point P on the straight line and outside the semi-circle, to touch the semi-circle at Q, as shown in the diagram.
The angle OQP is



Not to scale

A always acute, for all possible positions for P.
B always 90°, for all possible positions for P.
C always obtuse, for all possible positions for P.
D sometimes acute and sometimes obtuse, depending on the position of P.

END OF QUESTIONS