General Certificate of Education
January 2004
Advanced Subsidiary Examination

AQA

ASSESSMENT and
QUALIFICATIONS
ALLIANCE

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

Tuesday 13 January 2004   Morning 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.

GSA2

SECTION 1

Answer Questions 1 to 25

Each of the 25 questions carries 1 mark.

Read the passage entitled **FOOD - YOU ARE WHAT YOU EAT?** 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 two colouring additives would mimic the colour in a ripe raspberry? (paragraph 2 and Table 2)

    A   chlorophyll and carotenoids
    B   chlorophyll and flavonoid
    C   carotenoids and flavonoid
    D   carotenoids and azorubine

2   Which of the following is **not** a natural colour? (paragragh 2 and Table 2)

    A   azorubine
    B   carotenoids
    C   chlorophyll
    D   flavonoids

3   Which of the additives below is/are linked to a fossil fuel?

    1   E122
    2   E123
    3   E140
    4   E142

    Answer

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

4 Which colour would most likely be used with tinned strawberries in Sweden? (Table 2)

    A   E102
    B   E122
    C   E123
    D   E163

5 Which of the following conditions would result in food 'going off' quickest? (paragraph 4)

    A   very high temperatures, moist air
    B   very high temperatures, dry air
    C   warm temperatures, moist air
    D   warm temperatures, dry air

6 Benzoic acid is an organic acid (paragraph 4), therefore it must contain which of the following elements?

    A   carbon
    B   nitrogen
    C   phosphorus
    D   sulphur

7 According to Table 3, what is the maximum mass of sodium benzoate contained in a litre of orange drink?

    A   0.01 g
    B   25 mg
    C   25 g
    D   100 mg

8 According to the article, which of the additives may be both natural and artificial? (Tables 2, 3 and paragraph 6)

    A   E160
    B   E200
    C   E210a
    D   E360

9 Which of the additives is converted to a vitamin? (Tables 2, 3 and paragraph 6)

    A   E160
   **B**   E200
    C   E220
    D   E360

10   The accepted daily intake of BHA for a person was calculated to be 35 mg.
What would be the maximum acceptable level of BHT for the same person? (paragraph 7)

      A   10.5 mg per day
      B   21.0 mg per day
      C   35.0 mg per day
      D   58.3 mg per day

11   A person weighs 72 kg, the maximum amount of BHA and BHT they should consume (paragraph 7) is

      A   14.5 mg BHA, 27 mg BHT
      B   0.36 g BHA, 21 mg BHT
      C   22 mg BHA, 36 mg BHT
      D   0.036 g BHA, 21.6 mg BHT

12   Which of the foods in Table 1 contain thickeners? (paragraph 10)

      1   baked beans
      2   gravy browning
      3   sweet and sour sauce
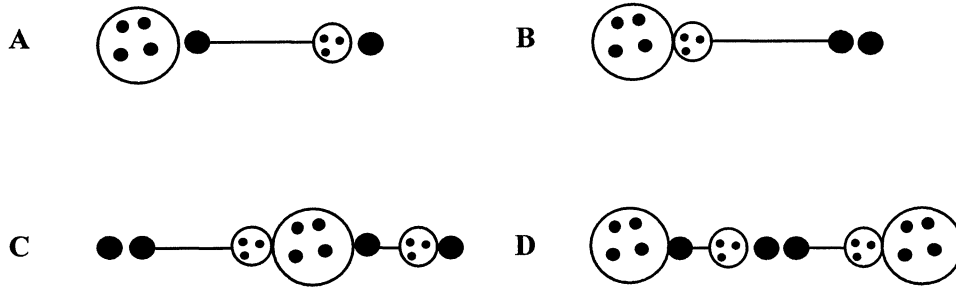   **4**   chicken chasseur sauce mix

    Answer

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

Questions 13 and 14

The symbols below represent the molecules in an emulsion.

oil water emulsifier

oil-friendly water-friendly
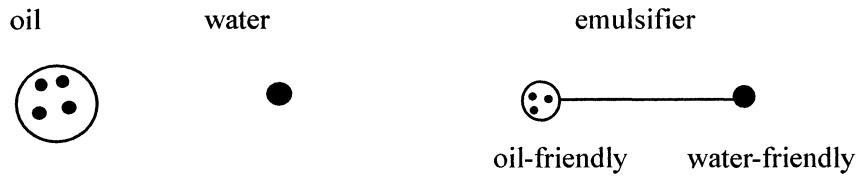
13 Which of the diagrams below shows how an emulsifier works? (paragraph 8)

14 Which of the diagrams below shows the emulsion in mayonnaise? (paragraph 8)
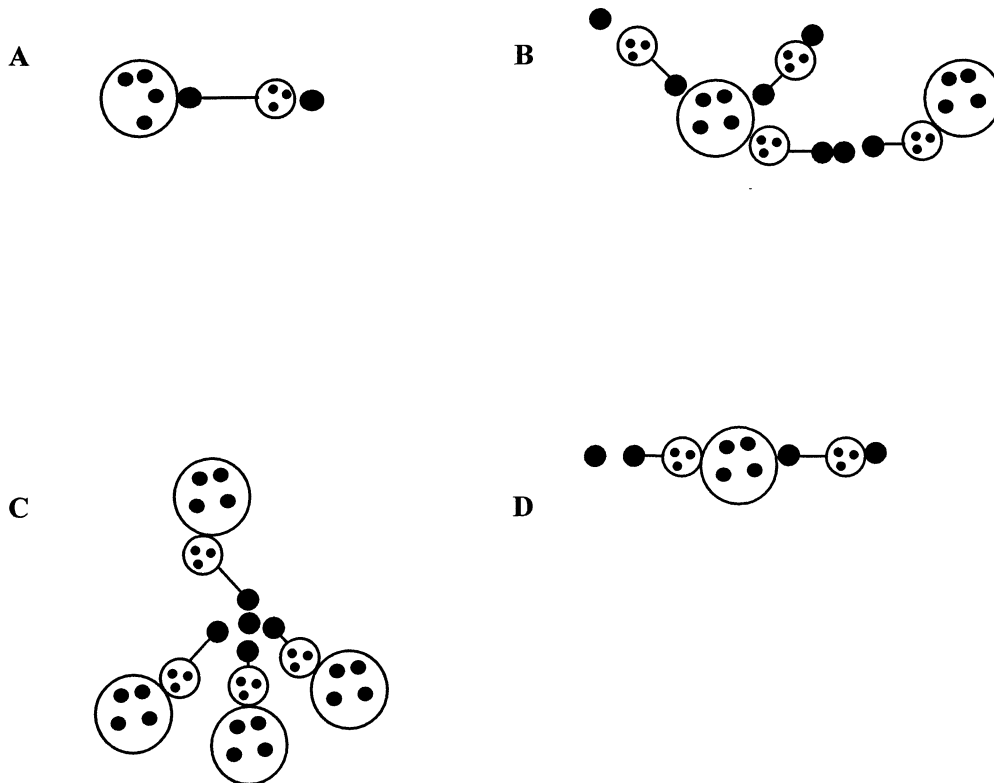
15   What is meant by agglomerate? (paragraph 11)

    A   oxidise

    B   melt

    C   dry out

    D   form lumps

16   In Table 1, which food contains a synthetic flavour enhancer? (paragraph 12)

    A   chicken chasseur mix

    B   baked beans

    C   sweet and sour sauce

    D   gravy browning

17   If all sweeteners were the same price (weight for weight) which of the following would be the most cost effective for food manufacturers to use? (paragraph 14 and Table 5)

    A   E952

    B   E954

    C   E957

    D   E959

18   The best description of a food containing E123, E160, E957 and methoxypyrazine would be (Tables 2, 4 and 5)

    A   orange-yellow, sweet, nut flavour.

    B   red-orange, sweet, earthy vegetable flavour.

    C   orange-yellow, very sweet, nut flavour.

    D   red-orange, very sweet, earthy vegetable flavour.

19   Lactitol is the sugar that comes from (paragaraph 15)

    A   milk.

    B   fruit.

    C   cane.

    D   beet.

20   A person wants to put on weight. Which of the following sweeteners would be the most appropriate to use? (Table 5 and paragraph 15)

    A   xylitol

    B   E952

    C   E950

    D   sucrose

21 According to paragraph 17, what is meant by 'intolerance'?

    A   immune
    B   harmless
    C   poisonous
    D   violent

22 Starch found in gravy browning (Table 1) is

    A   a preservative.
    B   an antioxidant.
    C   a thickener.
    D   an anti-caking agent.

TURN OVER FOR THE NEXT QUESTION

Assertion/reason questions

In Questions **23** to **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 **A**, **B**, **C** or **D** 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

23   Tartrazine (Table 2) is banned in Australia   because   the Norwegian government supports a ban.

24   Benzoic acid and caffeine may cause intolerance reactions (paragraph 17)   because   the person lacks the ability to produce an enzyme to break down the chemical.

25   The number of additives used has increased since 1968   because   the European Union introduced the E system of numbering.

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   Sam invested £5 000 at a compound interest rate of 4% per annum. Interest was added to the investment at the end of each year.

Which graph best shows the value of the investment over a number of years?
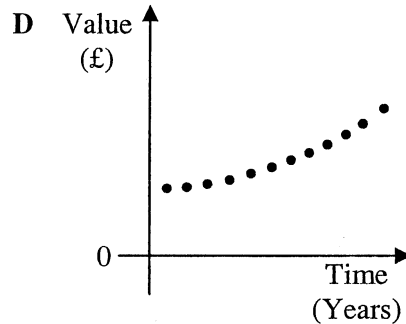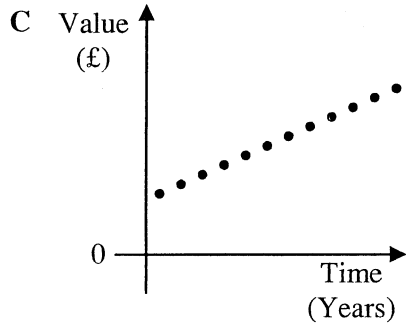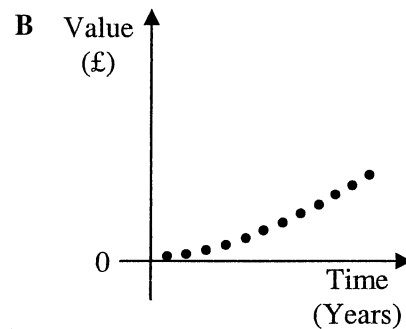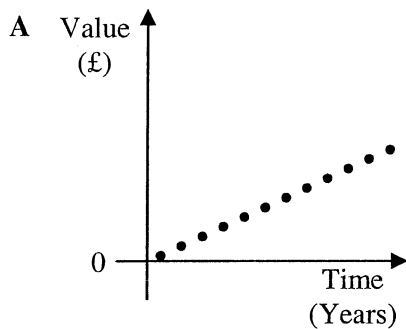
27   A garden water butt is approximately cylindrical with a diameter of 56 cm and a height of 90 cm. What is the approximate weight of water it contains when full, if 1 cubic centimetre of water weighs 1 gram?
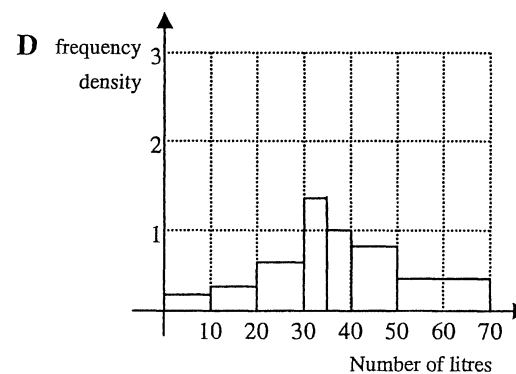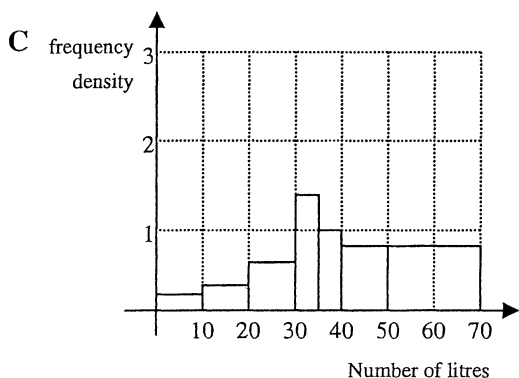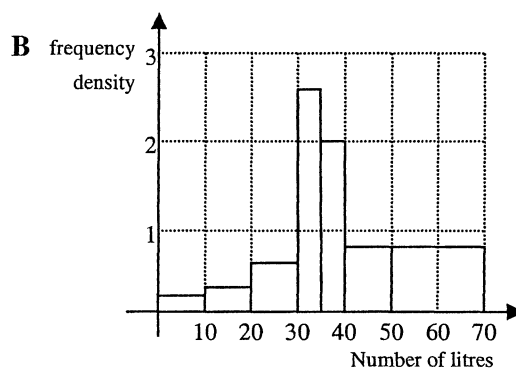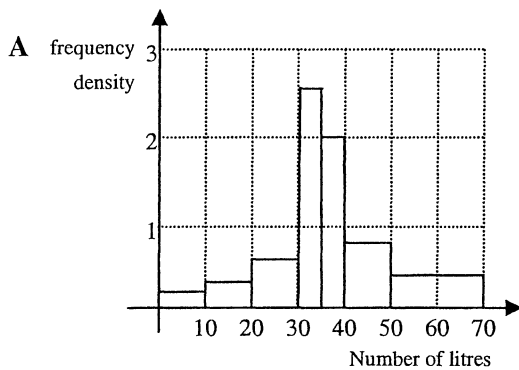
    A   890 kg
    B   220 kg
    C   32 kg
    D   16 kg

Questions 28 to 30

The owner of a fuel station investigated how much fuel his customers bought on average each visit. He collected the following data from the first 50 customers who bought fuel on a Monday morning.

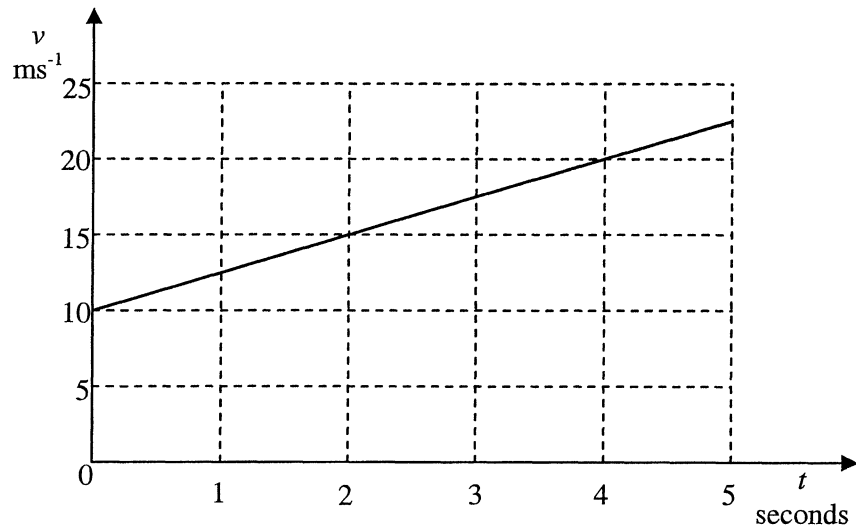| Number of litres (x)	Frequency
$0 < x \leq 10$	2
$10 < x \leq 20$	3
$20 < x \leq 30$	6
$30 < x \leq 35$	13
$35 < x \leq 40$	10
$40 < x \leq 50$	8
$50 < x \leq 70$	8

28 The mean number of litres bought was approximately?

A   7
B   10
C   37
D   42

29 Which one of the following is the main reason to decide that the results of this survey are not representative of the weekly sales?

A   The owner collected only 50 data items.
B   The owner collected data only from the first customers on a Monday morning.
C   The owner split the data into different width groups.
D   The owner included all types of fuel in the survey.

30 Which histogram shows the data correctly?

A   frequency density vs Number of litres

B   frequency density vs Number of litres

C   frequency density vs Number of litres

D   frequency density vs Number of litres

Turn over ▶

Questions 31 and 32

A velocity-time graph is shown.

31 The equation of the line can be written as each of the following **except**

A $v = \dfrac{5t}{2} + 10$

B $2v - 5t = 20$

C $v - 20 = \dfrac{5}{2}(t - 4)$

D $5v = 2t - 20$

32 The calculation $\dfrac{(17 \cdot 5 + 20)}{2} \times 1$ is used to work out

A the average speed in the first four seconds.
B the distance travelled in the first four seconds.
C the distance travelled in the fourth second.
**D** the acceleration in the fourth second.

33 In a cafe, 5 soft drinks and 3 coffees cost £6.60 and 3 soft drinks and one coffee cost £3.20. How much does it cost for an order of one soft drink and one coffee?

A £1.60
B £1.70
C £1.80
D £1.90

34 A ship's speed is often given in knots, i.e. nautical miles per hour.
Given the conversion factor, 1 nautical mile ≈ 1.15 miles, what is the time taken in hours to cover 60 miles at a speed of 12 knots?

A 4.35
B 4.85
C 5.00
D 5.75

35

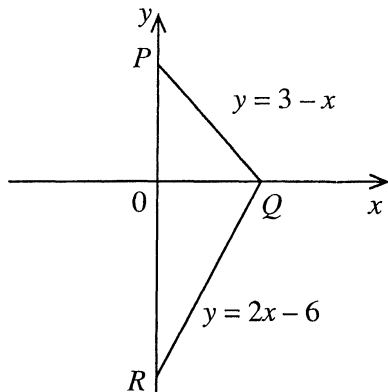Not to scale
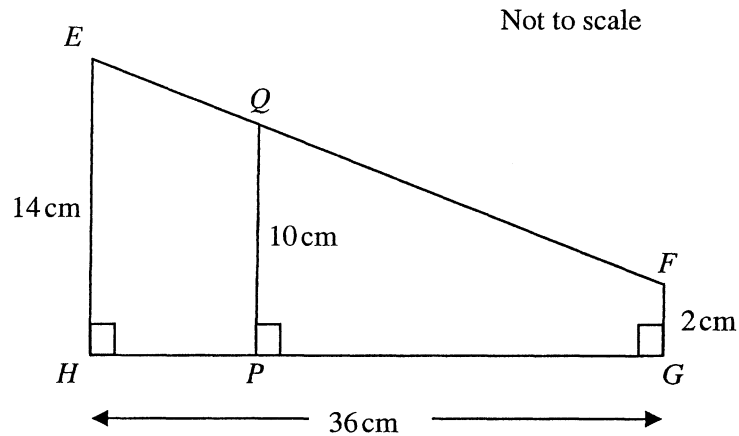
EFGH is trapezium. *EH* = 14 cm, *FG* = 2 cm and *HG* = 36 cm. The line *PQ*, perpendicular to *HG*, is of length 10 cm.

What is the length of *PG*?

A 12 cm
B 18 cm
C 24 cm
D 26 cm

Questions 36 and 37

The line $y = 3 - x$ intersects the y axis at P and the x axis at Q. The line $y = 2x - 6$ intersects the y axis at R and the x axis at Q.

36 The area of triangle PQR is

    A   13.5
    B   22.5
    C   27
    D   45

37 The length of PQ is

    A   2.45
    B   4.24
    C   6
    D   18

Questions 38 and 39

A mobile telephone company offers three alternative tariffs.

Tariff P: 5p per minute for all calls each month.
Tariff Q: 20 minutes of free calls each month; subsequent calls charged at 10p per minute.
Tariff R: 40 minutes of free calls each month; subsequent calls charged at 20p per minute.

38   In one month a customer on Tariff Q uses the phone for 90 minutes. What would be the percentage saving on Tariff P?
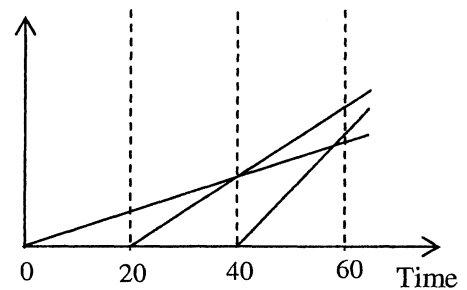
A	22%
B	36%
C	50%
D	64%

39   Which graph correctly illustrates the Cost against Time relationship for the three tariffs?
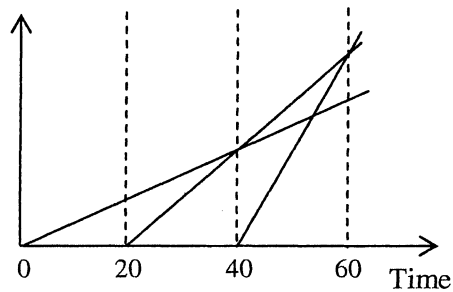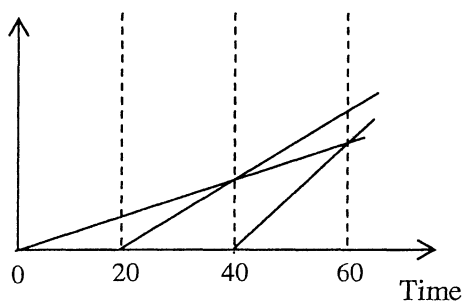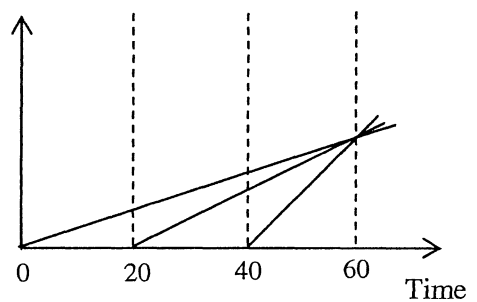
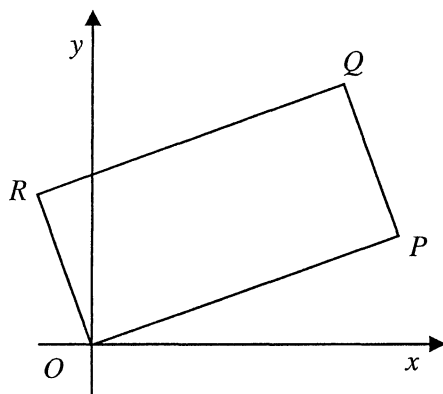**40** $OPQR$ is a rectangle. The equation of OP is $y = \frac{1}{2}x$. Point Q is at (10,10). What is the equation of side QR?

Not to scale

A $\quad y = \frac{1}{2}x - 5$

B $\quad y = \frac{1}{2}x + 5$

C $\quad y = 2x - 10$

D $\quad y = 30 - 2x$

41 A group of pupils sat a test in which the highest mark possible was 80.

The table shows the cumulative frequency of marks scored by the pupils.

Mark (x)	≤ 10	≤ 20	≤ 30	≤ 40	≤ 50	≤ 60	≤ 70	≤ 80
Cumulative frequency	7	15	31	46	66	74	79	82

How many pupils scored more than 60 marks?

A   5
B   8
C   13
D   You can't tell from this table.

Questions 42 and 43

The marks, out of 20, scored by 395 boys in a recent examination are as shown:

Mark	No. of Candidates	Cumulative Frequency	Mark	No. of Candidates	Cumulative Frequency	Mark	No. of Candidates	Cumulative Frequency
20	17	17	13	16	170	6	25	325
19	21	38	12	22	192	5	26	351
18	33	71	11	22	214	4	21	372
17	18	89	10	21	235	3	14	386
16	27	116	9	21	256	2	6	392
15	19	135	8	24	280	1	3	395
14	19	154	7	20	300	0	0	395

Mean: 11.36   **Upper Quartile:** 16.0   **Lower Quartile:** 7.0

386 girls also took the same examination. The corresponding statistics for the girls gave the following results:

Mean: 9.40   **Upper Quartile:** 13.0   **Lower Quartile:** 6.0   **Median:** 8.0

42   The median mark for the boys is

A   10
B   11
C   18
D   21

43   Which of the following statements are true?

1   The boys, on average, did better than the girls.
2   The girls, on average, did better than the boys.
3   The boys' marks were more consistent than the girls' marks.
4   The girls' marks were more consistent than the boys' marks.

Answer

A   1 and 3 only
B   2 and 4 only
C   2 and 3 only
D   1 and 4 only

44 $x = 1.5$ is a solution of each of these equations **except**

A $x^3 = 3.375$

B $\dfrac{1}{x} + \dfrac{x}{2} = \dfrac{17}{12}$

C $2x^2 - 16x + 15 = 0$

D $(2x - 3)(x + 5) = 0$

45 The volume, V, of a hemisphere, of radius r, is given by

$$V = \frac{2}{3}\pi r^3$$

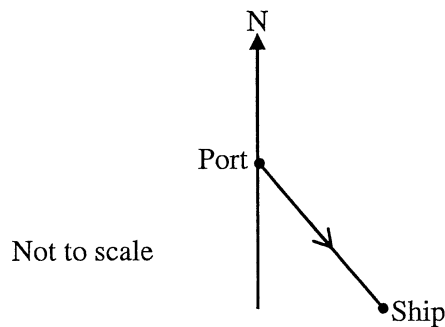Which of the following is a correct rearrangement of this formula?

A $r = \sqrt[3]{\dfrac{3V}{2\pi}}$

B $r = \sqrt[3]{\dfrac{3\pi V}{2}}$

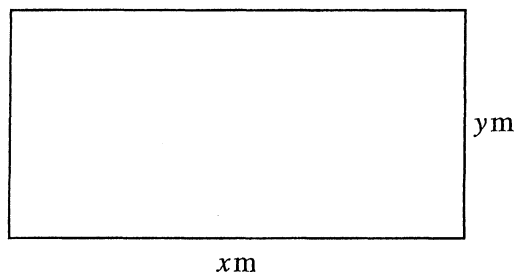C $r = \dfrac{3\sqrt[3]{V}}{2\pi}$

D $r = \dfrac{3\pi\sqrt[3]{V}}{2}$

46 A ship leaves a port and travels at $50\,\text{km h}^{-1}$ on a bearing of $140°$. After 2 hours, how far east of the port has the ship sailed?

Not to scale

A $32\,\text{km}$
B $64\,\text{km}$
C $77\,\text{km}$
D $84\,\text{km}$

47 Part of a field is to be fenced off as a rectangle with sides of length x m and y m as shown. The perimeter of the rectangle is 100 m.


x m

The area, F m^2, of the rectangle is given by

A $F = 50 - x^2$

B $F = x(50 - x)$

C $F = 100 - x^2$

D $F = x(100 - x)$

48 The expression $\dfrac{(x^2 + 3x - 10) + (2x - x^2)}{x - 2}$ can be simplified to

A $\dfrac{x - 10}{x - 2}$

B $x^2 + 3x + 5$

C   5

D   10

Turn over ▶

49 The side of a bottle, with a circular horizontal cross-section, is shown below.
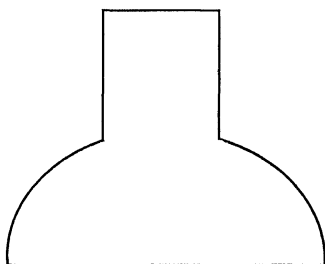
If water is poured into the bottle at a constant rate until the bottle is completely full, which graph best illustrates how the depth of the water will vary as the bottle is filled?

A Depth

Time

B Depth

Time

C Depth

Time

D Depth

Time
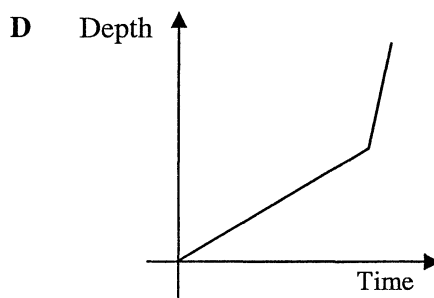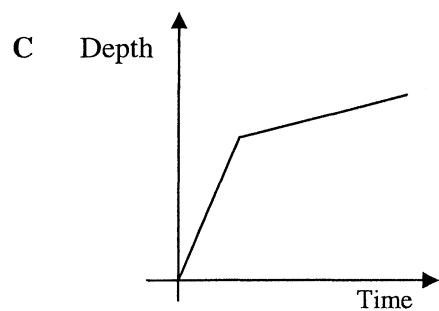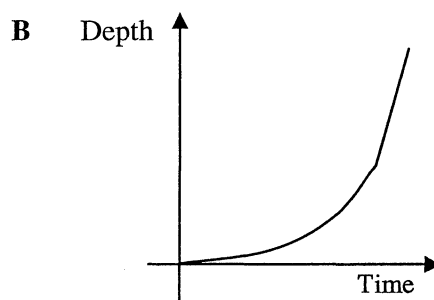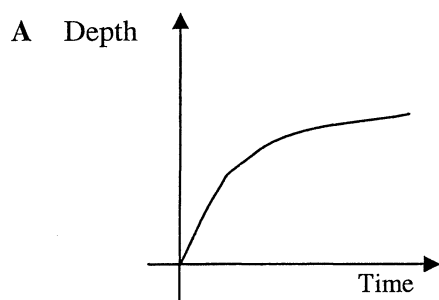
50 If $p = \dfrac{3q}{4}$ and $r = \dfrac{5q}{3}$ the ratio of $p{:}r$ is

A 9:20
B 3:5
C 2:3
D 4:5

END OF QUESTIONS

General Certificate of Education
January 2004
Advanced Subsidiary Examination

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

Data Booklet

Tuesday 13 January 2004   Morning Session

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

PASSAGE AND FIGURES FOR QUESTIONS 1 TO 25

Consider the following passage, and Tables 1-5, about Food.

FOOD - YOU ARE WHAT YOU EAT?

(1)   Contrary to popular belief, the number of food additives in use today has hardly changed during the last 30 to 40 years. A high proportion of additives are natural chemicals but some are synthetic or have synthetic versions. In 1982, the European Union introduced the E system of numbering the additives and these were printed on food labels. There are seven main groups of additives: colours, preservatives, antioxidants/acidity regulators, thickeners/emulsifiers, anti-caking agents, flavour enhancers and sweeteners.

All the processed foods in Table 1 contain one or more possible food additives.

Table 1: Ingredients in processed foods

Processed food	Ingredients
Baked beans	Beans, tomatoes, water, sugar, maize starch, salt, seasoning
Gravy browning	Starch, salt, dried yeast, colour, onion powder
Sweet and sour sauce	Water, vegetables, sugar, pineapple, vinegar, tomatoes, starch, spices, xanthan gum, guar gum
Chicken chasseur sauce mix	Wheat starch, salt, monosodium glutamate, dried onions, tomato powder, mixed mushroom powder, wheat flour, sugar, guar gum, spices, parsley, malt extract, tartaric acid

Colours

(2)   These are used to give food an appealing colour as our attraction to food depends on more than one of our senses. For example, tinned peas and strawberries would be khaki and dull brown respectively if they did not have added colour. The main classes of colours are natural colours, browning colours which are produced during cooking, and additives. Some of the natural colours are used as additives to increase the colour of cooked food. Examples of these include the green pigment chlorophyll, the carotenoids which give yellow and orange colours and flavonoids (especially anthocyanins which give flowers and fruits their violet and blue colours).

(3)   Artificial colours from azo dyes are also being used after being extensively tested, but the use of extracted anthocyanins is also expanding; these occur naturally in amaranth, a plant, and red wine. It has also been suggested that anthocyanins have antioxidant characteristics which help to counteract the effects of the alcohol in red wine!

Table 2: Colours

E number	Name/Colour/ Where obtained	Use	Possible harmful effects	Banned
102	Tartrazine Yellow	Coloured drinks, sweets, jams	Asthma attacks, nettle rash in children, thyroid tumours, hyperactivity, aspirin intolerance	Norway, Australia
122	Azorubine Red from coal tar	Marzipan, jelly	Local reactions in asthmatics and those intolerant to aspirin	Sweden, USA, Norway
123	Amaranth Red from a herbaceous plant	Cake mixes, jelly	Asthma, eczema and hyperactivity. Birth defects and foetal deaths in animal tests	USA, Russia, Austria, Norway
140	Chlorophyll Green naturally in green plants	Dyeing waxes and oils	None known	Nowhere
142	Green S Synthetic coal tar derivative	Canned peas, mint jelly, packet bread crumbs, cake mixes	None known	Sweden, USA, Norway
160	Carotenoids Orange-yellow From plants	Various soups	Vitamin A overdose (Human body converts E160 to Vitamin A in the liver)	Nowhere
163	Anthocyanins Violet colour of flowers and plants	Various	None known	Nowhere

TURN OVER FOR THE REST OF THE PASSAGE

Preservatives

(4)   Without preservatives food quickly goes off, as it is also food for microbes, some of which can be dangerous to human health. Preservation began with traditional processes, also chemical in their effects, for example wood smoking (the first method used), salting, and pickling in vinegar. These traditional methods do not have E numbers. However the more modern preservatives such as potassium sorbate and sodium benzoate act like broad-spectrum antibiotics as inhibitors of bacteria. Most are simple chemicals, for example: benzoic acid occurs in several fruits; and sorbic acid, the most widely used preservative, is found in some plants.

Table 3: Preservatives

E number	Name/Where obtained	Use	Possible harmful effects
200	Sorbic acid From berries or synthesised from ketene	In a wide variety of foods	Skin irritant
210a	Benzoic acid known as phenylcarboxylic acid from a resin exuded by trees native in Asia	In alcoholic beverages cheeses, gum, frozen dairy products	Asthma, neurological disorders, reputed to react with E222 to provoke hyperactivity
211	Sodium benzoate	To disguise taste in poor quality food (Orange drinks contain up to 25 mg per 250 ml). Also in milk and meat products	Nettle rashes and aggravate asthma
220	Sulphur dioxide derived from coal tar, produced by combustion of sulphur or gypsum	In beer, soft drinks, dried fruit, vinegar	Asthma, destroys vitamin B1 and difficult to metabolise for those with impaired kidney function

Antioxidants/acidity regulators

(5)   A common example of oxidation of food is the browning of cut apple surfaces where a well-known method to prevent this is to add lemon juice, which contains vitamin C (ascorbic acid). Vitamins C and E are found in living things, including ourselves, and act as antioxidants.

(6)   Vegetables contain several antioxidants besides vitamins C and E (E360), especially flavonoids such as quercetin in onions and epigallocatechin in tea. In one study, increasing vegetable intake by at least 400 g per day resulted in a 42% reduction in the risk of coronary heart disease. Diabetes may also be linked to oxidative reactions and vitamin E has been found to have a preventative role.

(7)   The most common synthetic antioxidants are butylated hydroxyanisole (BHA) and butylated hydroxytoluene (BHT) and the acceptable daily intakes have been set at a maximum of 0.5 mg/kg body weight for BHA and 0.3 mg/kg body weight for BHT.

Thickeners/emulsifiers

(8) These make food smooth and homogenous, for example in ice cream and mayonnaise. The smoothness is a result of emulsification in which incompatible oil and water are mixed together with an emulsifier, which is a molecule with one oil-friendly end and one water-friendly end. They act by surrounding the oil drops so the water-friendly ends are in contact with the water. Many living systems contain emulsifiers, as they are mixtures of oil and water. Mayonnaise is one of the most impressive emulsions with 80% oil dispersed into an acidified aqueous phase.

(9) Thickening and stabilising agents are gums that help emulsifiers to maintain the texture. Gums are thick and viscous but not usually tacky. They are odourless and tasteless but do have a function as they act like fibre, easing bowel function, and some are used as bulk laxatives.

(10) Many foods need thickening and gelling agents, for example pectin is used in jam. A more modern requirement is to bind Soya in veggie burgers. Gums come from a wide range of sources, many from plants such as gum arabic (E414), locust bean gum and guar gum. Others come from seaweed such as carageenan and alginates and many more from cellulose by chemical modification (for example E466). Gellan gum and xanthan gum are produced by microbiological fermentation. Starch found in flour is perhaps the best known thickening agent.

Anticaking agents

(11) The physical properties of food, how it handles, are increasingly important in the world of fast food. Vending machines rely on non-dairy creamers, which need to flow through the pipes and not agglomerate. Some added anti-caking agents are natural such as talc and bentonite; others, such as silicon dioxide, are manufactured. They are bland.

Flavour enhancers

(12) Traditionally there were four flavours - sweet, sour, bitter and salt. In recent years the food industry has recognised a fifth flavour, savoury, which is given to food by a natural amino acid, glutamic acid, and certain nucleotides. This flavour enhancer is best known in the synthetic form of monosodium glutamate.

(13) Really when we talk about flavour we are talking about our sense of smell. Natural products contain many aroma chemicals. For example, tarragon contains 77 components and coffee over 800. Synthetic flavours are mixtures of the various aroma chemicals but some are associated with specific chemicals.

Table 4: Flavour enhancers

Aroma chemical	Flavour
Methyl pyrazine	Roasted nut
Methoxypyrazine	Earthy vegetables
2-isobutyl-3-methoxypyrazine	Green Pepper
Acetyl-1-pyrazine	Popcorn
2-acetoxy pryrazine	Toasted flavours

Turn over ▶

Sweeteners

(14) Sugars such as the natural sugar, sucrose, found in granulated sugar, have the attraction of providing a quick energy source and of being sweet, but intake has increased and with it obesity and diabetes. The non-sugar sweeteners are many times sweeter than natural sugars and have no energy content.

Table 5: Sweeteners

Sweetener	Number of times sweeter than sugar
E950	130
E951	200
E952	30
E954	300
E957	3000
E959	400-600

(15) Bulk sweeteners are less concentrated and are similar in sweetening power to sucrose. They are made from natural sugars such as maltitol, xylitol and lactitol. They do not require insulin to control them and can be used for diabetic sweets.

(16) Many substances may produce an allergic reaction in those susceptible to them. One of the most common is an allergy to grass pollen; three quarters of the adult population cannot digest milk properly. Allergy to nuts has also been identified. So it is possible that individuals will be susceptible to additives.

(17) Other effects, such as toxic reactions may be caused by chemicals in food. These are called intolerance reactions. Some chemicals found in natural foodstuffs that are implicated are benzoic acid, caffeine, nicotine and tyramine. The problem is caused by not having an enzyme to break down the chemical.

(18) The addition of food additives is a necessity from the food manufacturing point of view, though some would say that more research is needed into the possible side effects of people being exposed to too much of some food additives.

END OF PASSAGE