General Certificate of Education
January 2006
Advanced Subsidiary Examination

ASSESSMENT and QUALIFICATIONS ALLIANCE

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

Friday 13 January 2006 9.00 am to 10.15 am

For this paper you must have:
- an objective test answer sheet
- a Data Booklet for Questions 1 to 25 (enclosed)
- a black ball-point pen

You may use a calculator.

Time allowed: 1 hour 15 minutes

Instructions
- Use a black ball-point pen.
- Answer **all** questions.
- Answer **both** Section 1 (Questions 1 to 25) **and** Section 2 (Question 26 to 50) using the answer sheet provided.
- 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
- The maximum mark for this paper is 50.
- This paper consists of **two** Sections.
  Section 1 contains 25 objective test questions based on material provided in a separate data booklet.
  Section 2 contains 25 objective test questions 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.

SECTION 1

Answer **Questions 1** to **25.**

Each question carries 1 mark.

Read the passage entitled **Metals in medicine** which is printed in the separate data booklet.

Each of **Questions 1** to **21** 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 21

1 A property of most metals is

A low electrical resistance.
B low density.
C low thermal conductivity.
D that they are brittle.

2 Metals in the body are needed for

1 carrying oxygen to the cells.
2 transmitting electronic messages through the cells.
3 providing a major part of bone to support the skeleton.
4 enabling many enzymes to function.

Answer

A if none is correct.
B if **1** and **3** only are correct.
C if **2** and **4** only are correct.
D if all of them are correct.

3 How do most people obtain the metals essential for their bodies to function (paragraphs 1 and 2)?

A medical prescription
B varied dietary intake
C dietary supplements
D multi-vitamin and mineral tablets

4 The mass of metal in a person weighing 70 kg is approximately

A 105 g
B 150 g
C 1 050 g
D 1 500 g

5 Which of the following (**Table 1**) would **not** be used as a treatment for indigestion?

A magnesium oxide
B magnesium sulphate
C calcium carbonate
D aluminium hydroxide

6 Side effects of drugs (paragraph 3) are

A new diseases.
B cures for other diseases.
C unwanted symptoms.
D permanent harm.

7 Although mercury (paragraph 3) is a poisonous element, it may be safe to take a compound of mercury. This is because

A in a compound the mercury is mixed with an antidote.
B the mercury passes straight through the body.
C there is very little mercury in compounds.
D a compound can be quite different from its component elements.

8 Calcium carbonate (paragraph 4) can be described as a simple salt. How many atoms does its formula contain?

A 3
B 4
C 5
D 6

9 The pH value of stomach acid (paragraph 4) is most likely to be which of the following?

A 2
B 5
C 7
D 9

10 To be effective, a drug needs to be soluble in water to

A enable it to be made into tablet form.
B enable it to be eliminated from the body.
C allow it to be broken down in the digestive system.
D allow it to be absorbed by the body.

11 Which of the following statements is/are true about the use of gold and its compounds?

1 It is worn to alleviate the symptoms of arthritis.
2 It was used by the Chinese 1500 years ago.
3 It is taken by mouth as a water soluble compound.
4 It is injected directly into the bloodstream as auranofin.

Answer

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

12 An auto-immune response (paragraph 5) is one in which

A enzymes destroy foreign proteins.
B bacteria invading the body are destroyed.
C poisonous chemicals are neutralised.
D healthy proteins can be destroyed.

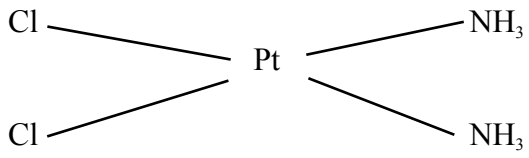
13 Which of the following statements is correct?

A Auranofin injections are used in the treatment of rheumatism.
B Enzymes are biological catalysts which destroy proteins that make up the body's structure.
C The auto-immune response is not a normal response.
D The build-up of gold compounds increases the enzyme action.

14 Which of the following is **not** true about cisplatin?

A Tumours are destroyed if sufficient cells are affected by cisplatin preventing DNA division.
B Cisplatin causes kidney problems.
C Cisplatin is a compound of platinum.
D Cisplatin causes irreversible damage to the spinal cord.

15 The formula of cisplatin is as follows



How many elements are present in this complex?

A 3
B 4
C 5
D 11

16 Radio pharmaceuticals are so-called because they

1 emit radio waves as signals.
2 contain a radioactive nucleotide.
3 are obtainable only on prescription from pharmacies.
4 emit gamma rays which can be detected on photographic film.

Answer

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

17 Technetium is the most commonly used radioactive metal for investigatory work because it

1 has a useful half-life.
2 is readily available.
3 emits gamma rays which are easily detected.
4 can be made to collect at different sites in the body.

Answer

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

18 Which of the following statements is/are true?

1 Radio pharmaceuticals use ultrasound to destroy tumours.
2 A pharmaceutical is a drug used to benefit patients.
3 Gamma rays are easily detected and highly penetrating.
4 Doctors working in nuclear medicine are concerned mainly with the effects of radioactive metals.

Answer

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

19 Technetium has a half-life of 6 hours. This means that after 18 hours the fraction remaining will be

A $\frac{1}{3}$

B $\frac{1}{4}$

C $\frac{1}{6}$

D $\frac{1}{8}$

20 Many metallic compounds are harmful to the body, but they are still used in medicine. This is because they

A cause less harm than the disease they cure.
B never cause permanent damage.
C are exceptionally easy to take.
D are less expensive than other medicines.

21 Not all inorganic drugs use metal ions. For which of the following is a non-metal ion used (**Table 1**)?

A anti-plaque
B anti-tooth decay
C high blood pressure
D jaundice

Assertion/ Reason questions

For each of **Questions 22** 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** to **D**) as follows and indicate your choice on the answer sheet.

	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	–	Not applicable

	ASSERTION		REASON
22	Metallic compounds are an essential part of a healthy diet	because	without minerals our bodies will not function.
23	After the reaction of the cisplatin the genetic code cannot be correctly copied to a new cell	because	the overall structure of the double helix has been bent.
24	A half-life of 6 hours is ‘useful’	because	it is long enough for tests to be carried out.
25	Cisplatin destroys tumours by changing the shape of their cells	because	when the platinum binds to guanine it bends the DNA molecule.

Turn over for SECTION 2

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

The census of 2001 recorded that there were 58 789 194 people in England and Wales living in 21 660 475 households.

26 The mean number of people per household, correct to 3 significant figures, was

A 1.27
B 2.40
C 2.71
D 3.68

27 One-person households accounted for 29.9% of all households.

The number of one-person households, correct to 3 significant figures, was

A 6.48×10^6
B 1.76×10^7
C 6.48×10^8
D 1.76×10^9

28 3.1 million one-person households were one-pensioner only households and one quarter of these were occupied by a man living on his own. For the remaining 3.4 million one-person households, the ratio of males to females was 3:2.

The total number of men living in one-person households, to 2 significant figures, was

A 1.4 million
B 2.0 million
C 2.8 million
D 3.7 million

29 What are the solutions of the equation $(4 - 9x)(8 + 7x) = 0$?

A $x = -\frac{4}{9}$ and $x = \frac{8}{7}$

B $x = \frac{9}{4}$ and $x = -\frac{7}{8}$

C $x = -\frac{9}{4}$ and $x = \frac{7}{8}$

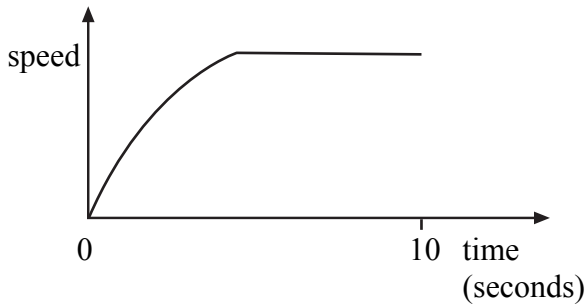
D $x = \frac{4}{9}$ and $x = -\frac{8}{7}$

30 During the summer of 2003, an Austrian sky diver flew across the English Channel using an aerodynamic wing. He was dropped from an aeroplane and made the 24 km crossing in 14 minutes. His average speed for the crossing was approximately

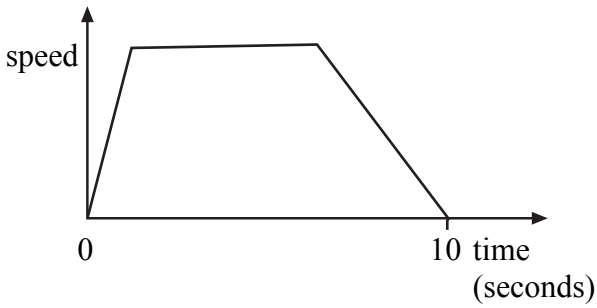
A $29\,\text{km h}^{-1}$
B $100\,\text{km h}^{-1}$
C $340\,\text{km h}^{-1}$
D $1700\,\text{km h}^{-1}$

31 An Olympic sprinter completes a 100 m race in a time of 10 seconds. Which of the following graphs best represents the sprinter's speed during the race?

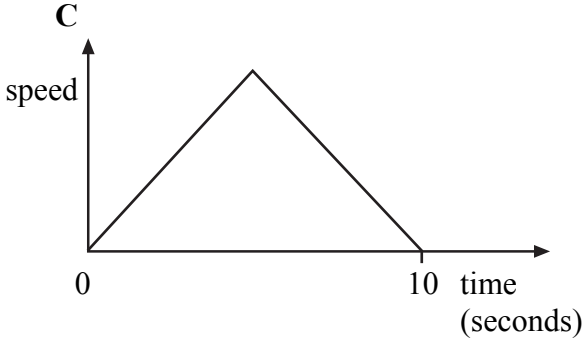
A



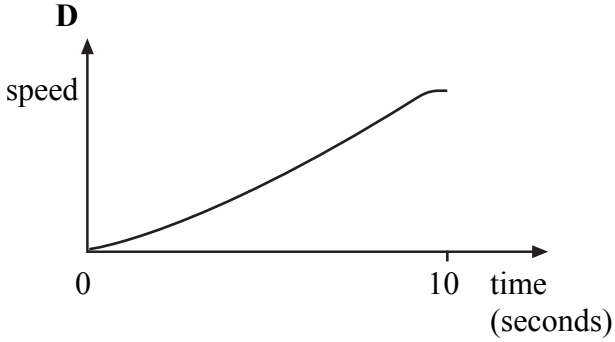
B



C

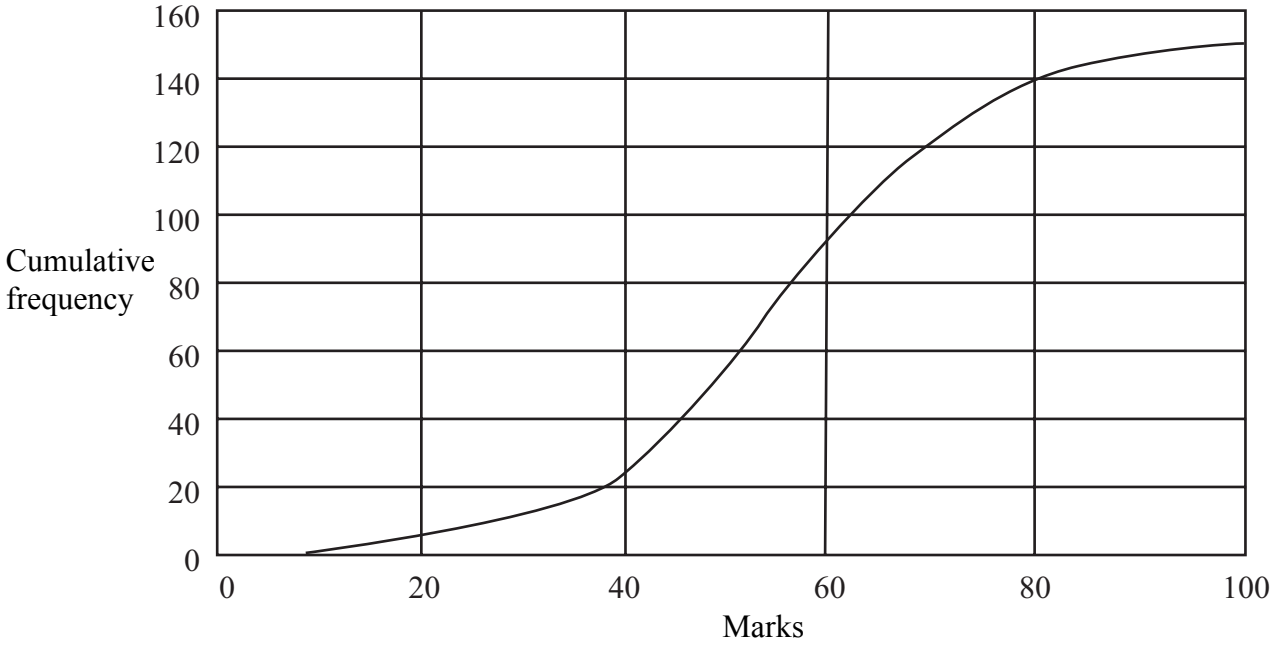


D



Questions 32 to 34

The diagram shows a cumulative frequency graph for the marks of 150 students in an examination.



32 The range of marks was

A 90
B 95
C 100
D 150

33 The median mark was

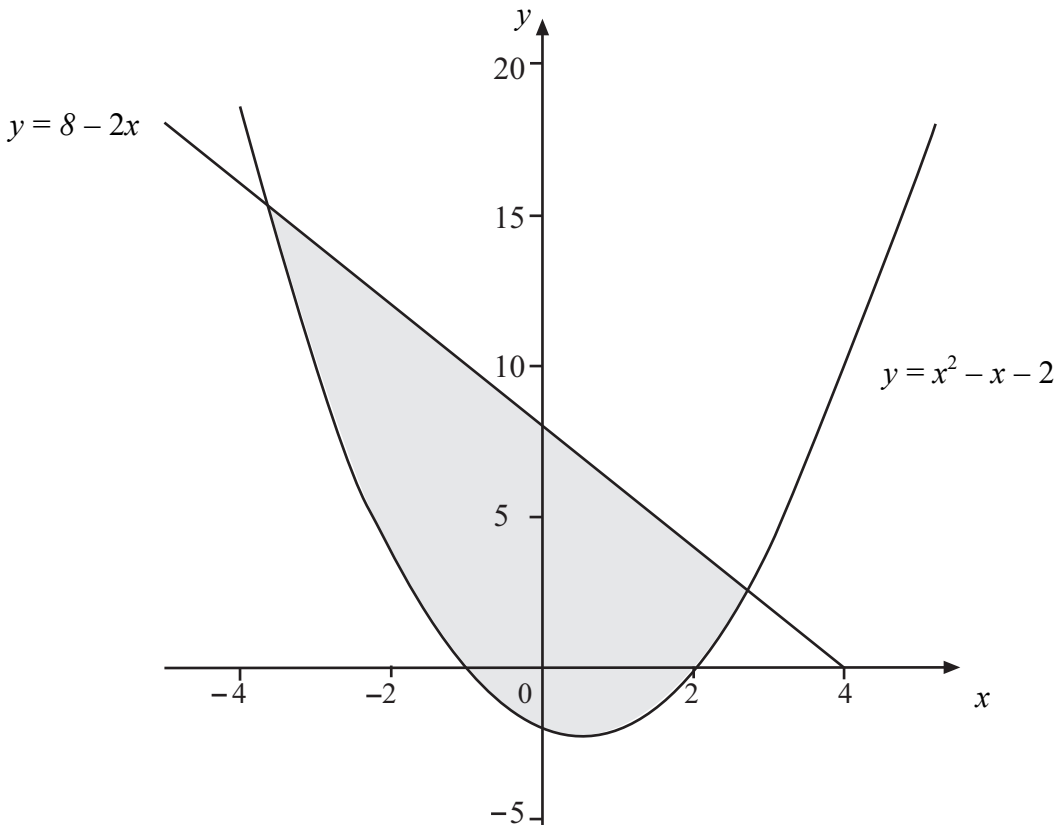
A 50
B 55
C 60
D 75

34 The pass mark was 38. What percentage of students failed the examination?

A 14
B 21
C 30
D 45

Questions 35 and 36

The graph shows part of the line $y = 8 - 2x$ and the curve $y = x^2 - x - 2$



35 Which of the following equations are satisfied by the x-coordinates of the points of intersection of the line and curve?

1 $x^2 - x - 2 = 8 - 2x$
2 $x^2 - 3x + 6 = 0$
3 $x^2 + x - 10 = 0$

Answer

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

36 Which two inequalities define the shaded area?

A $y < 8 - 2x$ and $y < x^2 - x - 2$
B $y > 8 - 2x$ and $y > x^2 - x - 2$
C $y > 8 - 2x$ and $y < x^2 - x - 2$
D $y < 8 - 2x$ and $y > x^2 - x - 2$

37 At the time of the introduction of the euro currency, 9 Deutschmarks were worth approximately 5 euros and 3 Irish punts were worth approximately 4 euros.
What was the approximate value of 1 Irish punt in Deutschmarks?

A 0.42
B 0.74
C 1.35
D 2.40

38 When Andrew plays snooker against Mary, the probability of Andrew winning a game is always 0.4. What is the probability of Andrew's first win being the third game?

A 0.064
B 0.096
C 0.144
D 0.216

39 The mean annual salary of 10 employees in a small business is £15 800 and the median annual salary is £16 000. Two more people are employed, one with a salary of £15 000 and one with a salary of £19 000.
Which of these statements is true?

A The median salary is unchanged and the mean salary is decreased.
B The median salary is unchanged and the mean salary is increased.
C The median salary is decreased and the mean salary is increased.
D The median salary is increased and the mean salary is increased.

40 A diet states that the daily requirement of iron is 14.5 milligrams. What is the approximate total dietary requirement of iron over a lifetime of 75 years?

A 40 g
B 400 g
C 4 kg
D 40 kg

41 A quadratic equation has solutions of $x = -3$ and $x = 5$.

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

A $(x + 3)(x - 5) = 0$

B $x^2 - 2x - 15 = 0$

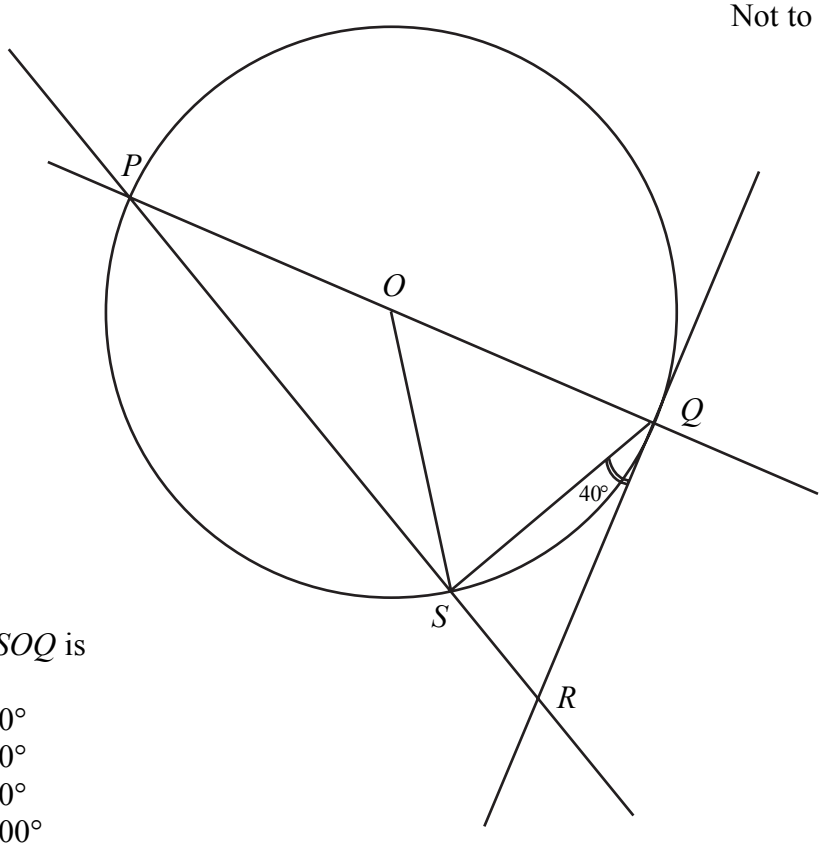
C $x^2 = 2x - 15$

D $x = 2 + \frac{15}{x}$

Questions 42 and 43

The diagram shows a circle, centre O and diameter PQ.
QR is a tangent to the circle.
PS and QS are chords across the circle.
Angle SQR is 40°.

Not to scale



42 Angle SOQ is

A 40°
B 50°
C 80°
D 100°

43 The reason that triangle PQR is right-angled is that

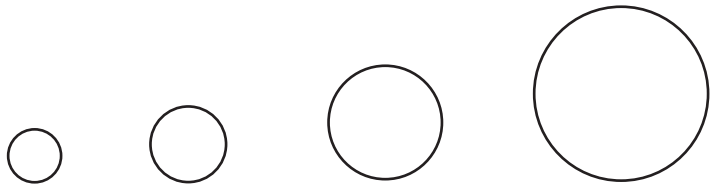
A PQ is a diameter and PS is a chord.
B PQ is a diameter and QS is a chord.
C QS is a chord and QR is a tangent.
D PQ is a diameter and QR is a tangent.

44 A 21 inch monitor is one that measures 21 inches, to the nearest inch, along a diagonal. What could be the dimensions of a 21 inch monitor?

A 16 inches wide by 12 inches high
B 16 inches wide by 13 inches high
C 17 inches wide by 14 inches high
D 18 inches wide by 14 inches high

Questions 45 and 46

The first four discs in a sequence of circular discs are shown.
The areas of the four discs are 2, 8, 18, and 32 cm^2 respectively.



45 An expression for the area, in cm^2, of the n^{th} disc in the sequence is

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

46 The third disc in the sequence has a radius, r cm, given by

A $r = \sqrt{\frac{18}{\pi}}$

B $r = \frac{\sqrt{18}}{\pi}$

C $r = \sqrt{18 - \pi}$

D $r = \sqrt{18} - \pi$

47 The value of a computing system, initially costing £25 000, is assumed to depreciate at a rate of 20 % each year.

The value of the computing system after 3 years will be

A £ $(25\,000 \times 0.2 \times 3)$

B £ $(0.8 \times 25\,000)^3$

C £ $[25\,000 \times \{1 - (0.2)^3\}]$

D £ $\{25\,000 \times (0.8)^3\}$

48 The point $(-4, -1)$ lies on which of the following curves?

1 $y = 2x^2 + 16x - 1$

2 $y = 1 + \dfrac{20}{x - 6}$

3 $y = 83 + x - x^2 + x^3$

4 $y = \dfrac{5 - x}{15 + 10x + x^2}$

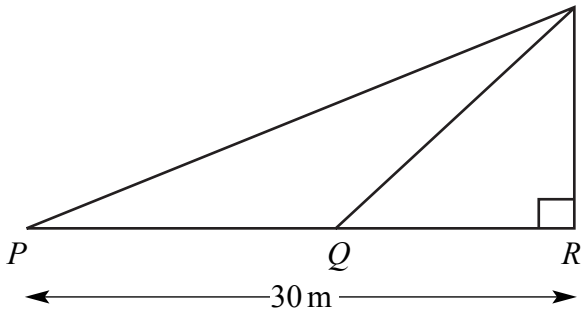
Answer

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

Turn over for the next question

49 Standing at P, 30 m from the base R of a mobile phone mast, the angle of elevation of the top of the mast is 37°.

Standing at Q, the angle of elevation is 44°.



Not to scale

The distance QR, in metres, is

A 30 tan 7°

B 30 tan 37° × tan 44°

C $\dfrac{30 \tan 44°}{\tan 37°}$

D $\dfrac{30 \tan 37°}{\tan 44°}$

50 $y = m_1x + c_1$ and $y = m_2x + c_2$ are two straight lines.
If the two lines do **not** intersect, this implies that

A $m_1 = m_2$ and $c_1 \neq c_2$

B $c_1 = c_2$

C $m_1 = m_2$ and $c_1 = c_2$

D $c_1 = c_2 = 0$

END OF QUESTIONS

General Certificate of Education
January 2006
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GENERAL STUDIES (SPECIFICATION A) **GSA2**
Unit 2 Science, Mathematics and Technology

Data Booklet

Friday 13 January 2006 9.00 am to 10.15 am

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

PASSAGE AND TABLE FOR QUESTIONS 1 TO 25

Consider the following passage and **Table 1**.

Metals in medicine

(1) We cannot get away from metals. Although they account for less than 1.5% of our body weight, without them there would be no life. Present only in trace amounts (apart from calcium, which is a major constituent of bones) they carry out vital functions within the body. To give you some idea of how many different metals we need, you just need to take a look at the list on the back of a bottle of multi-vitamins and minerals.

(2) The roles of metals in the body include functions such as carrying oxygen to cells (iron in haemoglobin), helping to carry electronic messages through cells (potassium, sodium and calcium in cell membranes) and in enzymes (e.g. zinc, copper and molybdenum) to name but a few. Diets deficient in any of these essential minerals will cause illness. Unsurprisingly, therefore, some of the more simple remedies for illness are formulations of metal complexes, for example, prescribing ferrous carbonate for iron deficiency (anaemia). Whilst these remedies are merely taken as supplements to boost a deficient diet, metallic salts have been used to attack and assist in the treatment of illnesses. See **Table 1**.

Table 1: Metallic salts used in drugs

Compound	**Use/ Effect**
Aluminium hydroxide	Antacid
Auranofin (gold compounds)	Anti-arthritic
Barium sulphate	X-ray imaging agent
Bismuth citrate	Anti-ulcer
Calcium carbonate	Antacid
Cisplatin (platinum compounds)	Anti-cancer
Fluoride	Anti-tooth decay
Gadolinium compounds	For magnetic resonance imaging
Magnesium oxide (milk of magnesia)	Antacid
Magnesium sulphate (Epsom salts)	Laxative
Silica	Abrasive in toothpaste
Sodium carbonate and bicarbonate	Antacid and laxative
Sodium ferrocyanide	For high blood pressure
Strontium compounds	Anti-plaque
Technetium compounds	Myocardial and neurological imaging agents
Tin compounds	For jaundice
Titanium compounds	Anti-cancer
Zinc compounds	Anti-plaque and skin soothers
Zirconium compounds	Antiperspirant

(3) Initially the use of metals was fairly indiscriminate in its approach. This is illustrated by how many medieval doctors prescribed mercury for a variety of ills. Today it is well known that the element mercury itself is hazardous to health but some compounds of mercury have in the past been used to treat syphilis. Modern medicine accepts that for a drug to be considered effective, it should cure the disease being treated without causing any other side effects that are equally debilitating. Nowadays the use of metals within medicines ranges from very simple compounds, such as calcium carbonate (used to treat indigestion), to more complex compounds, such as platinum-based drugs used for the treatment of cancer.

Indigestion treatments

(4) A common way to ease indigestion is to take a preparation that contains calcium carbonate. This reacts with the excess acid in the stomach, and so increases the stomach's pH value, and reduces any pain felt. The reaction between stomach acid (which is hydrochloric acid) and calcium carbonate, as shown below, is why you sometimes belch after taking indigestion tablets.

$$CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2$$

Gold

(5) One of the earliest descriptions of gold as a medicine comes from a sixth-century Chinese text, which describes a gold-containing elixir aimed at achieving immortality. Recent interest in the medicinal properties of gold has focused on its anti-arthritic properties, with the discovery and development of the compound 'auranofin'. This is a water-soluble drug taken orally for the treatment of rheumatism. Arthritis is an inflammation of the tissue that surrounds the joints. Enzymes acting as part of the body's immune system cause the damage. Enzymes normally destroy foreign proteins, but sometimes they can destroy perfectly healthy proteins that are similar to foreign ones: this is an auto-immune response. The gold accumulates in the joints and it is thought that it reduces the activity of these enzymes.

Platinum

(6) Cisplatin, a compound of platinum, is used to treat testicular and ovarian cancers, as well as tumours in the lungs, head, neck, bladder and cervix. The prospect of early recovery from early testicular and bladder cancers is greater than 90% following treatment with cisplatin. The cisplatin is injected directly into the blood which then carries the cisplatin to all parts of the body including the tumours that are being treated. The cisplatin diffuses through the tumour cell membrane easily because it is neutral (has no overall charge) as is the cell membrane. Once inside the cell, cisplatin enters the nucleus and the platinum binds to a base (guanine) on the DNA. This binding changes the overall structure of the double helix by bending it. This means that when the cancer cells come to replicate, the DNA cannot be separated and so the genetic code is not correctly copied to the new cell. If this occurs in any cell, it will die. A tumour is destroyed if enough cells absorb cisplatin and suffer this fate. Although it sounds as though cisplatin is a miracle drug it does have certain side effects, including kidney problems and reversible damage to the spinal cord.

This passage continues on the next page

Technetium

(7) Radio pharmaceuticals (drugs containing a radio nucleotide) are routinely used in nuclear medicine departments for the diagnosis and treatment of diseases. Technetium is the most commonly used radioactive imaging agent because of its ready availability, its useful half-life of 6 hours and because it emits gamma rays which are easily detected. Technetium is injected into the blood stream and collects in different organs according to the structure of the technetium compound. An image of the organ can then be observed and any damaged or diseased parts identified and thus assist in the treatment of the patient.

Conclusion

(8) Through this brief review of the compounds of just three metals, it is clear that metal-based drugs are diverse in their applications. If you consider how many metals there are, then the potential for using metallic salts in medicinal chemistry would seem to be enormous. The way forward lies very much with chemists working in close conjunction with biologists, and clinicians. The future for 'bio-inorganic' chemistry in medicine must surely hold many more exciting discoveries.

Source: adapted from SPENCER HARBEN and JON FREEMAN, *Chemistry Review,* November 1998

END OF PASSAGE