

0500/201

SCOTTISH
CERTIFICATE OF
EDUCATION
1997

MONDAY, 19 MAY
1.00 PM – 2.40 PM

CHEMISTRY
HIGHER GRADE
Paper I

Check that the answer sheet provided is for Chemistry Higher I.

Fill in the details required on the answer sheet.

Reference may be made to the Chemistry (Revised) Higher Grade and Certificate of Sixth Year Studies Data Booklet (1992 edition).

Rough working, if required, should be done only on this question paper, or on the rough working sheet provided—**not** on the answer sheet.

Instructions for the completion of **Part 1** and **Part 2** are given on pages two and nine respectively.

PART 1

In questions 1 to 40 of this part of the paper, an answer is given by indicating the choice A, B, C or D by a stroke made in INK in the appropriate place in Part 1 of the answer sheet—see the sample question below.

For each question there is only ONE correct answer.

This part of the paper is worth 40 marks.

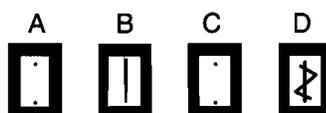
SAMPLE QUESTION

To show that the ink in a ball-pen consists of a mixture of dyes, the method of separation would be

- A fractional distillation
- B chromatography
- C fractional crystallisation
- D filtration.

The correct answer is B—chromatography. A **heavy** vertical line should be drawn joining the two dots in the appropriate box in the column headed **B** as shown **in the example on the answer sheet**.

If, after you have recorded your answer, you decide that you have made an error and wish to make a change, you should cancel the original answer and put a vertical stroke in the box you now consider to be correct. Thus, if you want to change an answer **D** to an answer **B**, your answer sheet would look like this:



If you want to change back to an answer which has already been scored out, you should **enter a tick (✓)** to the **RIGHT** of the box of your choice, thus:



- Which is a non-conductor but becomes a good conductor on melting?
 - Solid potassium fluoride
 - Solid argon
 - Solid potassium
 - Solid tetrachloromethane
- Barium chloride solution would **not** give a precipitate with a solution of a
 - carbonate
 - sulphate
 - sulphite
 - nitrate.
- 20 cm^3 of 0.3 mol l^{-1} sodium hydroxide solution can be exactly neutralised by
 - 20 cm^3 0.3 mol l^{-1} sulphuric acid
 - 20 cm^3 0.6 mol l^{-1} sulphuric acid
 - 10 cm^3 0.6 mol l^{-1} sulphuric acid
 - 10 cm^3 0.3 mol l^{-1} sulphuric acid.
- 56 g of an oxide of lead was strongly heated and hydrogen gas was passed over it. When the oxide was completely reduced, 52 g of lead remained.

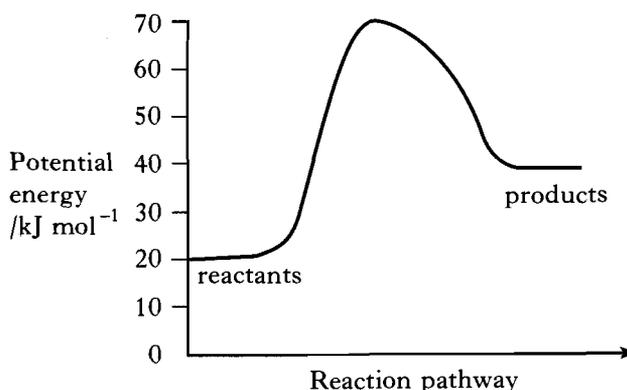
A possible formula for the oxide is

 - Pb_2O_3
 - PbO_2
 - Pb_2O
 - PbO .
- A mixture of magnesium bromide and magnesium sulphate is known to contain 3 mol of magnesium and 4 mol of bromide ions.

How many moles of sulphate ions are present?

 - 1
 - 2
 - 3
 - 4

- The following potential energy diagram represents the energy changes in a chemical reaction.



The activation energy for the reaction, in kJ mol^{-1} , is

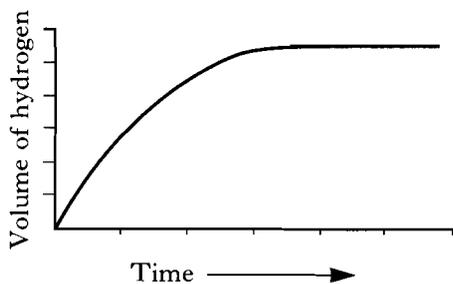
- 20
 - 30
 - 50
 - 70.
- Which of the following is not a correct statement about the effect of a catalyst?

The catalyst

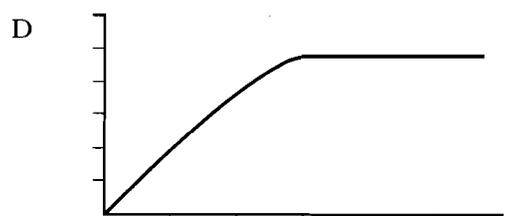
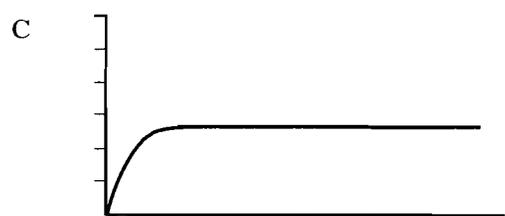
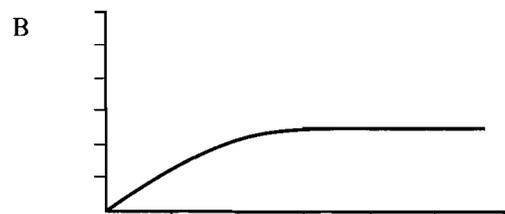
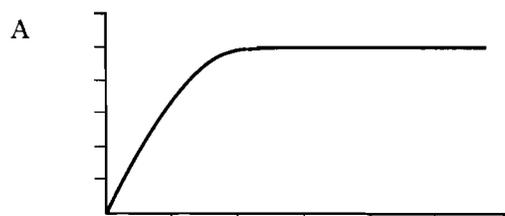
 - provides an alternative route to the products
 - lowers the energy which molecules need for successful collisions
 - provides energy so that more molecules have successful collisions
 - forms bonds with reacting molecules.

[Turn over

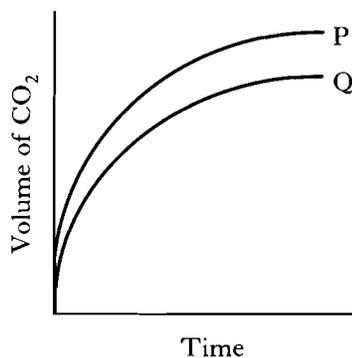
8. The graph shows the volume of hydrogen given off against time when an excess of magnesium ribbon is added to 100 cm³ of hydrochloric acid (concentration 1 mol l⁻¹) at 20 °C.



Which graph would show the volume of hydrogen given off when an excess of magnesium ribbon is added to 50 cm³ of hydrochloric acid of the same concentration at 30 °C?



9.

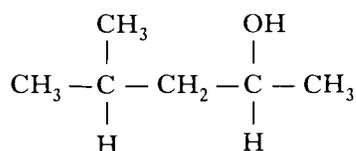


When copper carbonate is reacted with excess acid, carbon dioxide is produced. The curves shown above were obtained under different conditions.

The change from P to Q could be brought about by

- A increasing the concentration of the acid
- B decreasing the mass of copper carbonate
- C decreasing the particle size of the copper carbonate
- D adding a catalyst.

10.



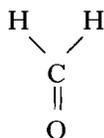
The product of oxidation of the above structure is

- A 4-methylpentan-2-one
- B 2-methylpentan-4-one
- C 2-methylpentanal
- D 4-methylpentanal.

11. When ethanol is passed over heated aluminium oxide, the main product will be

- A ethane
- B ethene
- C ethanal
- D ethanoic acid.

12. A compound used in the synthesis of thermosetting plastics is:



The name of this compound is

- A methanol
 B methanal
 C methanoic acid
 D methanone.
13. The tendency of a petrol component to ignite spontaneously is measured by its octane number.

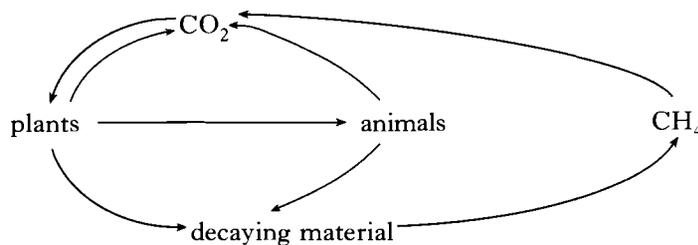
	Compound	Octane number
1	3-methylpentane	74.5
2	pentane	61.7
3	butane	93.6
4	2-methylpentane	73.4
5	hexane	24.8
6	methylcyclopentane	91.3

A pupil made the hypothesis that as the chain length of a hydrocarbon increases, the octane number decreases.

Which set of 3 components should have their octane numbers compared in order to test this hypothesis?

- A 1, 4, 6
 B 1, 2, 4
 C 2, 3, 5
 D 3, 4, 5

14. In nature, carbon is continually being recycled. Part of the cycle is shown below.



The production of methane from decaying material is due to

- A photosynthesis
 B respiration
 C aerobic fermentation
 D anaerobic fermentation.
15. Using the density quoted in the Data Booklet, what is the number of moles of nitrogen molecules in a 5 litre container?
- A 0.11
 B 0.21
 C 0.31
 D 0.41

16. $3\text{CuO} + 2\text{NH}_3 \rightarrow 3\text{Cu} + \text{N}_2 + 3\text{H}_2\text{O}$

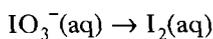
What volume of gas, in cm^3 , would be obtained by reaction between 100cm^3 of ammonia gas and excess copper(II) oxide?

(All volumes are measured at atmospheric pressure and 20°C .)

- A 50
 B 100
 C 200
 D 400
17. Diabetics suffer from a deficiency of the protein insulin (formula mass 6000). What mass of insulin will contain approximately 3×10^{20} molecules?
- A 3 g
 B 6 g
 C 30 g
 D 60 g

18. If 96 500 C of electricity are passed through separate solutions of copper(II) chloride and nickel(II) chloride, then
- A equal masses of copper and nickel will be deposited
 - B the same number of atoms of each metal will be deposited
 - C the metals will be plated on the positive electrode
 - D different numbers of moles of each metal will be deposited.

19. During a redox process in acid solution, iodate ions, $\text{IO}_3^-(\text{aq})$, are converted into iodine, $\text{I}_2(\text{aq})$.



The numbers of $\text{H}^+(\text{aq})$ and $\text{H}_2\text{O}(\ell)$ required to balance the ion-electron equation for the formation of 1 mol of $\text{I}_2(\text{aq})$ are, respectively

- A 6 and 3
 - B 3 and 6
 - C 12 and 6
 - D 6 and 12.
20. Ethyl butanoate is used in pineapple flavouring.
- The formulae for the molecules from which it is made are
- A $\text{C}_3\text{H}_7\text{OH}$ and CH_3COOH
 - B $\text{C}_2\text{H}_5\text{OH}$ and $\text{C}_2\text{H}_5\text{COOH}$
 - C $\text{C}_3\text{H}_7\text{COOH}$ and $\text{C}_2\text{H}_5\text{OH}$
 - D $\text{C}_2\text{H}_5\text{COOH}$ and $\text{C}_3\text{H}_7\text{OH}$.
21. The monomer units used to construct enzyme molecules are
- A esters
 - B amino acids
 - C fatty acids
 - D monosaccharides.

22. Polyester fibres and cured polyester are both very strong.

What kinds of structure do their molecules have?

	Fibre	Cured resin
A	cross-linked	cross-linked
B	linear	linear
C	cross-linked	linear
D	linear	cross-linked

23. Graphite, a form of carbon, conducts electricity because it has

- A metallic bonding
- B van der Waals bonding
- C delocalised electrons
- D pure covalent bonding.

24. Which type of bonding can be described as intermolecular?

- A Covalent
- B Hydrogen
- C Ionic
- D Metallic

25. Which chloride is most likely to be soluble in tetrachloromethane, CCl_4 ?

- A Barium chloride
- B Caesium chloride
- C Calcium chloride
- D Phosphorus chloride

26. On descending the halogen group of the Periodic Table, the

- A attracting power for bonding electrons increases
- B ionisation energy increases
- C nuclear charge increases
- D reactivity increases.

27. Which of the following compounds has polar molecules?

- A CH₄
- B CO₂
- C NH₃
- D CCl₄

28. Phosphorus trichloride reacts with water giving a gaseous product. This is most likely to consist of

- A chlorine only
- B hydrogen chloride only
- C a mixture of hydrogen and chlorine
- D a mixture of hydrogen chloride and chlorine.

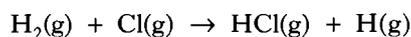
29. Which process is exothermic?

- A Li⁺(g) → Li⁺(aq)
- B Li(s) → Li(g)
- C Li(g) → Li⁺(g)
- D Li(s) → Li(l)

30. In which of the following reactions would the energy change represent the lattice enthalpy of sodium chloride?

- A Na⁺(g) + Cl⁻(g) → NaCl(s)
- B Na(g) + Cl(g) → NaCl(s)
- C Na(s) + $\frac{1}{2}$ Cl₂(g) → NaCl(s)
- D Na(s) + Cl(g) → NaCl(s)

31. In the presence of bright light, hydrogen and chlorine react explosively. One step in the reaction is shown below.



The enthalpy change for this step can be represented as the bond enthalpy of

- A H—H + Cl—Cl
- B H—H - Cl—Cl
- C H—H + H—Cl
- D H—H - H—Cl

32. Which of these processes can be described as an enthalpy of formation?

- A C₂H₄(g) + H₂(g) → C₂H₆(g)
- B 2C(s) + 3H₂(g) → C₂H₆(g)
- C 2C(g) + 6H(g) → C₂H₆(g)
- D C₂H₂(g) + 2H₂(g) → C₂H₆(g)

33. The bond enthalpy of the N—H bond is equal to $\frac{1}{3}$ of the value of ΔH for which change?

- A N(g) + 3H(g) → NH₃(g)
- B N₂(g) + 3H₂(g) → 2NH₃(g)
- C $\frac{1}{2}$ N₂(g) + 1 $\frac{1}{2}$ H₂(g) → NH₃(g)
- D 2NH₃(g) + 1 $\frac{1}{2}$ O₂(g) → N₂(g) + 3H₂O(g)

34. ICl(l) + Cl₂(g) ⇌ ICl₃(s) ΔH = -106 kJ mol⁻¹

Which of the following sets of changes will cause the greatest increase in the proportion of solid in the above equilibrium?

	Temperature	Pressure
A	decrease	decrease
B	decrease	increase
C	increase	decrease
D	increase	increase

35. A trout fishery owner added limestone to his loch to combat the effects of acid rain. He managed to raise the pH of the water from 4 to 6.

This caused the concentration of the H⁺(aq) to

- A increase by a factor of 2
- B increase by a factor of 100
- C decrease by a factor of 2
- D decrease by a factor of 100.

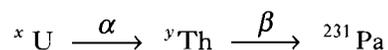
[Turn over

36. A fully dissociated acid is progressively diluted by the addition of water. Which of the following would increase with increasing dilution?
- A The pH value
 - B The electrical conductivity
 - C The rate of its reaction with chalk
 - D The volume of alkali which it will neutralise

37. A pH value greater than 7 would be shown by a 1.0 mol l^{-1} solution of
- A sodium sulphate
 - B ammonium chloride
 - C potassium ethanoate
 - D lithium chloride.

38. The stability of the nucleus of an ion depends on the ratio of
- A mass : charge
 - B neutrons : protons
 - C neutrons : electrons
 - D protons : electrons.

39. The following represents part of a natural radioactive decay series.



Which of the following represent the mass numbers x and y ?

	x	y
A	239	235
B	232	231
C	237	233
D	235	231

40. When some zinc pellets containing radioactive zinc are placed in a solution of zinc chloride, radioactivity soon appears in the solution. Compared with that of the pellets, the half-life of the radioactive solution will be
- A shorter
 - B the same
 - C longer
 - D dependent upon how long the zinc is in contact with the solution.

PART 2

In questions 41 to 48 of this part of the paper, an answer is given by circling the appropriate letter (or letters) in the answer grids provided on Part 2 of the answer sheet.

In some questions, two letters are required for full marks.

If more than the correct number of answers is given, marks will be deducted.

In some cases the number of correct responses is NOT identified in the question.

This part of the paper is worth 20 marks.

SAMPLE QUESTION

A	CH ₄	B	H ₂	C	CO ₂
D	CO	E	C ₂ H ₆	F	N ₂

(a) Identify the diatomic **compound(s)**.

A	B	C
<input checked="" type="radio"/> D	E	F

The one correct answer to part (a) is D. This should be circled.

(b) Identify the **two** substances which burn to produce **both** carbon dioxide **and** water.

<input checked="" type="radio"/> A	B	C
D	<input checked="" type="radio"/> E	F

As indicated in this question, there are **two** correct answers to part (b). These are A and E.

Both answers are circled.

(c) Identify the substance(s) which can **not** be used as a fuel.

A	B	<input checked="" type="radio"/> C
D	E	<input checked="" type="radio"/> F

There are **two** correct answers to part (c). These are C and F.

Both answers are circled.

If, after you have recorded your answer, you decide that you have made an error and wish to make a change, you should cancel the original answer and circle the answer you now consider to be correct. Thus, in part (a), if you want to change an answer **D** to an answer **A**, your answer sheet would look like this:

<input checked="" type="radio"/> A	B	C
<input checked="" type="radio"/> D	E	F

If you want to change back to an answer which has already been scored out, you should enter a tick (✓) in the box of the answer of your choice, thus:

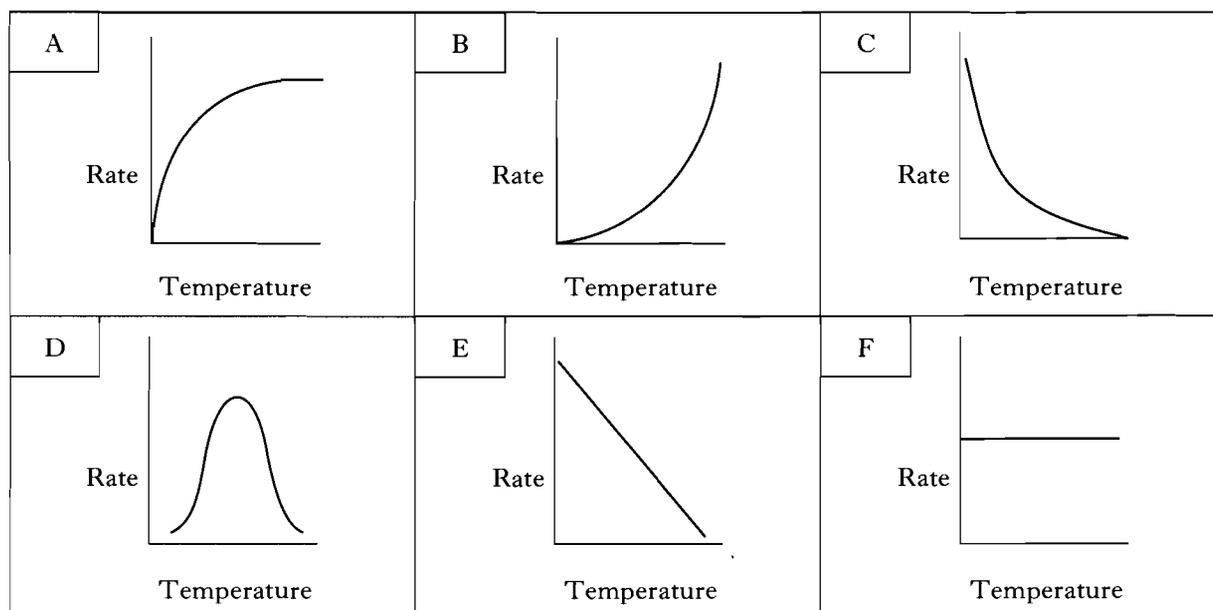
<input checked="" type="radio"/> A	B	C
✓ <input checked="" type="radio"/> D	E	F

41. Many organic compounds contain oxygen.

A	CH_3COOH	B	HCHO	C	$\text{CH}_3\text{COOCH}_3$
D	CH_3OH	E	$\text{HOCH}_2\text{CH}_2\text{OH}$	F	$(\text{COOH})_2$

- (a) Identify the product of the oxidation of the compound shown in box D.
 (b) Identify **two** compounds which could be used to make a polyester.

42.



Identify the graph which shows how the rate varies with temperature in

- (a) the reaction between sodium thiosulphate solution and dilute hydrochloric acid,
 (b) the fermentation of glucose,
 (c) the radioactive decay of uranium-235.

43. Hydrocarbons are compounds containing hydrogen and carbon only.

A		B		C	
	C_2H_4		C_3H_8		C_4H_{10}
D		E		F	
	C_4H_8		C_6H_{14}		CH_4

- (a) Identify the hydrocarbon which could belong to two different homologous series.
- (b) Identify the hydrocarbon which could be produced by reforming the hydrocarbon shown in box C.
- (c) Identify the **two** hydrocarbons which could be produced by cracking the hydrocarbon shown in box B.

44. The first twenty elements can be described in different ways.

A		B		C	
	Covalent		Metallic		Made up of discrete molecules
D		E		F	
	Made up of diatomic molecules		Gas		Solid

- (a) Identify the term which can be applied to lithium but **not** carbon.
- (b) Identify the term(s) which can be applied to **both** fluorine and phosphorus.

45. The following solutions have a concentration of 1 mol l^{-1} .

A		B		C	
	HCl(aq)		$\text{NH}_4\text{Cl(aq)}$		$\text{NH}_3\text{(aq)}$
D		E		F	
	$\text{CH}_3\text{COOH(aq)}$		$\text{Na}_2\text{CO}_3\text{(aq)}$		NaCl(aq)

- (a) Identify the solution which contains an equal number of $\text{H}^+\text{(aq)}$ and $\text{OH}^-\text{(aq)}$ ions.
 (b) Identify the solution(s) with a pH greater than 1 but less than 7.

46. Many organic compounds have different isomers.

Identify the compound(s) with isomeric forms.

A		B		C	
	$\text{CH}_3\text{CH}_2\text{CH}_2\text{Cl}$		$\text{CH}_3\text{CH}_2\text{Cl}$		CH_2CHCl
D		E		F	
	CH_2CCl_2		CCl_2CCl_2		CH_3Cl

47. Two flasks contained equal volumes of 0.1 mol l^{-1} hydrochloric acid and 0.1 mol l^{-1} ethanoic acid.

Identify the **true** statement(s) about the two solutions.

A	They give the same colour with Universal indicator.
B	They have pH less than 7.
C	They conduct electricity equally well.
D	They have equal concentrations of hydrogen ions.
E	They react at the same rate with magnesium.
F	They neutralise the same number of moles of sodium hydroxide.

48. An atom of X, a Group 1 element, reacts to become an ion, X⁺.

Identify the **true** statement(s) about this change.

A	The diameter of the particle increases.
B	The nucleus acquires a positive charge.
C	The number of energy levels (electron shells) decreases by one.
D	The atomic number increases by one.
E	An electron is emitted from the nucleus.
F	The number of neutrons does not change.

[END OF QUESTION PAPER]

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Presenting Centre No.	Subject No. 0500	Grade H	Paper No. 2	Group No.	Marker's No.
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Total

0500/202

SCOTTISH
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1997

MONDAY, 19 MAY
9.30 AM - 12.00 NOON

CHEMISTRY
HIGHER GRADE
Paper II

Fill in these boxes and read what is printed below.

Full name of school or college

Town

First name and initials

Surname

Date of birth

Day Month Year

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Candidate number

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Number of seat

All questions should be attempted.

Necessary data will be found in the Chemistry (Revised) Higher Grade and Certificate of Sixth Year Studies Data Booklet (1992 Edition) which is provided.

The questions may be answered in any order but all answers are to be written in this answer book, and must be written clearly and legibly in ink.

Rough work, if any should be necessary, as well as the fair copy, is to be written in this book.

Rough work should be scored through when the fair copy has been written.

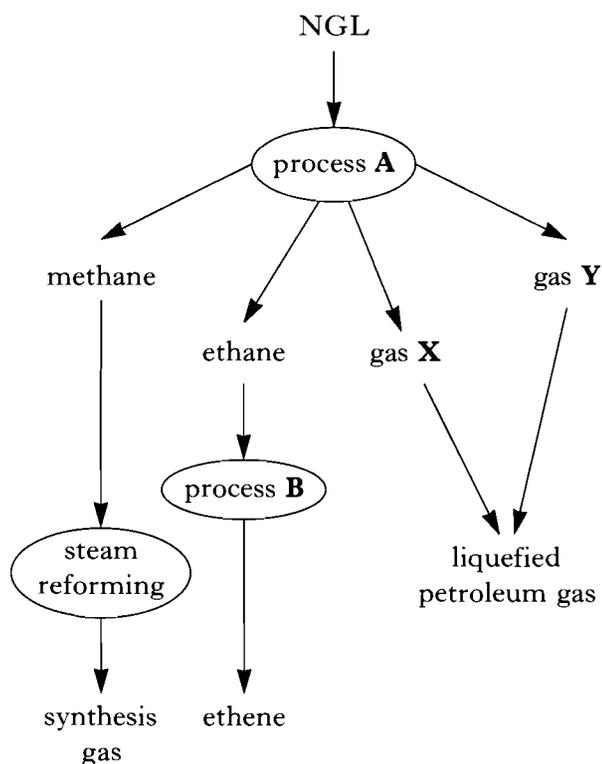
Additional space for answers and rough work will be found at the end of the book. If further space is required, supplementary sheets may be obtained from the invigilator and should be inserted inside the **front** cover of this booklet.

The size of the space provided for an answer should not be taken as an indication of how much to write. It is not necessary to use all the space.

Before leaving the examination room, you must give this book to the invigilator. If you do not, you may lose all the marks for this paper.

Marks

1. One of the fractions obtained from crude oil is natural gas liquid, NGL, a mixture of hydrocarbons, which is used as a feedstock for various processes.



(a) Name

(i) the two main components of synthesis gas,

1

(ii) gas **X** and gas **Y**.

1

(b) Name

(i) process **A**,

1

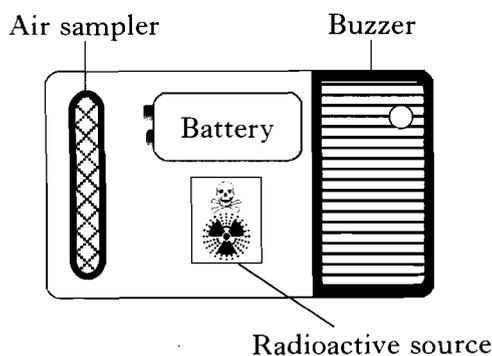
(ii) process **B**.

1

(4)

Marks

2.



Smoke detectors use the alpha radiation from americium-241 to ionise the air in a small chamber. When smoke is present, the conductivity of the air is changed and a buzzer is activated.

(a) Write a balanced nuclear equation for the alpha decay of americium-241.

1

(b) The half-life of americium-241 is 433 years.

Calculate the time taken for the activity of the sample to fall to 12.5% of its original value.

1

(c) Give **two** reasons why americium-241 is a suitable radioisotope for use in an overhead smoke detector.

2

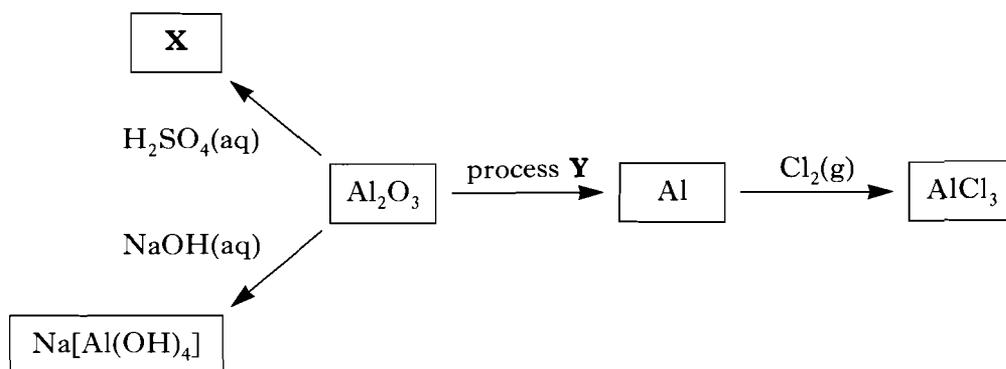
(d) A smoke detector uses 10^{-6} g of americium-241.
Calculate the number of atoms in this sample.

2

(6)

Marks

3. Some of the chemistry of Al_2O_3 is shown in the flow chart.



(a) What evidence from the chart indicates that Al_2O_3 is amphoteric?

1

(b) Write the formula for salt **X**.

1

(c) In industry, how is the reduction of Al_2O_3 carried out in process **Y**?

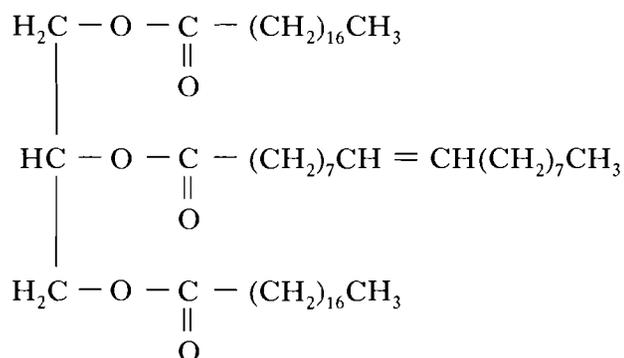
1

(d) AlCl_3 cannot be obtained by the reaction of $\text{Al}_2\text{O}_3(\text{s})$ with $\text{HCl}(\text{aq})$.
Why does AlCl_3 **not** exist in aqueous solution?

1
(4)

Marks

4. The following triglyceride is found in some fats and oils.



- (a) The triglycerides in fats and oils belong to which type of compound?
- (b) The hydrolysis of the triglyceride produces an alcohol and long chain fatty acids.
- (i) Name the alcohol produced by the hydrolysis of the triglyceride.
- (ii) Suggest why the sequence of fatty acids in the triglyceride can be referred to as S,O,S.
You may wish to refer to page 6 of the data booklet.
- (c) What happens to triglyceride molecules in the conversion of oils to hardened fats?

1

1

1

1

(4)

[Turn over

Marks

5. Chlorofluorocarbons, commonly known as CFCs, are widely used in fridges, aerosols and to preserve blood in blood banks.

(a) Information about three CFCs is shown in the table.

CFC	Name	Structure
12	dichlorodifluoromethane
13	1,1,2-trichloro-1,2,2-trifluoroethane	$\begin{array}{c} \text{F} \quad \text{Cl} \\ \quad \\ \text{F} - \text{C} - \text{C} - \text{Cl} \\ \quad \\ \text{Cl} \quad \text{F} \end{array}$
114	$\begin{array}{c} \text{F} \quad \text{F} \\ \quad \\ \text{Cl} - \text{C} - \text{C} - \text{Cl} \\ \quad \\ \text{F} \quad \text{F} \end{array}$

(i) Draw the full structural formula for CFC 12.

1

(ii) Give the name of CFC 114.

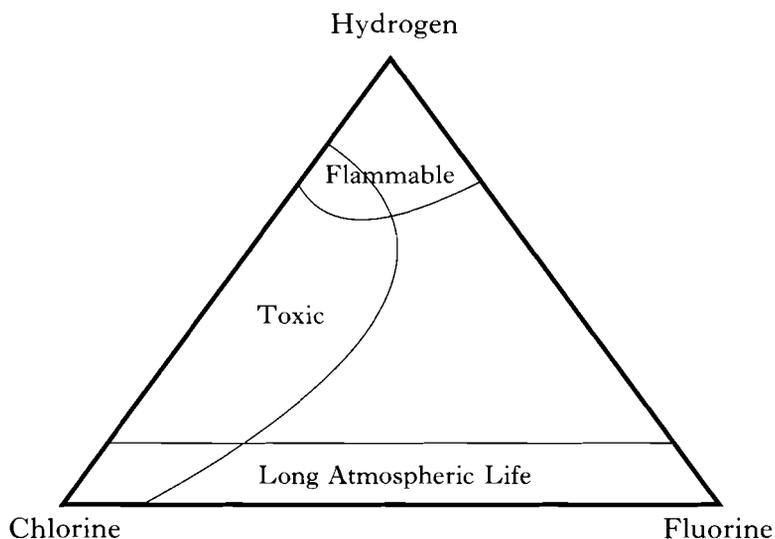
1

Marks

5. (continued)

- (b) Concern about the ozone layer has led to the replacement of CFCs by HFAs, compounds which contain hydrogen in addition to carbon, fluorine and chlorine.

Three properties of CFCs and HFAs are linked to the proportion of chlorine, fluorine and hydrogen in their molecules as shown in the diagram.



Use the three terms in the diagram to compare the properties of the following two compounds.

Compound	Formula
HFA 134a	$\text{CF}_3\text{CH}_2\text{F}$
CFC 13	$\text{CF}_2\text{ClCCl}_2\text{F}$

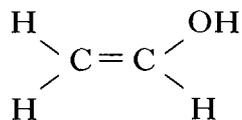
1
(3)

[Turn over

Marks

6. Laundry bags, used in hospitals, are made from poly(ethenol), a polymer which will dissolve in hot or cold water.

Poly(ethenol) is made from a monomer which has the following structure.



- (a) What type of polymerisation produces poly(ethenol)?

1

- (b) Draw the full structural formula for a section of the polymer made from **three** of these monomer units.

1

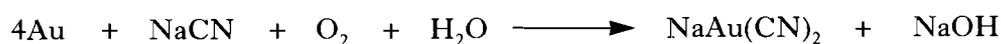
- (c) Poly(ethene) is insoluble in water.
Explain why poly(ethenol) is soluble in water.

2
(4)

7. The most common method for the industrial purification of gold is the cyanide process.

- (a) The impure gold is first dissolved in sodium cyanide solution, NaCN, to give sodium gold cyanide, NaAu(CN)₂.

The partially balanced equation for the reaction is:



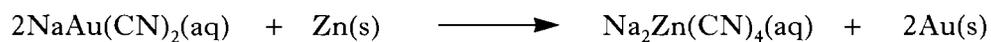
Complete the balancing of this equation.

1

Marks

7. (continued)

- (b) The gold is then obtained by a redox reaction using zinc.



Give another name for this type of reaction.

- (c) Gold may be purified by electrolysis.

- (i) In an industrial process, a current of 10 000 A was passed through a gold solution for 25 minutes producing 10.21 kg of gold.

Calculate the charge on the gold ions in the solution.

(Show your working clearly.)

- (ii) In the laboratory, the electrolysis of gold chloride solution can be used to find the number of coulombs required to plate 1 g of gold on pure gold sheet. The second electrode would be impure gold.

Draw a clearly labelled diagram of the assembled apparatus.

1

3

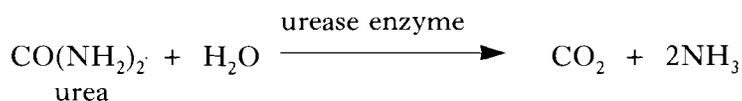
2

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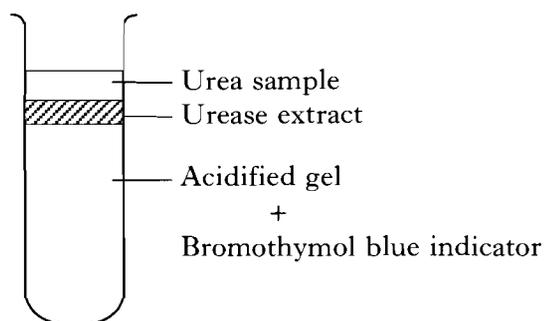
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Marks

8. Urea is a substance found in human urine. The enzyme urease catalyses the hydrolysis of urea.



The concentration of urea in a sample can be estimated using an indicator as shown in the diagram.



The bromothymol blue indicator is yellow below pH 6 and blue above pH 8.3.

- (a) Draw the full structural formula for urea.

1

- (b) The initial yellow colour of the indicator changed to blue as the experiment proceeded.

Explain **fully** the colours observed.

2

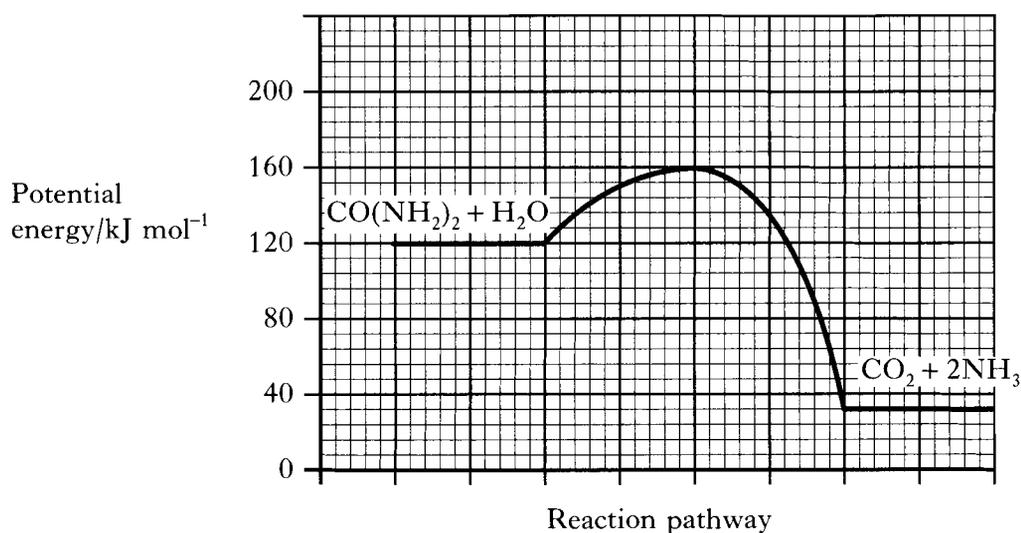
Marks

8. (continued)

- (c) The pH of the gel after one completed experiment was found to be 11.
Calculate the concentration of hydroxide ions.

1

- (d) The graph shows the potential energy diagram for a urease catalysis of urea.



- (i) What is the enthalpy change for the reaction?

1

- (ii) Acid is a **less** effective catalyst than urease for this reaction.
Add a curve to the potential energy diagram to show the hydrolysis
when acid is used as the catalyst.

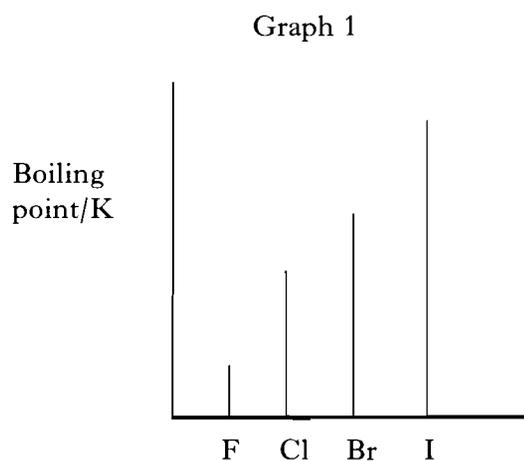
1

(6)

[Turn over

Marks

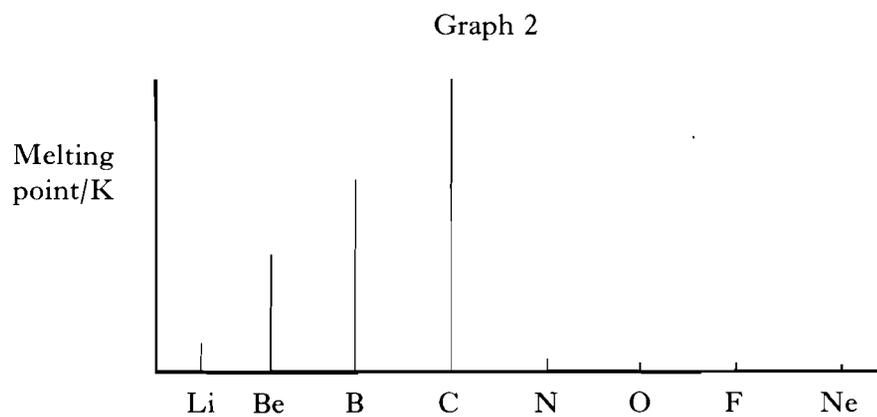
9. Graph 1 shows the boiling points of the Group 7 elements.



- (a) Why do the boiling points increase down Group 7?

1

- (b) Graph 2 shows the melting points of elements from lithium to neon across the second period.



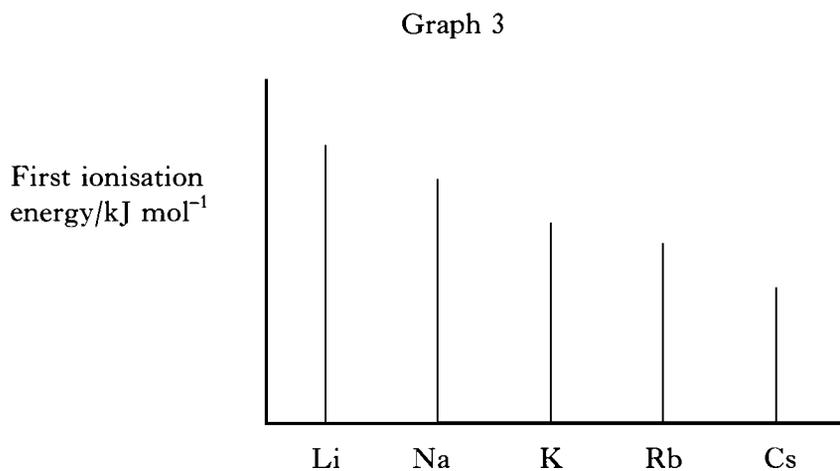
Give a reason for the high melting points of boron and carbon.

1

Marks

9. (continued)

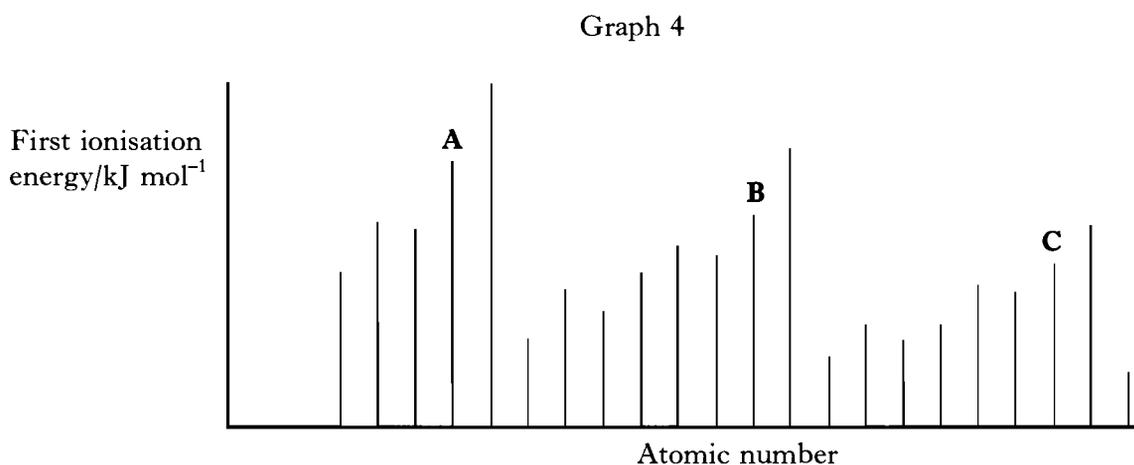
(c) Graph 3 shows the first ionisation energies of the Group 1 elements.



Explain why there is a decrease in first ionisation energy down this group.

2

(d) Graph 4 shows the first ionisation energies of successive elements with increasing atomic number.



Elements **A**, **B** and **C** belong to the same group of the Periodic Table.
Identify the group.

1
(5)

Marks

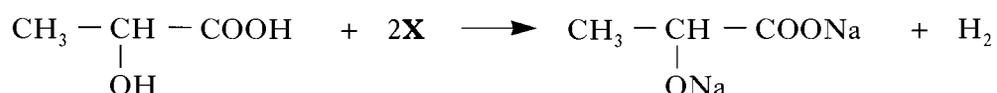
10. Lactic acid can be found in wine. The acid contains both the hydroxyl and the carboxyl functional groups.



- (a) Circle the hydrogen atom of the above lactic acid molecule which would be replaced in the reaction of lactic acid with magnesium.

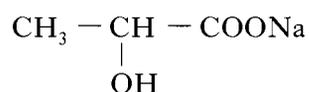
1

- (b) Name the substance **X** which reacts with lactic acid in the following equation.



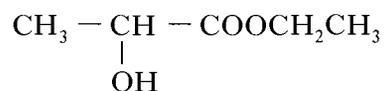
1

- (c) Name the substance which reacts with lactic acid to produce the following compound.



1

- (d) The following compound is sometimes found in wine.

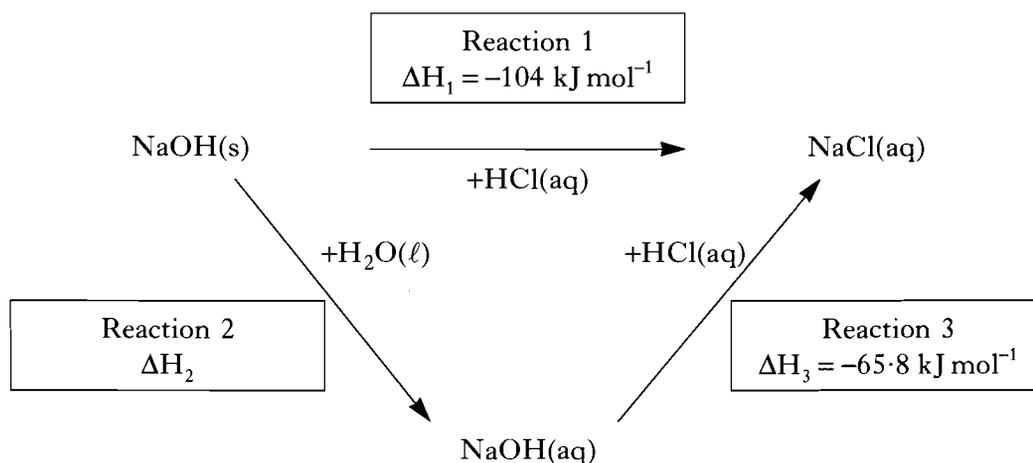


Explain why this compound can be formed.

2
(5)

Marks

11. A pupil tried to confirm Hess's Law using the reactions shown below.



In reaction 1, the pupil measured the mass of NaOH(s) and the temperature change of the reaction mixture.

(a) Which further measurement would have been taken?

1

(b) Use the enthalpy changes in the diagram to calculate the enthalpy change for reaction 2.

1

(c) Write, in words, a statement of Hess's Law.

1

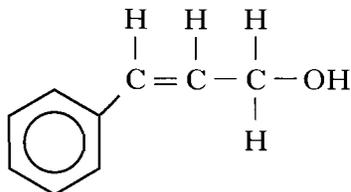
(3)

[Turn over

Marks

12. Synthetic perfumes are cheaper and easier to produce than natural perfumes.

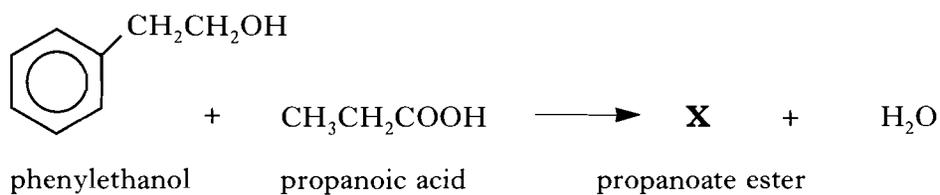
- (a) Cinnamyl alcohol smells pleasantly of hyacinths; it can be described as unsaturated.



Give **two** other terms which could be used to describe this alcohol.

2

- (b) Phenylethanol has a smooth rose-like odour and is used in floral perfumes together with its propanoate ester.



Mass of one mole
= 122 g

Mass of one mole
= 74 g

Mass of one mole
= 178 g

- (i) Draw the structural formula for ester **X**.

1

Marks

12. (b) (continued)

(ii) 3.05 tonnes of phenylethanol was refluxed with 1.48 tonnes of propanoic acid.

Show, by calculation, that the phenylethanol is in excess.

(one tonne = 1000 kg)

1

(iii) The formation of the propanoate ester gives a 70% yield after refluxing.

Calculate the mass of ester obtained.

(Show your working clearly.)

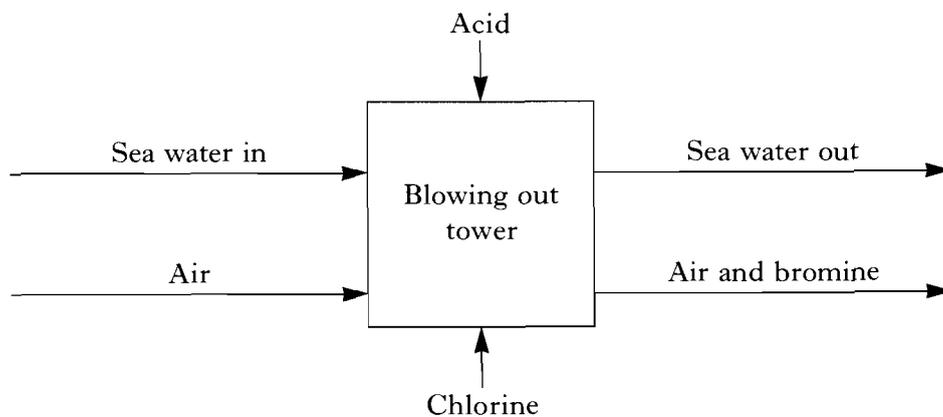
2

(6)

[Turn over

Marks

13. The main source of bromine is the bromide ions in sea water. One stage in the production of bromine is shown in the diagram.



- (a) Write the balanced redox equation for the displacement reaction taking place in the blowing out tower.

You may wish to refer to page 13 of the data booklet.

1

- (b) The hydrolysis of bromine to bromate ions, BrO_3^- , reduces the yield of bromine.



Why does the addition of acid to the blowing out tower slow down the hydrolysis and increase the yield of bromine?

1

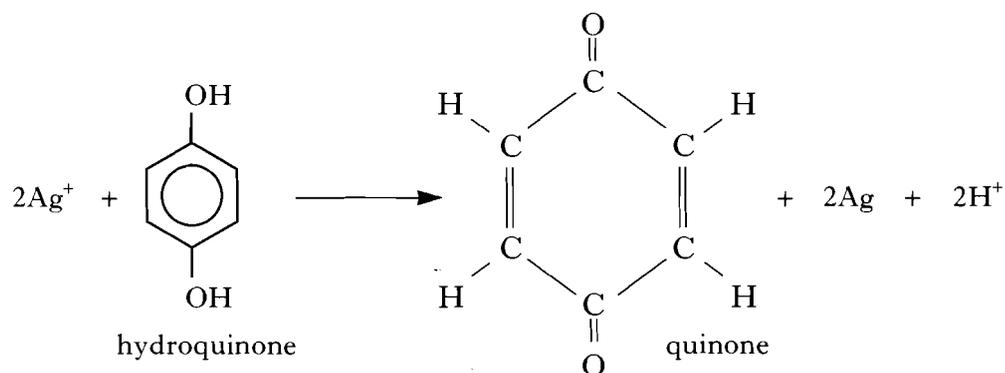
- (c) The majority of the world's bromine is used to make 1,2-dibromoethane, a compound added to leaded petrol.

State **one** difference between the hydrocarbons found in unleaded petrol and the hydrocarbons found in leaded petrol.

1
(3)

Marks

14. Silver halides are used in black and white photography. Hydroquinone is a typical black and white developer which is oxidised by silver ions as follows:



- (a) Write the molecular formula for hydroquinone.

1

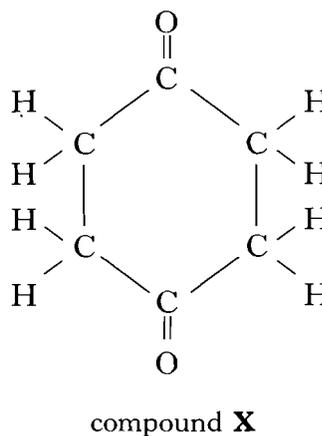
- (b) Write the ion-electron half equation for the oxidation reaction.

1

- (c) A saturated version of quinone, compound **X**, has the structure shown opposite.

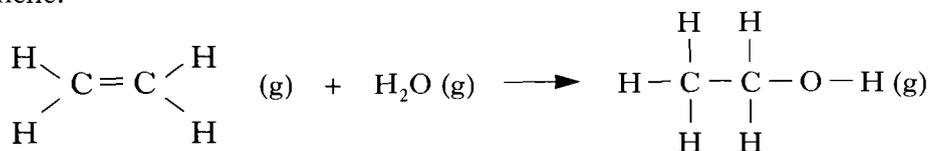
Compound **X** can be formed by the oxidation of compound **Y**.

Draw a structural formula for compound **Y**.

1
(3)

Marks

15. Ethanol can be prepared in industry by an addition reaction between steam and ethene.



- (a) (i) Give another name for this type of reaction.

1

- (ii) Calculate the enthalpy change for the reaction using the tables of bond enthalpies on page 11 of the data booklet.

(Show your working clearly.)

3

- (b) When 4 g of ethanol was dissolved in 100 cm³ of water, the temperature rose from 17.5 °C to 19.8 °C.

- (i) Give **one** method of preventing heat loss during the experiment.

1

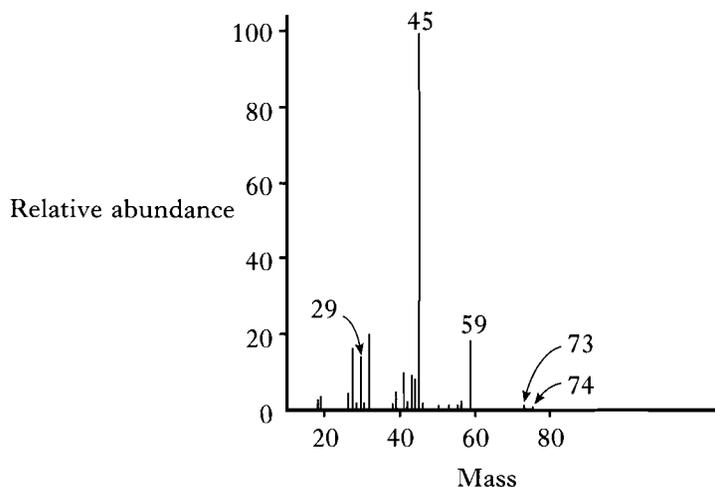
- (ii) Calculate the enthalpy of solution of ethanol using the specific heat capacity of liquid water given on page 7 of the data booklet.

(Show your working clearly.)

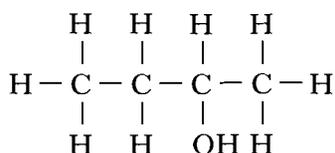
2
(7)

Marks

16. In a mass spectrometer, the energy of an electron beam can break bonds in molecules to form fragments containing groups of atoms. The positions of the peaks (or lines) in a mass spectrum correspond to the masses of the fragments which are formed.



In the mass spectrum shown, the peaks at masses 29, 45 and 59 are formed by the breaking of carbon to carbon bonds in:



- (a) Name the above compound.

1

- (b) Complete the table below.

Relative mass	Formula of fragment
29	C_2H_5
45	$\text{C}_2\text{H}_4\text{OH}$
59	

1

- (c) What causes the peaks at masses just below the main peak at 45, eg at 44, 43, 42, 41?

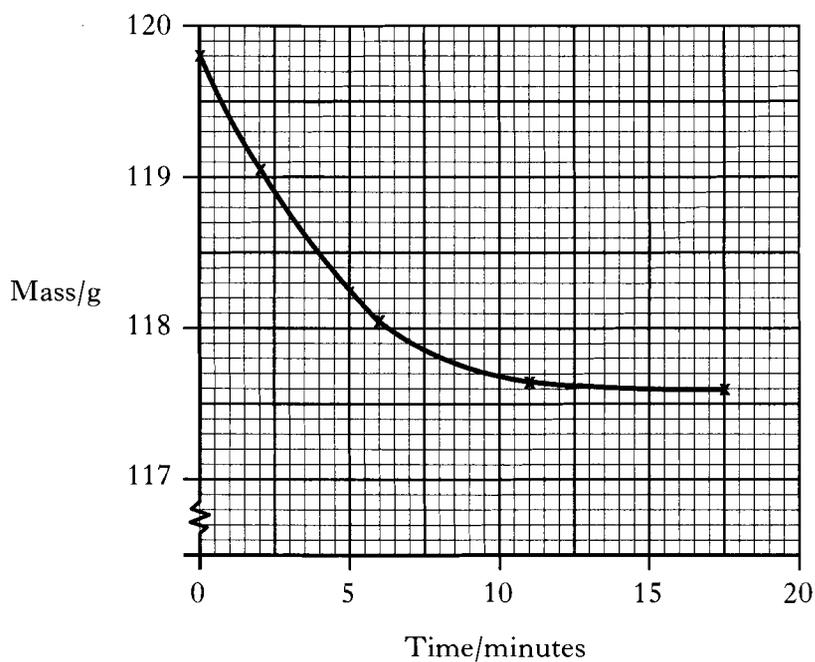
1

(3)

Marks

17. Marble chips, calcium carbonate, reacted with excess dilute hydrochloric acid. The rate of reaction was followed by recording the mass of the container and the reaction mixture over a period of time.

The results of an experiment are shown in the following graph.



- (a) Write a balanced equation for the reaction.

1

- (b) Calculate the average rate of reaction over the first five minutes.

1

- (c) Why does the average rate of reaction decrease as the reaction proceeds?

1

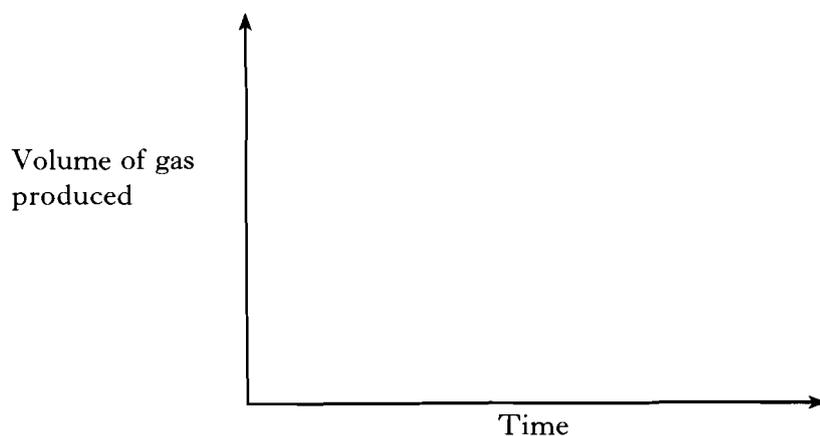
Marks

17. (continued)

- (d) The half-life of the reaction is the time taken for half of the calcium carbonate to be used up.
Calculate the half-life for this reaction.

1

- (e) Use the axes below to sketch a curve showing how the volume of gas produced changes over the same period of time.



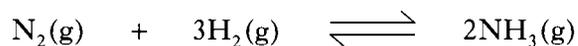
1
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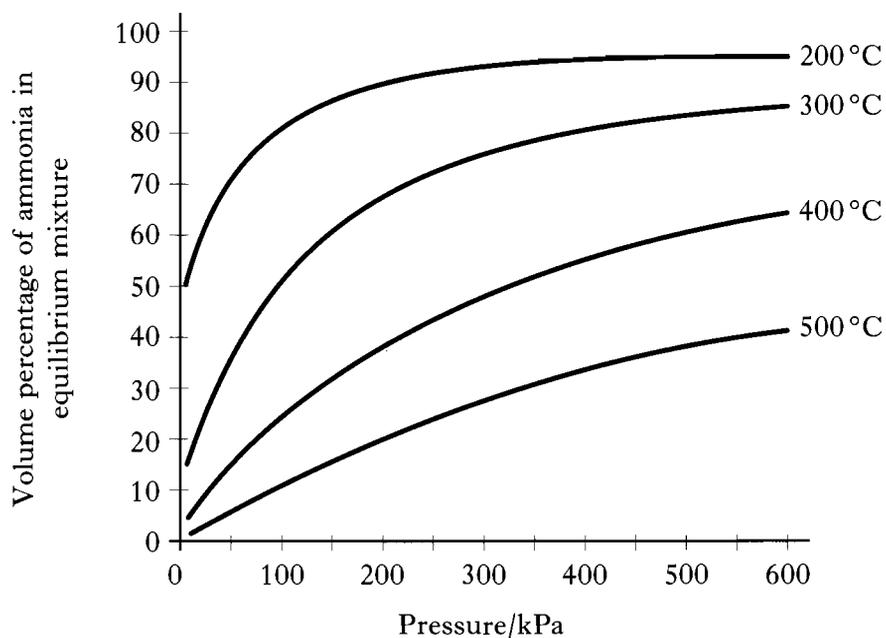
Marks

18. Ammonia is now one of the world's most important chemicals, about two million tonnes being produced each year in the UK alone.

It is manufactured by the direct combination of nitrogen and hydrogen by the Haber process.



The graph shows how the percentage of ammonia in the gas mixture at equilibrium varies with pressure at different temperatures.



- (a) What does the term “at equilibrium” mean?

1

- (b) Use the graph **and** the chemical equation to explain the conclusion that the reaction is exothermic.

2

Marks

18. (continued)

- (c) (i) Typical conditions for the Haber process are approximately 400°C and 200 kPa .

Use the graph to estimate the percentage of ammonia which could be obtained if the mixture was left until equilibrium was reached at this temperature and pressure.

1

- (ii) In practice, the percentage of ammonia in the gas mixture never rises above 15%.

Although the yield is low, the process is still profitable.

Give **one** reason for this fact.

1

(5)

[Turn over

Marks

19. Cigarette lighter flints are composed principally of an alloy of iron and “misch” metal. One flint has a mass of 0.20 g. Its percentage composition by mass is shown in Table 1. Table 2 shows the percentage composition by mass of “misch” metal.

Table 1

Metal	Percentage
Misch metal	75.00
Iron	19.70
Others	5.30

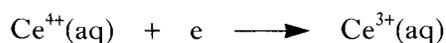
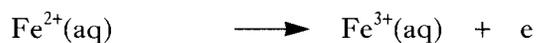
Table 2

Metal	Percentage
Cerium	44.00
Lanthanum	35.00
Neodymium	12.50
Praseodymium	4.75
Others	3.75

- (a) Calculate the mass of cerium metal in the flint.

1

- (b) A second flint, also with a mass of 0.20 g, was dissolved in 30 cm³ of dilute sulphuric acid, and heated with a catalyst to produce a solution containing Ce⁴⁺(aq) ions. The mass of cerium in this second flint was found by titrating 10 cm³ of the Ce⁴⁺(aq) solution with iron(II) sulphate solution, using a suitable indicator.

Equations

- (i) What is the purpose of the indicator?

1

Marks

19. (b) (continued)

(ii) 0.76 g of solid FeSO_4 was required to make 100 cm^3 of 0.05 mol l^{-1} iron(II) sulphate solution.

Describe fully how you would prepare 100 cm^3 of 0.05 mol l^{-1} iron(II) sulphate solution.

2

(iii) It was found that 4.85 cm^3 of 0.05 mol l^{-1} iron(II) sulphate solution was required to reduce 10 cm^3 of the $\text{Ce}^{4+}(\text{aq})$ solution.

Calculate the mass of cerium in the flint.

(Take the relative atomic mass of cerium to be 140.)

(Show your working clearly.)

3
(7)

[END OF QUESTION PAPER]