

[0500/301]

1993

SCOTTISH CERTIFICATE OF EDUCATION

# CHEMISTRY (REVISED)

Higher Grade—PAPER I

Thursday, 13th May—9.30 a.m. to 11.10 a.m.

## READ CAREFULLY

1. Check that the answer sheet provided is for Chemistry (Revised) Higher I.
2. Fill in the details required on the answer sheet.
3. Reference may be made to the Chemistry (Revised) Higher Grade and Certificate of Sixth Year Studies Data Booklet (1992 edition).
4. Rough working, if required, should be done only on this question paper, or on the rough working sheet provided—NOT on the answer sheet.
5. 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.

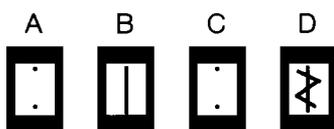
SAMPLE QUESTION

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

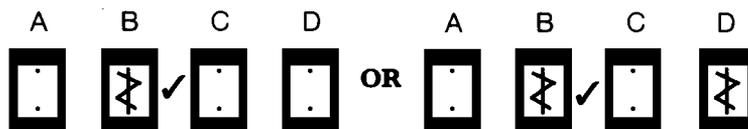
- A fractional distillation
- B chromatography
- C fractional crystallisation
- D filtration.

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:

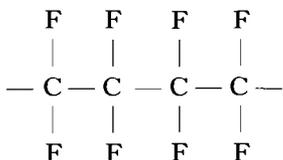


If you want to change back to an answer which has already been scored out, you should enter a tick (✓) to the RIGHT of the box of your choice, thus:



1. Which compound contains **both** a halide ion and a transition metal ion?
- A Iron oxide  
 B Potassium permanganate  
 C Nickel bromide  
 D Copper iodate

2. A part of the molecular structure for PTFE is shown.



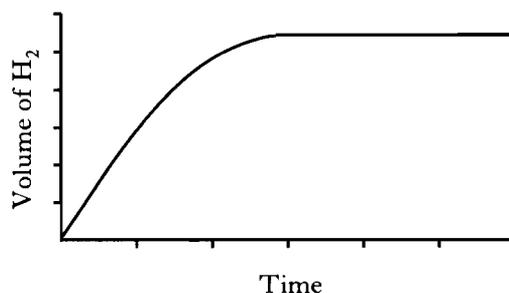
This is classed as a

- A synthetic addition polymer  
 B synthetic condensation polymer  
 C natural condensation polymer  
 D natural addition polymer.
3. Four metals **W**, **X**, **Y** and **Z** and their compounds were tested as described.
- (i) Only **X**, **Y** and **Z** reacted with dilute hydrochloric acid.
- (ii) The oxides of **W**, **X** and **Y** were reduced to the metal when heated with carbon powder. The oxide of **Z** did not react.
- (iii) A displacement reaction occurred when **X** was added to an aqueous solution of the nitrate of **Y**.

The correct order of reactivity of these metals (most reactive first) is

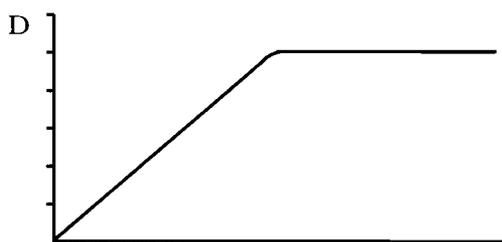
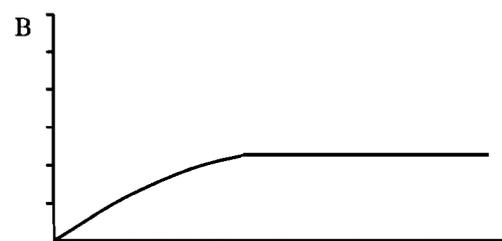
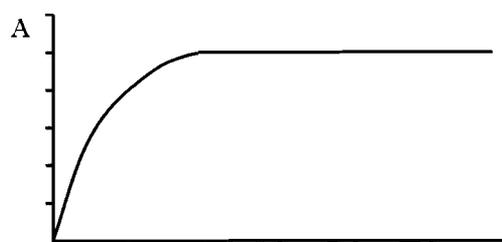
- A W, Y, X, Z  
 B W, X, Y, Z  
 C Z, X, Y, W  
 D Z, Y, X, W.
4. What is the amount of iron(II) ions in 40 cm<sup>3</sup> of 0.1 mol l<sup>-1</sup> iron(II) sulphate solution?
- A 0.1 mol  
 B 0.01 mol  
 C 0.04 mol  
 D 0.004 mol

5. The graph shows the volume of hydrogen given off against time when an excess of magnesium ribbon is added to 100 cm<sup>3</sup> of hydrochloric acid, concentration 1 mol l<sup>-1</sup>, at 20 °C.

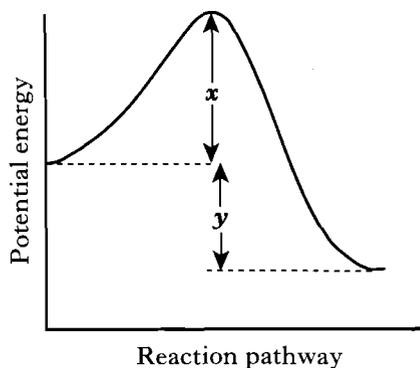


Which graph would show the volume of hydrogen given off when an excess of magnesium ribbon is added to 50 cm<sup>3</sup> of hydrochloric acid of the same concentration at 30 °C?

(The axes all have the same scales as the above graph.)



6.



The activation energy for the reverse reaction can be represented by

- A  $x$
- B  $y$
- C  $x + y$
- D  $x - y$

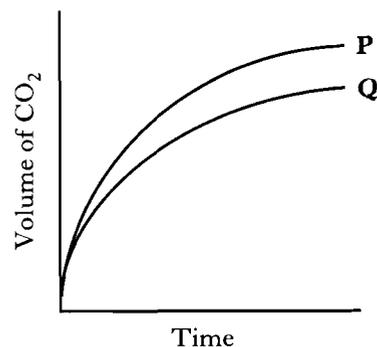
7. The same reaction was carried out at four different temperatures. The table shows the times taken for the reaction to occur.

Temperature/ $^{\circ}\text{C}$	20	30	40	50
Time/s	60	30	14	5

The results show that

- A a small rise in temperature results in a large increase in reaction rate
  - B the activation energy increases with increasing temperature
  - C the rate of the reaction is directly proportional to the temperature
  - D the reaction is endothermic.
8. Which pollutant, produced during internal combustion in a car engine, is **not** the result of incomplete combustion?
- A Nitrogen dioxide
  - B Hydrocarbons
  - C Carbon
  - D Carbon monoxide

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



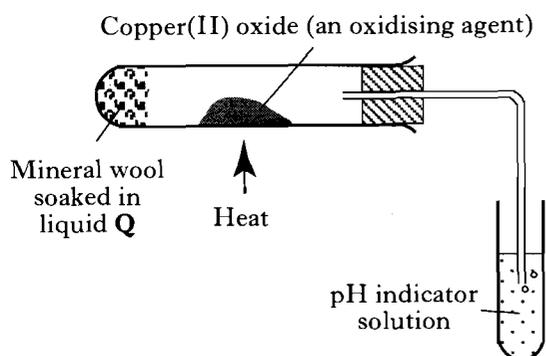
The change from **P** to **Q** could be brought about by

- 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. Synthesis gas is a mixture of carbon monoxide and hydrogen.
- It can be made by
- A fractional distillation of liquid air
  - B burning coal in excess air
  - C burning natural gas in excess air
  - D reacting natural gas with steam.
11. Which is true of a compound with the following formula?



- A It is a primary alcohol.
- B It can be oxidised to an aldehyde.
- C It is a tertiary alcohol.
- D It can be oxidised to a ketone.

12.



After heating for several minutes as shown in the diagram, the pH indicator solution turned red.

Liquid Q could be

- A propanone  
 B paraffin  
 C propan-1-ol  
 D propan-2-ol.
13. The gas  $C_3H_6$  is used on an industrial scale in the manufacture of
- A an addition polymer  
 B a condensation polymer  
 C bottled gas  
 D diesel fuel.
14. Which process is used to convert methanol to methanal?
- A Oxidation  
 B Condensation  
 C Hydration  
 D Hydrogenation
15. What is the amount of oxygen atoms in 0.5 mol of carbon dioxide?
- A 0.25 mol  
 B 0.5 mol  
 C 1 mol  
 D 2 mol

16. In which of these gaseous reactions is the volume of products less than the volume of reactants?

- A  $CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$   
 B  $2NH_3(g) \rightarrow N_2(g) + 3H_2(g)$   
 C  $H_2(g) + Cl_2(g) \rightarrow 2HCl(g)$   
 D  $2CO(g) + O_2(g) \rightarrow 2CO_2(g)$

17. Avogadro's Constant is the same as the number of

- A electrons in 0.5 mol of hydrogen atoms  
 B atoms in 0.5 mol of chlorine gas  
 C molecules in 0.5 mol of carbon monoxide  
 D ions in 0.5 mol of sodium oxide.

18. Which statement **cannot** be true of two atoms with the same mass number?

- A They are isotopes of the same element.  
 B They have different numbers of protons.  
 C They have different numbers of neutrons.  
 D They are atoms of two different elements.

19.  $N_2(g) + 2O_2(g) \rightarrow 2NO_2(g)$

How many litres of nitrogen dioxide gas could theoretically be obtained by sparking 5 litres of nitrogen gas with 2 litres of oxygen gas?

(All volumes are measured under the same conditions of temperature and pressure.)

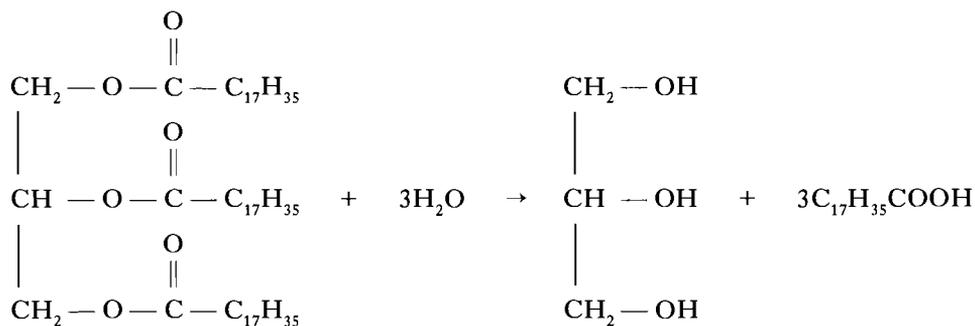
- A 2  
 B 3  
 C 4  
 D 5

20. If a steady current of 0.4 A is passed through silver nitrate solution, concentration  $1 \text{ mol l}^{-1}$ , for 40 minutes, what amount of silver will be liberated?

- A 0.001 mol  
 B 0.01 mol  
 C 0.1 mol  
 D 1.0 mol

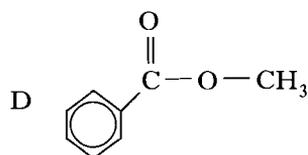
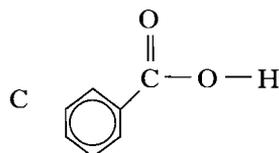
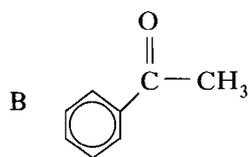
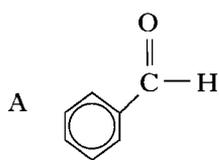
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21. Which process is represented by the following equation?



- A Condensation
- B Hydrolysis
- C Oxidation
- D Dehydration

22. Which of the following is an ester?



23. Silicon carbide can be used as

- A a lubricant
- B a tip for cutting/grinding tools
- C a substitute for pencil "lead"
- D an electrical conductor.

24. Which oxide would be a solid at room temperature (298 K) and a gas at 600 K?

You may wish to use page 9 of the data booklet.

- A Fluorine oxide
- B Phosphorus oxide
- C Magnesium oxide
- D Boron oxide

25. Which compound contains hydride ions?

- A HCl
- B H<sub>2</sub>O
- C NH<sub>3</sub>
- D NaH

26. Which element has the greatest attraction for bonding electrons within a bond?

- A Caesium
- B Oxygen
- C Fluorine
- D Iodine

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

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

28. Which chloride is most likely to be soluble in tetrachloromethane,  $\text{CCl}_4$ ?

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

29. Which is the best term to describe aluminum oxide?

- A Acidic
- B Amphoteric
- C Basic
- D Neutral

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

- A  $\text{C}_2\text{H}_4(\text{g}) + \text{H}_2(\text{g}) \rightarrow \text{C}_2\text{H}_6(\text{g})$
- B  $2\text{C}(\text{s}) + 3\text{H}_2(\text{g}) \rightarrow \text{C}_2\text{H}_6(\text{g})$
- C  $2\text{C}(\text{g}) + 6\text{H}(\text{g}) \rightarrow \text{C}_2\text{H}_6(\text{g})$
- D  $\text{C}_2\text{H}_2(\text{g}) + 2\text{H}_2(\text{g}) \rightarrow \text{C}_2\text{H}_6(\text{g})$

31. The mean bond enthalpy of the N–H bond is equal to one third of the value of  $\Delta H$  for which change?

- A  $\text{N}(\text{g}) + 3\text{H}(\text{g}) \rightarrow \text{NH}_3(\text{g})$
- B  $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightarrow 2\text{NH}_3(\text{g})$
- C  $\frac{1}{2}\text{N}_2(\text{g}) + 1\frac{1}{2}\text{H}_2(\text{g}) \rightarrow \text{NH}_3(\text{g})$
- D  $2\text{NH}_3(\text{g}) + 1\frac{1}{2}\text{O}_2(\text{g}) \rightarrow \text{N}_2(\text{g}) + 3\text{H}_2\text{O}(\text{g})$

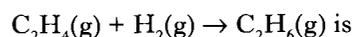
32. For which of these processes does the enthalpy change have a negative sign?

- A  $\text{K}(\text{g}) \rightarrow \text{K}^+(\text{g}) + \text{e}$
- B  $\text{K}(\text{s}) \rightarrow \text{K}(\text{g})$
- C  $\text{Cl}(\text{g}) + \text{e} \rightarrow \text{Cl}^-(\text{g})$
- D  $\text{Cl}_2(\text{g}) \rightarrow 2\text{Cl}(\text{g})$

33. The table shows the enthalpies of combustion ( $\Delta H_c$ ) and formation ( $\Delta H_f$ ) for ethene and ethane.

Compound	$\Delta H_c$	$\Delta H_f$
Ethene	$\Delta H_1$	$\Delta H_3$
Ethane	$\Delta H_2$	$\Delta H_4$

The enthalpy change for the reaction



- A  $\Delta H_1 - \Delta H_2$
- B  $\Delta H_2 - \Delta H_1$
- C  $\Delta H_3 - \Delta H_4$
- D  $\Delta H_4 - \Delta H_3$

34. The enthalpy of solution of an ionic salt is numerically equal to the difference between the enthalpies of

- A hydration and lattice-breaking
- B neutralisation and hydration
- C lattice-breaking and electron gain
- D electron gain and neutralisation.

35.  $2\text{NO}(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{NO}_2(\text{g})$   
 $\Delta H = -560 \text{ kJ mol}^{-1}$

Which two conditions favour the formation of  $\text{NO}_2$ ?

- A High temperature, high pressure
- B High temperature, low pressure
- C Low temperature, high pressure
- D Low temperature, low pressure

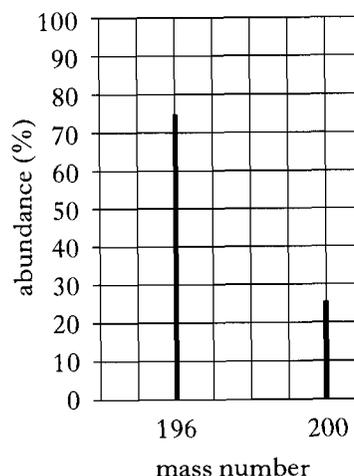
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36. A fully dissociated acid is progressively diluted by the addition of water.

Which of the following will 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. The concentration of  $\text{OH}^{\text{(aq)}}$  ions in a solution is  $0.1 \text{ mol l}^{-1}$ .
- What is the pH of the solution?
- A 8
  - B 13
  - C 14
  - D 15
38. 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.
39. Which of the following particles will be formed when an atom of  ${}_{83}^{211}\text{Bi}$  loses an alpha particle and the decay product then loses a beta particle?
- A  ${}_{79}^{210}\text{Au}$
  - B  ${}_{80}^{209}\text{Hg}$
  - C  ${}_{81}^{209}\text{Tl}$
  - D  ${}_{82}^{207}\text{Pb}$

40. The chart below was obtained from an 8-day old sample of an  $\alpha$ -emitting radioisotope.



What is the half-life of the radioisotope?

- A 2 days
- B 4 days
- C 8 days
- D 12 days

**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 or more 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	B	C
CH <sub>4</sub>	H <sub>2</sub>	CO <sub>2</sub>
D	E	F
CO	C <sub>2</sub> H <sub>6</sub>	N <sub>2</sub>

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

A	B	C
Ⓓ	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.

Ⓐ	B	C
D	Ⓔ	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	Ⓒ
D	E	Ⓕ

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

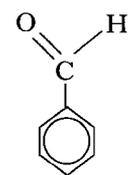
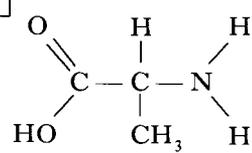
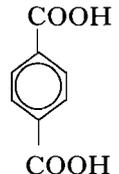
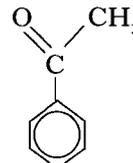
Both answers are circled.

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:

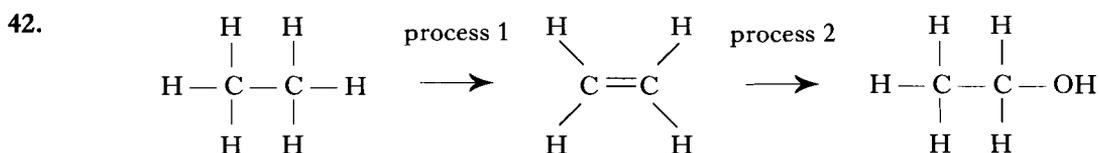
Ⓐ	B	C
<del>Ⓓ</del>	E	F

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:

<del>Ⓐ</del>	B	C
✓ <del>Ⓓ</del>	E	F

<p>A</p> 	<p>B</p> <p>HOCH<sub>2</sub>CH<sub>2</sub>OH</p>	<p>C</p> 
<p>D</p> 	<p>E</p> <p>C<sub>2</sub>H<sub>5</sub>NH<sub>2</sub></p>	<p>F</p> 

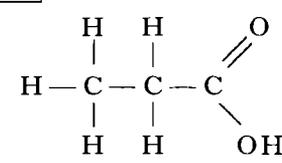
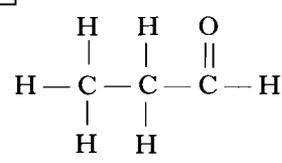
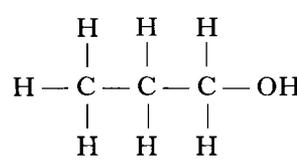
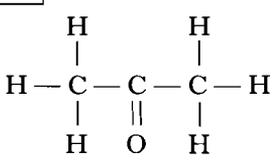
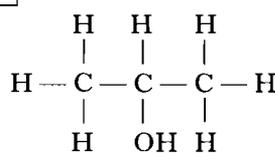
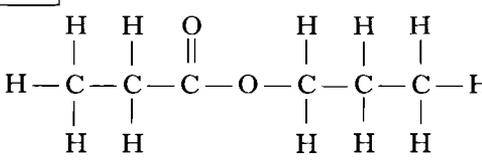
- (a) Identify the molecule which could be produced when a protein is hydrolysed.
- (b) Identify the **two** molecules which contain the carboxyl group.
- (c) Identify the **two** molecules which could be used to make polyester.



<p>A</p> <p>condensation</p>	<p>B</p> <p>cracking</p>	<p>C</p> <p>dehydration</p>
<p>D</p> <p>hydration</p>	<p>E</p> <p>hydrolysis</p>	<p>F</p> <p>oxidation</p>

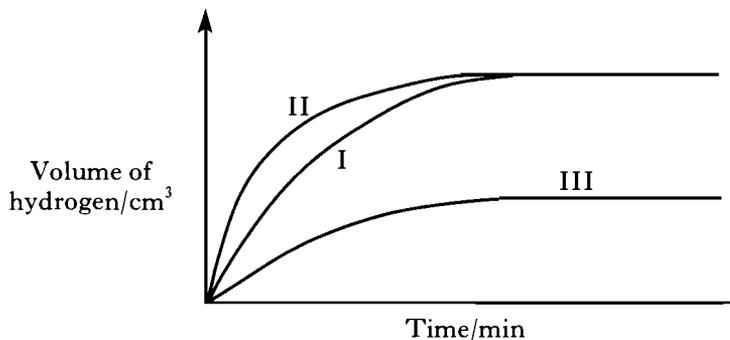
- (a) Identify process 1.
- (b) Identify process 2.

43.

<p>A</p> 	<p>B</p> 	<p>C</p> 
<p>D</p> 	<p>E</p> 	<p>F</p> 

- (a) Identify the **two** compounds which would react to produce the compound shown in box **F**.
- (b) Identify the alkanone.
- (c) Identify the **two** compounds which can be oxidised to produce the compound shown in box **A**.

44. The results of three reactions are plotted on the graph.



Curve I shows the results for the reaction of excess zinc with  $100 \text{ cm}^3$  of  $0.2 \text{ mol l}^{-1}$  sulphuric acid.

A	Excess copper	B	Excess magnesium	C	Excess iron
D	$50 \text{ cm}^3$ of $0.2 \text{ mol l}^{-1}$ sulphuric acid	E	$100 \text{ cm}^3$ of $0.2 \text{ mol l}^{-1}$ sulphuric acid	F	$200 \text{ cm}^3$ of $0.2 \text{ mol l}^{-1}$ sulphuric acid

- (a) Identify the **two** chemicals which would react to give the results shown by curve II.  
 (b) Identify the **two** chemicals which would react to give the results shown by curve III.

45.

A	$\text{CH}_3\text{NH}_2(\text{g})$	B	$\text{CH}_4(\text{g})$	C	$\text{PCl}_3(\ell)$
D	$\text{Na}_2\text{O}(\text{s})$	E	$\text{NaCl}(\text{s})$	F	$\text{SiO}_2(\text{s})$

- (a) Identify the compound which reacts with water to form an acidic gas.  
 (b) Identify the compound which exists as a covalent network.  
 (c) Identify the compound(s) which would form an alkaline solution in water.

46. Identify the statement(s) which would describe a trend in the Periodic Table.

A	The metallic bond strengths decrease down Group 1.
B	The first ionisation energies decrease from sodium to argon.
C	The numbers of electrons in the outer energy levels increase from lithium to neon.
D	The covalent radii increase from lithium to fluorine.
E	The strengths of the Van der Waal's forces decrease down Group 0.

47. 0.2 mol of  $\text{CuSO}_4$  and 0.1 mol of  $\text{Na}_2\text{SO}_4$  were dissolved in water and the solution made up to  $500 \text{ cm}^3$ . Identify the true statement(s).

A	The solution contained 0.1 mol of sodium ions.
B	The solution contained equal numbers of copper(II) and sodium ions.
C	The solution contained equal numbers of positive and negative ions.
D	The concentration of copper(II) ions in the solution is $0.4 \text{ mol l}^{-1}$ .
E	The concentration of sulphate ions in the solution is $0.8 \text{ mol l}^{-1}$ .

48. Benzene is an important feedstock.

Identify the statement(s) which can **not** be applied to benzene.

A	It is the simplest aromatic hydrocarbon.
B	It can be obtained by the distillation of coal tar.
C	It quickly decolourises bromine solution.
D	It can be obtained from naphtha.
E	It has the same empirical (simplest) formula as ethene.
F	It contains delocalised electrons.

[END OF QUESTION PAPER]

FOR OFFICIAL USE

Presenting Centre No.	Subject No.	Grade	Paper No.	Group No.	Marker's No.
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Marks  
Total

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[0500/302]

1993

SCOTTISH CERTIFICATE OF EDUCATION

# CHEMISTRY (REVISED)

Higher Grade – PAPER II

Thursday, 13th May—1.30 p.m. to 4.00 p.m.

Fill in these boxes and read what is printed below.

Full Name of school or college

Town

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Christian Name|First Name, Initial(s) (of other|middle name(s)) Surname

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Date of Birth

Day Month Year

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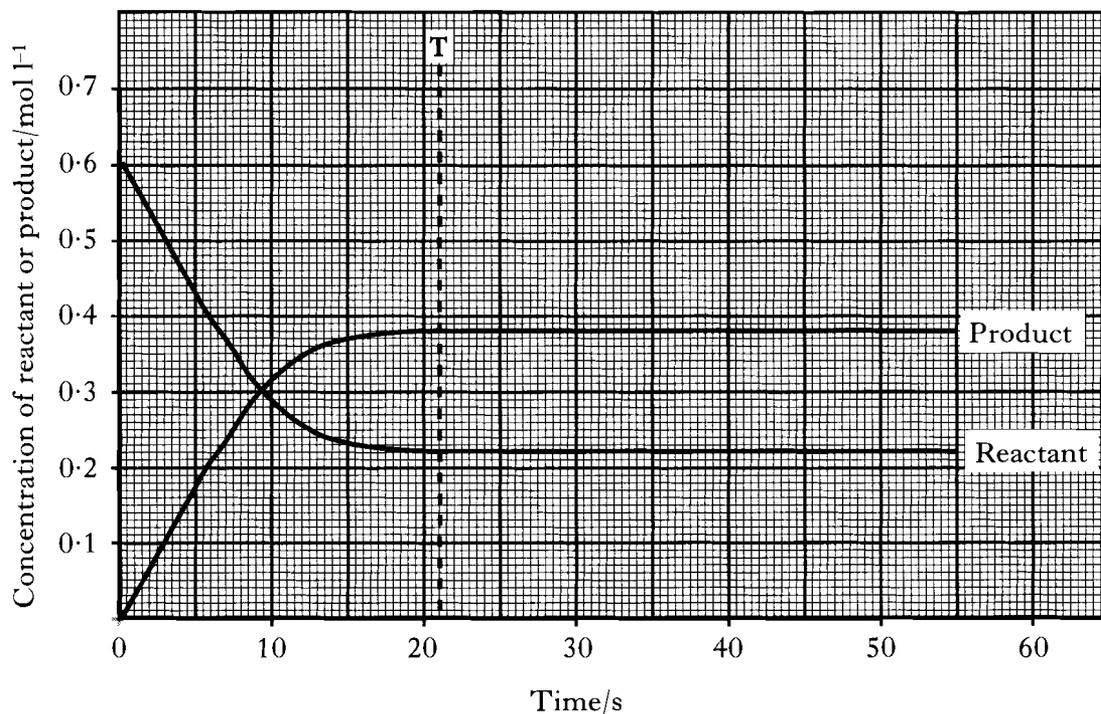
Number of seat occupied  
at examination

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1. All questions should be attempted.
2. Necessary data will be found in the Chemistry (Revised) Higher Grade and Certificate of Sixth Year Studies Data Booklet (1992 Edition) which is provided.
3. 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.
4. 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.
5. 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.
6. 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.
7. 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. The graph below shows how the concentration of a reactant and product change during the course of a reaction.



- (a) Calculate the average rate of reaction over the first 15 s.

1

- (b) After time **T**, the concentrations of reactant and product remain constant. What does this indicate about the reaction?

1  
(2)

Marks

2. Fats and oils are naturally occurring esters of fatty acids and glycerol.

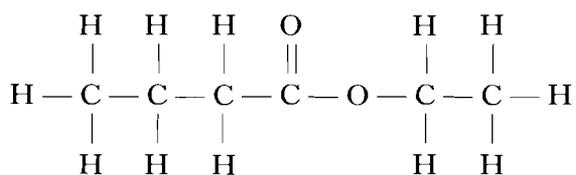
(a) (i) Why do oils tend to have lower melting points than fats?

1

(ii) Draw the full structural formula for glycerol.

1

(b) The full structural formula for an ester found in pineapples is shown.



(i) Name the ester.

1

(ii) What would be observed if this ester was added to water?

1  
(4)

Marks

3. (a) The table shows the abundances of the naturally occurring isotopes of strontium.

Isotope	Abundance/%
$^{84}\text{Sr}$	0.5
$^{86}\text{Sr}$	9.9
$^{87}\text{Sr}$	7.0
$^{88}\text{Sr}$	82.6

Calculate the relative atomic mass of strontium.

**(Show your working clearly.)**

- (b) Strontium-90 is a radioisotope which decays by beta emission. It can be used in thickness gauges to measure steel up to a thickness of 0.2 cm.

(i) Write a balanced nuclear equation for the decay of strontium-90.

(ii) Name the type of radiation which could be used to measure steel up to 5 cm thick.

2

1

1  
(4)

Marks

4. Titanium(IV) oxide is used as a white pigment in paint. It is extracted from the ore ilmenite by reaction with sulphuric acid.

(a) Write the formula for titanium(IV) oxide.

1

(b) Titanium(IV) oxide is an amphoteric oxide.

What is meant by an amphoteric oxide?

1

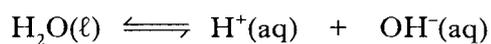
(c) The effluent from the factory which makes the oxide was found to have an  $\text{H}^+(\text{aq})$  concentration of  $0.001 \text{ mol l}^{-1}$ .

State the pH of the effluent.

1

(3)

5. Some of the molecules in water are dissociated, giving the equilibrium:



(a) State the concentration of hydrogen ions in pure water.

1

(b) When sodium carbonate dissolves in water, the pH increases.

Explain this change.

2

(3)

6. Part of a workcard is shown.

**WORKCARD**

To find the number of coulombs required to deposit one mole of nickel from a solution containing  $\text{Ni}^{2+}(\text{aq})$

The diagram shows a circuit for electroplating. At the top, a D.C. supply is connected to a variable resistor and an ammeter (A). The positive terminal (+) of the supply is connected to a Nickel electrode, and the negative terminal (-) is connected to a Copper electrode. Both electrodes are immersed in a solution containing  $\text{Ni}^{2+}(\text{aq})$ .

1. Assemble the apparatus as shown. (DO NOT SWITCH ON.)
2. Set the voltage to 6V D.C.
3. Switch on and adjust the variable resistor to give a current of 0.5 A.
4. Switch off.

(a) Describe fully what should be done before switching the current back on again.

*Marks*

**6. (continued)**

(b) Why must a D.C. supply be used?

**1**

(c) A pupil carrying out this experiment found that 0.23 g of nickel was deposited on the copper electrode.

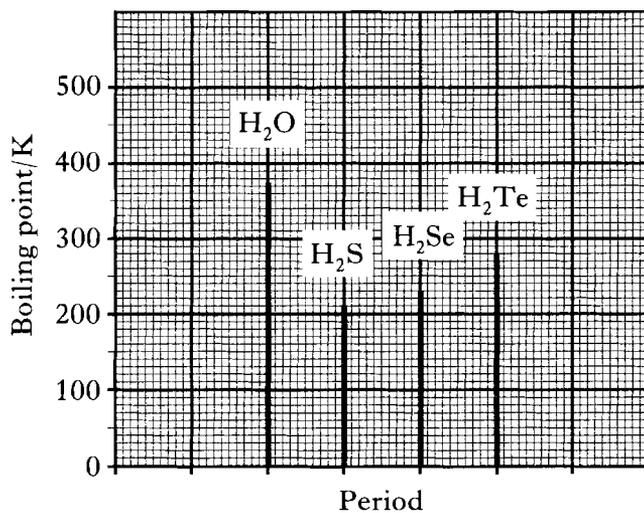
For how long did the pupil pass the current through the solution?

**3  
(6)**

**[Turn over**

Marks

7. The graph shows the boiling points of the Group 6 hydrides.



- (a) Explain why the boiling points increase from H<sub>2</sub>S to H<sub>2</sub>Te.

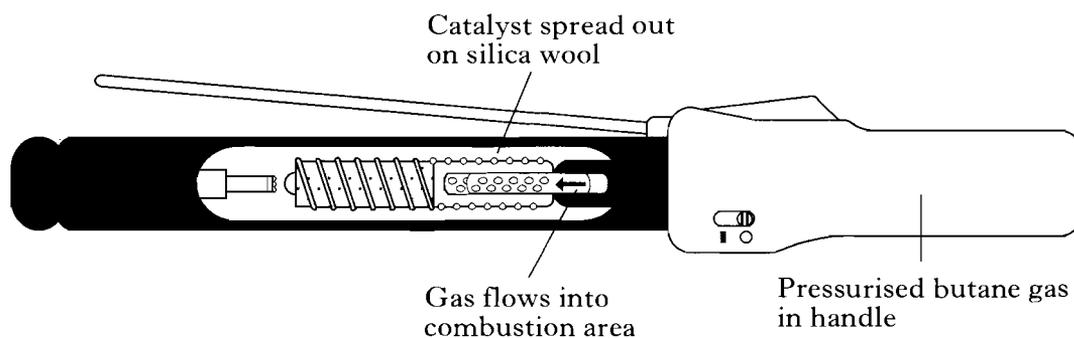
2

- (b) Why does H<sub>2</sub>O have an unusually high boiling point compared to the other Group 6 hydrides?

1  
(3)

Marks

8. A simplified diagram of a portable hair curler is shown.



The catalyst is heated electrically. Butane gas then passes over the catalyst where it reacts with oxygen from the air. The tongs remain hot until the gas is switched off.

- (a) Although the catalyst has to be kept hot, the electrical heater can be switched off after the reaction has started.

Suggest why this is possible.

1

- (b) Name the type of catalysis taking place.

1

- (c) Why is the catalyst spread out?

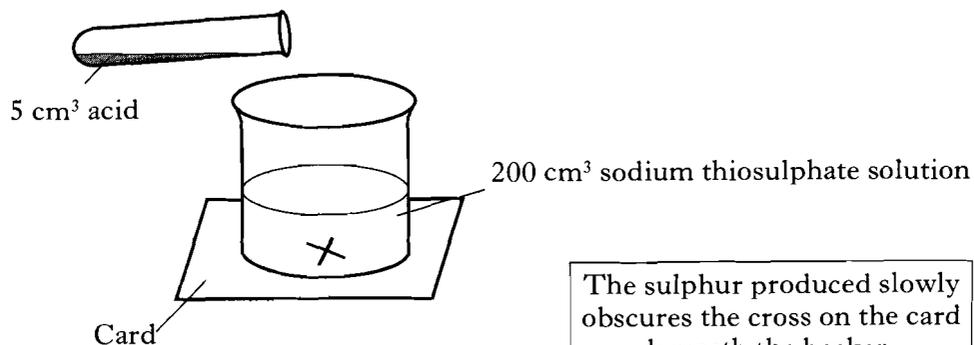
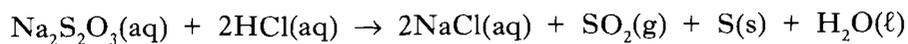
1

- (d) Balance the equation for the combustion of butane.

1  
(4)

Marks

9. (a) Dilute hydrochloric acid reacts with sodium thiosulphate solution producing sulphur.



You are given

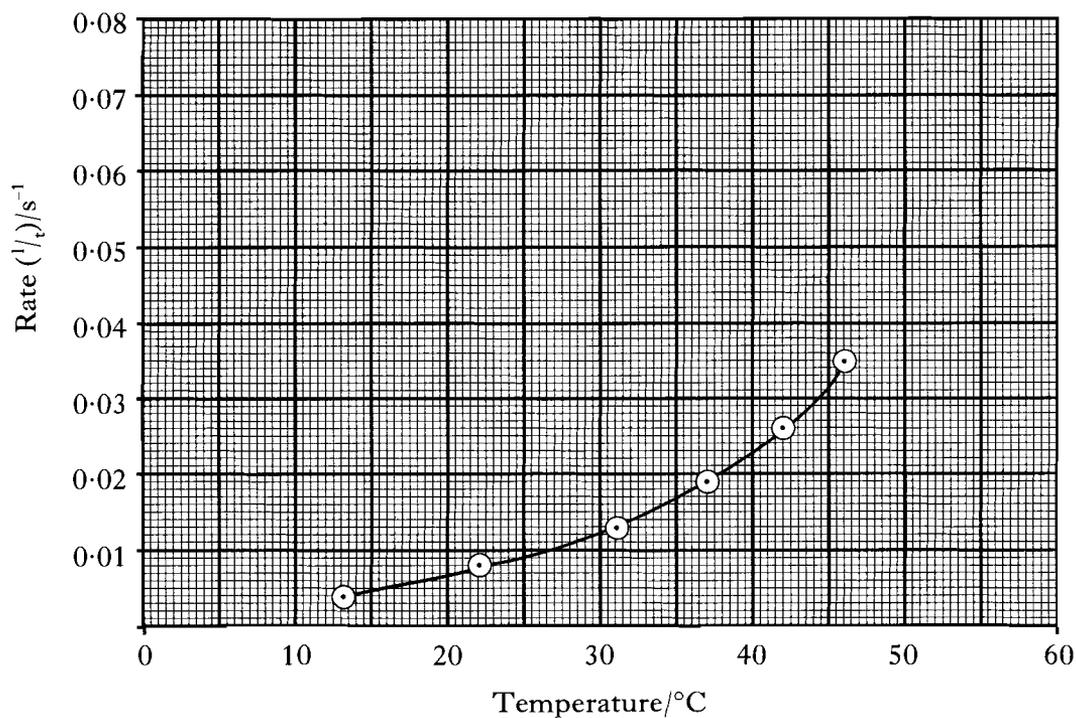
- 0.2 mol l<sup>-1</sup> sodium thiosulphate solution,
- 0.1 mol l<sup>-1</sup> hydrochloric acid,
- any laboratory equipment you require.

Describe fully how you would investigate the effect on the reaction rate of varying the concentration of sodium thiosulphate solution.

2

## 9. (continued)

- (b) The graph shows the effect of temperature on the rate of reaction when  $5 \text{ cm}^3$  of  $0.1 \text{ mol l}^{-1}$  hydrochloric acid is added to  $200 \text{ cm}^3$  of  $0.2 \text{ mol l}^{-1}$  sodium thiosulphate solution.



- (i) For how long was the reaction at  $37^\circ\text{C}$  timed?  
**(Show your working clearly.)**

1

- (ii) Continue the graph to predict the rate at  $52^\circ\text{C}$ .

1  
(4)

Marks

10. (a) The table shows the enthalpies of lattice breaking for some alkali metal halides in kilojoules per mole.

Ions	F <sup>-</sup>	Cl <sup>-</sup>	Br <sup>-</sup>
Li <sup>+</sup>	1022	846	800
Na <sup>+</sup>	902	771	733
K <sup>+</sup>	801	701	670

Write a general statement linking enthalpy of lattice breaking to ion size.

1

- (b) Hess's Law can be used to calculate the enthalpy of lattice breaking.

	Enthalpy change	$\Delta H/\text{kJ mol}^{-1}$
1	$\text{RbCl(s)} \rightarrow \text{Rb}^+(\text{aq}) + \text{Cl}^-(\text{aq})$	+17
2	$\text{Rb}^+(\text{g}) \rightarrow \text{Rb}^+(\text{aq})$	-301
3	$\text{Cl}^-(\text{g}) \rightarrow \text{Cl}^-(\text{aq})$	-364

- (i) Name enthalpy change 1.

1

- (ii) Calculate the enthalpy of lattice breaking for rubidium chloride.

2  
(4)

Marks

11. Diamond and graphite are well known forms of the element carbon. New forms of pure carbon have recently been made. They exist as individual molecules of different sizes and are called fullerenes. The main fullerene has the formula  $C_{60}$ .

(a) How does the structure of a fullerene differ from that of diamond?

1

(b) Fullerenes were first made by passing a high current of electricity through a graphite rod in an atmosphere of helium. This caused the graphite to vaporise.

Suggest why helium gas was used.

1

(c) Fullerenes can be made into hydrocarbons. One such hydrocarbon has the formula  $C_{60}H_{36}$ .

Describe a chemical test which could be carried out on a solution of  $C_{60}H_{36}$  to show whether the hydrocarbon is saturated or unsaturated.

1

(3)

[Turn over

12. The following results are taken from the notebook of a pupil who was trying to confirm Hess's Law.

Experiment 1 — Addition of 1.6 g of sodium hydroxide solid to 50 cm<sup>3</sup> of 1 mol l<sup>-1</sup> hydrochloric acid



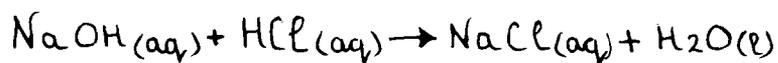
Mass = 50 g

Initial temperature of HCl(aq) = 21.7°C

Highest temperature during experiment = 29.9°C

$$\Delta T = \underline{8.2^\circ\text{C}}$$

Experiment 2 — Addition of 25 cm<sup>3</sup> of 2 mol l<sup>-1</sup> sodium hydroxide solution to 25 cm<sup>3</sup> of 2 mol l<sup>-1</sup> hydrochloric acid



Mass = 50 g

Initial temperature of HCl(aq) - T<sub>1</sub> = 21.7°C

Initial temperature of NaOH(aq) - T<sub>2</sub> = 22.1°C

Highest temperature during experiment = 28.6°C

$$\Delta T =$$

- (a) (i) In **experiment 1**, calculate which reactant is in excess.  
(You **must** show your working clearly.)

Marks

--

Marks

**12. (a) (continued)**

(ii) In **experiment 1**, calculate the enthalpy change during the reaction.

You may wish to use page 7 of the data booklet to help you.

2

(b) Calculate  $\Delta T$  for **experiment 2**.

1

(c) Outline a third experiment which would have to be carried out in order to confirm Hess's Law.

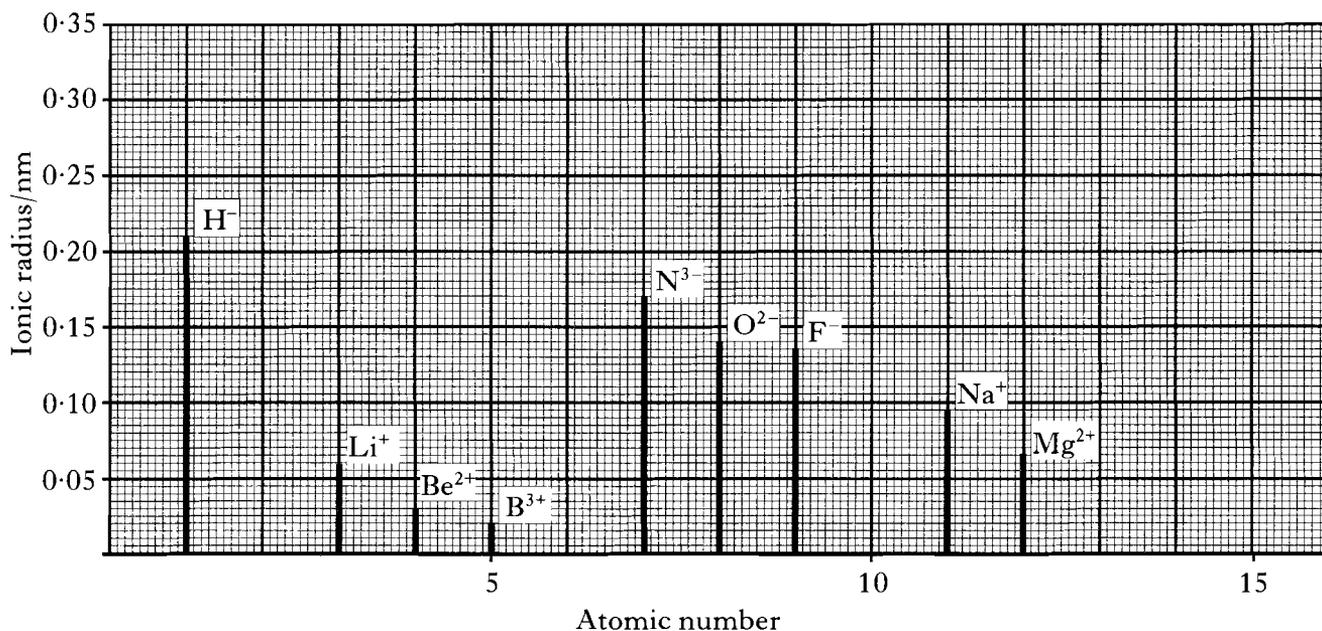
1

(d) Describe a precaution which should be taken to minimise heat loss during the experiments.

1  
(7)

Marks

13. The graph below relates the ionic radii of some elements to their atomic numbers.



- (a) On the graph, plot the ionic radii you would predict for the ions of the elements with atomic numbers 13 and 15.

You may wish to refer to a Periodic Table in the data booklet to help you.

2

- (b) The value quoted for hydrogen is for the hydride ion ( $\text{H}^-$ ).

(i) Why is no value quoted for the  $\text{H}^+$  ion?

1

(ii) Why is the  $\text{H}^-$  ion larger than the  $\text{Li}^+$  ion?

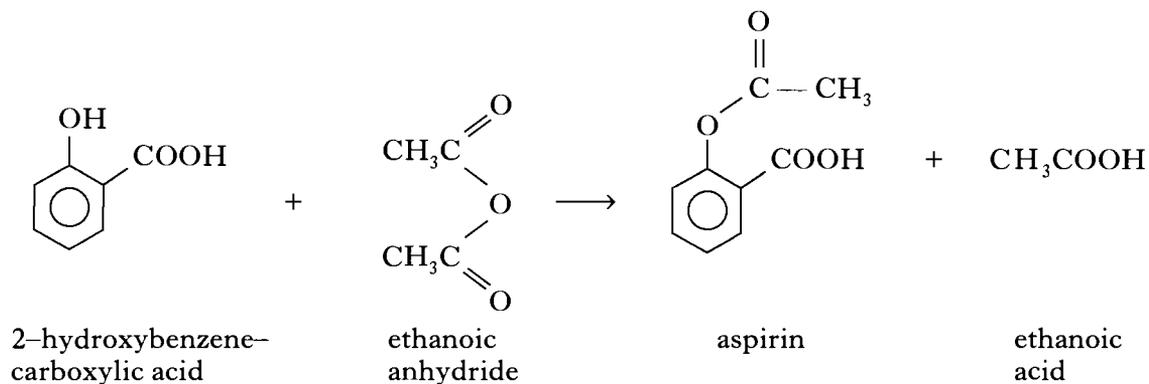
1

- (c) Why is there a large increase in ion size from boron to nitrogen?

1  
(5)

Marks

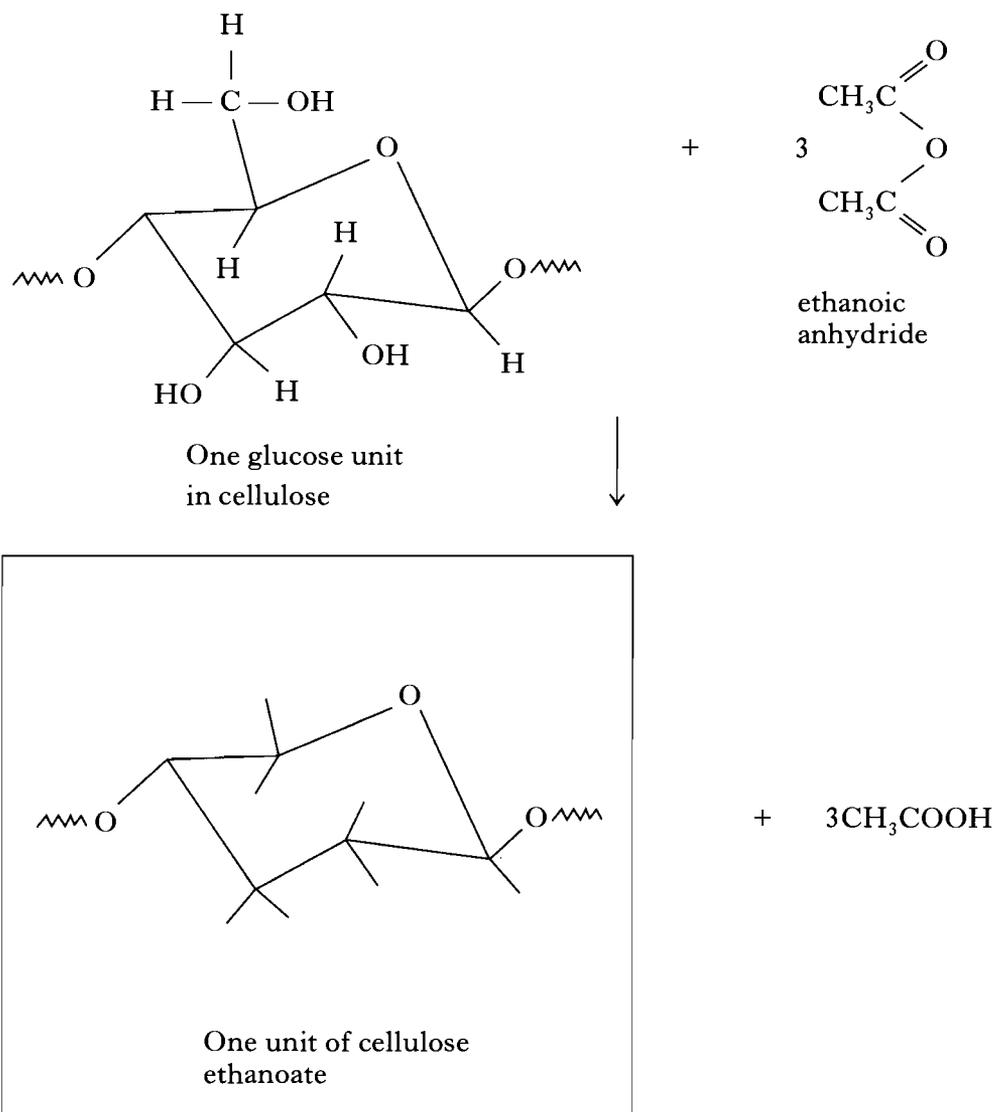
14. Aspirin can be made by reacting 2-hydroxybenzenecarboxylic acid with ethanoic anhydride.



- (a) Write the molecular formula for aspirin.

1

- (b) Cellulose ethanoate fibres can be made from cellulose in a similar way. Complete the structure for the unit of cellulose ethanoate.

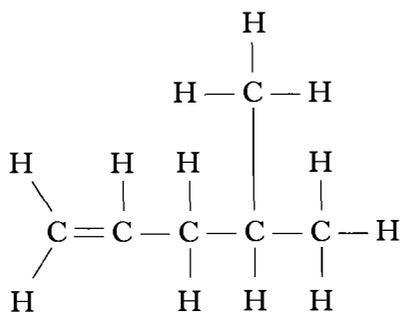


1  
(2)

Marks

15. Petrol is a mixture of chemicals.

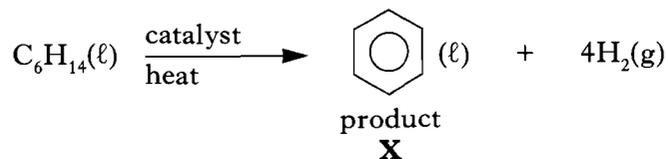
(a) The structural formula for a hydrocarbon found in petrol is:



State the systematic name for this hydrocarbon.

1

(b) A possible route to another compound found in petrol is:



(i) Name product **X**.

1

(ii) Name the process taking place.

1

(c) 2-methylpropan-2-ol is used as an anti-knocking agent in petrol.

Draw the full structural formula for 2-methylpropan-2-ol.

1

Marks

**15. (continued)**

(d) Nitrogen oxides are polluting gases which are present in the exhaust mixture from petrol engines. The production of these gases is not such a problem with diesel engines.

(i) Explain why this is the case.

2

(ii) In a catalytic converter, nitrogen oxides can react with carbon monoxide to form two non-toxic gases.

Name the two gases.

1  
(7)

**[Turn over**

16. Ozone ( $O_3$ ) is formed in the upper atmosphere as described in reactions 1 and 2.

**Reaction 1:** Diatomic oxygen molecules are split into atoms.

**Reaction 2:** An oxygen atom reacts with more diatomic oxygen to form ozone.

CFC 12 ( $CCl_2F_2$ ) is one of a group of chemicals known as CFCs which are thought to be destroying the ozone layer. A possible sequence of reactions leading to the breakdown of ozone is outlined in reactions 3 to 6.

**Reaction 3:** A chlorine atom breaks off from a CFC 12 molecule.

**Reaction 4:** The chlorine atom reacts with ozone to form diatomic oxygen and a very reactive species called chlorine oxide (ClO).

**Reaction 5:** The chlorine oxide reacts with an oxygen atom to form a chlorine atom and a diatomic oxygen molecule.

**Reaction 6:** The chlorine atom reacts with more ozone.

(a) Using symbols and formulae, write equations for reactions 2 to 5.  
(Reactions 1 and 6 have been done for you.)

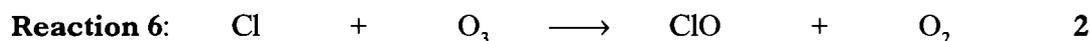


**Reaction 2:**

**Reaction 3:**

**Reaction 4:**

**Reaction 5:**

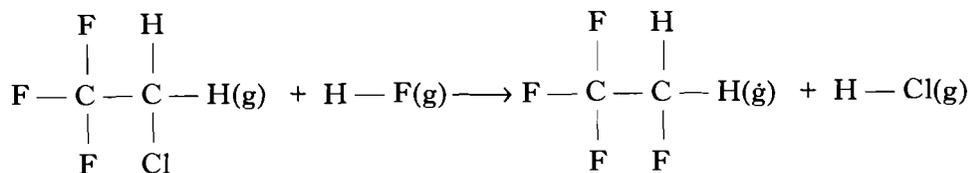


(b) Suggest why it is more likely that a chlorine atom will break off from  $CCl_2F_2$  than a fluorine atom.

Marks

**16. (continued)**

- (c) HFAs are seen as possible substitutes for CFCs. One such HFA is  $\text{CF}_3\text{CH}_2\text{F}$ .  
The last step in its manufacture is:



Using the information on page 11 of the data booklet, calculate the total enthalpy change for the reaction.

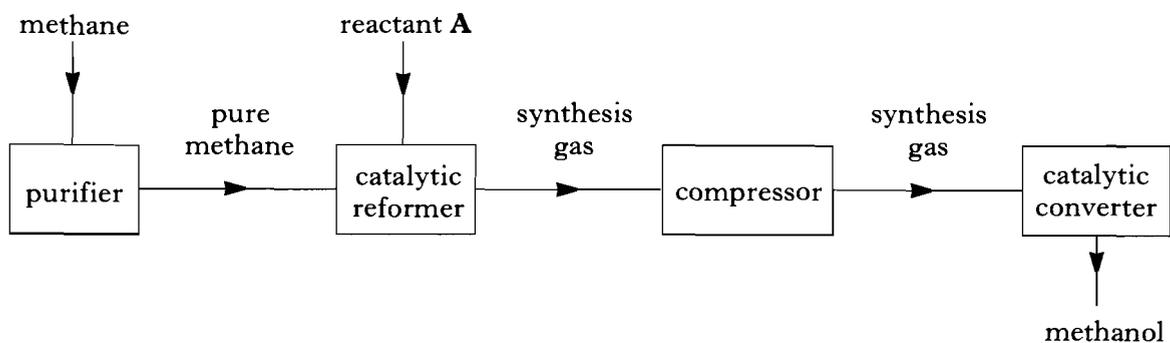
**(Show your working clearly.)**

2  
(5)

[Turn over

Marks

17. The simplified flow diagram shows how methanol can be manufactured from methane.



(a) Name a source of methane.

1

(b) Suggest why sulphur compounds have to be removed in the purifier.

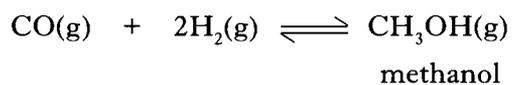
1

(c) Name reactant A.

1

*Marks***17. (continued)**

- (d) In the converter, one of the reactions taking place is:



Explain why the gas pressure is increased before the synthesis gas enters the catalytic converter.

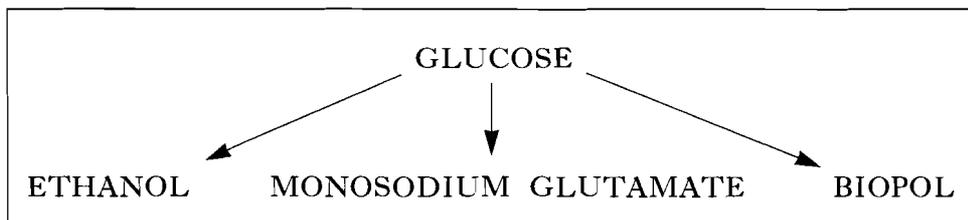
2

- (e) Methanol is a feedstock for the production of methanal.  
State an industrial use for methanal.

1  
(6)**[Turn over**

Marks

18. Fermenting glucose can give different products, depending on the conditions.



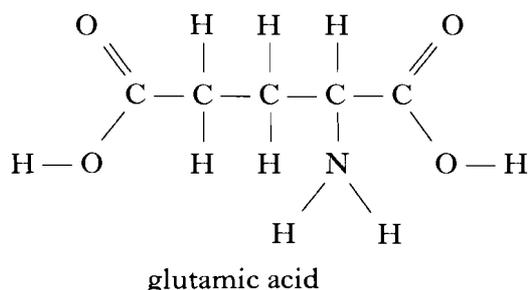
(a) (i) Why do alcoholic beverages produced by the fermentation of glucose have an alcohol content of less than 15%?

1

(ii) To meet market demand, ethanol is also produced directly from ethene. State how this process is carried out industrially.

1

(b) Monosodium glutamate is a salt of glutamic acid.



(i) On the formula for glutamic acid, circle a hydrogen atom which can be replaced by a sodium ion to form monosodium glutamate.

1

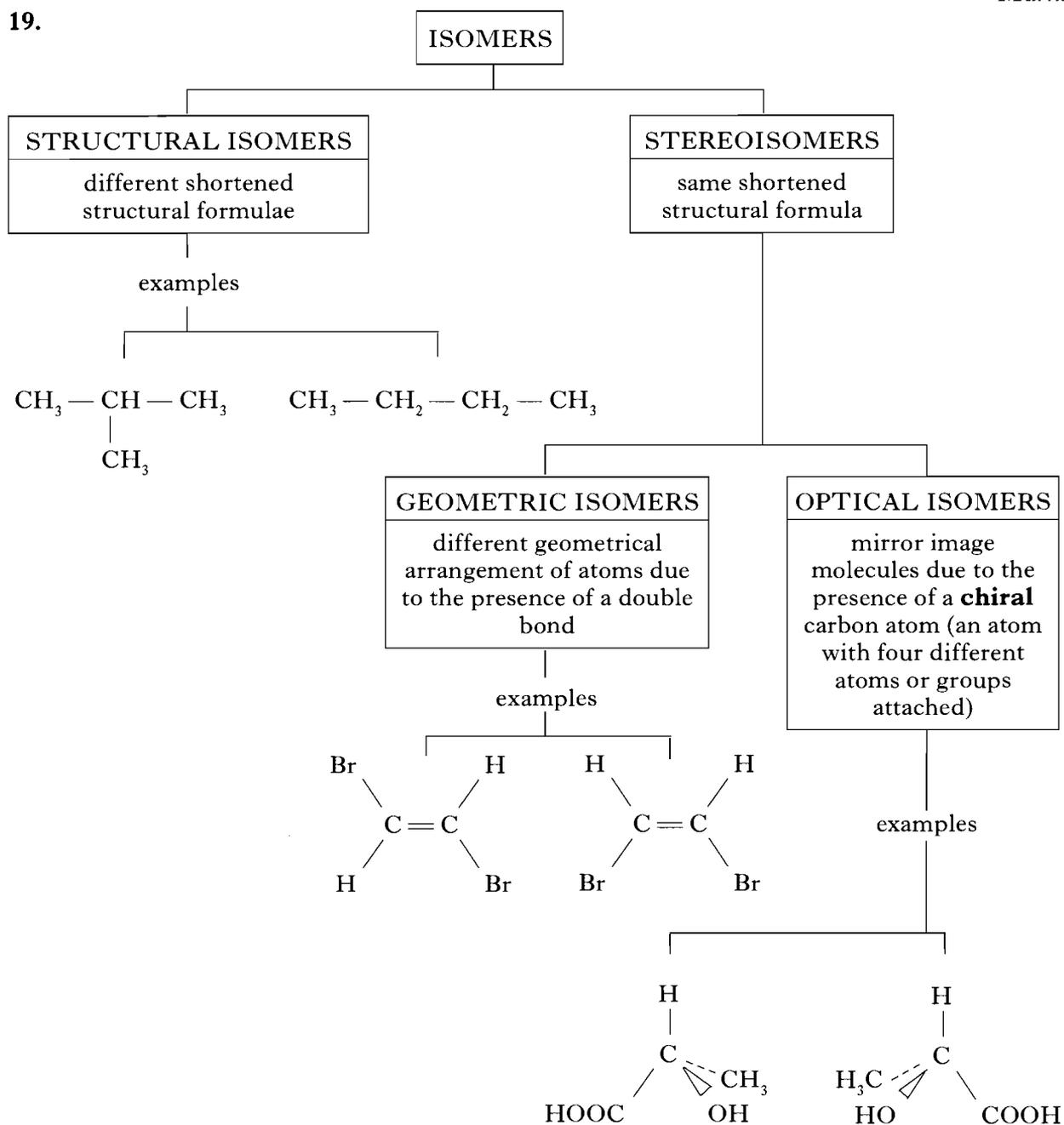
(ii) Which functional group, other than the acid group, does glutamic acid contain?

1



Marks

19.



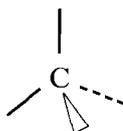
Marks

## 19. (continued)

(b) Draw the geometric isomers of but-2-ene.

1

(c) Complete the diagram below to show the lightest alkane molecule containing a **chiral** carbon atom.

1  
(3)

20. Radon is a radioactive gas found in the air. It contributes to the level of background radiation.

The volume of radon in a breath of air was calculated to be  $1.05 \times 10^{-19}$  litres. Calculate the number of radon atoms in this breath.

(Take the volume of one mole of radon gas to be 24.2 litres.)

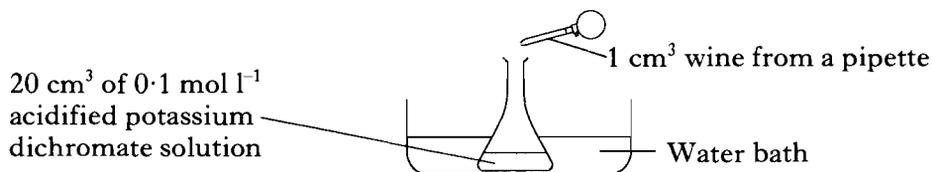
**(Show your working clearly.)**

(2)

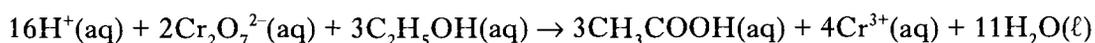
Marks

21. A pupil calculated the mass of alcohol in a bottle of wine.

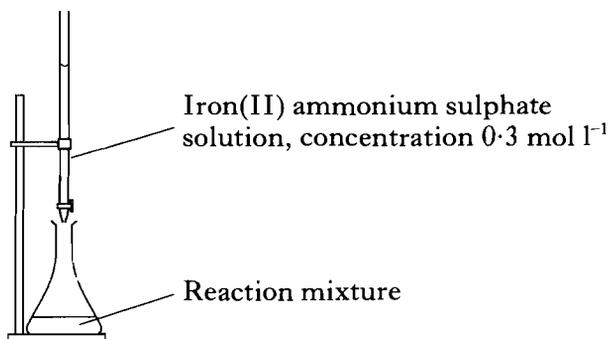
**Step 1** The alcohol in a 1 cm<sup>3</sup> sample of the wine was oxidised using acidified potassium dichromate solution.



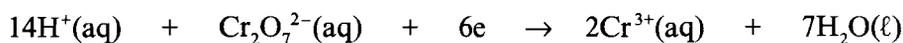
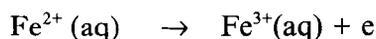
Equation



**Step 2** The excess dichromate was then determined by titration. From this, the amount of dichromate needed to oxidise the alcohol in the 1 cm<sup>3</sup> sample of wine was found.



Equations



(a) Why is the potassium dichromate solution acidified before use in **step 1**?

1

(b) Write the balanced ionic equation for **step 2**.

1

Marks

**21. (continued)**

- (c) To make  $250 \text{ cm}^3$  of  $0.3 \text{ mol l}^{-1}$  iron(II) ammonium sulphate solution requires  $29.4 \text{ g}$  of iron(II) ammonium sulphate.

Given this mass of solute, describe fully how to prepare  $250 \text{ cm}^3$  of  $0.3 \text{ mol l}^{-1}$  solution.

2

- (d) It was found that  $12.5 \text{ cm}^3$  of  $0.1 \text{ mol l}^{-1}$  acidified potassium dichromate solution was required to oxidise the alcohol in the  $1 \text{ cm}^3$  sample of wine.

Calculate the mass of alcohol in the  $1 \text{ cm}^3$  sample of wine.

**(Show your working clearly.)**

3  
(7)

[END OF QUESTION PAPER]