0500/197

SCOTTISH CERTIFICATE OF EDUCATION 1995

MONDAY, 15 MAY
9.30 AM – 11.10 AM

CHEMISTRY (REVISED)
HIGHER GRADE
Paper I

Check that the answer sheet provided is for Chemistry (Revised) 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.

ES 0500/197 6/3/2/22210

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

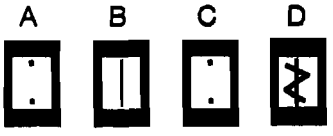
B chromatography

C fractional crystallisation

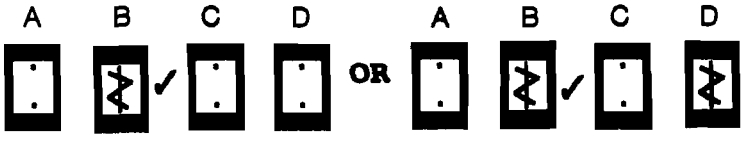
D filtration.

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. The reaction of copper(II) oxide with dilute sulphuric acid is an example of

   A oxidation

   B reduction

   C neutralisation

   D displacement.

2. Which pair of solutions is most likely to produce a precipitate when mixed?

   A Silver nitrate + sodium chloride

   B Magnesium nitrate + sodium sulphate

   C Magnesium nitrate + sodium chloride

   D Silver nitrate + sodium sulphate

3. The reaction

   $$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$$

   is an example of

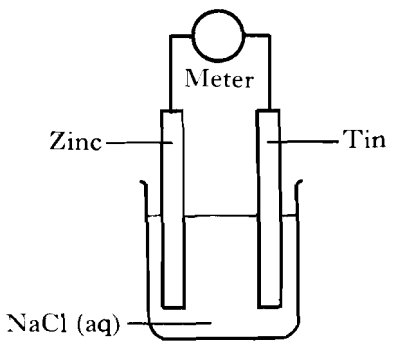
   A photosynthesis

   B hydrolysis

   C combustion

   D hydration.

4.



Which set of observations would apply to this cell?

	Change in mass of zinc	Electron flow through meter
A	lighter	tin to zinc
B	lighter	zinc to tin
C	heavier	tin to zinc
D	heavier	zinc to tin

5. A pupil obtained a certain volume of carbon dioxide by the reaction of 20 cm^3 of 2 mol l^{-1} hydrochloric acid with excess sodium carbonate.

   Which of the following acids would give the same final volume of carbon dioxide when added to excess sodium carbonate?

   A 20 cm^3 of 4 mol l^{-1} hydrochloric acid

   B 10 cm^3 of 4 mol l^{-1} hydrochloric acid

   C 20 cm^3 of 2 mol l^{-1} sulphuric acid

   D 40 cm^3 of 2 mol l^{-1} hydrochloric acid

6. A metal (melting point 843 °C, density 1·54 g cm^{-3}) was obtained by electrolysis of its just molten chloride (melting point 772 °C, density 2·15 g cm^{-3}).

   During the electrolysis, how would the metal occur?

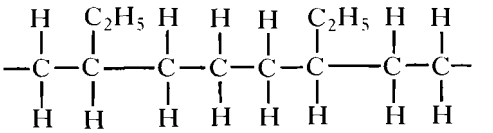
   A As a solid on the surface of the electrolyte

   B As a liquid on the surface of the electrolyte

   C As a solid at the bottom of the electrolyte

   D As a liquid at the bottom of the electrolyte

7. Part of a polymer is shown.



   Which pair of alkenes was used as monomers?

   A Ethene and propene

   B Ethene and but-1-ene

   C Propene and but-1-ene

   D Ethene and but-2-ene

8. 1 mol of hydrogen gas and 1 mol of iodine vapour were mixed and allowed to react. After t seconds, 0·8 mol of hydrogen remained.

   The number of moles of hydrogen iodide formed at t seconds was

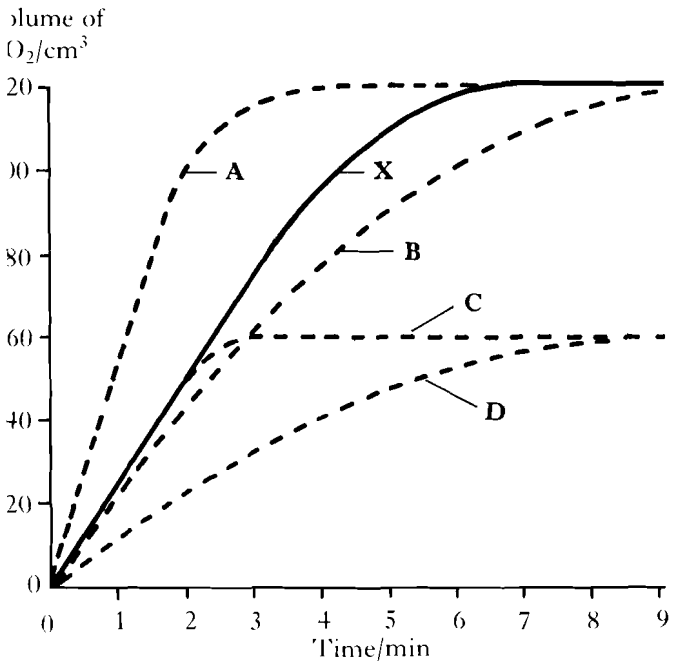
   A 0·2

   B 0·4

   C 0·8

   D 1·6.

9. Graph **X** was obtained when 1 g of calcium carbonate powder reacted with excess dilute hydrochloric acid at 20 °C.

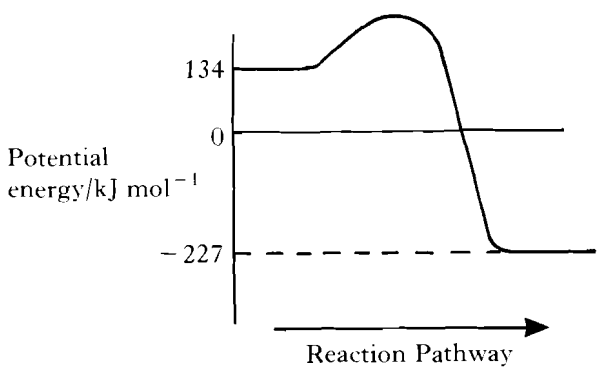


Which curve would best represent the reaction of 0·5 g lump calcium carbonate with excess of the same dilute hydrochloric acid?

10. The potential energy diagram for the reaction

$$CO(g) + NO_2(g) \rightarrow CO_2(g) + NO(g)$$

is shown.



ΔH, in kJ mol^{-1}, for the reaction is

A −361

B −227

C −93

D +361.

11. Which of the following describes the effect of a catalyst?

	Activation energy	Enthalpy of reaction
A	decreased	decreased
B	decreased	no change
C	no change	decreased
D	decreased	increased

12. What compound is formed by the oxidation of propan-2-ol?

A CH_3CH_2CHO

B CH_3COCH_3

C CH_3CH_2COOH

D $CH_3CH_2CH_2OH$

13. Ethanol vapour is passed over hot aluminium oxide.

What kind of reaction occurs?

A Hydrogenation

B Dehydration

C Hydrolysis

D Dehydrogenation

14. One of the main methods for the production of diesel is

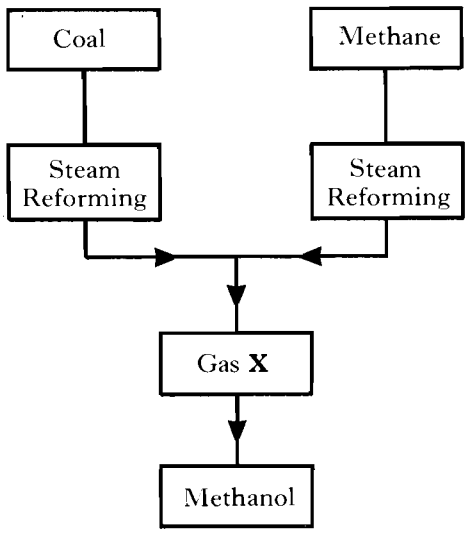
A blending of naphtha fractions

B reforming of naphtha fractions

C reforming of gas oil fractions

D blending of gas oil fractions.

15.



Gas **X**, a feedstock for the manufacture of methanol, is

A methanal

B hydrogen

C carbon monoxide

D synthesis gas.

16. The equation for the complete combustion of propane is

$$C_3H_8(g) + 5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(\ell).$$

50 cm^3 of propane is mixed with 500 cm^3 of oxygen and the mixture is ignited.

What is the volume of the resulting gas mixture? (All volumes are measured at the same temperature and pressure.)

A 150 cm^3

B 300 cm^3

C 400 cm^3

D 700 cm^3

17. The density of chlorine gas is found to be 3·00 g l^{-1}.

Under the experimental conditions, the molar volume, in litres, is

A 11·8

B 22·4

C 23·7

D 35·5.

18. Avogadro's constant is the same as the number of

A molecules in 1 mol of oxygen gas

B atoms in 1 mol of hydrogen gas

C ions in 1 mol of NaCl

D electrons in 1 mol of helium gas.

19. 160 g of calcium contains as many atoms as

A 28 g of carbon

B 92 g of sodium

C 160 g of silver

D 256 g of sulphur.

20. What mass of copper metal, in grams, would be deposited by electrolysis of a solution of $Cu^{2+}(aq)$ ions if 1000 coulombs of electrical charge were passed?

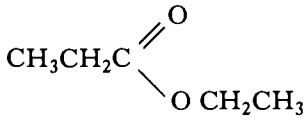
A 12 352

B 3·3

C 0·66

D 0·33

21. The compound with formula



can be made from

A ethanol and ethanoic acid

B propan-1-ol and ethanoic acid

C ethanol and propanoic acid

D propan-1-ol and propanoic acid.

22. Which of the following decolourises bromine solution **least** rapidly?

A Palm oil

B Hex-1-ene

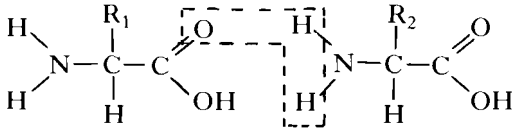
C Cod liver oil

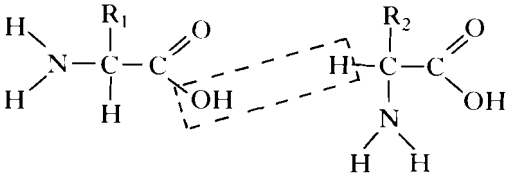
D Mutton fat

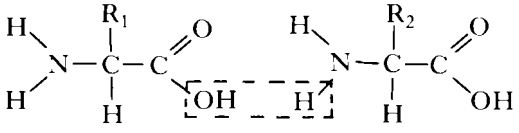
[Turn over

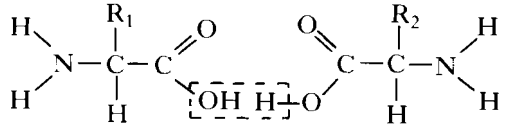
23. When two amino acids condense together, water is eliminated and a peptide link is formed.

Which of the following represents this process?

A 

B 

C 

D 

24. Proteins can be denatured under acid conditions.

During this denaturing, the protein molecule

A changes shape

B is dehydrated

C is neutralised

D is polymerised.

25. Which type of structure is found in a substance melting at 771 K which conducts electricity when molten, but not when solid?

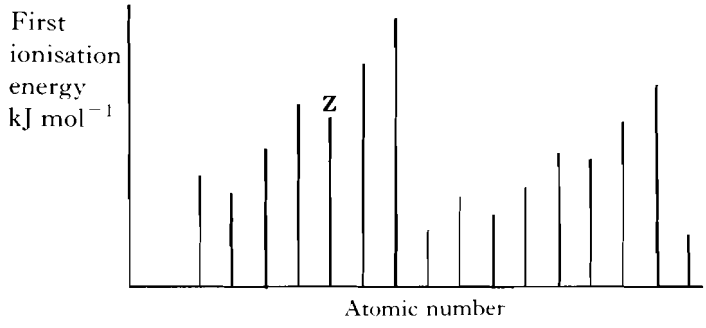
A Covalent (discrete molecules)

B Covalent (network structure)

C Ionic

D Metallic

26. The spike graph shows the variation in the first ionisation energy with atomic number for sixteen consecutive elements in the Periodic Table. The element at which the spike graph starts is **not** specified.



In which group of the Periodic Table is element **Z**?

A 1

B 3

C 5

D 6

27. Which of the following chlorides is likely to have **least** ionic character?

A $BeCl_2$

B $CaCl_2$

C LiCl

D CsCl

28. Which equation represents the first ionisation energy of a diatomic element, X_2?

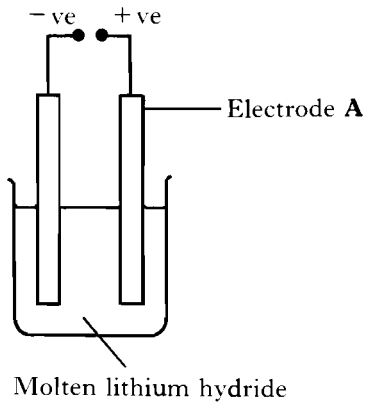
A $\frac{1}{2}X_2(s) \rightarrow X^+(g)$

B $\frac{1}{2}X_2(g) \rightarrow X^-(g)$

C $X(s) \rightarrow X^-(g)$

D $X(g) \rightarrow X^+(g)$

29. Molten lithium hydride can be electrolysed using platinum electrodes.



What is the reaction taking place at electrode **A**?

A $2H^-(\ell) \rightarrow H_2(g) + 2e$

B $2H^+(\ell) + 2e \rightarrow H_2(g)$

C $Li^+(\ell) + e \rightarrow Li(\ell)$

D $Li(\ell) \rightarrow Li^+(\ell) + e$

30. In which of the following would a displacement reaction take place?

A Bubbling chlorine gas through an aqueous solution of sodium fluoride

B Adding bromine solution to an aqueous solution of sodium chloride

C Adding bromine solution to an aqueous solution of sodium fluoride

D Bubbling chlorine gas through an aqueous solution of sodium iodide

31.

Bond	Bond enthalpy/kJ mol^{-1}
H—H	436
I—I	151
H—I	299

$$H_2(g) + I_2(g) \rightarrow 2HI(g)$$

What is the enthalpy of reaction, in kJ mol^{-1}, for the above reaction?

A +11

B −11

C +288

D −288

32. Here are some enthalpy changes relating to chlorine.

ΔH_1 — hydration enthalpy of chloride ions
ΔH_2 — first ionisation energy of chlorine
ΔH_3 — bond enthalpy of Cl — Cl bond
ΔH_4 — electron gain enthalpy (affinity) of chlorine

$$\tfrac{1}{2}Cl_2(g) \rightarrow Cl^-(g)$$

Which of these enthalpy changes are needed to calculate the enthalpy change for the above process?

A ΔH_1 and ΔH_4

B ΔH_2 and ΔH_3

C ΔH_3 and ΔH_4

D ΔH_2 and ΔH_4

33. The mean bond enthalpy of a C—F bond is 486 kJ mol^{-1}.

In which of the processes is ΔH approximately equal to +1944 kJ mol^{-1}?

A $CF_4(g) \rightarrow C(s) + 2F_2(g)$

B $CF_4(g) \rightarrow C(g) + 4F(g)$

C $CF_4(g) \rightarrow C(g) + 2F_2(g)$

D $CF_4(g) \rightarrow C(s) + 4F(g)$

[Turn over

34. Chemical reactions are in a state of dynamic equilibrium only when

A the rate of the forward reaction equals that of the backward reaction

B the concentrations of reactants and products are equal

C the activation energies of the forward and backward reactions are equal

D the reaction involves no enthalpy change.

35. Under the conditions used industrially, ethene and steam react as follows.

$C_2H_4(g) + H_2O(g) \rightarrow C_2H_5OH(g)$

$\Delta H = -46 \text{ kJ mol}^{-1}$

Which set of conditions would give the best yield of ethanol at equilibrium?

A High temperature, low pressure

B High temperature, high pressure

C Low temperature, high pressure

D Low temperature, low pressure

36. Which of the following is the same for equal volumes of equimolar solutions of sodium hydroxide and ammonia?

A pH of solution

B Mass of solute present

C Conductivity of solution

D Moles of acid needed for complete reaction

37. β-particles emitted by certain radioactive atoms are

A electrons from the outer shell

B electrons from the nucleus

C particles consisting of 2 protons and 2 neutrons

D electromagnetic radiations of very short wavelength.

38. $^{27}_{13}Al$ can absorb an α-particle with the emission of a neutron.

What is the product of this reaction?

A $^{30}_{14}Si$

B $^{28}_{15}P$

C $^{30}_{15}P$

D $^{31}_{16}S$

39. Plants take in radon with water through their roots.

Compared with radon in the water, the half-life of the radon in the plant cells will be

A shorter

B longer

C the same

D dependent on the size of the plant.

40. The half-life of the isotope ^{14}C is $5{\cdot}5 \times 10^3$ years.

What fraction of the original ^{14}C atoms will be present after $2{\cdot}2 \times 10^4$ years?

A 0·5

B 0·25

C 0·125

D 0·0625

PART 2

In questions 41 to 47 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_2H_6	F N_2

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

A	B	C
(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.

(A)	B	C
D	(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	(C)
D	E	(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:

(A)	B	C
~~(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:

~~(A)~~	B	C
√ ~~(D)~~	E	F

[Turn over

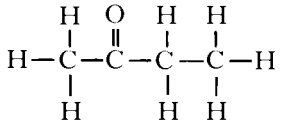
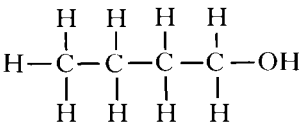
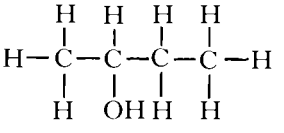
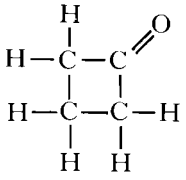
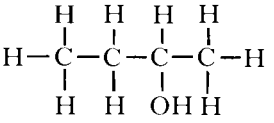
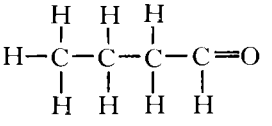
41. The grid shows concentrations of solutions in mol l^{-1}.

A 1×10^{-1}	B 1×10^{-3}	C 1×10^{-6}
D 1×10^{-8}	E 1×10^{-11}	F 1×10^{-13}

(*a*) Identify the concentration of hydroxide ions in a solution of sodium hydroxide with a pH of 11.

(*b*) Identify the concentration of hydrogen ions in a solution made by pipetting $1{\cdot}0\ cm^3$ of $0{\cdot}001$ mol l^{-1} hydrochloric acid into a litre standard flask and making up with distilled water.

42.

A 	B 	C 
D 	E 	F 

(*a*) Identify the compound which can be oxidised to produce the compound shown in box **F.**

(*b*) Identify the isomer of the compound shown in box **C.**

(*c*) Identify the **two** ketones.

43.

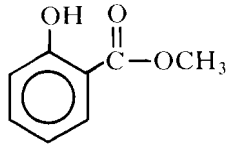
A $NH_4Cl(s)$	B $CH_3OH(\ell)$	C $C_6H_{14}(\ell)$
D $KOH(s)$	E $Na_2CO_3(s)$	F $SiO_2(s)$

(*a*) Identify the covalent network substance.

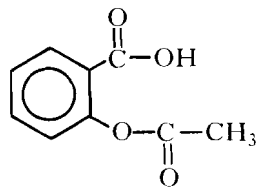
(*b*) Identify the substance which contains hydrogen bonds.

(*c*) Identify the substance(s) which when added to water would produce an alkaline solution.

44. Oil of wintergreen and aspirin are used in medicine. Their structures are shown below.



Oil of wintergreen



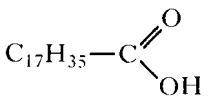
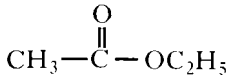
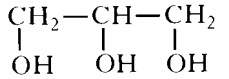
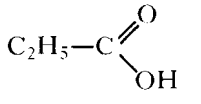
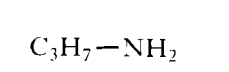
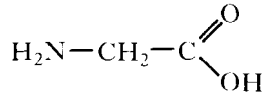
Aspirin

A hydrocarbon	B aromatic	C aldehyde
D alcohol	E carboxylic acid	F ester

(*a*) Identify the term which can be applied to aspirin but **not** to oil of wintergreen.

(*b*) Identify the term(s) which can be applied to **both** aspirin and oil of wintergreen.

45. Proteins and fats are hydrolysed during digestion.

A 	B 	C 
D 	E 	F 

(*a*) Identify the compound which could be produced by the hydrolysis of a protein.

(*b*) Identify the compound(s) which could be produced by the hydrolysis of a fat.

[Turn over

46.

A carbon monoxide	B ethanol	C hydrogen
D ammonia	E methane	F water

(*a*) Identify the **two** substances which would be gaseous at room temperature and made up of molecules which are **not** diatomic.

(*b*) Identify the substance(s) which would be made up of non-polar molecules.

47. Carbon dioxide is produced in respiration.

Identify the **true** statement(s) about carbon dioxide.

A	The mass of $6{\cdot}02 \times 10^{23}$ molecules of the gas is 44 g.
B	44 g of the gas contains $6{\cdot}02 \times 10^{23}$ atoms.
C	One molecule of the gas is 44 times as heavy as a molecule of hydrogen.
D	44 g of the gas occupies the same volume as 16 g of oxygen, under the same conditions.
E	44 g of the gas contains the same number of atoms as 60 g of neon.
F	One molecule of the gas has a mass of 44 g.

[END OF QUESTION PAPER]

FOR OFFICIAL USE

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

Total

0500/198

SCOTTISH CERTIFICATE OF EDUCATION 1995

MONDAY, 15 MAY
1.30 PM – 4.00 PM

CHEMISTRY (REVISED)
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

Candidate number

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.

Candidates must not write in this margin

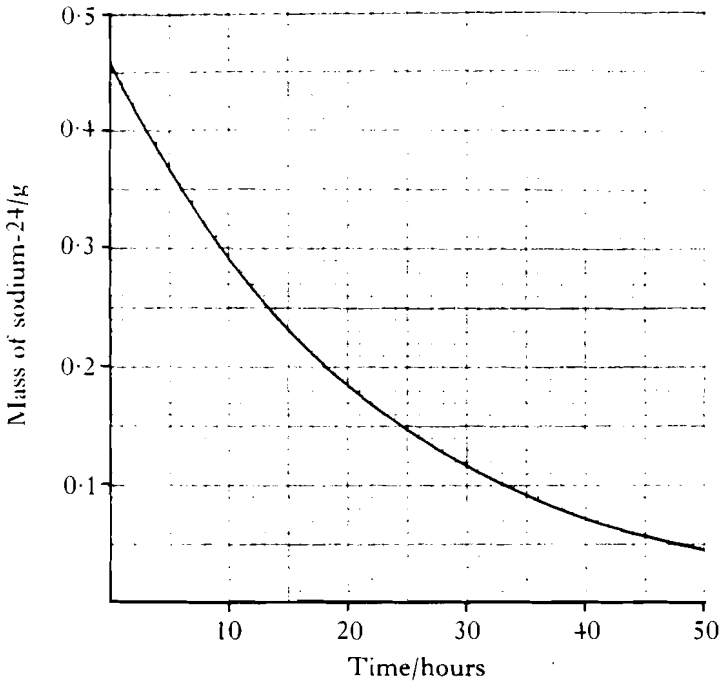
Marks

1. The radioisotope, sodium-24, can be made in a nuclear reactor by bombarding element **X** with neutrons.

$$ {}^{\mathbf{a}}_{\mathbf{b}}\mathbf{X} + {}^{1}_{0}n \longrightarrow {}^{24}_{11}Na $$

(*a*) Identify element **X** and write values for **a** and **b**. 1

(*b*) The graph shows how the mass of a sample of sodium-24 varies with time.



(i) What is the half-life of sodium-24? 1

(ii) Calculate the average rate of decay of sodium-24 over the first ten hours. 1
(Show your working clearly.)

Candidates must not write in this margin

Marks

1. (continued)

(iii) If the temperature of the sodium-24 sample is increased, how would this affect its rate of decay?

1

(*c*) Two samples of ^{24}Na and $^{24}NaCl$ have the same mass.

Why are their intensities of radiation different?

1

(5)

2. Rechargeable nickel-cadmium cells are widely used in portable electronic equipment.

When such a cell is **discharging**, the following half-reactions take place.

$$Cd(s) + 2OH^-(aq) \longrightarrow Cd(OH)_2(s) + 2e$$

$$Ni(OH)_3(s) + e \longrightarrow Ni(OH)_2(s) + OH^-(aq)$$

(*a*) Combine the half-reactions to write a balanced equation for the reaction which takes place when this cell is discharging.

1

(*b*) What effect would **recharging** the cell have on the above half-reactions?

1

(2)

[Turn over

Candidates must not write in the margin

Marks

3. The germanes are a homologous series of germanium hydrides, similar to the alkanes.

The simplest is monogermane, GeH_4. It can be prepared by the reaction of germanium(IV) chloride with lithium aluminium hydride, $LiAlH_4$. Both lithium chloride and aluminium chloride are also produced in the reaction.

(*a*) What is meant by a homologous series?

1

(*b*) What would be the shape of a monogermane molecule?

1

(*c*) Write a balanced equation for the production of monogermane as outlined in the above reaction.

1

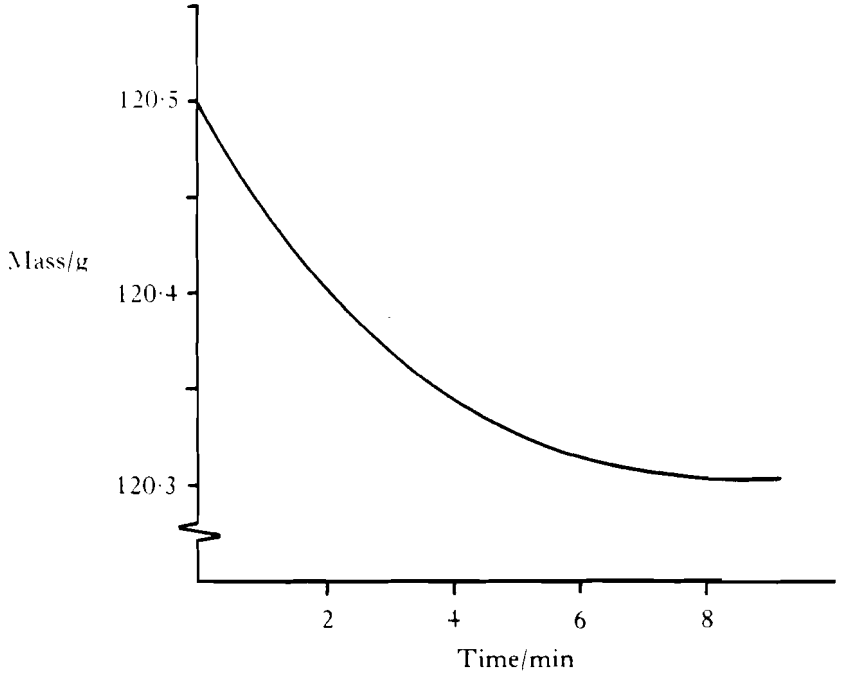
(*d*) Draw the full structural formula for trigermane.

1

(4)

Marks

4. Three experiments were carried out in a study of the rate of reaction between magnesium (in excess) and dilute hydrochloric acid. A balance was used to record the mass of the reaction flask and its contents. The results of Experiment 1, using 0·4 mol l^{-1} acid, are shown in the graph.



(*a*) Why did the balance record a decrease in mass during the reaction?

1

(*b*) The **only** difference between Experiment 2 and Experiment 1 was the use of a catalyst.
On the above graph, sketch a curve that could be expected for Experiment 2 (label 2).

1

(*c*) The **only** difference between Experiment 3 and Experiment 1 was the use of 0·2 mol l^{-1} acid.
On the above graph, sketch a curve that could be expected for Experiment 3 (label 3).

1
(3)

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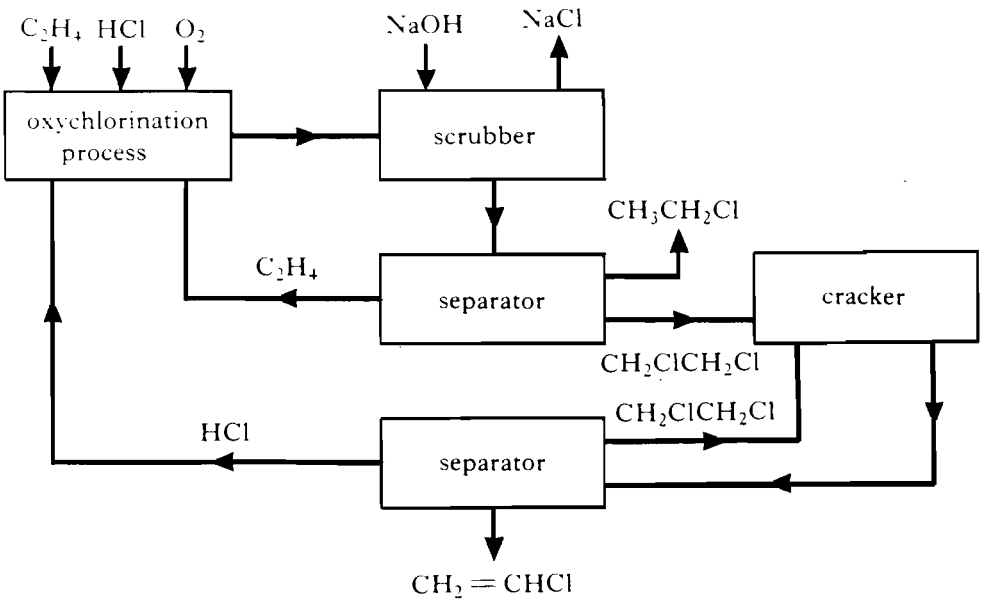
Marks

5. The flow diagram shows how vinyl chloride ($CH_2=CHCl$), an important feedstock, is made in industry.



(*a*) (i) What is the systematic name for vinyl chloride?

1

(ii) Give a use for vinyl chloride.

1

(*b*) Write the formulae for the **three** substances which are recycled.

1

(*c*) Write the equation for the reaction taking place in the cracker.

1

Candidates must not write in this margin

Marks

5. (continued)

(*d*) Name the process taking place in the separator units.

1

(*e*) Name the type of reaction taking place in the scrubber unit.

1

(6)

6. *Markovnikoff's Rule*

Addition of hydrogen chloride to an alkene can give two products.

Markovnikoff observed that the hydrogen of the hydrogen chloride mainly attaches to the carbon atom of the double bond which already has the most hydrogens **directly** attached to it.

(*a*) Draw the full structural formula for the major product formed when hydrogen chloride reacts with propene.

1

(*b*) Why is it not necessary to consider Markovnikoff's rule when hydrogen chloride reacts with but-2-ene?

1

(2)

[Turn over

Candidates must not write in this margin

Marks

7. Diamond and graphite are forms of carbon with very different properties.
Graphite can mark paper, is a lubricant and is a conductor of electricity.
Diamond has none of these properties.

(*a*) Draw a diagram to show the structure of diamond.

1

(*b*) Why is graphite an effective lubricant?

1

(*c*) A pupil uses a graphite pencil to write her signature 100 times on a piece of weighed paper.

Results	*Number of signatures*	=	*100*
	Mass of blank paper	=	*4·895 g*
	Mass of paper + 100 signatures	=	*4·905 g*

Use her results to calculate the number of carbon atoms present in one signature.
(Show your working clearly.)

2

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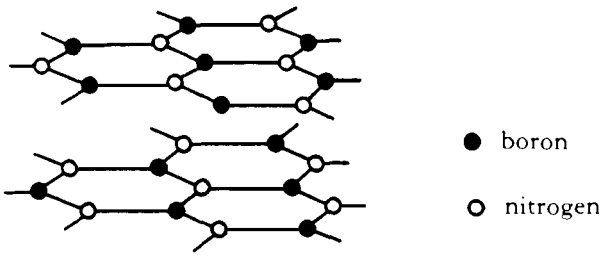
Marks

7. (continued)

(*d*) Boron nitride can form a similar strucure to graphite. The boron and nitrogen atoms alternate throughout the structure as shown.



(i) Why is this substance a non-conductor, while graphite is a conductor?

1

(ii) Suggest why the bonds between the layers in boron nitride are stronger than the bonds between the layers in graphite.

1

(6)

[Turn over

Candidates must not write in this margin

Marks

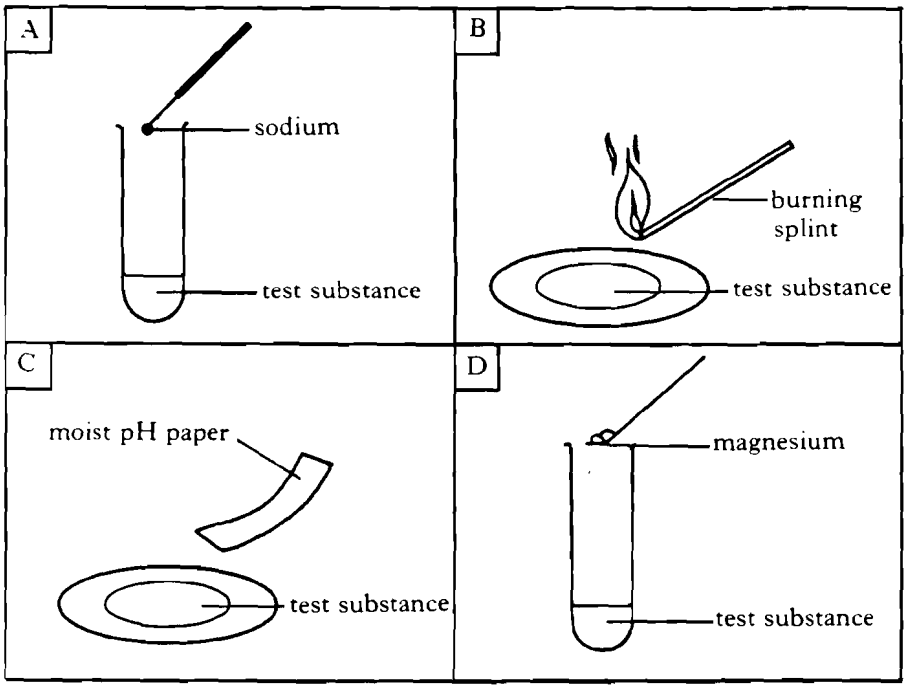
8. Members of a homologous series contain the same functional group.

(*a*) What is meant by a functional group?

1

(*b*) A student carried out four tests on ethanol and ethanoic acid to compare the properties of the two homologous series, alcohols and carboxylic acids.

The tests are illustrated below.



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Marks

8. (continued)

(i) Choose **one** test in which ethanol and ethanoic acid give different results and state the results.

1

(ii) Choose **another** test in which ethanol and ethanoic acid give a similar result and state the result.

1

(*c*) Ethanol can be oxidised to compound **X** which can be further oxidised to ethanoic acid.

Name compound **X**.

1

(*d*) Ethanol can be classified as a primary alcohol.

Name an alcohol which can be classified as a secondary alcohol.

1

(5)

Candidates must not write in this margin

Marks

9. A page of a pupil's notebook shows instructions on how to measure the enthalpy of combustion of an alcohol.

> *Experimental procedure*
>
> 1. *Measure out 100 cm^3 of water into a beaker.*
> 2. *Take steps to insulate the apparatus.*
> 3. *Read the water temperature before and after using the alcohol burner to heat it.*
> 4. *Weigh the alcohol burner before and after the experiment.*

(*a*) Draw a neat labelled diagram of the apparatus which the pupil could use to carry out this experiment.

2

(*b*) Write the equation corresponding to the enthalpy of combustion of methanol.

1

Marks

9. (continued)

(*c*) The pupil found that when 0·23 g of methanol burned, the heat produced raised the temperature of 100 g of water by 9·2 °C.

Using information on page 7 of the data booklet, calculate the enthalpy of combustion of methanol.

(Show your working clearly.)

2

(*d*) The pupil's result is well below the value in the data booklet. Even with insulation, much heat is lost to the surroundings, including the apparatus. Suggest one **other** reason why the experimental result is low.

1

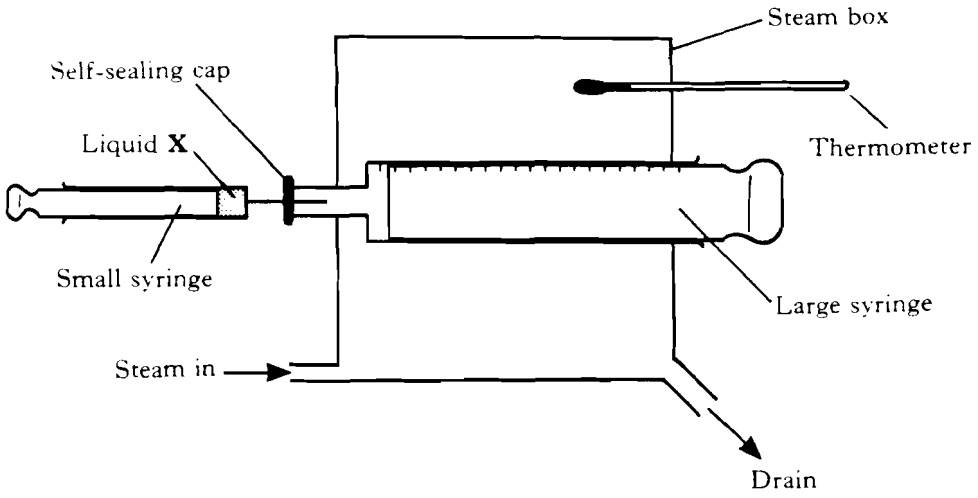
(6)

[Turn over

Candidates must not write in this margin

Marks

10. The following apparatus can be used to determine the relative formula masses of liquids which are easily evaporated.



Some of liquid **X** is injected into the large syringe and it evaporates.
The following results were obtained:

Mass of small syringe before injection	=	5·774 g
Mass of small syringe after injection	=	5·648 g
Large syringe reading before injection	=	5 cm^3
Large syringe reading after injection	=	89 cm^3

(*a*) Calculate the relative formula mass of liquid **X.**

(Take the molar volume of a gas to be 30·6 litre mol^{-1}.)

(Show your working clearly.)

2

(*b*) Suggest why the above apparatus could **not** be used to determine the relative formula masses of liquids with boiling points above 100 °C.

1

(3)

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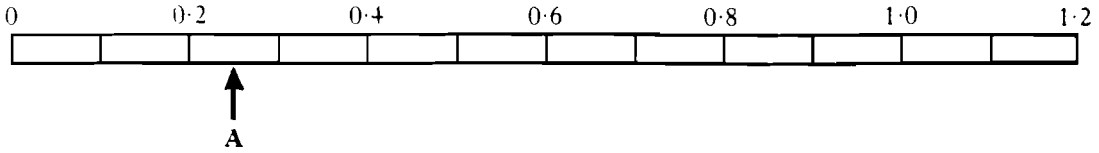
Marks

11. A ratio line can be used to illustrate the carbon to hydrogen ratio in different compounds.

carbon to hydrogen ratio



Methane would appear at point **A**.

(*a*) At what value on the line would butane appear?

1

(*b*) A hydrocarbon **X** with six carbon atoms per molecule has a carbon to hydrogen ratio of 0·5. **X** does **not** immediately decolourise bromine solution.

Give a name for **X.**

1

(*c*) Reforming is an industrial process which can convert alkanes into aromatic hydrocarbons.

(i) In relation to the alkane hydrocarbons, where on the line would the reformed hydrocarbons appear?

1

(ii) Name the aromatic hydrocarbon produced by reforming hexane.

1

(iii) Explain why the demand for fuel with a higher aromatic content has increased in the last ten years.

2

(6)

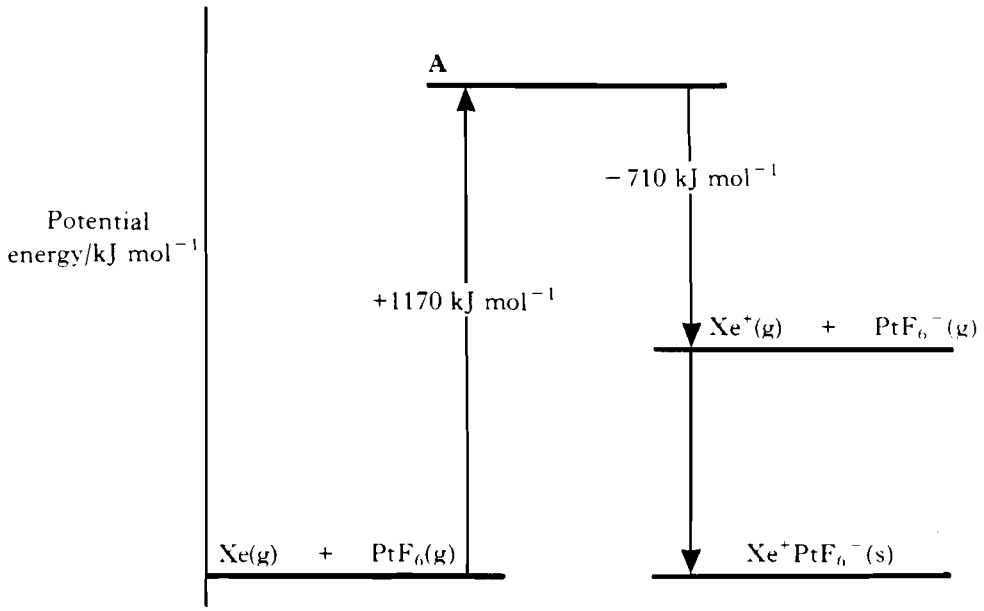
Candidates must not write in this margin

Marks

12. The first noble gas compound, xenon hexafluoroplatinate(V), was prepared in 1962 by Professor Neil Bartlett, a British scientist working in Canada.

$$Xe(g) + PtF_6(g) \longrightarrow \underset{\text{xenon hexafluoroplatinate(V)}}{Xe^+PtF_6^-(s)} \qquad \Delta H = 0\ kJ\ mol^{-1}$$

(*a*) The energy diagram for this reaction is illustrated below.



(i) On the line marked **A**, write the appropriate symbols and formulae.

1

(ii) Calculate the lattice-making enthalpy of $Xe^+PtF_6^-(s)$.

1

Marks

12. (continued)

(*b*) Xenon(VI) fluoride is another noble gas compound. It can be prepared directly from its elements.

$$Xe(g) + 3F_2(g) \longrightarrow XeF_6(g) \qquad \Delta H = -329 \text{ kJ mol}^{-1}$$

(i) What name is given to this kind of enthalpy change?

1

(ii) Using information on bond enthalpies from the data booklet, calculate the bond enthalpy of the Xe – F bond in XeF_6.

(Show your working clearly.)

2

(5)

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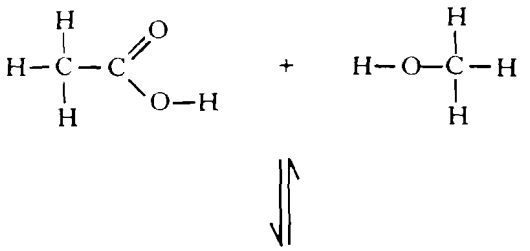
Marks

13. (*a*) Esters are formed when carboxylic acids react with alcohols, e.g.



ester + H_2O

(i) Name the ester formed in this reaction.

1

(ii) Name the type of reaction which takes place.

1

(iii) To find out which atoms of the alcohol and carboxylic acid go to form the water molecule, the reaction was carried out using an alcohol in which the ^{16}O atom was substituted by the ^{18}O isotope. All of the ^{18}O was found in the ester and none in the water.

In the equation above, circle the atoms in the acid and the alcohol which combine to form the water molecule.

1

Marks

13. (continued)

(*b*) Esters can be prepared in the laboratory by heating an alcohol and a carboxylic acid with a few drops of concentrated sulphuric acid in a water bath. After 10 minutes or so, the reaction mixture is poured into sodium hydrogencarbonate solution.

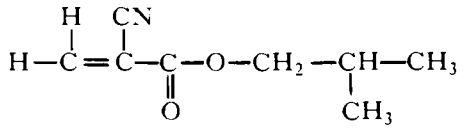
(i) What evidence, apart from smell, shows that the ester has been formed?

1

(ii) State **two** safety precautions that should be adopted when carrying out this experiment.

1

(*c*) Bucrylate is an ester which is used in surgery for repairing torn tissue.



It instantaneously polymerises when it comes in contact with ionic solutions.

(i) What type of polymerisation will bucrylate undergo?

1

(ii) Draw the structure of the **repeating unit** in polybucrylate.

1

(7)

Candidates must not write in this margin

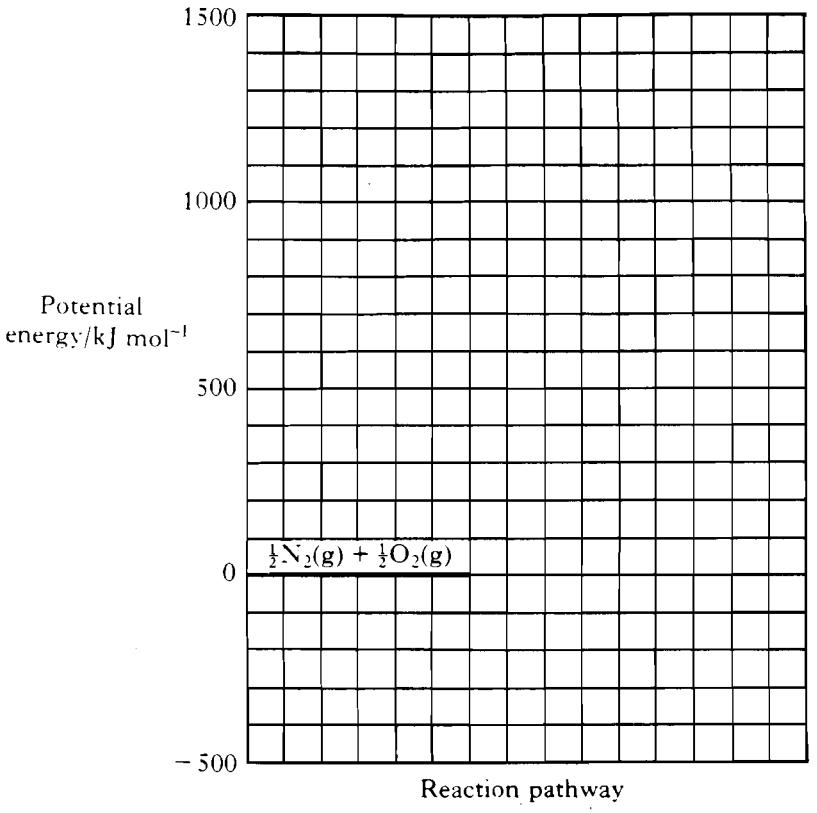
Marks

14. In the Birkeland-Eyde Process, nitrogen and oxygen combine on sparking to produce nitrogen monoxide.

$$\tfrac{1}{2}N_2(g) + \tfrac{1}{2}O_2(g) \rightleftharpoons NO(g) \qquad \Delta H_f = +100 \text{ kJ mol}^{-1}$$

The activation energy for this reaction is 1200 kJ mol^{-1}.

(*a*) Complete the energy-diagram for the industrial process.



2

(*b*) (i) Suggest a feedstock for the Birkeland-Eyde Process.

1

(ii) Explain how an increase in temperature would affect the yield of nitrogen monoxide.

2

Marks

14. (continued)

(*c*) In industry, nitrogen monoxide is now produced in the UK by the Ostwald Process.

(i) Name the **two** reactants in the Ostwald Process.

1

(ii) Suggest why it is more economical to produce nitrogen monoxide by the Ostwald Process than by the Birkeland-Eyde Process.

1

(iii) What is the industrial importance of the Ostwald Process?

1
(8)

[Turn over

Candidates must not write in this margin

Marks

15. The water in swimming pools can be kept sterile by the addition of chlorine which kills microorganisms. The chlorine levels in swimming pool water can be determined by titrating samples against acidified iron(II) sulphate solution. The reaction taking place is:

$$Cl_2(aq) + 2Fe^{2+}(aq) \longrightarrow 2Cl^-(aq) + 2Fe^{3+}(aq)$$

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

1

(*b*) A 100 cm^3 sample of water from a swimming pool required 24·9 cm^3 of $2{\cdot}82 \times 10^{-4}$ mol l^{-1} iron(II) sulphate solution to reach the end-point.

Calculate the chlorine concentration, in g l^{-1}, in the swimming pool water.

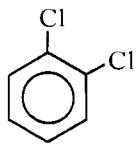
(Show your working clearly.)

3
(4)

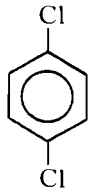
Candidates must not write in this margin

Marks

16. Three dichlorobenzene isomers are known. Their structures depend on the positions of the chlorine atoms in the benzene ring. Two of the isomers are shown.



A 1,2 dichlorobenzene



B 1,4 dichlorobenzene

(*a*) Draw the structure of the third isomer and name it.

1

(*b*) Give the molecular formula for the three isomers.

1

(*c*) Why is molecule **A** polar while molecule **B** is not polar?

1

(3)

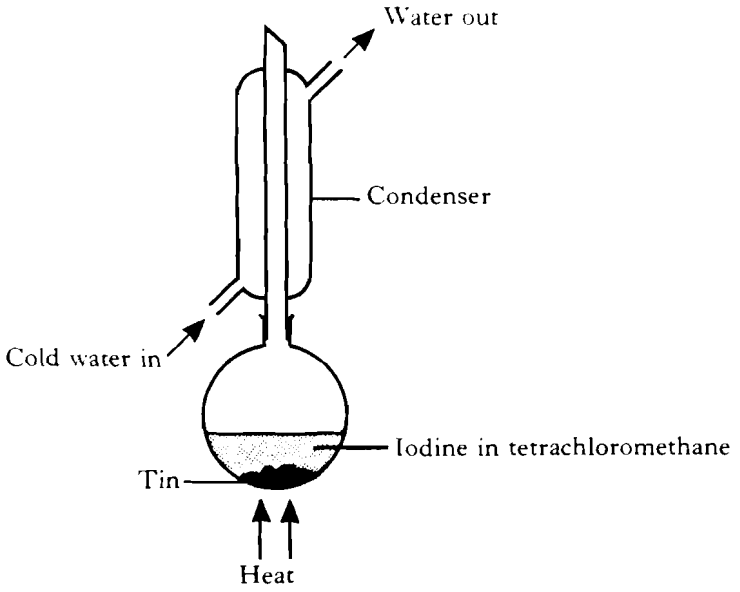
Candidates must not write in this margin

Marks

17. Tin iodide can be prepared directly from its elements.

Excess tin is heated for about an hour with iodine dissolved in tetrachloromethane.

Tetrachloromethane, which has a boiling point of 77 °C, acts as a solvent both for the iodine and for the tin iodide that is formed.



When the reaction is complete, the excess tin is removed. On cooling the remaining solution, orange crystals of tin iodide appear.

The crystals have a melting point of 144 °C.

(*a*) Why is a condenser used when heating the reaction mixture?

1

(*b*) (i) Give **two** pieces of evidence from the method of preparation which suggest that tin iodide is a discrete molecular covalent compound.

2

Candidates must not write in this margin

Marks

17. (continued)

(ii) What type of bonds would be broken when tin iodide melts?

1

(*c*) The following results were obtained in the experiment.

Mass of iodine = 6·34 g
Initial mass of tin = 3·60 g
Final mass of tin = 2·13 g

Use the data to calculate the empirical formula for tin iodide.

(Show your working clearly.)

2

(*d*) Tin iodide reacts readily with water to produce an acidic gas.

Name the gas that is formed in this reaction.

1

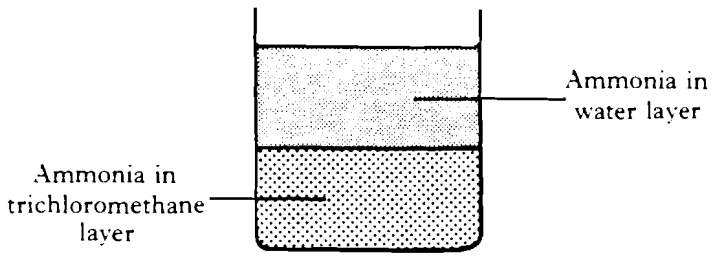
(7)

[Turn over

Candidates must not write in this margin

Marks

18. Trichloromethane is insoluble in water. When ammonia is added to a beaker containing water and trichloromethane, the ammonia dissolves in both solvents giving different concentrations.



The ratio

$$\frac{\text{concentration of ammonia in water}}{\text{concentration of ammonia in trichloromethane}}$$

is called the partition coefficient.

This can be found by titrating the ammonia in each layer against dilute hydrochloric acid.

(*a*) Write an equation to show why an aqueous solution of ammonia is a weak alkali.

1

(*b*) (i) How could the end-points of the titrations be observed?

1

Marks

18. (continued)

(ii) The concentration of ammonia in water was calculated from three titrations. The titre volumes were as follows.

1st	24·7 cm^3
2nd	24·0 cm^3
3rd	23·9 cm^3

What volume of dilute hydrochloric acid would be used to calculate the concentration of ammonia in water?

1

(iii) The concentration of ammonia in water was found to be 1·7 mol l^{-1}. For the ammonia in trichloromethane, it was found that 18·4 cm^3 of dilute hydrochloric acid, concentration 0·050 mol l^{-1} was required to neutralise 20·0 cm^3 of the ammonia solution.

Calculate the value for the partition coefficient of ammonia between water and trichloromethane.

(Show your working clearly.)

2

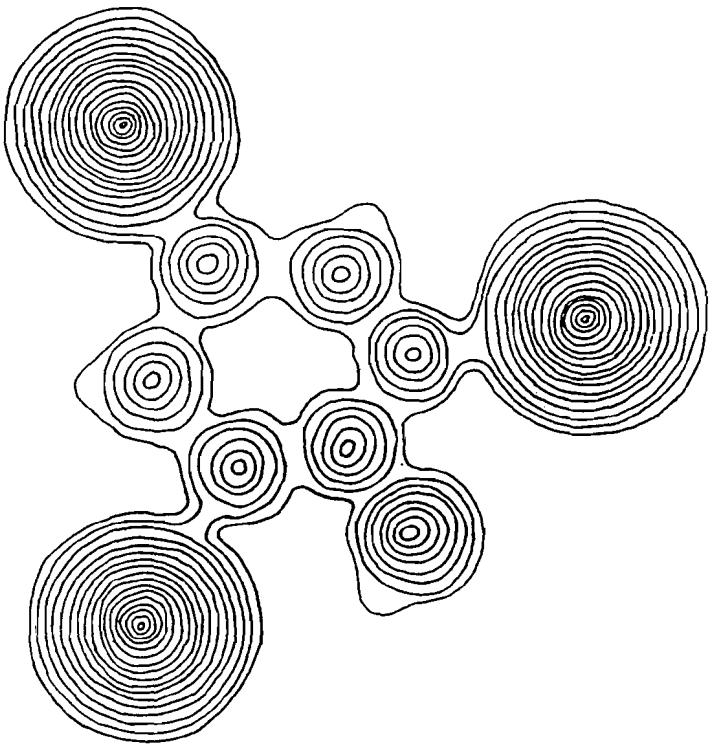
(5)

[Turn over

Marks

19. X-ray diffraction is a technique used to determine the structures of molecules. It is the electrons in the atoms of the molecule which diffract the X-rays. From the diffraction pattern, an electron-density contour map of the molecule can be constructed.

The following map was obtained using an aromatic compound with molecular formula $C_6H_3Cl_3O$.



(*a*) Suggest why the hydrogen atoms do not show up clearly in the electron-density contour map. 1

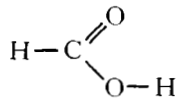
Marks

19. (continued)

(*b*) Draw the full structural formula for this compound.

1

(*c*) Draw the electron-density contour map that would be obtained for methanoic acid:



1

(3)

[END OF QUESTION PAPER]