[CO12/SQP006]

Higher Chemistry

Time: 1 hour

NATIONAL QUALIFICATIONS

Paper I

Specimen Question Paper

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

Fill in the details required on the answer sheet.

Reference may be made to the Chemistry Higher and Advanced Higher Data Booklet (1999 edition). [**This will be provided October/November 1998.**]

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 eight respectively.

SCOTTISH QUALIFICATIONS AUTHORITY

PART 1

In questions 1 to 30 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 30 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

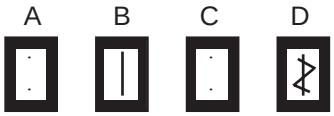
B chromatography

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. In which of the following structures would the nails corrode before the roof itself?

A Zinc roof with iron nails

B Iron roof with copper nails

C Zinc roof with copper nails

D Copper roof with iron nails

2. Different isotopes of the same element have identical

A nuclei

B electron arrangements

C numbers of neutrons

D mass numbers.

3. 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?

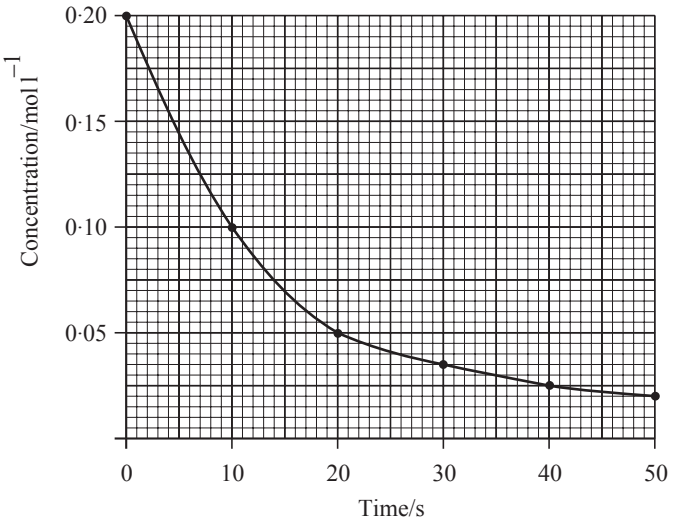
A 1

B 2

C 3

D 4

4. The graph below shows the variation of concentration of a reactant with time as a reaction proceeds.



The average reaction rate, in mol l^{-1} s^{-1}, during the first 20 s is

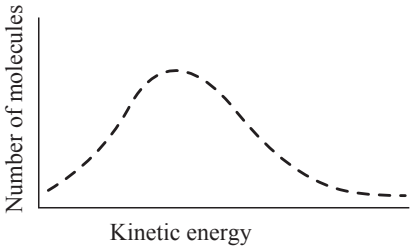
A 0·0025

B 0·0036

C 0·0075

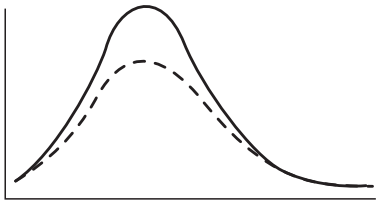
D 0·0090.

5. The graph shows the distribution of kinetic energies of the molecules in a sample of gas.

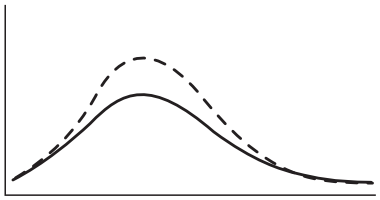


Which graph would show the kinetic energies of the molecules when the sample is cooled by 10 °C?

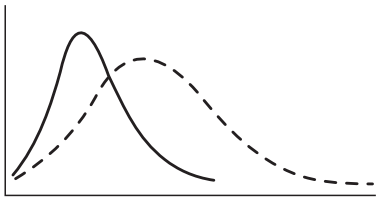
A



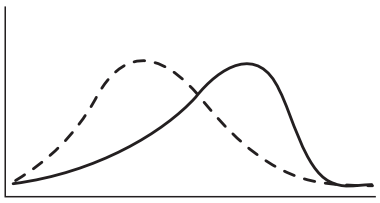
B



C



D



6. A student found that 310 kJ of energy was released on burning 10 g of propan-1-ol, $CH_3CH_2CH_2OH$.

From this experiment, what is the enthalpy of combustion, in kJ mol^{-1}, of propan-1-ol?

A –310

B –1296

C –1860

D –3100

7. 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.

8. 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

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

How many litres of nitrogen dioxide gas could theoretically be obtained by sparking 4 litres of nitrogen gas with excess of oxygen gas?

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

A 2

B 4

C 6

D 8

10. Which of the following contains approximately 3×10^{23} molecules?

A 17 g NH_3

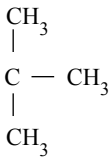
B 36 g H_2O

C 4 g CH_4

D 22 g CO_2

11. Which reaction is an example of a reaction which takes place during reforming?

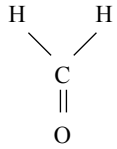
A $CH_3 - CH_2 - CH_2 - CH_2 - CH_3 \rightarrow CH_3 - CH_2 - CH_3 + CH_2 = CH_2$

B $CH_3 - CH_2 - CH_2 - CH_2 - CH_3 \rightarrow$ 

C $CH_3 - CH_3 \rightarrow CH_2 = CH_2 + H_2$

D $n\ CH_2 = CH_2 \rightarrow -(CH_2 - CH_2)_n -$

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. Which of the alcohols can be oxidised to give a ketone?

A 2-methylbutan-1-ol

B 2, 3-dimethylpentan-1-ol

C 3-methylbutan-2-ol

D 2-methylbutan-2-ol

14. Which kind of reaction is used to produce an ester from a carboxylic acid and an alcohol?

A Addition

B Condensation

C Hydration

D Hydrolysis

15. The dehydration of butan-2-ol can produce two isomeric alkenes, but-1-ene and but-2-ene.

Predict which alkanol can similarly produce, on dehydration, a pair of isomeric alkenes.

A propan-2-ol

B pentan-3-ol

C hexan-3-ol

D heptan-4-ol

16. Destroying ozone may have serious consequences.

Which statement about ozone is **untrue**?

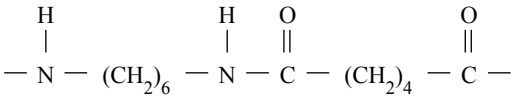
A It absorbs ultraviolet radiation.

B It has the formula O_3.

C It is classified as a CFC.

D It can react with halogenoalkanes.

17. A part of the formula for nylon is shown.



This polymer is classed as a

A synthetic addition polymer

B synthetic condensation polymer

C natural condensation polymer

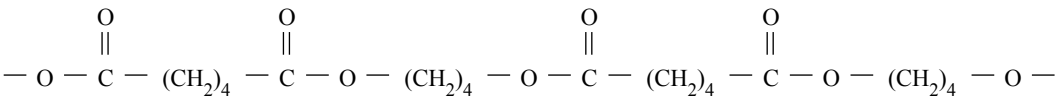
D natural addition polymer.

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

Which kinds of structure do their molecules have?

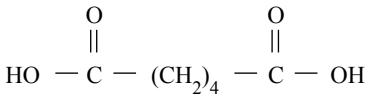
	Fibre	Cured resin
A	three-dimensional	three-dimensional
B	linear	linear
C	three-dimensional	linear
D	linear	three-dimensional

19. Part of a polyester chain is shown below.

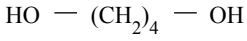


Which compound, when added to the reactants during polymerisation, would stop the polyester chain from getting too long?

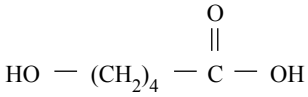
A



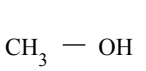
B



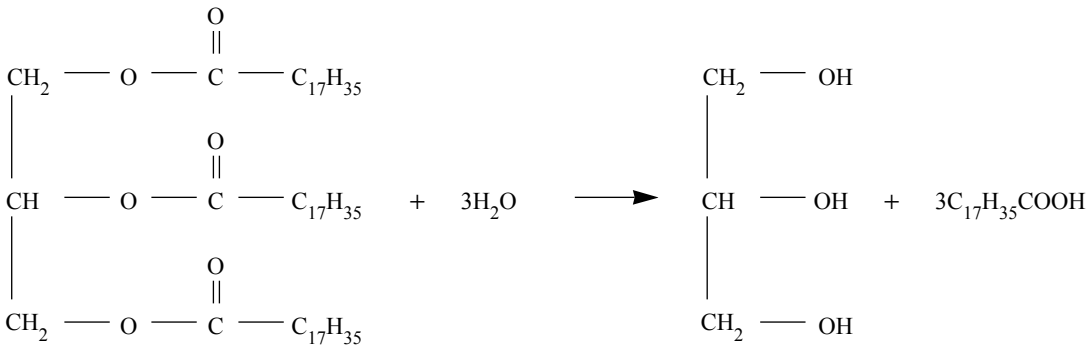
C



D



20. Which process is represented by the following equation?



A Condensation

B Hydrolysis

C Oxidation

D Dehydration

---

21. Which of the following **must** contain nitrogen?

A A protein

B An oil

C A polyester

D A carbohydrate

22. Which of the following is **not** a raw material in the chemical industry?

A Air

B Ethene

C Methane

D Water

23. The enthalpies of combustion of C(s), $H_2(g)$ and $C_4H_9OH(\ell)$, butan-1-ol, in kJ mol^{-1}, are as follows.

$$C(s) + O_2(g) \rightarrow CO_2(g) \qquad \Delta H = a$$
$$H_2(g) + \tfrac{1}{2}O_2(g) \rightarrow H_2O(\ell) \qquad \Delta H = b$$
$$C_4H_9OH(\ell) + 6O_2(g) \rightarrow 4CO_2(g) + 5H_2O(\ell) \qquad \Delta H = c$$

The enthalpy of formation of butan-1-ol is given by the equation:

$$4C(s) + 5H_2(g) + \tfrac{1}{2}O_2(g) \rightarrow C_4H_9OH(\ell)$$

Which of the following can be used to calculate the enthalpy of formation of butan-1-ol?

A $4a + 5b - c$

B $2a + 10b - c$

C $c - 4a - 5b$

D $2a + 5b + c$

24. In which of the reactions will the equilibrium be unaffected by a change in pressure?

A $2NO(g) + O_2(g) \rightleftharpoons 2NO_2(g)$

B $2NO_2(g) \rightleftharpoons N_2O_4(g)$

C $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$

D $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$

25.

$$Cl_2(g) + H_2O(\ell) \rightleftharpoons Cl^-(aq) + ClO^-(aq) + 2H^+(aq)$$

Which substance would move the above equilibrium to the right?

A Hydrogen chloride

B Sodium bromide

C Chlorine

D Hydrogen

26. The following acid solutions all have a concentration of 0·1 mol l^{-1}.

In which solution would the concentration of $H^+(aq)$ ions be less than 0·1 mol l^{-1}?

A Ethanoic acid

B Hydrochloric acid

C Nitric acid

D Sulphuric acid

27. A fully dissociated acid is 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

28. During a redox process in acid solution, iodate ions, $IO_3^-(aq)$, are converted into iodine, $I_2(aq)$.

$$2\ IO_3^-(aq) \rightarrow I_2(aq)$$

The numbers of $H^+(aq)$ and $H_2O(\ell)$ required to balance the ion-electron equation for the formation of 1 mol of $I_2(aq)$ are, respectively

A 6 and 3

B 3 and 6

C 12 and 6

D 6 and 12.

29. Which of the following has an electrical charge?

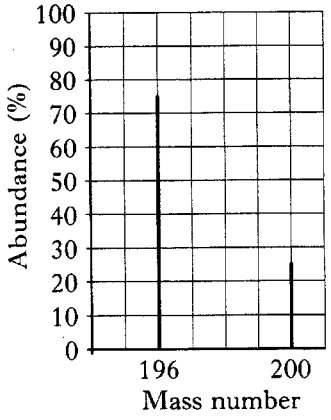
A α-particles

B X-rays

C Neutrons

D γ-rays

30. The chart below was obtained from an 8-day old sample of an α-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 31 to 34 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 may be deducted.

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

This part of the paper is worth 10 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.

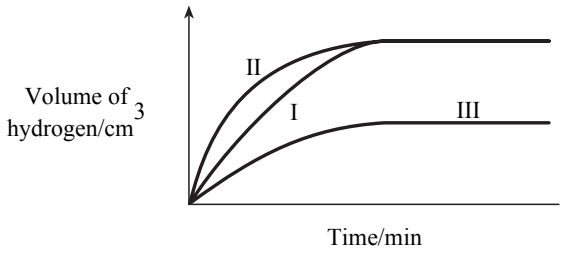
If, after you have recorded your answer, you decide that you have made an error and wish to make a change, you should cancel the original answer and circle the answer you now consider to be correct. Thus, in part (*a*), if you want to change an answer **D** to an answer **A**, your answer sheet would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

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



Curve I shows the results for the reaction of excess zinc with 100 cm^3 of 0·2 $mol\,l^{-1}$ sulphuric acid.

A Excess copper	B Excess magnesium	C Excess iron
D 50 cm^3 of 0·2 $mol\,l^{-1}$ sulphuric acid	E 100 cm^3 of 0·2 $mol\,l^{-1}$ sulphuric acid	F 200 cm^3 of 0·2 $mol\,l^{-1}$ 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.

32. The first twenty elements in the Periodic Table can be categorised according to their bonding and structure.

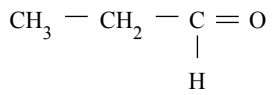
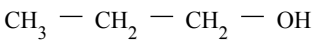
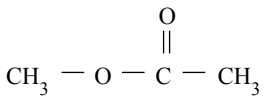
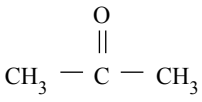
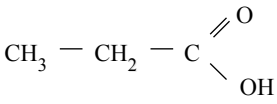
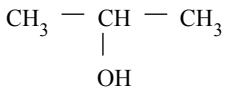
A Boron	B Chlorine	C Fluorine
D Nitrogen	E Phosphorus	F Sodium

(*a*) Identify the element which exists as a covalent network solid.

(*b*) Identify the element which exists as a discrete covalent molecular solid.

(*c*) Identify the most electronegative element.

33. Many organic compounds contain oxygen.

A	B	C
		
D	**E**	**F**
		

(*a*) Identify the compound which is an isomer of the compound shown in box **A**.

(*b*) Identify the compound(s) which could be oxidised to form the compound shown in box **E**.

34. Read the following passage from a popular scientific journal. It discusses the nuclear reactions which occur during the explosion of a star.

"Stars produce heavier elements when they explode as supernovae . . . The main product (of the supernova) should be radioactive nickel. It forms (from) nuclei of oxygen. Heat from a shock wave 'welds' the oxygen into heavier nuclei. This radioactive nickel decays into cobalt, which in turn decays into iron."

(from *New Scientist,* 11 August 1988)

Identify the reaction(s) which can be found in the passage.

A	Nuclear fission	B	Nuclear fusion
C	Loss of an alpha particle	D	Loss of a beta particle
E	Loss of a proton	F	Loss of a neutron

[*END OF QUESTION PAPER*]

FOR OFFICIAL USE

Total

Higher Chemistry

Paper 1

Specimen Question Paper

NATIONAL QUALIFICATIONS

ANSWER SHEET

Full name of school or college

Town

First name and initials

Surname

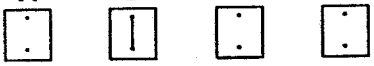
Date of birth

Day Month Year

Candidate number

Number of seat

Using ink, indicate your choice of answer by a single stroke **joining the two dots** in the box, as in the following example:



Using ink, indicate your choice of answer(s) by **circling the appropriate letter(s)** as in the following example:

A	B	C
D	(E)	F

	A	B	C	D
1	·	·	·	·
2	·	·	·	·
3	·	·	·	·
4	·	·	·	·
5	·	·	·	·
6	·	·	·	·
7	·	·	·	·
8	·	·	·	·
9	·	·	·	·
10	·	·	·	·
11	·	·	·	·
12	·	·	·	·
13	·	·	·	·
14	·	·	·	·
15	·	·	·	·

	A	B	C	D
16	·	·	·	·
17	·	·	·	·
18	·	·	·	·
19	·	·	·	·
20	·	·	·	·
21	·	·	·	·
22	·	·	·	·
23	·	·	·	·
24	·	·	·	·
25	·	·	·	·
26	·	·	·	·
27	·	·	·	·
28	·	·	·	·
29	·	·	·	·
30	·	·	·	·

31 a	A	B	C
	D	E	F
b	A	B	C
	D	E	F
32 a	A	B	C
	D	E	F
b	A	B	C
	D	E	F
c	A	B	C
	D	E	F

33 a	A	B	C
	D	E	F
b	A	B	C
	D	E	F
34	A	B	C
	D	E	F

[CO12/SQP006]

Higher Chemistry

NATIONAL QUALIFICATIONS

Paper I

Specimen Marking Instructions

SCOTTISH QUALIFICATIONS AUTHORITY

Higher Chemistry Paper I

Marking Instructions

(1) - for each correct response

1	**D**	**11**	**B**	**21**	**A**	**31 a**	**B E**
2	**B**	**12**	**B**	**22**	**B**	**b**	**C D**
3	**A**	**13**	**C**	**23**	**A**	**32 a**	**A**
4	**C**	**14**	**B**	**24**	**C**	**b**	**E**
5	**C**	**15**	**C**	**25**	**C**	**c**	**C**
6	**C**	**16**	**C**	**26**	**A**	**33 a**	**D**
7	**B**	**17**	**B**	**27**	**A**	**b**	**A B**
8	**C**	**18**	**D**	**28**	**C**	**34**	**B E**
9	**D**	**19**	**D**	**29**	**A**		
10	**D**	**20**	**B**	**30**	**B**		

[CO12/SQP006]

Higher Chemistry

Time: 1 hour 30 minutes

NATIONAL QUALIFICATIONS

Paper II

Specimen Question Paper

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 Higher and Advanced Higher Data Booklet (1999 Edition). [**This will be provided October/November 1998.**]

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.

Candidate must not write in this margin

Marks

1. Both hydrogen and methanol have been considered as alternative fuels to petrol for use in cars.

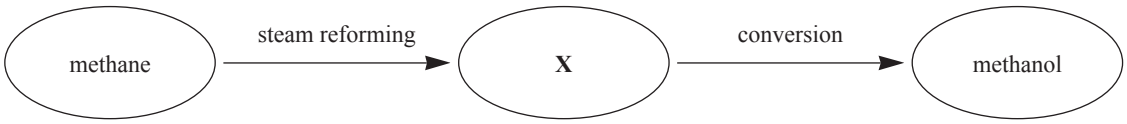
(*a*) (i) State **one** advantage in using hydrogen as a fuel instead of petrol.

1

(ii) State **one** disadvantage of using methanol as a fuel instead of petrol.

1

(*b*) Methanol can be prepared in the following way.



Identify **X**.

1

(3)

Candidate must not write in this margin

Marks

2. Diamond and graphite are well known forms of the element carbon. Other forms of pure carbon have 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.

Why was an atmosphere of helium used for producing fullerenes?

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)

Candidate must not write in this margin

Marks

3. 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.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \qquad \Delta H = -92\ kJ\,mol^{-1}$$

The Haber Process is operated as a continuous process, and the reaction is never allowed to reach equilibrium.

(*a*) (i) What does the term "equilibrium" mean, when applied to a chemical reaction?

1

(ii) Why is the Haber Process not carried out at a very high temperature?

1

(*b*) State **one** advantage of operating the Haber Process as a **continuous** process.

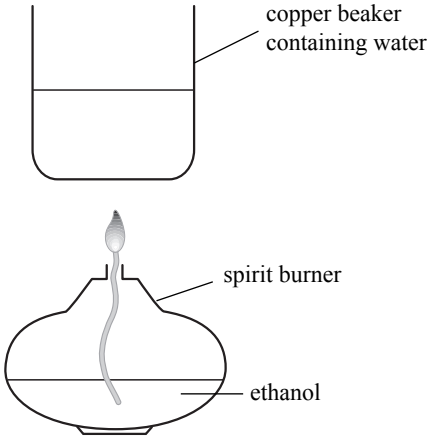
1

(3)

Candidate must not write in this margin

Marks

4. The apparatus below was used by a student to find the enthalpies of combustion of alcohols.



(*a*) Write down the measurements the student should take.

2

(*b*) The enthalpies of combustion of three alcohols are shown in the table.

Alcohol	Enthalpy of combustion/kJ mol^{-1}
methanol	–715
ethanol	–1371
propanol	–2010

Why is there a **regular** stepwise increase in the enthalpies of combustion from methanol to ethanol to propanol?

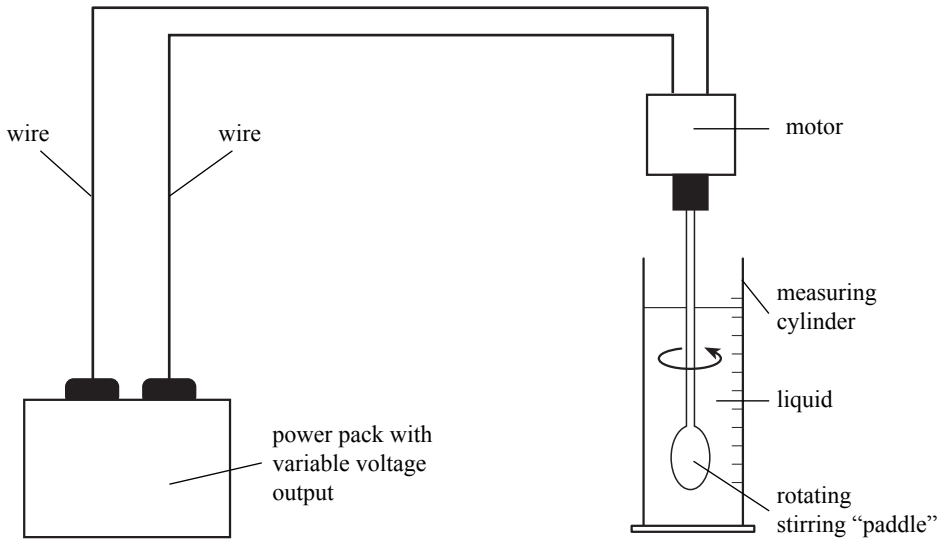
1

(3)

Candidate must not write in this margin

Marks

5. A group of students designed the following apparatus to compare the viscosities of different liquids.



(*a*) Suggest how the apparatus could be used to compare the viscosities of different liquids.

2

(*b*) The viscosities of many liquids are affected by hydrogen bonding.
Explain what is meant by hydrogen bonding.

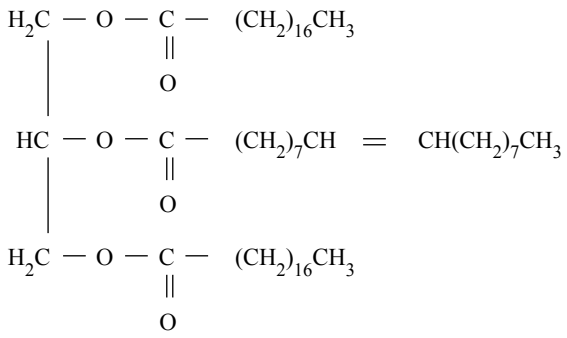
2

(4)

Candidate must not write in this margin

Marks

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



(*a*) The hydrolysis of the triglyceride produces an alcohol and long chain fatty acids.

(i) Name the alcohol produced by the hydrolysis of the triglyceride.

1

(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 the data booklet.)

1

(*b*) What happens to triglyceride molecules in the conversion of oils to hardened fats?

1

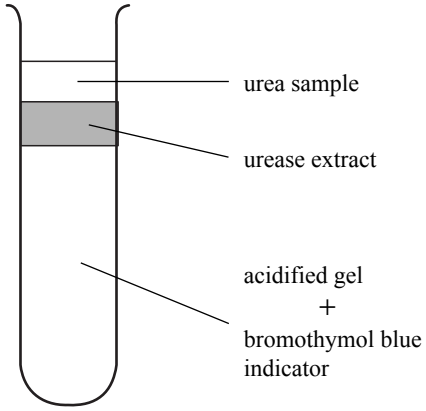
(3)

Marks

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

$$\underset{\text{urea}}{CO(NH_2)_2} + H_2O \xrightarrow{\text{urease enzyme}} CO_2 + 2NH_3$$

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 pH6 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

Candidate must not write in this margin

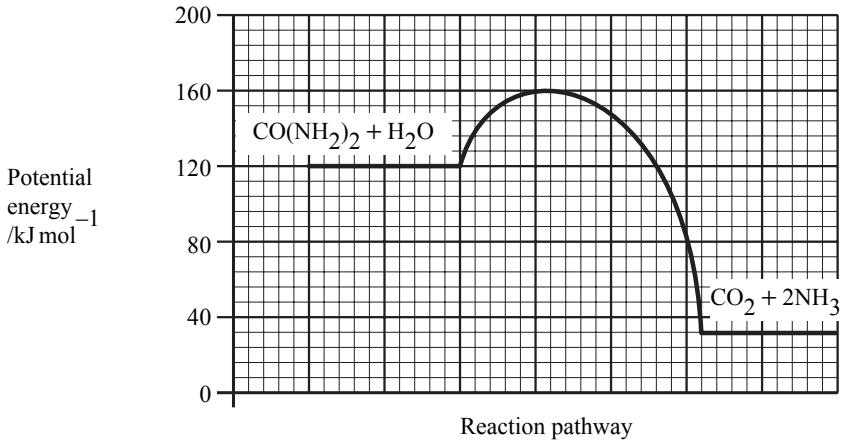
Marks

7. (continued)

(*c*) The pH of the gel after one completed experiment was found to be 11.
Calculate the concentration of hydroxide ions, in mol l^{-1}.

1

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



(i) What is the enthalpy change for the reaction, in kJ mol^{-1}?

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)

Candidate must not write in this margin

Marks

8. Esters are important compounds which have many applications.

(*a*) Some of the instructions outlining the laboratory preparation of an ester are shown below.

Preparation of an Ester

1 Mix 1 cm^3 of the alkanol with 1 cm^3 of the alkanoic acid in a test tube.

2

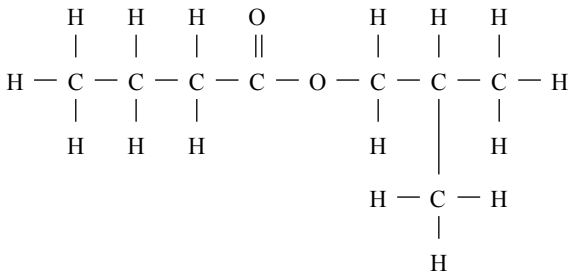
3

4 After 20 minutes, pour the contents of the test tube into a beaker containing sodium hydrogen carbonate solution.

Add appropriate instructions for steps 2 and 3.

2

(*b*) The full structural formula for an ester is shown below.



Give the systematic name of the alkanol used in making this ester.

1

(*c*) State a use of esters.

1

(4)

Candidate must not write in this margin

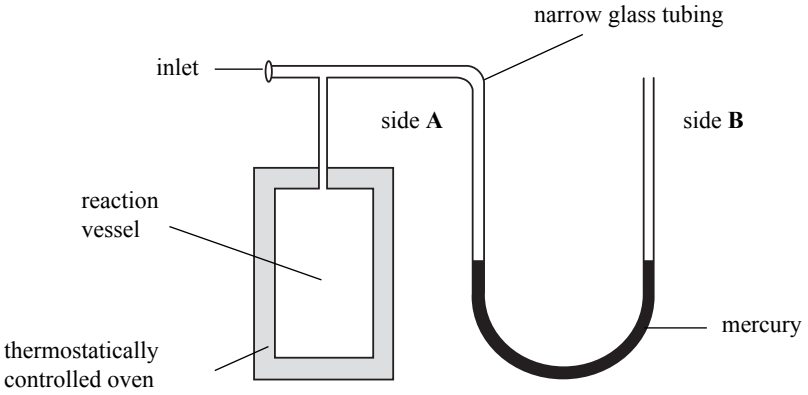
Marks

9. In 1926, Hinshelwood and Green studied the reaction between nitric oxide and hydrogen at temperatures above 150 °C.

The equation for the reaction is:

$$2NO(g) + 2H_2(g) \longrightarrow N_2(g) + 2H_2O(g)$$

A simplified diagram of their apparatus is shown below.



(*a*) Predict what will happen to the mercury levels as the reaction proceeds.

1

(*b*) The use of narrow glass tubing ensured that only a small volume of gas was outwith the reaction vessel.

Suggest why this precaution was taken.

1

(*c*) Calculate the mass of nitrogen obtained under these conditions when 500 cm^3 of nitric oxide reacted completely with hydrogen.

(Take the molar volume of nitrogen to be 25·0 litres mol^{-1}.)

(Show your working clearly.)

2

(4)

Candidate must not write in this margin

Marks

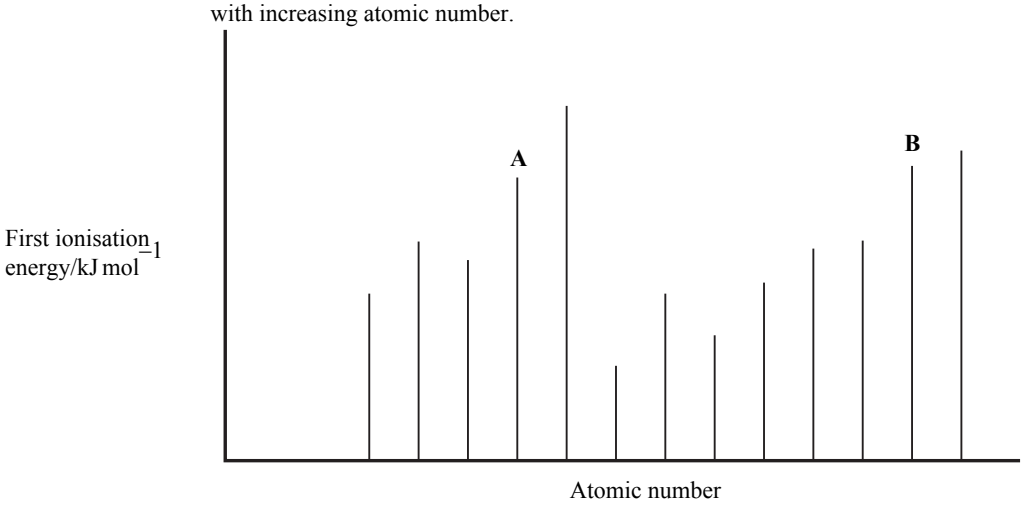
10. The boiling points of three halogens are shown in the table.

Halogen	Boiling point/°C
chlorine	–35
bromine	59
iodine	184

(*a*) Explain why the boiling points of the halogens increase down the group.

2

(*b*) (i) The graph shows the first ionisation energies of successive elements with increasing atomic number.



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

1

(ii) Calculate the energy change for the process:

$$Al(g) \longrightarrow Al^{3+}(g) + 3e^-$$

1

(4)

Candidate must not write in this margin

Marks

11. The enthalpy of lattice breaking for rubidium chloride is the enthalpy change for the following process.

$$RbCl(s) \longrightarrow Rb^{+}(g) + Cl^{-}(g)$$

This enthalpy change can be calculated using the enthalpy changes in the table below.

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

(*a*) Name enthalpy change 1.

1

(*b*) Calculate the enthalpy of lattice breaking, in $kJ\,mol^{-1}$, for rubidium chloride.
(Show your working clearly.)

2

(3)

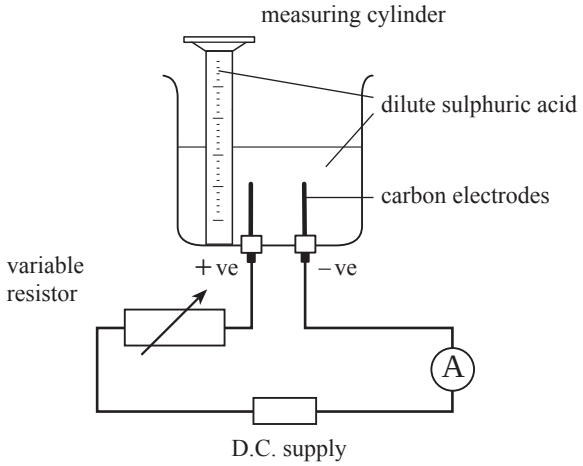
Candidate must not write in this margin

Marks

12. Part of a workcard is shown.

WORKCARD

To find the number of coulombs required to produce one mole of hydrogen by electrolysing dilute sulphuric acid.



1 Assemble the apparatus as shown. (**Do not switch on.**)

2 Set the voltage to 6 V D.C.

3 Switch on and adjust the variable resistor to give a current of 0·5 A.

4 Switch off.

(*a*) (i) What is the next step before switching the current back on again?

1

(ii) In addition to the current, what measurements should be taken?

1

(*b*) A student carrying out this experiment passed the current through the solution for 10 minutes. Calculate the mass of hydrogen produced.

(Show your working clearly.)

3

(5)

Candidate must not write in this margin

Marks

13. The following reaction can be readily carried out in the laboratory.

$$\underset{\text{alcohol}}{C_6H_{12}O} \longrightarrow \underset{\text{product}}{C_6H_{10}O}$$

(*a*) Why can this reaction be classified as oxidation?

1

(*b*) The alcohol does not react with bromine solution and the product does not react with Benedict's solution.
Draw a structural formula for the product.

1

(2)

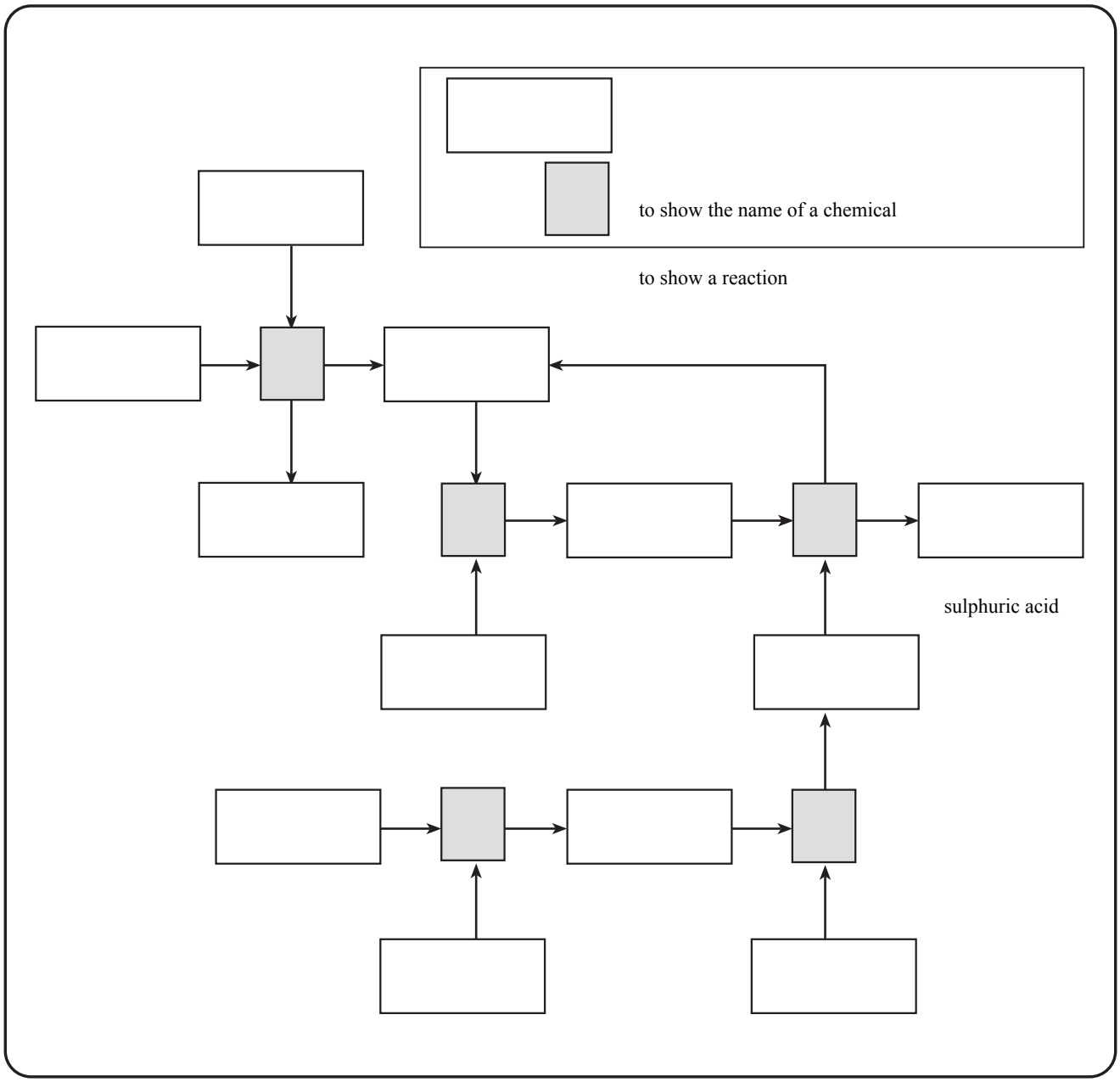
Marks

14. About 2·5 million tonnes of sulphuric acid are produced each year in the UK.

(*a*) Sulphuric acid was made industrially by the Chamber Process.
The following chemical reactions are involved.

Sulphur is burned to produce sulphur dioxide.
Sulphur dioxide reacts with water to produce sulphurous acid.
Nitric oxide is produced by the catalytic oxidation of ammonia; water is also a product of this reaction.
Nitric oxide reacts with oxygen to form nitrogen dioxide.
Nitrogen dioxide reacts with sulphurous acid to form sulphuric acid and regenerate nitric oxide.

Complete the flow diagram of the Chamber Process with the names of the chemicals involved in the reactions.



2

Candidate must not write in this margin

Marks

14. (continued)

(*b*) Sulphuric acid is used in the manufacture of fertilisers.

(i) Write a balanced equation showing the formation of ammonium sulphate from ammonia and sulphuric acid.

1

(ii) Explain why ammonium sulphate dissolves in water to form an acidic solution.

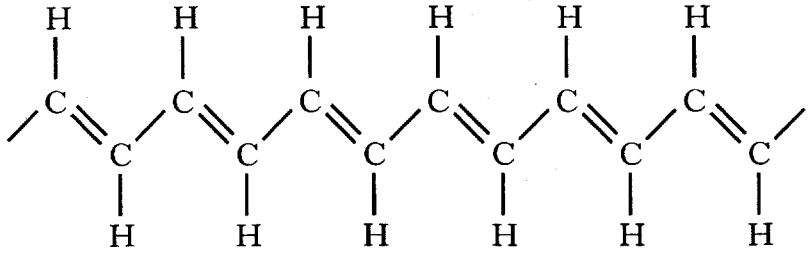
2

(5)

must not write in this margin

Marks

15. Part of a polymer structure is shown below.



(*a*) Draw the structure for the monomer from which it is made.

1

(*b*) This polymer can be treated to make a polymer which conducts electricity. Why does it conduct electricity?

1

(2)

Candidate must not write in this margin

Marks

16. 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)

Candidate must not write in this margin

Marks

17. 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 $24{\cdot}9\,cm^3$ 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)

[*END OF QUESTION PAPER*]

Candidate must not write in this margin

SPACE FOR ANSWERS

Candidate must not write in this margin

SPACE FOR ANSWERS

[C012/SQP006]

Higher Chemistry

NATIONAL QUALIFICATIONS

Paper II

Specimen Marking Instructions

SCOTTISH QUALIFICATIONS AUTHORITY

1.

(a) (i) Hydrogen does not produce CO / CO_2 on combustion
or hydrogen does not pollute
or petrol produces CO / CO_2 on combustion
or petrol produces pollutants 1

(ii) Methanol can result in corrosion in the car engine
or produces less energy per litre
or methanol is toxic 1

(b) **X** is synthesis gas
or a mixture of CO and H_2 1

total 3 marks

2.

(a) Fullerenes comprise discrete (covalent) molecules
or diamond is a (covalent) network 1

(b) So that carbon would not react (with anything)
or so that carbon dioxide would not form
or helium is inactive / inert 1

(c) Add the $C_{60}H_{36}$ to bromine (solution)(water) 1/2
rapidly decolourised -------> unsaturated 1/2
or not/slowly decolourised -----> saturated 1/2

total 3 marks

3.

(a) (i) Rate of forward reaction = rate of reverse reaction
or reactants are converted to products at same rate as products are converted to reactants 1

(ii) The ammonia formed breaks down again
or the equilibrium may be driven to the LHS
or the reverse reaction may be favoured
or the yield of ammonia is low 1

(b) Method is suited to high production
or process is more easily automated
or process is more easily controlled
or low risk of contamination
or quality is consistent
or labour costs are lower
or waste is minimal 1

Total 3 marks

4.

(a) mass (volume) of water 1/2

initial **and** final temperature of water
or temperature rise 1/2

initial **and** final mass of burner
or mass / weight change of burner 1

(b) Each member of series has 1 more C and 2 more H's
or one more CO_2 and one more H_2O forms
or regular increase arises from the regular increase in number of bonds being broken and new bonds being formed 1

total 3 marks

5.

(a) Set the power pack to a fixed voltage 1
the higher the rate of rotation,
the less viscous the liquid 1

or

Find the voltage required to maintain a certain rate of rotation of the glass stirring paddle 1
the higher the voltage, the more viscous the liquid 1

or

Maintain a certain rate of rotation 1
the higher the liquid rises,
the less viscous it is 1

(b) Large difference in electronegativity between atoms in covalent bonds leads to very polar bonds 1
this leads to strong intermolecular forces 1

total 4 marks

6.

(a) (i) glycerol
or propane-1,2,3-triol
or propan-1,2,3-triol 1

(Do not penalise missing dashes, commas)

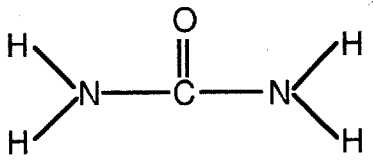
(ii) SOS refers to the sequence
stearic, oleic, stearic 1

(b) Hydrogen is added to double bonds
or the molecules become saturated
or saturation takes place
or reduction takes place (addition of hydrogen) 1

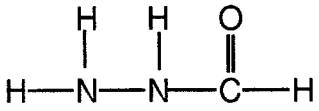
total 3 marks

7.

(a)



Allow $-NH_2$ at right hand side and
H_2N- at left hand side
do not allow $-NH_2$ at left hand side
do not allow other structures such as



1

(b) Initial yellow colour is due to the gel being acidified 1/2
as reaction proceeds ammonia forms 1/2
ammonia is alkaline 1/2
indicator changes colour 1/2

(c) pH = 11
so $[H^+]$ = 10^{-11} 1/2
so $[OH^-]$ = 10^{-14} / 10^{-11} = **10^{-3}** $moll^{-1}$ 1/2

(No penalty for no units
deduct 1/2 for wrong units)

(d) (i) **-88** kJ mol^{-1} (allow -86 to -90) 1

(No penalty for no units
deduct 1/2 for wrong units)

(ii) curve **must** commence at 120 **and** end at 32
and lie wholly **above** the given curve. 1

total 6 marks

8.

(a) 2. Add a few drops of (concentrated) sulphuric acid. 1

3. Place in a warm water bath. 1

(b) 2-methylpropan-1-ol
or methyl propan-1-ol 1

2 - methylpropanol 1/2

(c) flavouring
or in perfumes
or in solvents. 1

total 4 marks

9.

(a) The mercury will rise in side **A**
or the mercury will fall in side **B** 1

(b) To ensure that as much of the gas as possible is at the correct temperature
or water might condense 1

(c) $2NO + 2H_2 \text{ -----> } N_2 + 2H_2O$

2 mol <------> 1 mol
2 vol <------> 1 vol 1/2

500 cm^3 <------> 250 cm^3 = 0.25 litre 1/2
= 0.25/25 mol
= 0.01 mol 1/2

1 mol = 28g -------> 0.01 mol = **0.28g** 1/2

total 4 marks

(Deduct 1/2 for no units or wrong units)

10.

(a) The molecules become larger **or** heavier 1
therefore Van der Waals' forces are stronger 1
(allow "intermolecular" forces for 1/2)
(direction of increase need not be mentioned since it is stated in question)

(b) (i) Group 7 1

(ii) 584 + 1830 + 2760 = **5174 kJ mol^{-1}** 1

(Deduct 1/2 for no units or wrong units)

total 4 marks

11.

(a) Enthalpy of solution 1

(b) $RbCl(s) \dashrightarrow Rb^+(aq) + Cl^-(aq)$ $\Delta H = +17$

$Rb^+(aq) \dashrightarrow Rb^+(g)$ $\Delta H = +301$ 1/2

$Cl^-(aq) \dashrightarrow Cl^-(g)$ $\Delta H = +364$ 1/2

$RbCl(s) \dashrightarrow Rb^+(g) + Cl^-(g)$ $\Delta H =$ **+682** kJ mol^{-1}

1/2 mark for each correct ΔH (incl. sign)

1/2 mark for final correct result

(No penalty for no units, deduct 1/2 for wrong units)

total 3 marks

12.

(a) (i) Place measuring cylinder in position over negative electrode 1

(ii) Volume of hydrogen collected 1/2
time during which current was passed 1/2

(b) $2H^+ + 2e \dashrightarrow H_2$

2 mol 1 mol 1/2

2 x 96 500 C 2g 1/2

Q = It 1/2

0.5 x 10 x 60 = 300 Coulombs 1/2

moles H_2 = 300 / 193 000 1/2

mass H_2 = 2 x 300 / 193 000

= **3.109 x 10^{-3} g** 1/2

accept 3.1

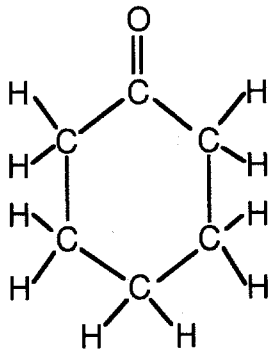
(Deduct 1/2 for each arithmetical error
deduct 1/2 for no / wrong units)

total 5 marks

13.

(a) The reaction involves a loss of hydrogen
or there is a fall in the hydrogen : oxygen ratio 1

(b) Other isomeric cyclic ketones are acceptable

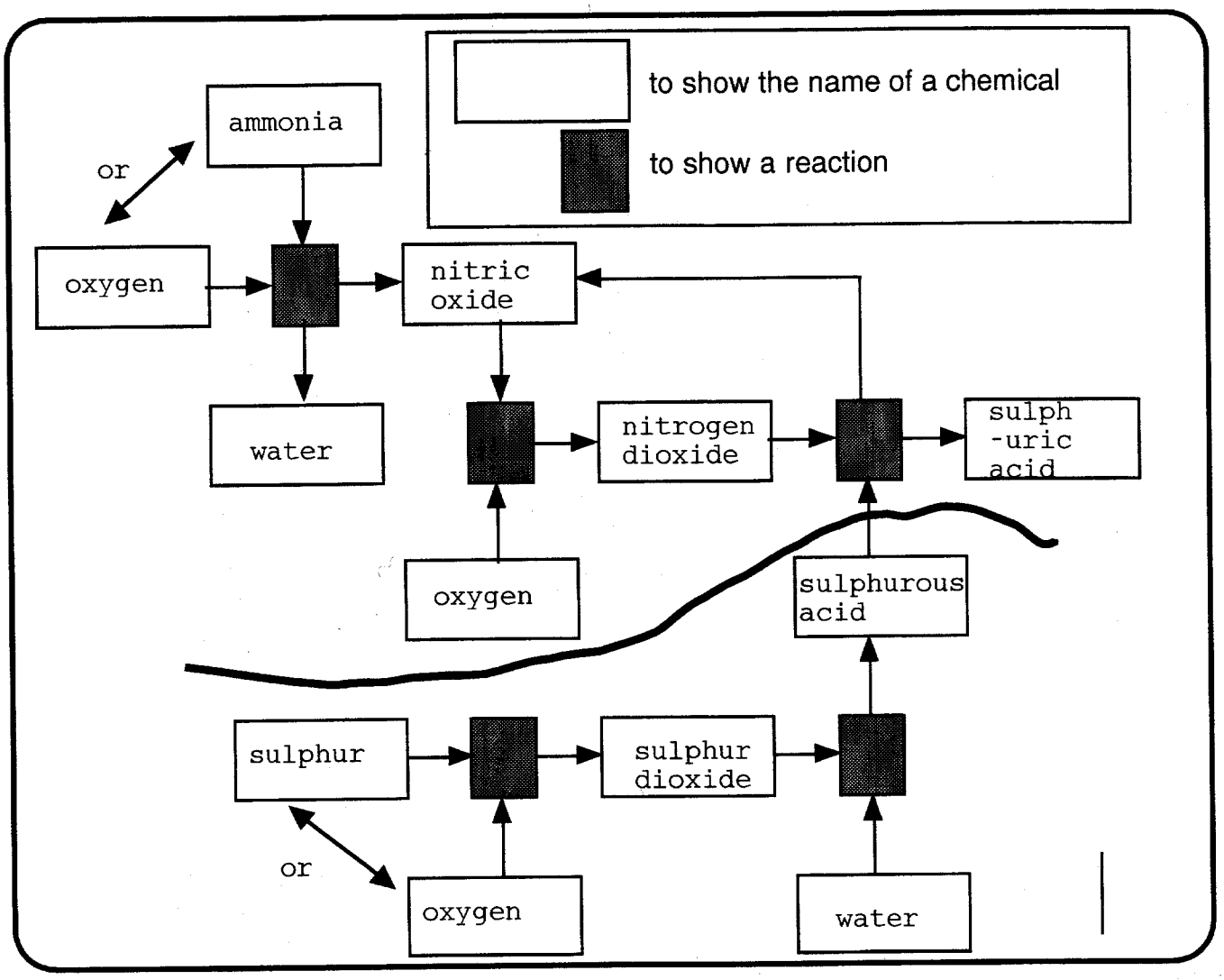


1

total 2 marks

14.

(a)



Lower region correct		1
Upper region correct		1
(b) (i)	$2NH_3 + H_2SO_4 \text{ -----> } (NH_4)_2SO_4$	1
	Unbalanced, but all formulae correct	1/2
(ii)	NH_3/NH_4OH is weak	1/2
	H_2SO_4 is strong	1/2
or	salt of strong acid / weak base	1
or	NH_4^+ combines with OH^-	1
	SO_4^{2-} does not combine with H^+	
or	leaving a surplus of H^+	1

total 5 marks

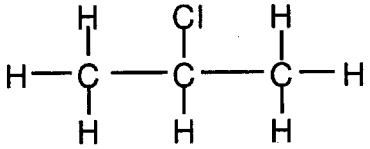
15.

(a)  or 1

(b) Electrons are free to move across double bonds
or electrons in double bonds are delocalised 1

total 2 marks

16.

(a)  allow one missing H but all bonds must be shown. 1

(b) Only one product is possible
or the double bond is in the centre of the molecule
or the but-2-ene is symmetrical
or the two central C atoms are the same 1

total 2 marks

17.

(a) $2Fe^{2+}$ -------> $2Fe^{3+}$ + $2e^-$

or Fe^{2+} -------> Fe^{3+} + e^- 1

(b) Moles of iron(II) sulphate solution required
= $2.82 \times 10^{-4} \times 24.9 / 1000$
= 7.021×10^{-6} 1

moles of chlorine = $7.021 \times 10^{-6} / 2$
= 3.51×10^{-6} present in 100 cm^3 of water. 1/2

moles of chlorine present in 1 litre of water
= 3.51×10^{-5} mol 1/2

mass of chlorine present in 1 litre of water
= $3.51 \times 10^{-5} \times 71$
= **2.49×10^{-3}**

(No penalty for no units
wrong units deduct 1/2) 1

total 4 marks

[END OF MARKING INSTRUCTIONS]