CHEMISTRY (REVISED)

Higher Grade—PAPER I

Wednesday, 20th 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 (1991 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.

$\mathcal{L}$

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:
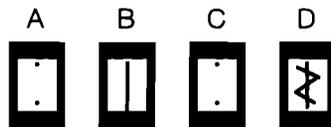
    A   B   C   D

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:

    A   B   C   D   **OR**   A   B   C   D
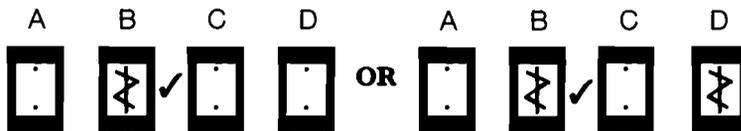
1. In which of the following structures would the nails corrode before the roof itself?

   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. An element was burned in air. The product was added to water, producing a solution with a pH less than 7.

   The element could be

   A   hydrogen

   B   sodium

   C   tin

   D   carbon.

4. The instruction card shown below was used by pupils when they were preparing a sample of a salt.

   ┌─────────────────────────────────┐
   │   INSTRUCTION CARD   │
   │   SALT PREPARATION   │
   │   │
   │ 1. Mix 20 cm³ of solution X with 20 cm³ │
   │   of solution Y.   │
   │   │
   │ 2. Stir the mixture.   │
   │   │
   │ 3. Remove the salt by filtration. │
   │   │
   │ 4. Dry the salt in an oven at 100 °C for │
   │   30 minutes.   │
   └─────────────────────────────────┘

   A barium salt prepared by this method could be a

   A   bromide

   B   chloride

   C   nitrate

   D   sulphate.

5. When a series of electric sparks was passed through a flask of air, a chemical reaction occurred producing a gas.

   If a little water was added to the flask then the gas

   A   would dissolve to form an acid

   B   would dissolve to form an alkali

   C   would dissolve to form a neutral solution

   D   would not dissolve.

6. A white powder when mixed with sodium hydroxide and heated strongly gave off an alkaline gas.

   The white powder could be

   A   calcium oxide

   B   ammonium chloride

   C   potassium carbonate

   D   zinc nitrate.

7. Which of the following covalent substances does **not** react with water forming ions?

   A   HBr

   B SO_2

   C NH_3

   D CH_4

8. 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

[Turn over

9. Particles with the same electron arrangement are said to be isoelectronic.

Which of the following compounds contains ions which are isoelectronic?

A Na_2S

B $MgCl_2$

C KBr

D $CaCl_2$

10. 0·5 mol of copper(II) chloride and 0·5 mol of copper(II) sulphate are dissolved together in water and made up to 500 cm^3 of solution.

What is the concentration of $Cu^{2+}(aq)$ ions in the solution (in mol l^{-1})?

A 0·5

B 1·0

C 2·0

D 4·0

11. A pupil is asked to react chalk with acid and measure accurately the volume of carbon dioxide produced every minute.
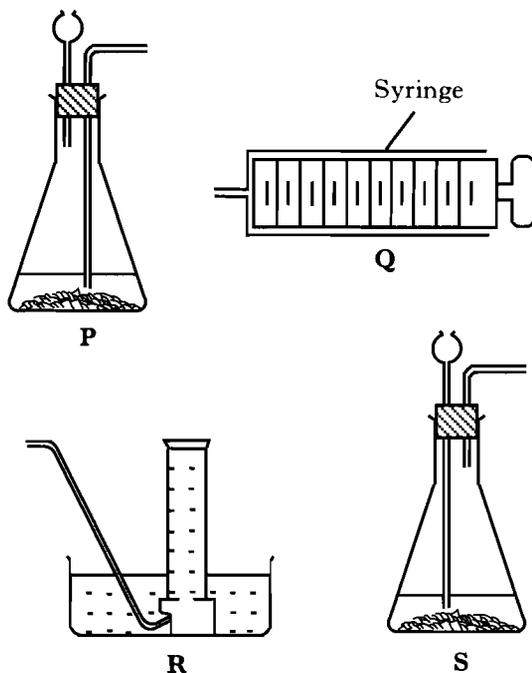
From the diagrams above, which of the following combinations is the best one to use?

A P and Q

B P and R

C S and Q

D S and R

12. Which of the following graphs of rate of reaction against temperature would apply to the neutralisation of dilute hydrochloric acid with zinc?
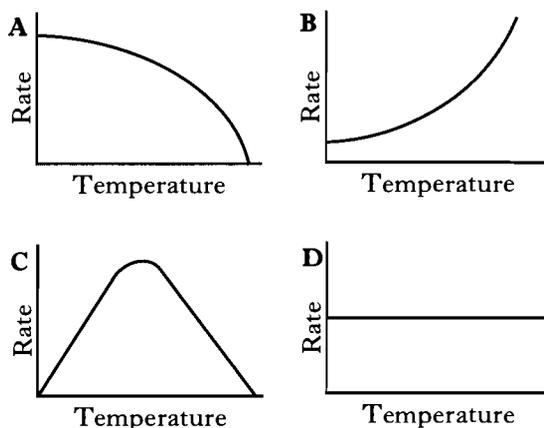
13. Which of the following is **not** a factor which affects the rate of a reaction?

A Collision geometry

B Concentration of reactants

C Kinetic energies of reactants

D Enthalpy change of reaction

14. The graph shows the variation of concentration of a reactant with time as a reaction proceeds.
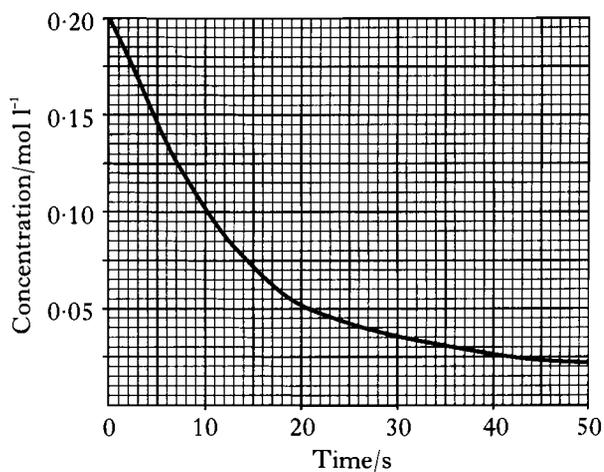
What is the average reaction rate during the first 20 s?

A 0·0025 mol $l^{-1}s^{-1}$

B 0·0050 mol $l^{-1}s^{-1}$

C 0·0075 mol $l^{-1}s^{-1}$

D 0·0150 mol $l^{-1}s^{-1}$

15. The graph shows the distribution of kinetic energies of the molecules in a sample of gas.
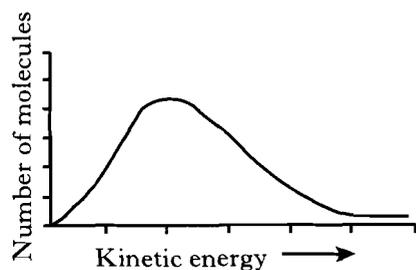
Which graph would show the kinetic energies of the molecules when the sample is cooled by 10 K?

A

B

C

D
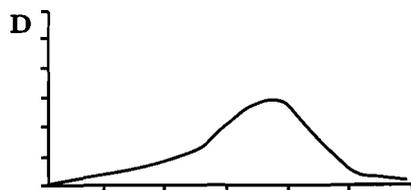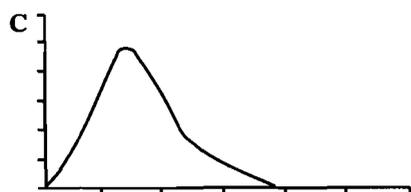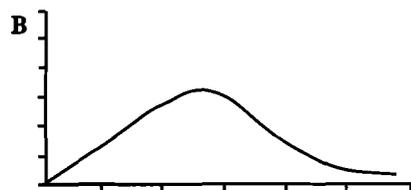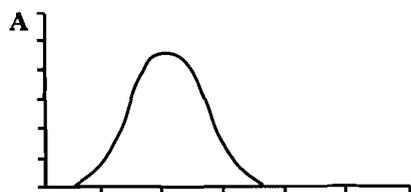
16. Methanol may be converted to methanal by

   A oxidation

   B hydration

   C cracking

   D condensation.

17. Liquefied petroleum gas (LPG) is generally a mixture of

   A methane and ethane

   B ethane and propane

   C propane and butane

   D butane and octane.

18. Which compound has a formula mass of 84 amu?

   A Hexane

   B Hexene

   C Cyclohexene

   D Benzene

19. Synthesis gas can be made by

   A reacting ethene gas with steam

   B burning coke in excess air

   C burning methane gas in excess air

   D reacting methane gas with steam.

20. Which of the following hydrocarbons immediately decolourises bromine water?

   A Cyclohexane

   B Benzene

   C Hexane

   D Cyclohexene

21. The reduction of zinc ions during electroplating can be represented as:

$$Zn^{2+}(aq) + 2e \rightarrow Zn(s)$$
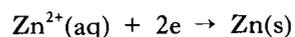
What is the quantity of electricity needed to produce 0·25 mol of zinc?

   A 24 125 C

   B 48 250 C

   C 96 500 C

   D 193 000 C

[Turn over

22. The mass of 1 mol of sodium is 23 g.

What is the mass of one sodium atom?

A 6×10^{23} g

B 6×10^{-23} g

C $3 \cdot 8 \times 10^{-23}$ g

D $3 \cdot 8 \times 10^{-24}$ g

23. The Avogadro Constant is the same as the number of

A molecules in 16 g of oxygen

B ions in 1 litre of sodium chloride solution, concentration 1 mol l^{-1}

C atoms in 24 g of carbon

D molecules in 2 g of hydrogen.

24. A mixture of 50 cm^3 carbon monoxide and 40 cm^3 carbon dioxide is heated with excess copper(II) oxide until no further reaction occurs.

What is the total volume of gas after the reaction?

(All volumes are measured at the same temperature and pressure.)

A 40 cm^3

B 50 cm^3

C 90 cm^3

D 140 cm^3

25. In which of the following kinds of compounds is nitrogen always present?

A Enzymes

B Oils

C Polyesters

D Carbohydrates

26. Rum flavouring is based on the compound with the formula shown:

$$CH_3CH_2CH_2C \overset{\displaystyle O}{\underset{\displaystyle O\,CH_2CH_3}{<}}$$
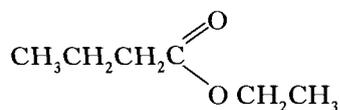
It can be made from

A ethanol and butanoic acid

B propanol and ethanoic acid

C butanol and methanoic acid

D propanol and propanoic acid.

27. **Essential** amino acids are defined as the amino acids which

A are necessary for building polypeptides

B humans must acquire through their diet

C plants cannot synthesise for themselves

D are produced when any protein is hydrolysed.

28. As the atomic number increases in the alkali metal group

A the metallic bond strength increases

B the ionisation enthalpy decreases

C the covalent radius decreases

D the number of occupied energy levels decreases.

29. In which of the following liquids does hydrogen bonding occur?

A Ethanol

B Ethyl ethanoate

C Hexane

D Pent–1–ene

30. Which of the following exists as discrete molecules?

    A Magnesium oxide

    B Aluminium oxide

    C Silicon oxide

    D Hydrogen oxide

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

    $C(s) + O_2(g) \rightarrow CO_2(g)$ $\Delta H = a$

    $H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(\ell)$ $\Delta H = b$

    $C_4H_9OH(\ell) + 6O_2(g) \rightarrow 4CO_2(g) + 5H_2O(\ell)$

                                      $\Delta H = c$

    What is the enthalpy of formation of butanol?

    A $4a + 5b - c$

    B $2a + 10b - c$

    C $c - 4a - 5b$

    D $2a + 5b + c$

32. Which of the following equations represents the first ionisation energy of fluorine?

    A $F(g) + e \rightarrow F^-(g)$

    B $F(g) \rightarrow F^+(g) + e$

    C $F^-(g) \rightarrow F(g) + e$

    D $F^+(g) + e \rightarrow F(g)$

33. The mean bond enthalpy of the C—H bond is $414\,kJ\,mol^{-1}$.

    From this information, it can be calculated that 1656 kJ of energy is

    A evolved when 1 mol of methane is burned in excess oxygen

    B required to dissociate 1 mol of methane into free carbon and hydrogen atoms

    C required for the complete combustion of 1 mol of methane

    D evolved when 1 mol of graphite combines with 2 mol of hydrogen gas.

34. Which of the following is the best description of a $0{\cdot}1\,mol\,l^{-1}$ solution of nitric acid?

    A Dilute solution of a weak acid

    B Dilute solution of a strong acid

    C Concentrated solution of a weak acid

    D Concentrated solution of a strong acid

35. In a reversible reaction, equilibrium is reached when

    A molecules of reactants cease to change into molecules of products

    B the concentrations of reactants and products are equal

    C the concentrations of reactants and products are constant

    D the activation energy of the forward reaction is equal to that of the reverse reaction.

36. In which of the following systems 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 $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$

37. Equal volumes of solutions of ethanoic acid and hydrochloric acid, of equal concentrations, are compared.

    In which of the following cases does the ethanoic acid give the higher value?

    A Rate of reaction with magnesium

    B Volume of sodium hydroxide solution neutralised

    C pH of solution

    D Conductivity of solution

[Turn over

38. The relative abundance of the two isotopes of boron are shown in the table below.

Isotope	Relative abundance/%
^{10}B	18·7
^{11}B	81·3

What is the relative atomic mass of boron?

A 10·6

B 10·7

C 10·8

D 10·9

39. Which of the following have an electrical charge?

A α-particles

B X-rays

C Neutrons

D γ-rays

40. Chemists use microwave ovens to speed up the synthesis of drugs that contain a radioactive atom, such as ^{18}F. These labelled drugs are called radio-pharmaceuticals and they have a very short shelf-life. Indeed, they must be used within an hour of synthesis. The drugs are introduced into a volunteer subject, where they are used in the body in the same way as similar non-radioactive compounds. The progress of the drug through the organ can be easily monitored.

Which conclusion can reasonably be drawn from the information in the passage?

A Labelled drugs are prone to oxidation.

B Microwaves increase the shelf time of a labelled drug.

C The labelling atom is an alpha emitter.

D ^{18}F has a very short half life.

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 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_4	H_2	CO_2
D	E	F
CO	C_2H_6	N_2

(*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
~~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

41. Many organic compounds contain oxygen.

A		B		C	
	$CH_3 - O - CH_3$		$CH_3 - CH_2 - OH$		$CH_3 - \overset{\overset{\displaystyle OH}{|}}{\underset{\underset{\displaystyle H}{|}}{C}} - CH_3$
D		E		F	
	$CH_3 - \overset{\overset{\displaystyle O}{\|}}{C} - CH_3$		$CH_3 - CH_2 - C\overset{\displaystyle \diagup O}{\diagdown H}$		$CH_3 - \overset{\overset{\displaystyle CH_3}{|}}{\underset{\underset{\displaystyle OH}{|}}{C}} - CH_3$

(a) Identify the **two** compounds which contain the carbonyl group.

(b) Identify the primary alcohol.

(c) Identify the compound which can give propene on dehydration.

(d) Identify the isomer of methoxyethane: $CH_3 - O - CH_2 - CH_3$

42. 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

43. The wide availability of petrol and diesel has revolutionised transportation this century.

Identify the true statement(s).

A	Diesel evaporates more readily than petrol.
B	Diesel contains smaller molecules than petrol.
C	Diesel is produced by blending different gas oil fractions obtained by distillation.
D	An electric spark is used to ignite petrol in a petrol engine but not diesel in a diesel engine.
E	Diesel contains more branched chain alkanes and aromatic hydrocarbons than petrol.

44. The progress of reactions can be followed by energy diagrams.

(R = Reactants   P=Products)
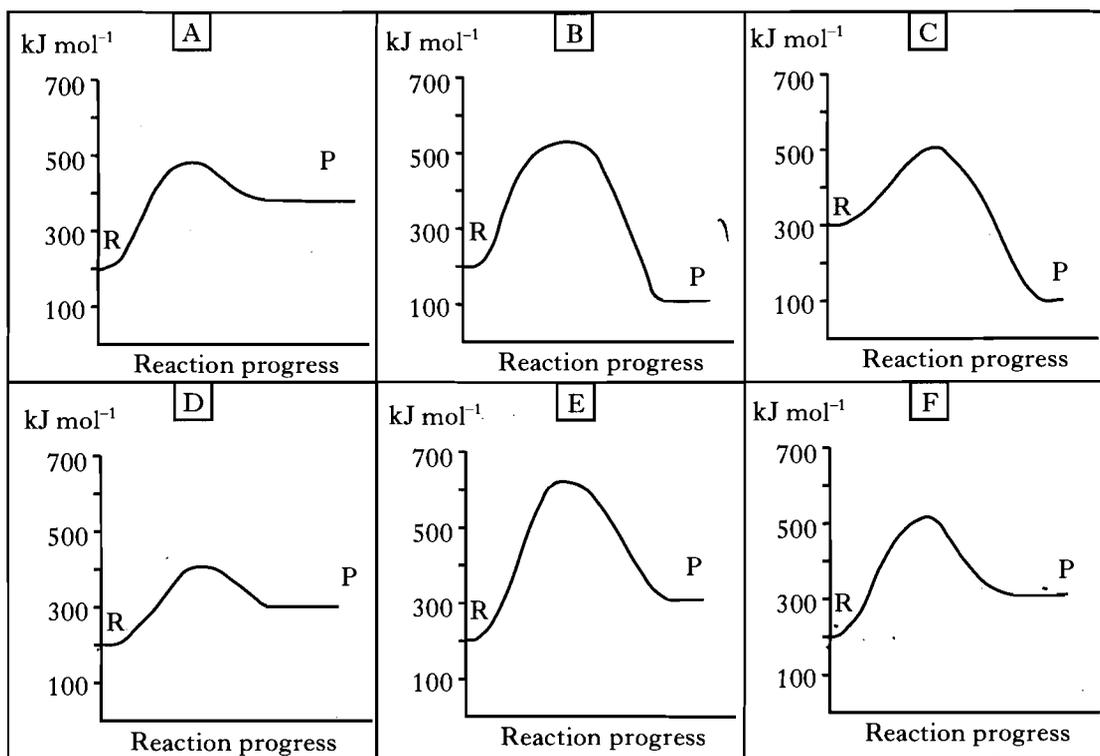
(a) Identify the diagram which could represent the catalysed version of the reaction in diagram F.

(b) Identify the diagram which represents the reaction with the highest energy of activation.

(c) Identify the diagram which represents the reaction with an enthalpy change of -200 kJ mol^{-1}.

45. The grid shows information which can be applied to different elements in the solid state.

A		B		C	
	discrete molecules		conducts electricity		contains van der Waals' bonds
D		E		F	
	contains covalent bonds		network solid		monatomic

(a) Identify the statement(s) which can be applied to sulphur but **not** to silicon.

(b) Identify the statement(s) which can be applied to neon.

[Turn over

46. The grid shows information about acidic solutions.

A		B	
	400 cm^3 of 1 mol l^{-1} sulphuric acid		100 cm^3 of 4 mol l^{-1} hydrochloric acid
C		D	
	200 cm^3 of 2 mol l^{-1} ethanoic acid		800 cm^3 of $0 \cdot 5 \text{ mol l}^{-1}$ nitric acid

(a) Identify the solution which contains the fewest $H^+(aq)$ ions.

(b) Identify the solution which would **not** produce a neutral solution when added to 100 cm^3 of 4 mol l^{-1} sodium hydroxide solution.

47. The flow diagram shows three steps in the preparation of a plastic from propane feedstock.
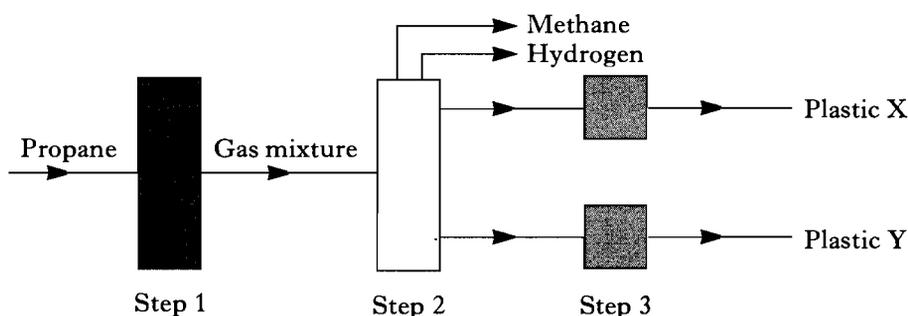
A		B		C	
	cracking		hydrolysis		distillation
D		E		F	
	polymerisation		hydrogenation		hydration

(a) Identify the process which takes place in Step 1.

(b) Identify the process which takes place in Step 2.

(c) Identify the process which takes place in Step 3.

[END OF QUESTION PAPER]

[0500/338]   1992

SCOTTISH CERTIFICATE OF EDUCATION

CHEMISTRY (REVISED)

Higher Grade – PAPER II

Wednesday, 20th May—1.30 p.m. to 4.00 p.m.

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 (1991 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.**

6. **Before leaving the examination room you must give this book to the Invigilator. Failure to do so may result in you losing all marks.**

1. A pupil was studying reactions involving alkanols and alkanoic acids.

   (*a*) (i) Fill in the blanks (i) to (iv).

	ETHANOL	ETHANOIC ACID
Reaction with sodium	(i)	Hydrogen gas given off
Flammability	(ii)	Burns with some difficulty
pH of aqueous solution	7	(iii)
Reaction with magnesium	(iv)	Hydrogen gas released

        2

      (ii) Describe **two** safety precautions which must be taken when reacting sodium with ethanol.

        1

   (*b*) Alkanols can react with alkanoic acids to form esters.

      (i) Give **two** uses of esters.

        1

      (ii) Draw the **full** structural formula for methyl ethanoate.

        1
       (5)

Marks

2. "It is thought that every square mile of soil on Earth, to a depth of six inches, contains about one gram of radium."

(*a*) Calculate the number of atoms in 1g of $^{226}_{88}Ra$.

2

(*b*) $^{226}_{88}Ra$ is a radioisotope which decays by alpha emission to give radon gas.

(i) Write a nuclear equation for the decay of $^{226}_{88}Ra$.

1

(ii) Why are the nuclei of radioisotopes unstable?

1

(*c*) Radon gas is a source of background radiation.

Give **one** other source of background radiation.

1
(5)

[Turn over

Page three

3. The reaction of solid calcium hydride with water, to form calcium hydroxide and hydrogen, is often used to supply the gas in weather balloons.

(*a*) Balance the equation for the *reaction* of calcium hydride with water.

$$CaH_2 \quad + \quad H_2O \longrightarrow \quad Ca(OH)_2 \quad + \quad H_2$$

1

(*b*) Draw a diagram of the apparatus that could be used to show that the hydride ion in calcium hydride has a negative charge.

Clearly label the diagram.

2
(3)

Marks

4. Mutton fat contains a compound called tristearin.

$$H-\underset{\underset{\displaystyle H-\underset{\underset{\displaystyle H-\underset{\underset{\displaystyle H}{\big|}}{C}-O-C-C_{17}H_{35}}{\big|}}{C}-O-C-C_{17}H_{35}}{\overset{\overset{\displaystyle H}{\big|}}{C}}-O-\overset{\overset{\displaystyle O}{\|}}{C}-C_{17}H_{35}$$
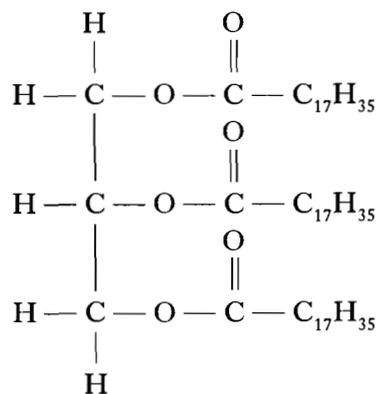
Tristearin is hydrolysed in the body during digestion by an enzyme known as lipase.

(a) Give **one** reason why fats can be a useful part of a balanced diet.

1

(b) To which set of compounds do enzymes belong?

1

(c) The hydrolysis of tristearin produces a fatty acid.

Name the other product of this reaction.

1

(3)

[Turn over

5. Hydrogen peroxide solution decomposes to produce oxygen gas.

$$2H_2O_2 \longrightarrow 2H_2O + O_2$$

Solutions of hydrogen peroxide are marketed with a "volume strength". This relates to the volume of oxygen which can be produced.

Volume of oxygen produced	=	Volume strength	×	Volume of hydrogen peroxide solution

A pupil carried out an experiment.

Water bath
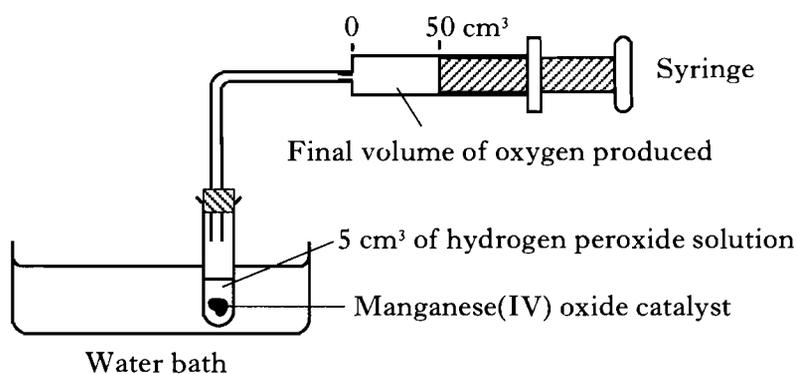
(*a*) Why is the catalyst more effective if used in powdered form?

1

(*b*) Calculate the volume strength of the hydrogen peroxide solution used in the pupil's experiment.

1

5. (continued)

(*c*) The experiment was repeated with the temperature in the water bath increased by 20 K.

State how this change would affect

  (i) the volume of oxygen produced in the first 20 s of the reaction,

1

  (ii) the total volume of oxygen produced.

1

(*d*) Calculate the total volume of oxygen produced by the decomposition of a solution containing 3·4 g of hydrogen peroxide.

(Take the molar volume of oxygen as 24·0 litres.)

Show your working clearly.

2
(6)

[Turn over

6. Ammonia is manufactured in industry by the reaction of nitrogen with hydrogen.

$$N_2(g) \quad + \quad 3H_2(g) \quad \rightleftharpoons \quad 2NH_3(g) \quad \Delta H = -91 \text{ kJ mol}^{-1}$$

Typical conditions for an ammonia plant are as follows:

Pressure	250 atmospheres
Temperature	380–450 °C
Catalyst	Iron containing promoters to stop catalyst poisoning
Conversion	15% by volume of ammonia

(*a*) Name the industrial process used to manufacture ammonia.

1

(*b*) What is meant by catalyst poisoning?

1

(*c*) Explain what would be expected to happen to the percentage conversion if the temperature of the ammonia plant was decreased.

2

(*d*) High pressure favours conversion to ammonia.

Suggest why pressures higher than 250 atmospheres are **not** used.

1
(5)

7. The radioisotope $^{131}_{53}I$ is used in hospitals. It has a half-life of 8 days and decays to give a stable product.

A bag of hospital linen contaminated with $^{131}_{53}I$ was found to give a count rate of 320 counts s^{-1}.

(*a*) Draw a graph to show how the count rate of the linen will change with time.

Use appropriate scales to fill most of the graph paper.
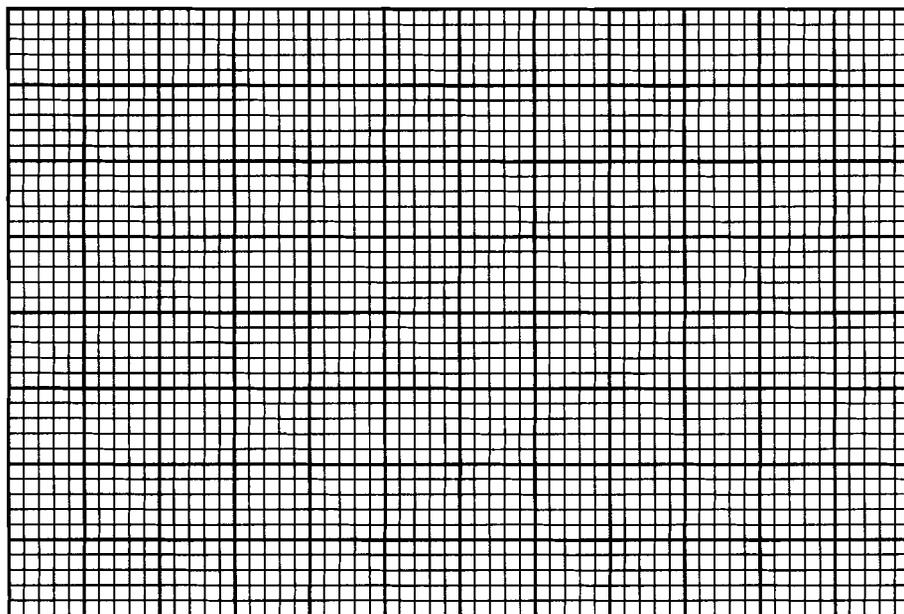
2

(*b*) Hospitals are not allowed to dispose of material contaminated with $^{131}_{53}I$ until the count rate has fallen to 30 counts s^{-1}.

Use the graph to determine how long the bag of linen must be stored before disposal.

1

(3)

[Turn over

8.

$$Cu^{2+}(g) + 2e + Cl_2(g) \qquad \qquad \qquad \qquad \mathbf{Y} \qquad -728 \text{ kJ}$$

+243 kJ

$Cu^{2+}(g) + 2e + Cl_2(g)$

+1970 kJ

$Cu^{2+}(g) + 2Cl^-(g)$

$Cu^+(g) + e + Cl_2(g) \qquad \qquad \mathbf{B} \qquad -2781 \text{ kJ}$

+751 kJ   **A**

$Cu(g) + Cl_2(g)$

+339 kJ   **X**

ΔH_f $Cu^{2+}(Cl^-)_2(s)$
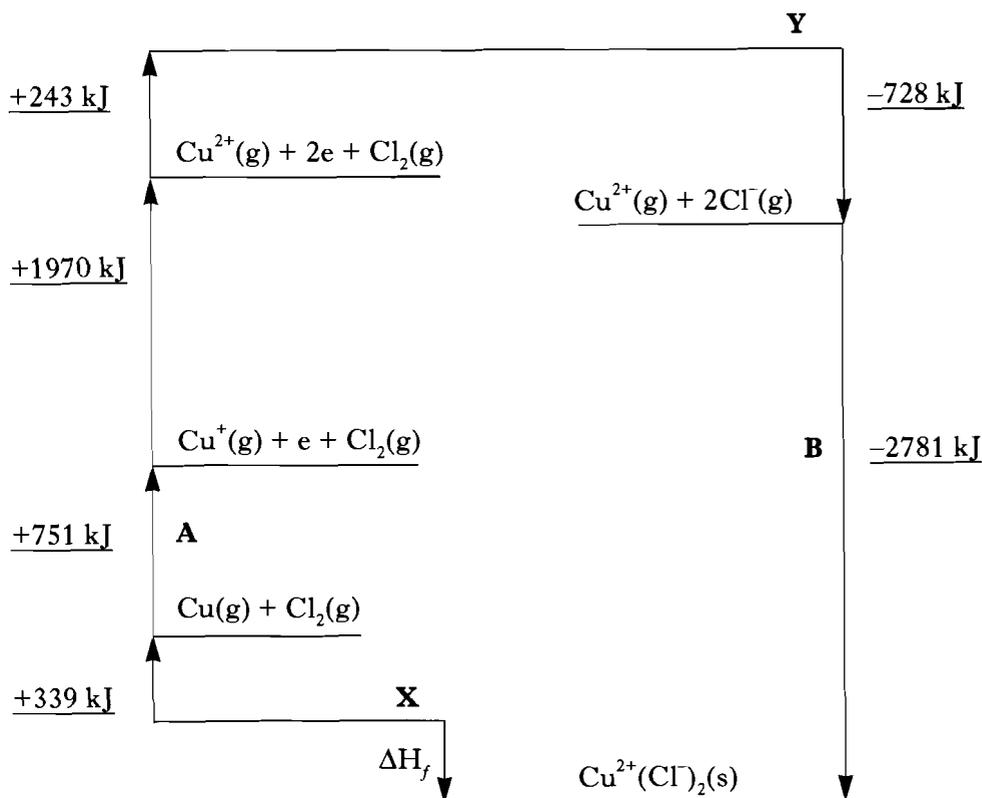
The above energy diagram, which is not drawn to scale, could be used to calculate the enthalpy of formation (ΔH_f) of copper(II) chloride.

(a) Name the enthalpy changes **A** and **B**.

    A

    B

(b) On the lines marked **X** and **Y**, write the appropriate symbols and formulae.

2

(c) Calculate the enthalpy of formation of copper(II) chloride.

2

1
(5)

Marks

9. The apparatus below was used by a pupil to find the enthalpies of combustion of alcohols.
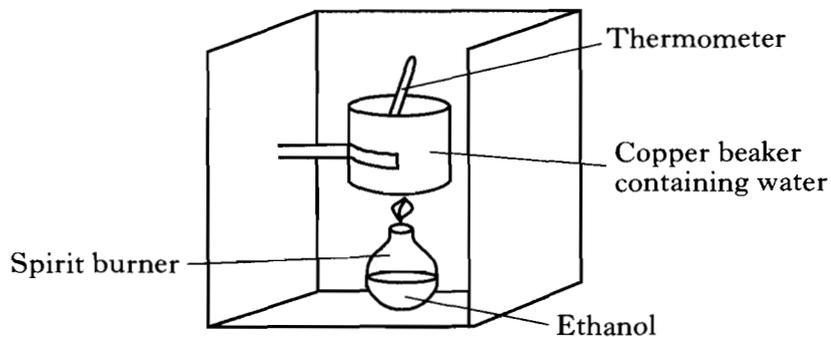
(a) Write down the measurements the pupil should make.

2

(b) Suggest why the values found by this experiment are likely to be less than the theoretical values given in the data booklet.

1

(3)

[Turn over

10. About 2½ million tonnes of sulphuric acid are produced each year in the UK.

(a) Sulphuric acid can be prepared in industry by the Chamber Process. The following chemical reactions are involved.

Sulphur is burned to produce sulphur dioxide.

Sulphur dioxide reacts with water to provide 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.

to show the name of a chemical   to show a reaction

Sulphuric
acid

2
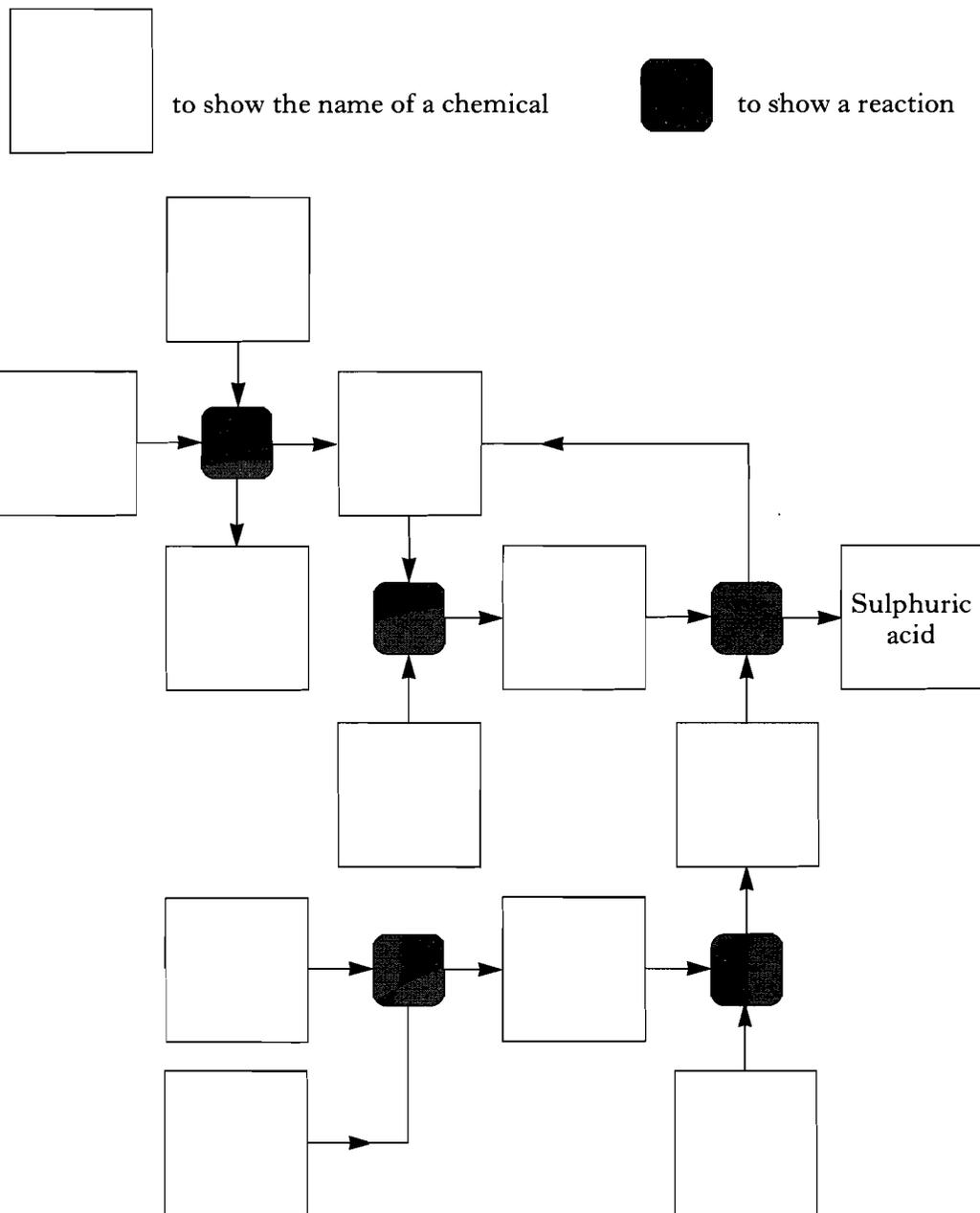
10. (continued)

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

        (i)   Write the formula for each of the two potassium salts which can be obtained from sulphuric acid.

        (ii)   Why does ammonium sulphate dissolve in water to form an acidic solution?

1
(5)

[Turn over

/338]

Page thirteen

11.

PERIODIC TABLE OF THE ELEMENTS

Some Periodic Tables show hydrogen at the top of Group 1 and/or Group 7.

(a) Suggest why some chemists think it appropriate to place hydrogen

    (i) at the top of Group 1,

                                                                 1

    (ii) at the top of Group 7.

                                                                 1

(b) The covalent radii of the Group 1 elements are shown below.

Element	Covalent radius/pm
Li	123
Na	157
K	203
Rb	216
Cs	235

Explain this trend.

                                                                  2

11. (continued)

(c)

Heating mantle

Tube packed
with silicon
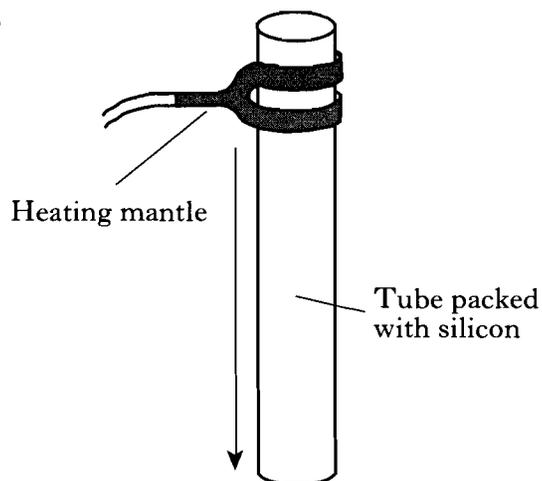
Ultra pure silicon for silicon chips
is obtained by zone refining. This
process involves passing a heating
coil down a tube packed with
silicon which is already fairly
pure.

The coil melts a small region of
the contents of the tube.

(i) State the type of bonding which exists in silicon.

1

(ii) Suggest why, after zone refining, the bottom of the bar is cut off and
discarded.

1

(iii) Why can the tube **not** be made of copper?

You may wish to refer to page 4 of the data booklet.

1

(d) Diamond and graphite are both forms of carbon. Industrial diamonds are
used in drill bits whereas graphite is used in lubricants.

Draw diagrams to show the difference in the structures of diamond and
graphite.

2

(9)

One of the most important feedstocks in the petrochemical industry is ethene.
The following flow-chart gives some uses of ethene.
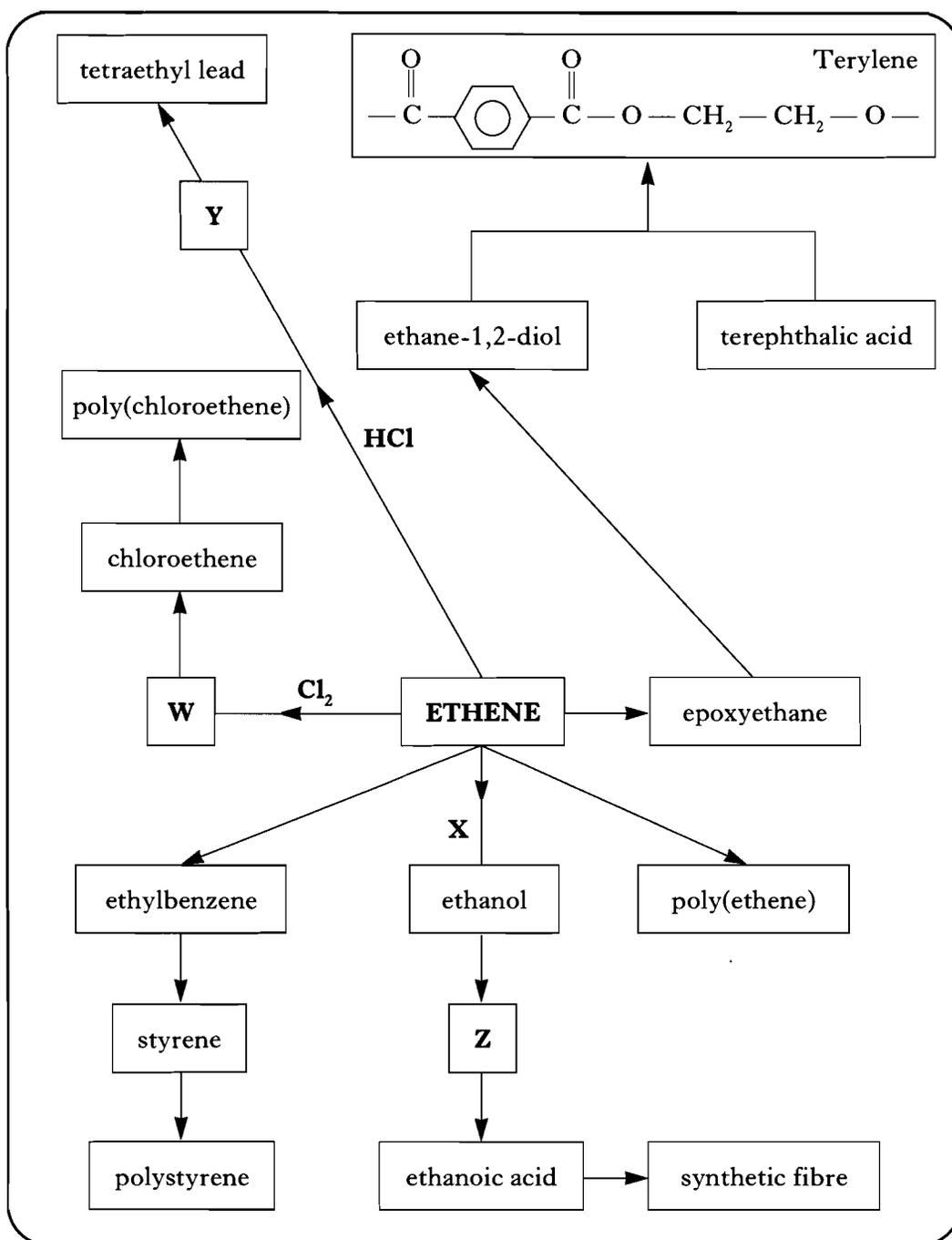
12. (continued)

(a) What is meant by a feedstock?

1

(b) State **one** way in which ethene is formed in the petrochemical industry.

1

(c) Name the kind of polymerisation which takes place in the formation of poly(ethene), poly(chloroethene) and polystyrene.

1

(d) Name product **W**.

1

(e) Name reactant **X**.

1

(f) Draw the **full** structural formulae for compounds **Y** and **Z**.

Y   **Z**

2

Marks

12. (continued)

(*g*)   Draw the **full** structural formula for terephthalic acid.

1

(*h*)   Styrene has the following structure:

$$CH=CH_2$$
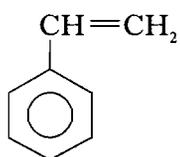
(i)   Give the systematic name for styrene.

You may wish to use page 6 of the data booklet.

1

(ii)   Draw the part of the polystyrene chain which is formed by **three** monomer units linking together.

1
(10)

Marks

13. A mixture of hydrogen and chlorine gases reacts explosively when exposed to ultraviolet light. The reaction involves very reactive chlorine atoms (Cl) and hydrogen atoms (H).

Step 1 $Cl_2 \longrightarrow 2Cl$

Step 2 $Cl + H_2 \longrightarrow HCl + H$

Step 3 $H + Cl_2 \longrightarrow HCl + Cl$
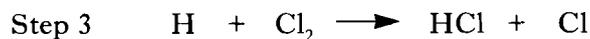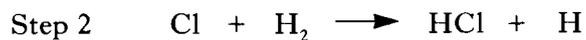
(*a*) A pupil made the following statement about the reaction:

"Since light energy speeds up the reaction it is acting as a catalyst".

Explain whether or not you agree with this statement.

1

(*b*) Suggest why Step 1 is speeded up when the mixture of gases is exposed to ultraviolet light.

1

(*c*) Using the bond enthalpies on page 11 of the data booklet, calculate the total enthalpy change for Step 2.

Show your working clearly.

2

(4)

14. A group of pupils used the following method to calculate the mass of iodine in a sample of seaweed.

Step 1   The organic material, which is combustible, is removed to leave a mineral ash.

Step 2   The ash is boiled in water and the mixture filtered. The filtrate is then treated with an excess of acidified hydrogen peroxide solution to oxidise the iodide ions.

$$2H^+ \quad + \quad H_2O_2 \quad + \quad 2I^- \quad \longrightarrow \quad I_2 \quad + \quad 2H_2O$$

Step 3   The liberated iodine is removed by dissolving it in hexane.

Step 4   The liberated iodine is titrated against standard sodium thiosulphate solution.

$$2S_2O_3^{2-} \quad + \quad I_2 \quad \longrightarrow \quad S_4O_6^{2-} \quad + \quad 2I^-$$

$\quad$ (colourless) $\quad$ (yellow/brown) $\quad$ (colourless) $\quad$ (colourless)
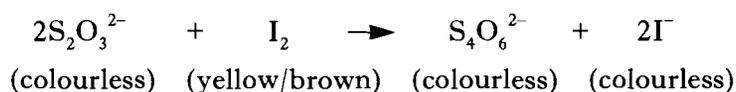
The end-point can be detected by the loss of colour in the reaction mixture.

(*a*) Suggest how the organic material could have been removed in Step 1.

1

(*b*) Write the ion-electron equation for the reduction reaction in Step 2.

1

(*c*) Why is hexane a more suitable solvent than water in Step 3?

1

Marks

14. (continued)

(*d*) Suggest another way of detecting the end-point in step 4.

1

(*e*) The following table of results was obtained:

Rough titre	= 25·60 cm^3
1st	= 25·20 cm^3
2nd	= 25·30 cm^3

State the volume of thiosulphate solution that should be used in the calculation.

1

(*f*) The total volume of the solution of iodine in hexane was 110 cm^3.

In each titration with thiosulphate solution, the volume of iodine solution used was 20 cm^3. The concentration of thiosulphate solution used in the experiment was 0·01 mol l^{-1}.

Using your answer to (*e*), calculate the mass of iodine extracted from the sample of seaweed.

Show your working clearly.

3

(8)

[Turn over

Marks

15. A temperature sensor linked to a computer was used to measure the temperature change when 50·0 cm^3 of sodium hydroxide solution, concentration 1 mol l^{-1}, was neutralised. Two different acids were used.

The following graphs were produced.
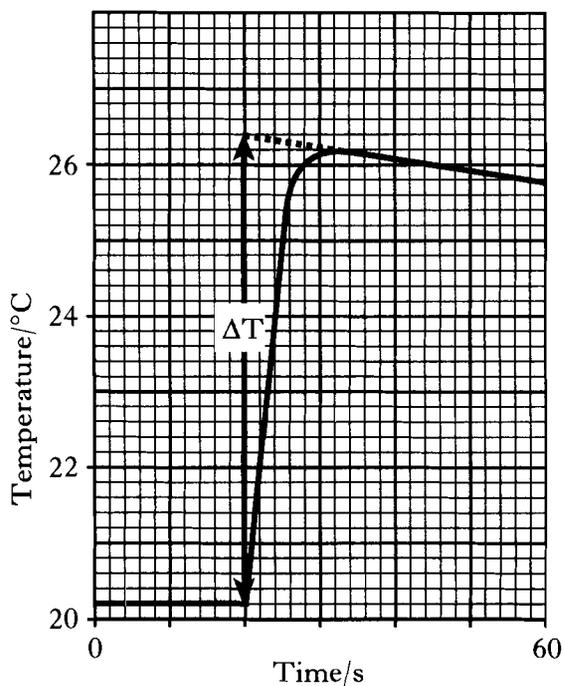
Addition of 50·0 cm^3
hydrochloric acid,
concentration 1 mol l^{-1}

Experiment 1
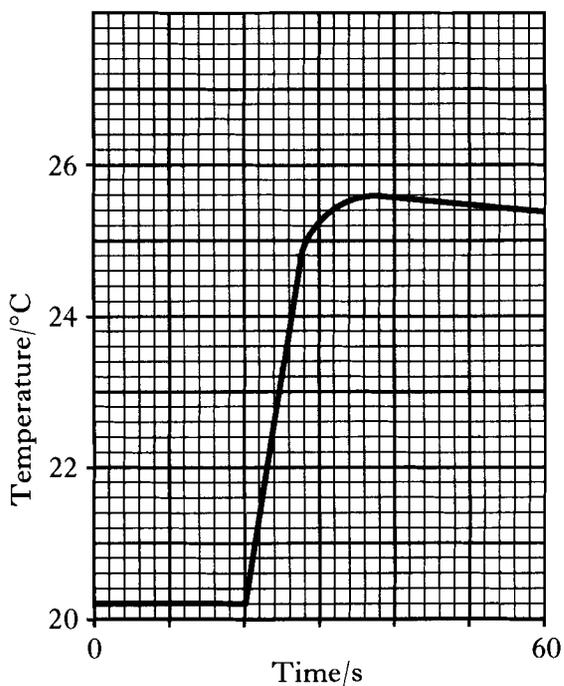
Addition of 50·0 cm^3
ethanoic acid,
concentration 1 mol l^{-1}

Experiment 2

(*a*) Suggest why there was a delay between the start of recording the temperature and adding the acid.

1

(*b*) Why is a smaller temperature rise observed in Experiment 2?

1

15. (continued)

(c)   Use the temperature difference from the graph and information from page 7
of the data booklet to calculate the enthalpy of neutralisation for the reaction
of sodium hydroxide solution with hydrochloric acid.

Show your working clearly.

3
(5)

[Turn over

16. A jet of water from a burette is deflected when a charged rod is held close to it.
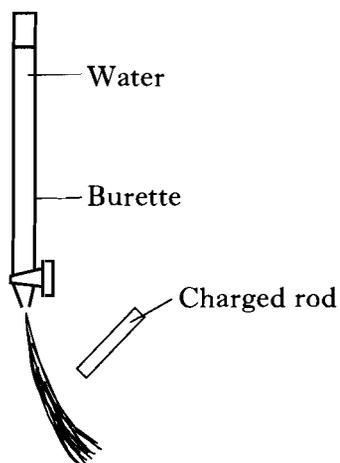
Other liquids can be tested in a similar way.

RESULTS

Group **A**	Group **B**
water propanone ethanol trichloromethane	cyclohexane benzene pentane

(*a*) Why are the liquids in group **A** deflected but those in group **B** are not?

<div style="text-align: right">1</div>

(*b*) Explain what would happen with a jet of tetrachloromethane.

<div style="text-align: right">1
(2)</div>

17. Sodium hydroxide is a strong alkali. A solution of sodium hydroxide, concentration $1 \text{ mol } l^{-1}$, has a pH of 14.

(*a*) Describe how to prepare a series of solutions which could be used to show the relationship between the pH of a sodium hydroxide solution and the concentration of the hydroxide ions.

3

(*b*) State the concentration of $H^+(aq)$ ions in a sodium hydroxide solution with a pH of 10.

1

(*c*) Calculate the concentration of $H^+(aq)$ ions in a solution of sodium hydroxide, concentration $0.001 \text{ mol } l^{-1}$ ($1 \times 10^{-3} \text{ mol } l^{-1}$).

1
(5)

[Turn over

18. Complex ions are formed when molecules or ions join to a central metal ion by means of co-ordinate bonds.

The molecules or ions joining the central metal ion are called ligands and the total number of bonds being made to the central ion is known as the co-ordination number.

The charge of the complex ion is the combined charges of the central ion and the ligands.

(a) Complete the table below.

Central metal ion	Ligand	Co-ordination number	Structure of complex ion	Charge of complex ion
Al^{3+}	F^-		F—Al—F (with F groups, octahedral)	3−
	NH_3	4	H_3N—Cu—NH_3 (with NH_3 groups)	2+
Fe^{2+}	CN^-	6	NC—Fe—CN (with CN groups, octahedral)	
Co^{2+}		6	CH_2—CH_2 with NH_2 groups chelating Co	2+

2
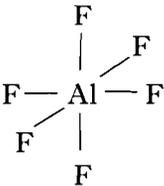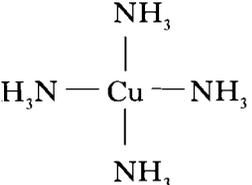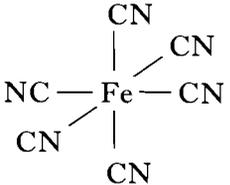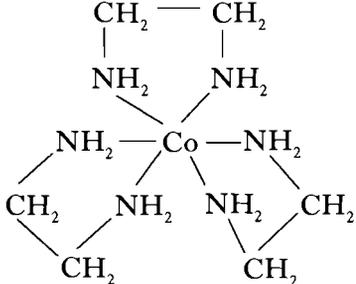
18. (continued)

   (*b*) A coloured complex ion is formed when solutions of nickel(II) sulphate react with solutions of ammonia.

      The colour is most intense when the concentration of complex ions is greatest.

      The graph below shows the colour intensity when different volumes of equimolar nickel(II) sulphate and ammonia react.
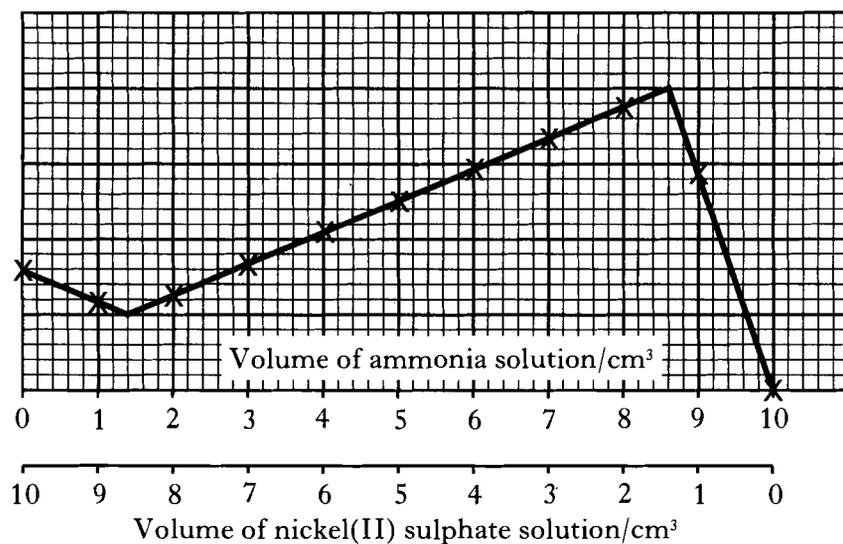
      (i) Describe how a pupil could have carried out this experiment.

             1

      (ii) What ratio of ammonia to nickel(II) sulphate gives the highest colour intensity?

             1
            (4)

[END OF QUESTION PAPER]   **[Turn over**