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Total Section B

# X012/301

NATIONAL QUALIFICATIONS 2007

TUESDAY, 29 MAY 9.00 AM – 11.30 AM

# CHEMISTRY HIGHER

**Fill in these boxes and read what is printed below.**

Full name of centre

Town

Forename(s)

Surname

Date of birth
Day Month Year

Scottish candidate number

Number of seat

Reference may be made to the Chemistry Higher and Advanced Higher Data Booklet.

**SECTION A—Questions 1–40 (40 marks)**

Instructions for completion of **Section A** are given on page two.

For this section of the examination you must use an **HB pencil**.

**SECTION B (60 marks)**

1 All questions should be attempted.

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

3 Rough work, if any should be necessary, should be written in this book and then scored through when the fair copy has been written. If further space is required, a supplementary sheet for rough work may be obtained from the invigilator.

4 Additional space for answers 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 book.

5 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. If you do not, you may lose all the marks for this paper.

SA X012/301 6/16370

## SECTION A

**Read carefully**

1 Check that the answer sheet provided is for **Chemistry Higher (Section A)**.

2 For this section of the examination you must use an **HB pencil** and, where necessary, an eraser.

3 Check that the answer sheet you have been given has **your name**, **date of birth**, **SCN** (Scottish Candidate Number) and **Centre Name** printed on it.

Do not change any of these details.

4 If any of this information is wrong, tell the Invigilator immediately.

5 If this information is correct, **print** your name and seat number in the boxes provided.

6 The answer to each question is **either** A, B, C or D. Decide what your answer is, then, using your pencil, put a horizontal line in the space provided (see sample question below).

7 There is **only one correct** answer to each question.

8 Any rough working should be done on the question paper or the rough working sheet, **not** on your answer sheet.

9 At the end of the exam, put the **answer sheet for Section A inside the front cover of your answer book**.

**Sample Question**

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

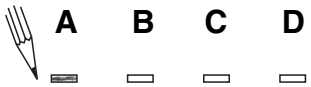
A chromatography

B fractional distillation

C fractional crystallisation

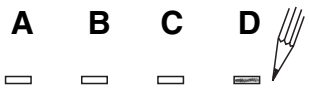
D filtration.

The correct answer is **A—**chromatography. The answer **A** has been clearly marked in **pencil** with a horizontal line (see below).




**Changing an answer**

If you decide to change your answer, carefully erase your first answer and using your pencil, fill in the answer you want. The answer below has been changed to **D**.



**1.** Which of the following compounds contains **both** a halide ion and a transition metal ion?

A Iron oxide

B Silver bromide

C Potassium permanganate

D Copper iodate

**2.** Which of the following substances is a non-conductor but becomes a good conductor on melting?

A Solid potassium fluoride

B Solid argon

C Solid potassium

D Solid tetrachloromethane

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

Which of the following compounds contains ions which are isoelectronic?

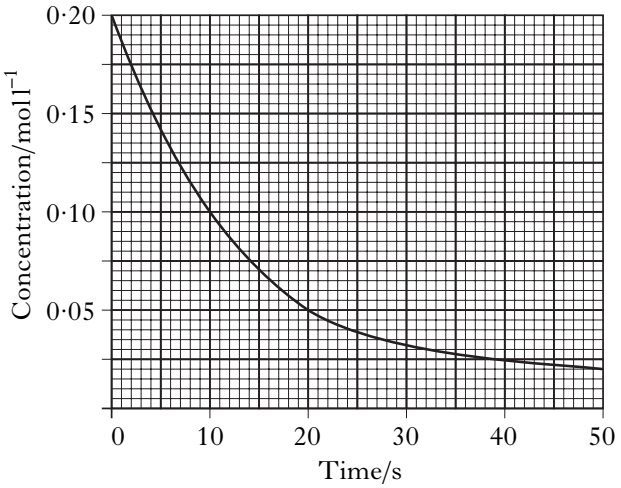
A $Na_2S$

B $MgCl_2$

C KBr

D $CaCl_2$

**4.** 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?

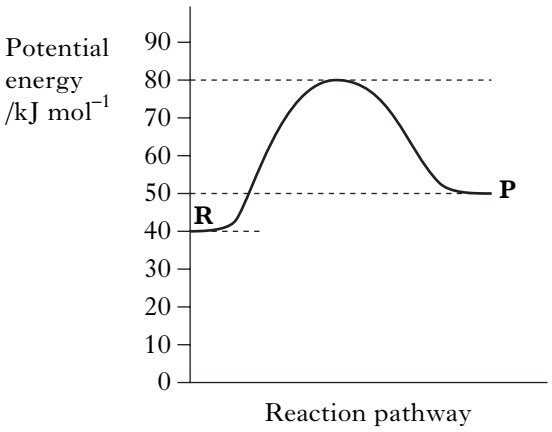
A $0{\cdot}0025\ mol\,l^{-1}\,s^{-1}$

B $0{\cdot}0050\ mol\,l^{-1}\,s^{-1}$

C $0{\cdot}0075\ mol\,l^{-1}\,s^{-1}$

D $0{\cdot}0150\ mol\,l^{-1}\,s^{-1}$

**5.** The potential energy diagram below refers to the reversible reaction involving reactants **R** and products **P**.




What is the enthalpy change, in kJ $mol^{-1}$, for the reverse reaction $\mathbf{P} \rightarrow \mathbf{R}$?

A + 30

B + 10

C – 10

D – 40

**6.** The enthalpy of neutralisation in an acid/alkali reaction is **always** the energy released in

A the formation of one mole of salt

B the formation of one mole of water

C the neutralisation of one mole of acid

D the neutralisation of one mole of alkali.

**7.** 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 $X(g) \rightarrow X^+(g)$

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

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

A $BeCl_2$

B $CaCl_2$

C LiCl

D CsCl

**[Turn over**

**9.** Which of the following chlorides is most likely to be soluble in tetrachloromethane, $CCl_4$?

A Barium chloride

B Caesium chloride

C Calcium chloride

D Phosphorus chloride

**10.** Which of the following compounds exists as discrete molecules?

A Sulphur dioxide

B Silicon dioxide

C Aluminium oxide

D Iron(II) oxide

**11.** An element (melting point above 3000 °C) forms an oxide which is a gas at room temperature.

Which type of bonding is likely to be present in the element?

A Metallic

B Polar covalent

C Non-polar covalent

D Ionic

**12.** Which of the following compounds has polar molecules?

A $CO_2$

B $NH_3$

C $CCl_4$

D $CH_4$

**13.** How many moles of oxygen atoms are in 0·5 mol of carbon dioxide?

A 0·25

B 0·5

C 1

D 2

**14.** A fullerene molecule consists of 60 carbon atoms.

Approximately how many such molecules are present in 12 g of this type of carbon?

A $1{\cdot}0 \times 10^{22}$

B $1{\cdot}2 \times 10^{23}$

C $6{\cdot}0 \times 10^{23}$

D $3{\cdot}6 \times 10^{25}$

**15.** Avogadro's Constant is the same as the number of

A molecules in 16·0 g of oxygen

B atoms in 20·2 g of neon

C formula units in 20·0 g of sodium hydroxide

D ions in 58·5 g of sodium chloride.

**16.** The equation for the complete combustion of propane is:

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

30 $cm^3$ of propane is mixed with 200 $cm^3$ 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 90 $cm^3$

B 120 $cm^3$

C 140 $cm^3$

D 210 $cm^3$

**17.** A mixture of carbon monoxide and hydrogen can be converted into water and a mixture of hydrocarbons.

$$nCO + (2n + 1)H_2 \rightarrow nH_2O + \text{hydrocarbons}$$

What is the general formula for the hydrocarbons produced?

A $C_nH_{2n-2}$

B $C_nH_{2n}$

C $C_nH_{2n+1}$

D $C_nH_{2n+2}$

**18.** Chemical processes are used to produce a petrol that burns more efficiently.

Which of the following types of hydrocarbon does **not** improve the burning efficiency of petrol?

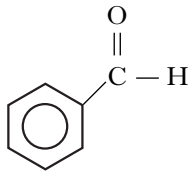
A straight-chain alkanes

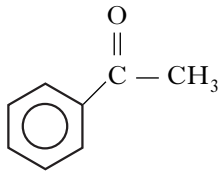
B branched-chain alkanes

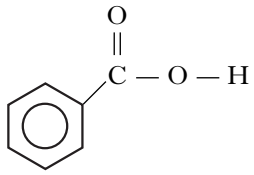
C cycloalkanes

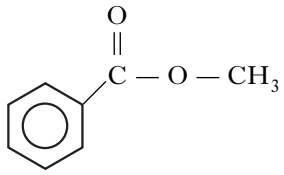
D aromatics

**19.** Which of the following is an aldehyde?

A 

B 

C 

D 

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

Which of the following alkanols 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

**21.** Which of the following reactions can be classified as reduction?

A $CH_3CH_2OH \rightarrow CH_3COOH$

B $CH_3CH(OH)CH_3 \rightarrow CH_3COCH_3$

C $CH_3CH_2COCH_3 \rightarrow CH_3CH_2CH(OH)CH_3$

D $CH_3CH_2CHO \rightarrow CH_3CH_2COOH$

**22.** Which of the following compounds would react with sodium hydroxide solution to form a salt?

A $CH_3CHO$

B $CH_3COOH$

C $CH_3COCH_3$

D $CH_3CH_2OH$

**23.** The extensive use of which type of compound is thought to contribute significantly to the depletion of the ozone layer?

A Oxides of carbon

B Hydrocarbons

C Oxides of sulphur

D Chlorofluorocarbons

**24.** Propene is used in the manufacture of addition polymers.

What type of reaction is used to produce propene from propane.

A Addition

B Cracking

C Hydrogenation

D Oxidation

**25.** Cured polyester resins

A are used as textile fibres

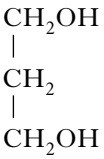
B are long chain molecules

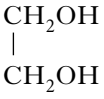
C are formed by addition polymerisation

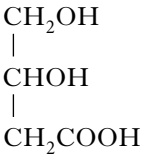
D have a three-dimensional structure with cross linking.

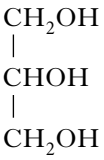
**[Turn over**

**26.** What is the structural formula for glycerol?

A


B


C


D


**27.** The monomer units used to construct enzyme molecules are

A alcohols

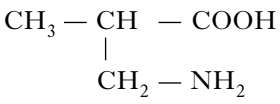
B esters

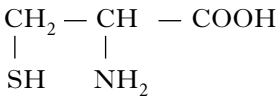
C amino acids

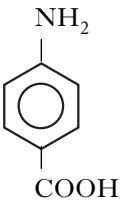
D fatty acids.

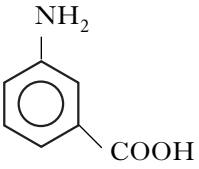
**28.** In α-amino acids the amino group is on the carbon atom adjacent to the acid group.

Which of the following is an α-amino acid?

A


B


C


D


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

A Benzene

B Water

C Iron ore

D Sodium chloride

**30.** $N_2(g) + 2O_2(g) \rightarrow 2NO_2(g) \quad \Delta H = +88\,kJ$
$N_2(g) + 2O_2(g) \rightarrow N_2O_4(g) \quad \Delta H = +10\,kJ$

The enthalpy change for the reaction

$$2NO_2(g) \rightarrow N_2O_4(g)$$

will be

A +98 kJ

B +78 kJ

C –78 kJ

D –98 kJ.

**31.** A catalyst is used in the Haber Process.

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

Which of the following best describes the action of the catalyst?

A Increases the rate of the forward reaction only

B Increases the rate of the reverse reaction only

C Increases the rate of both the forward and reverse reactions

D Changes the position of the equilibrium of the reaction

**32.** In which of the following systems will the equilibrium be **unaffected** by a change in pressure?

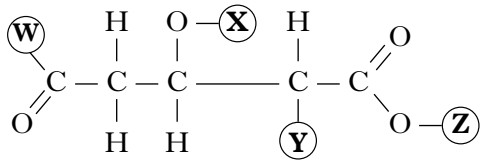
A $2NO_2(g) \rightleftharpoons N_2O_4(g)$

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

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

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

**33.** On the structure shown, four hydrogen atoms have been replaced by letters **W**, **X**, **Y** and **Z**.




Which letter corresponds to the hydrogen atom which can ionise most easily in aqueous solution?

A **W**

B **X**

C **Y**

D **Z**

**34.** The concentration of $OH^-(aq)$ ions in a solution is $0{\cdot}1\ mol\,l^{-1}$.

What is the pH of the solution?

A 1

B 8

C 13

D 14

**35.** A lemon juice is found to have a pH of 3 and an apple juice a pH of 5.

From this information, the concentrations of $H^+(aq)$ ions in the lemon juice and apple juice are in the proportion (ratio)

A 100 : 1

B 1 : 100

C 20 : 1

D 3 : 5.

**36.** Which line in the table is correct for $0{\cdot}1\ mol\,l^{-1}$ sodium hydroxide solution compared with $0{\cdot}1\ mol\,l^{-1}$ ammonia solution?

| | **pH** | **Conductivity** |
|---|---|---|
| A | higher | lower |
| B | higher | higher |
| C | lower | higher |
| D | lower | lower |

**37.** The iodate ion, $IO_3^-$, can be converted to iodine.

Which is the correct ion-electron equation for the reaction?

A $2IO_3^-(aq) + 12H^+(aq) + 12e^- \rightarrow 2I^-(aq) + 6H_2O(\ell)$

B $IO_3^-(aq) + 6H^+(aq) + 7e^- \rightarrow I^-(aq) + 3H_2O(\ell)$

C $2IO_3^-(aq) + 12H^+(aq) + 11e^- \rightarrow I_2(aq) + 6H_2O(\ell)$

D $2IO_3^-(aq) + 12H^+(aq) + 10e^- \rightarrow I_2(aq) + 6H_2O(\ell)$

**38.** Which of the following is a redox reaction?

A $Mg + 2HCl \rightarrow MgCl_2 + H_2$

B $MgO + 2HCl \rightarrow MgCl_2 + H_2O$

C $MgCO_3 + 2HCl \rightarrow MgCl_2 + H_2O + CO_2$

D $Mg(OH)_2 + 2HCl \rightarrow MgCl_2 + 2H_2O$

**39.** Strontium-90 is a radioisotope.

What is the neutron to proton ratio in an atom of this isotope?

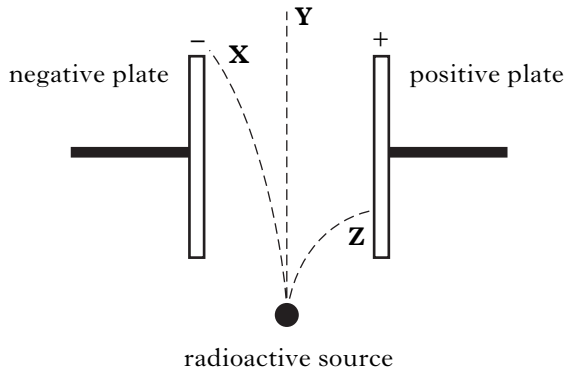
A 0·730

B 1·00

C 1·37

D 2·37

**40.** The diagram shows the paths of alpha, beta and gamma radiations as they pass through an electric field.




Which line in the table correctly identifies the types of radiation which follow paths **X**, **Y** and **Z**?

| | **Path X** | **Path Y** | **Path Z** |
|---|---|---|---|
| A | gamma | beta | alpha |
| B | beta | gamma | alpha |
| C | beta | alpha | gamma |
| D | alpha | gamma | beta |

**Candidates are reminded that the answer sheet MUST be returned INSIDE the front cover of this answer book.**

*Marks*

## SECTION B

**All answers must be written clearly and legibly in ink.**

**1.** (*a*) Atoms of different elements have different attractions for bonded electrons.
What term is used as a measure of the attraction an atom involved in a bond has for the electrons of the bond?

**1**

(*b*) Atoms of different elements are different sizes.
What is the trend in atomic size across the period from sodium to argon?

**1**

(*c*) Atoms of different elements have different ionisation energies.
**Explain clearly** why the first ionisation energy of potassium is less than the first ionisation energy of sodium.

**2**

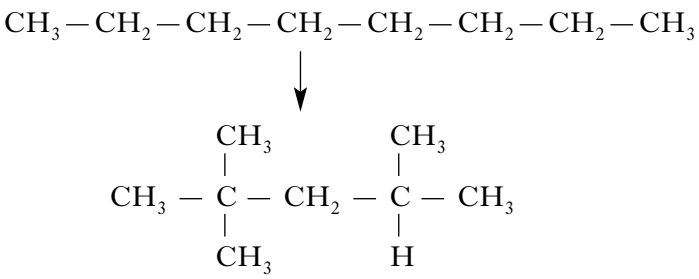
**(4)**

**[Turn over**

*Marks*

**2.** Carbon compounds take part in a wide variety of chemical reactions.

(*a*)



Name this type of chemical reaction.

**1**

(*b*) $C_3H_6O \xrightarrow{\text{oxidation}}$ propanoic acid

Draw a structural formula for $C_3H_6O$.

**1**

(*c*) Kevlar is an aromatic polyamide made by condensation polymerisation.
Give **one** use for Kevlar.

**1**

**(3)**

*Marks*

**3.** Tritium, $^{3}_{1}H$, is an isotope of hydrogen. It is formed in the upper atmosphere when neutrons from cosmic rays are captured by nitrogen atoms.

$$^{14}_{7}N + {}^{1}_{0}n \rightarrow {}^{12}_{6}C + {}^{3}_{1}H$$

Tritium atoms then decay by beta-emission.

$$^{3}_{1}H \rightarrow \quad + \quad$$

(*a*) Complete the nuclear equation above for the beta-decay of tritium atoms. **1**

(*b*) In the upper atmosphere, tritium atoms are present in some water molecules. Over the years, the concentration of tritium atoms in rain has remained fairly constant.

(i) Why does the concentration of tritium in rain remain fairly constant?

**1**

(ii) The concentration of tritium atoms in fallen rainwater is found to decrease over time. The age of any product made with water can be estimated by measuring the concentration of tritium atoms.

In a bottle of wine, the concentration of tritium atoms was found to be $\frac{1}{8}$ of the concentration found in rain.

Given that the half-life of tritium is 12·3 years, how old is the wine?

**1**

**(3)**

**[Turn over**

*Marks*

**4.** Hydrogen gas is widely regarded as a very valuable fuel for the future.

(*a*) Hydrogen can be produced from methane by steam reforming. The process proceeds in two steps.

Step 1: $CH_4(g) + H_2O(g) \rightarrow CO(g) + 3H_2(g)$

Step 2: $CO(g) + H_2O(g) \rightarrow CO_2(g) + H_2(g)$

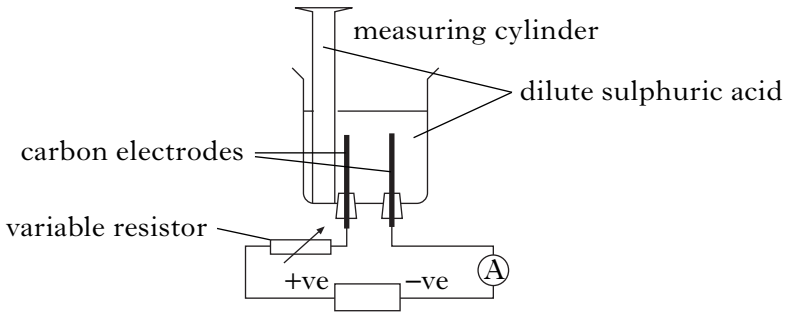
(i) What name is given to the gas mixture produced in step 1?

**1**

(ii) Using this process, how many moles of hydrogen gas can be produced overall from one mole of methane?

**1**

(*b*) Hydrogen can be produced in the lab from dilute sulphuric acid. The apparatus shown below can be used to investigate the quantity of electrical charge required to form one mole of hydrogen gas.




(i) Above which electrode should the measuring cylinder be placed to collect the hydrogen gas?

**1**

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

**1**

**(4)**

*Marks*

**5.** The energy changes taking place during chemical reactions have many everyday uses.

(*a*) Some portable cold packs make use of the temperature drop that takes place when the chemicals in the pack dissolve in water.

Name the type of reaction that results in a fall in temperature.

**1**

(*b*) Flameless heaters are used by mountain climbers to heat food and drinks. The chemical reaction in a flameless heater releases 45 kJ of energy.

If 200 g of water is heated using this heater, calculate the rise in temperature of the water, in °C.

**1**

**(2)**

**[Turn over**

*Marks*

**6.** Temperature has a very significant effect on the rate of a chemical reaction.

(*a*) The reaction shown below can be used to investigate the effect of temperature on reaction rate.

$5(COOH)_2(aq) + 6H^+(aq) + 2MnO_4^-(aq) \rightarrow 2Mn^{2+}(aq) + 10CO_2(g) + 8H_2O(\ell)$

The instructions for such an investigation are shown below.

**Procedure**

1. Using syringes, add 5 $cm^3$ of sulphuric acid, 2 $cm^3$ of potassium permanganate solution and 40 $cm^3$ of water to a 100 $cm^3$ dry glass beaker.
2. Heat the mixture to about 40 °C.
3. Place the beaker on a white tile and measure 1 $cm^3$ of oxalic acid solution into a syringe.
4. Add the oxalic acid to the mixture in the beaker as quickly as possible and at the same time start the timer.
5. Gently stir the reaction mixture with the thermometer.
6. When the reaction is over, stop the timer and record the time. Measure and record the temperature of the reaction mixture.
7. Repeat the experiment three times but heat the initial sulphuric acid/potassium permanganate/water mixtures first to 50 °C, then to 60 °C and finally to 70 °C.

(i) What colour change indicates that the reaction is over?

**1**

(ii) With each of the experiments, the temperature of the solution was measured both during heating and at the end of the reaction.

When plotting graphs of the reaction rate against temperature, it is the temperature measured at the end of reaction, rather than the temperature measured while heating, that is used.

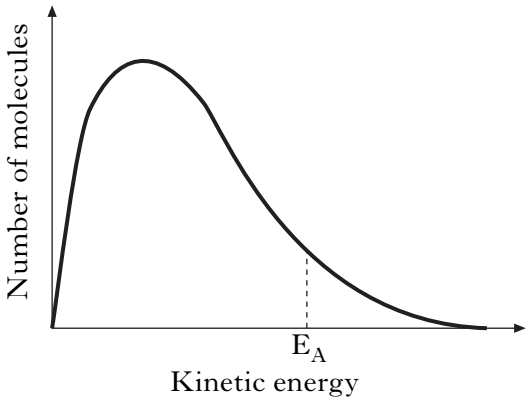
Give a reason for this.

**1**

*Marks*

**6. (continued)**

(*b*) The graph shows the distribution of kinetic energy for molecules in a reaction mixture at a given temperature.




Why does a small increase in temperature produce a large increase in reaction rate?

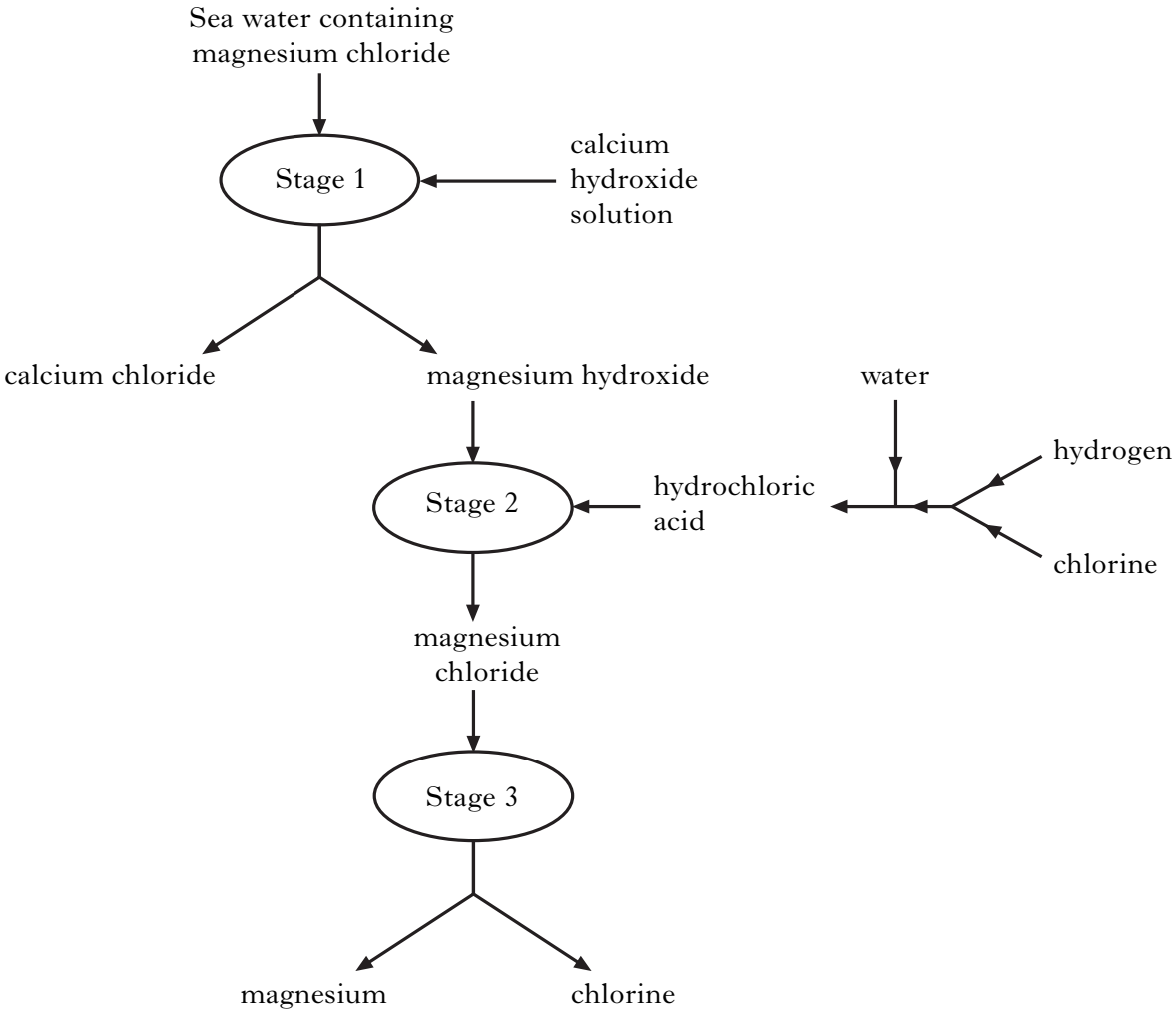
**1**

**(3)**

**[Turn over**

*Marks*

**7.** Magnesium metal can be extracted from sea water.
An outline of the reactions involved is shown in the flow diagram.




(*a*) Why can the magnesium hydroxide be easily separated from the calcium chloride at Stage 1?

**1**

(*b*) Name the type of chemical reaction taking place at Stage 2.

**1**

*Marks*

**7. (continued)**

(*c*) Give **two** different features of this process that make it economical.

**2**

(*d*) At Stage 3, electrolysis of molten magnesium chloride takes place.

If a current of 200 000 A is used, calculate the mass of magnesium, in kg, produced in 1 minute.

**Show your working clearly.**

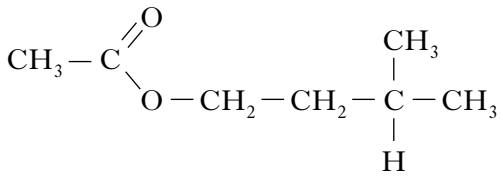
**3**

**(7)**

**[Turn over**

*Marks*

**8.** One of the chemicals released in a bee sting is an ester that has the structure shown.

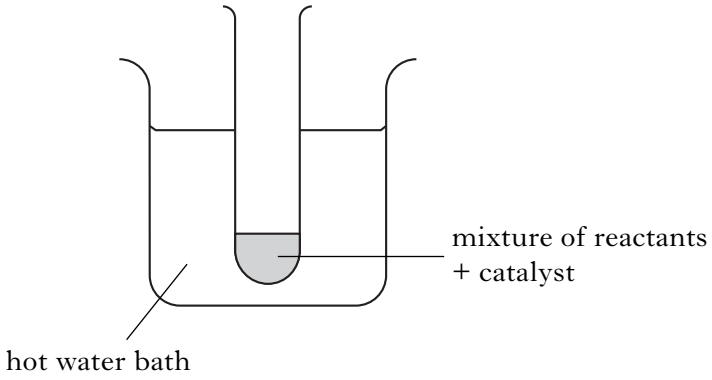


This ester can be produced by the reaction of an alcohol with an alkanoic acid.

(*a*) Name this acid.

**1**

(*b*) The ester can be prepared in the lab by heating a mixture of the reactants with a catalyst.




(i) Name the catalyst used in the reaction.

**1**

(ii) What improvement could be made to the experimental set-up shown in the diagram?

**1**

*Marks*

**8. (continued)**

(*c*) If there is a 65% yield, calculate the mass of ester produced, in grams, when 4·0 g of the alcohol reacts with a slight excess of the acid.

(Mass of one mole of the alcohol = 88 g;
mass of one mole of the ester = 130 g)

**Show your working clearly.**

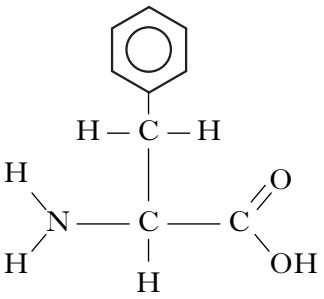
**2**

**(5)**

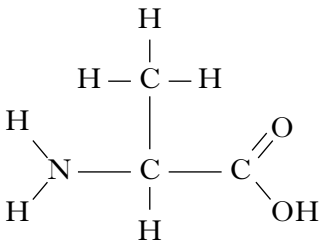
**[Turn over**

*Marks*

**9.** Phenylalanine and alanine are both amino acids.



phenylalanine



alanine

(*a*) Phenylalanine is an essential amino acid.

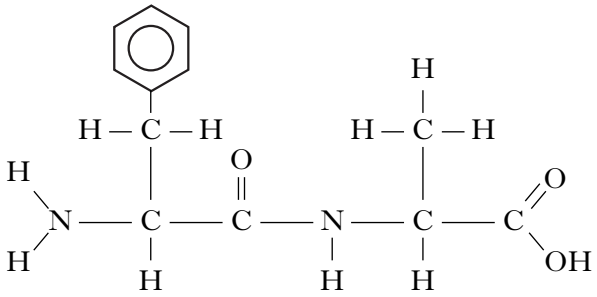
(i) What is meant by an essential amino acid?

**1**

(ii) How many hydrogen atoms are present in a molecule of phenylalanine?

**1**

(*b*) Phenylalanine and alanine can react to form the dipeptide shown.



Circle the peptide link in this molecule. **1**

(*c*) Draw a structural formula for the other dipeptide that can be formed from phenylalanine and alanine.

**1**

**(4)**

*Marks*

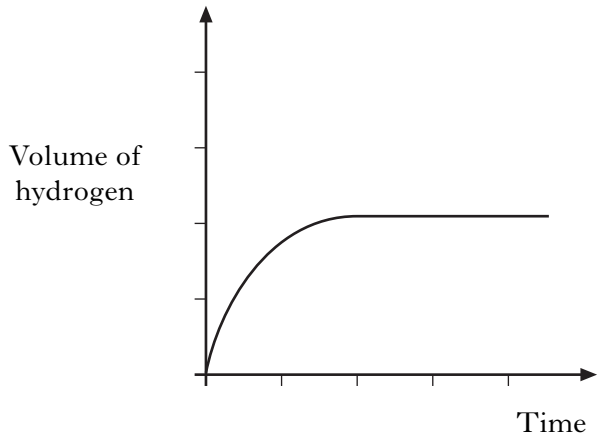
**10.** A student carried out three experiments involving the reaction of excess magnesium ribbon with dilute acids. The rate of hydrogen production was measured in each of the three experiments.

| Experiment | Acid |
|---|---|
| 1 | 100 $cm^3$ of 0·10 $mol\,l^{-1}$ sulphuric acid |
| 2 | 50 $cm^3$ of 0·20 $mol\,l^{-1}$ sulphuric acid |
| 3 | 100 $cm^3$ of 0·10 $mol\,l^{-1}$ hydrochloric acid |

The equation for **Experiment 1** is shown.

$$Mg(s) + H_2SO_4(aq) \rightarrow MgSO_4(aq) + H_2(g)$$

(*a*) The curve obtained for **Experiment 1** is drawn on the graph.




Draw curves on the graph to show the results obtained for **Experiment 2** and **Experiment 3**.

Label each curve clearly.

(An additional graph, if required, can be found on *Page thirty*.) **2**

(*b*) The mass of magnesium used in **Experiment 1** was 0·50 g.

For this experiment, calculate the mass of magnesium, in grams, left unreacted.

**2**

**(4)**

*Marks*

**11.** Nitrogen dioxide gas can be prepared in different ways.

(*a*) It is manufactured industrially as part of the Ostwald process. In the first stage of the process, nitrogen monoxide is produced by passing ammonia and oxygen over a platinum catalyst.

$$NH_3(g) + O_2(g) \rightarrow NO(g) + H_2O(g)$$

(i) Balance the above equation. **1**

(ii) Platinum metal is a heterogeneous catalyst for this reaction.
What is meant by a **heterogeneous** catalyst?

**1**

(iii) The nitrogen monoxide then combines with oxygen in an exothermic reaction to form nitrogen dioxide.

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

What happens to the yield of nitrogen dioxide gas if the reaction mixture is cooled?

**1**

(*b*) In the lab, nitrogen dioxide gas can be prepared by heating copper(II) nitrate.

$$Cu(NO_3)_2(s) \rightarrow CuO(s) + 2NO_2(g) + \tfrac{1}{2}O_2(g)$$

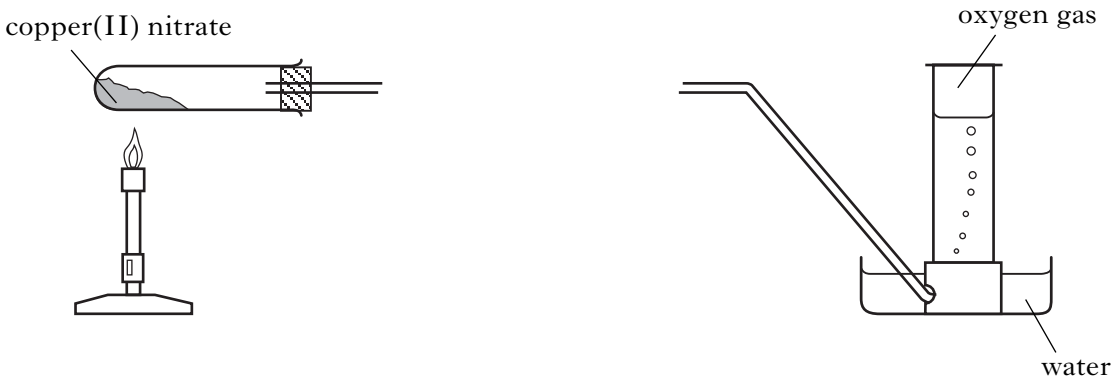
(i) Calculate the volume of nitrogen dioxide gas produced when 2·0 g of copper(II) nitrate is completely decomposed on heating.
(Take the molar volume of nitrogen dioxide to be 24 litres $mol^{-1}$.)
**Show your working clearly.**

**2**

*Marks*

**11. (*b*) (continued)**

(ii) Nitrogen dioxide has a boiling point of 22 °C.
Complete the diagram to show how nitrogen dioxide can be separated and collected.




**1**

**(6)**

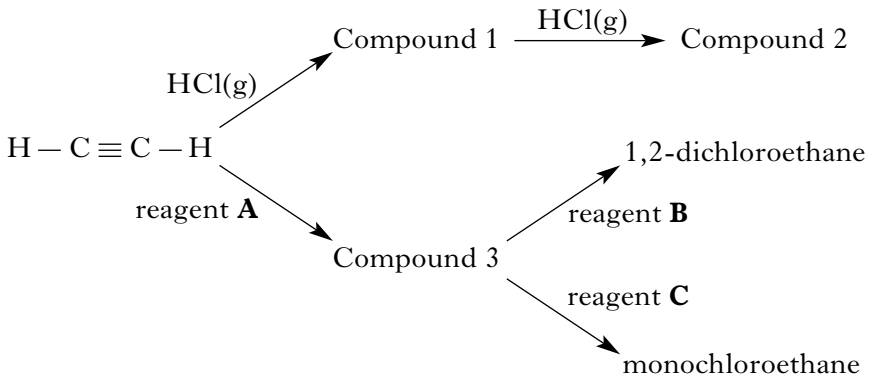
**[Turn over**

DO NOT WRITE IN THIS MARGIN

*Marks*

**12.** Ethyne is the first member of the homologous series called the alkynes.

(*a*) Ethyne can undergo addition reactions as shown in the flow diagram.




(i) Compound 2 is an isomer of 1,2-dichloroethane.
Draw a structural formula for compound 2.

**1**

(ii) Reagents **A**, **B** and **C** are three **different** diatomic gases.
Using information in the flow diagram, identify reagents **A**, **B** and **C**.

| **Reagent** | **Gas** |
|---|---|
| **A** | |
| **B** | |
| **C** | |

**1**

*Marks*

**12. (continued)**

(*b*) The equation for the enthalpy of formation of ethyne is:

$$2C(s) + H_2(g) \rightarrow C_2H_2(g)$$

Use the enthalpies of combustion of carbon, hydrogen and ethyne given in the data booklet to calculate the enthalpy of formation of ethyne, in kJ $mol^{-1}$.

**Show your working clearly.**

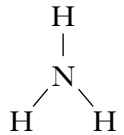
**2**

**(4)**

**[Turn over**

*Marks*

**13.** Compared to other gases made up of molecules of similar molecular masses, ammonia has a relatively high boiling point.



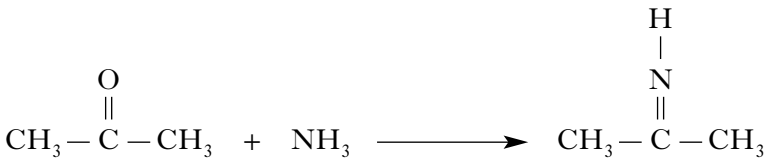
ammonia

(*a*) In terms of the intermolecular bonding present, **explain clearly** why ammonia has a relatively high boiling point.

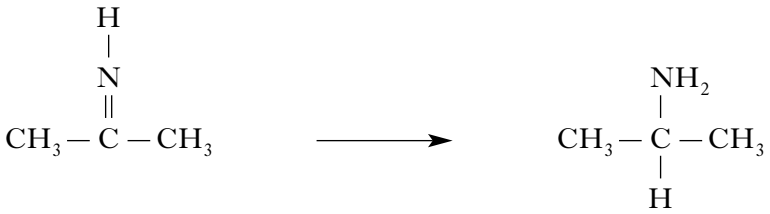
**2**

(*b*) Amines can be produced by reacting ammonia with an aldehyde or a ketone. This reaction, an example of reductive amination, occurs in two stages.

**Stage 1 Amination**



**Stage 2 Reduction**



(i) Give another name for the type of reaction taking place in Stage 2.

**1**

*Marks*

**13. (*b*) (continued)**

(ii) Draw the structural formula for the amine produced when butanal undergoes reductive amination with ammonia.

**1**

**(4)**

**[Turn over**

DO NOT WRITE IN THIS MARGIN

*Marks*

**14.** Foodstuffs have labels that list ingredients and provide nutritional information.

(*a*) The label on a tub of margarine lists **hydrogenated vegetable oils** as one of the ingredients.

Why have some of the vegetable oils in this product been hydrogenated?

**1**

(*b*) Potassium sorbate is a salt that is used as a preservative in margarine.

Potassium sorbate dissolves in water to form an alkaline solution.

What does this indicate about sorbic acid?

**1**

(*c*) The nutritional information states that 100 g of margarine contains 0·70 g of sodium. The sodium is present as sodium chloride (NaCl).

Calculate the mass of sodium chloride, in g, present in every 100 g of margarine.

**1**

**(3)**

*Marks*

**15.** Seaweeds are a rich source of iodine in the form of iodide ions. The mass of iodine in a seaweed can be found using the procedure outlined below.

(*a*) **Step 1**

The seaweed is dried in an oven and ground into a fine powder. Hydrogen peroxide solution is then added to oxidise the iodide ions to iodine molecules. The ion-electron equation for the reduction reaction is shown.

$$H_2O_2(aq) + 2H^+(aq) + 2e^- \rightarrow 2H_2O(\ell)$$

Write a balanced redox equation for the reaction of hydrogen peroxide with iodide ions.

**1**

(*b*) **Step 2**

Using starch solution as an indicator, the iodine solution is then titrated with sodium thiosulphate solution to find the mass of iodine in the sample. The balanced equation for the reaction is shown.

$$2Na_2S_2O_3(aq) + I_2(aq) \rightarrow 2NaI(aq) + Na_2S_4O_6(aq)$$

In an analysis of seaweed, $14{\cdot}9\,cm^3$ of $0{\cdot}00500\ mol\,l^{-1}$ sodium thiosulphate solution was required to reach the end-point.

Calculate the mass of iodine present in the seaweed sample.

**Show your working clearly.**

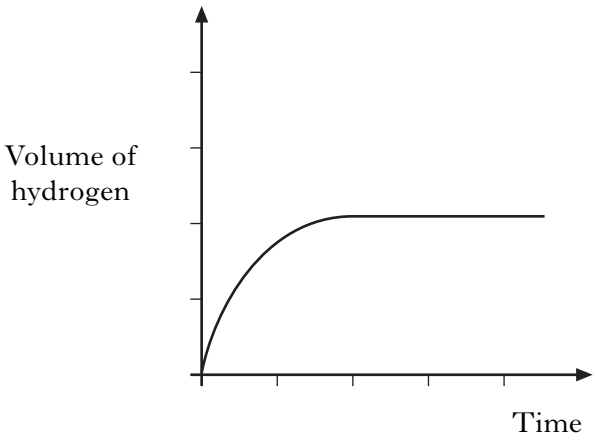
**3**

**(4)**

[*END OF QUESTION PAPER*]

**SPACE FOR ANSWERS**

ADDITIONAL GRAPH FOR QUESTION 10(*a*)



## ADDITIONAL SPACE FOR ANSWERS

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