

FOR OFFICIAL USE

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Total  
Section B

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**X012/12/02**

NATIONAL MONDAY, 14 MAY  
QUALIFICATIONS 1.00 PM – 3.30 PM  
2012

**CHEMISTRY  
HIGHER**

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

Full name of centre

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Town

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Forename(s)

--

Surname

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Date of birth

Day      Month      Year

--	--	--	--	--	--	--

Scottish candidate number

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Number of seat

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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.



## SECTION A

### Read carefully

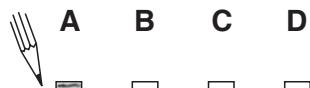
- 1 Check that the answer sheet provided is for **Chemistry Higher (Section A)**.
- 2 For this section of the examination you must use an **HB pencil** and, where necessary, an eraser.
- 3 Check that the answer sheet you have been given has **your name, date of birth, SCN** (Scottish Candidate Number) 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 examination, 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. Isotopes of an element have

- A the same mass number
- B the same number of neutrons
- C equal numbers of protons and neutrons
- D different numbers of neutrons.

2. Four metals **W**, **X**, **Y** and **Z** and their compounds behaved as described.

- (i) Only **X**, **Y** and **Z** reacted with dilute hydrochloric acid.
- (ii) The oxides of **W**, **X** and **Y** were reduced to the metal when heated with carbon powder. The oxide of **Z** did not react.
- (iii) A displacement reaction occurred when **X** was added to an aqueous solution of the nitrate of **Y**.

What is the correct order of reactivity of these metals (most reactive first)?

- A **W, Y, X, Z**
- B **W, X, Y, Z**
- C **Z, X, Y, W**
- D **Z, Y, X, W**

3. A positively charged particle with electron arrangement 2, 8 could be

- A a neon atom
- B a fluoride ion
- C a sodium atom
- D an aluminium ion.

4. A solution of potassium carbonate, made up using tap water, was found to be cloudy. This could result from the tap water containing

- A sodium ions
- B chloride ions
- C magnesium ions
- D sulphate ions.

(You may wish to refer to the Data Booklet.)

5. 1 mol of hydrogen gas and 1 mol of iodine vapour were mixed and allowed to react. After  $t$  seconds, 0.8 mol of hydrogen remained. The number of moles of hydrogen iodide formed at  $t$  seconds was

- A 0.2
- B 0.4
- C 0.8
- D 1.6.

6. In a reaction involving gases, an increase in temperature results in

- A an increase in activation energy
- B an increase in the enthalpy change
- C a decrease in the activation energy
- D more molecules per second forming an activated complex.

---

7. Calcium carbonate reacts with nitric acid as follows.

$$\text{CaCO}_3(\text{s}) + 2\text{HNO}_3(\text{aq}) \rightarrow \text{Ca}(\text{NO}_3)_2(\text{aq}) + \text{H}_2\text{O}(\ell) + \text{CO}_2(\text{g})$$

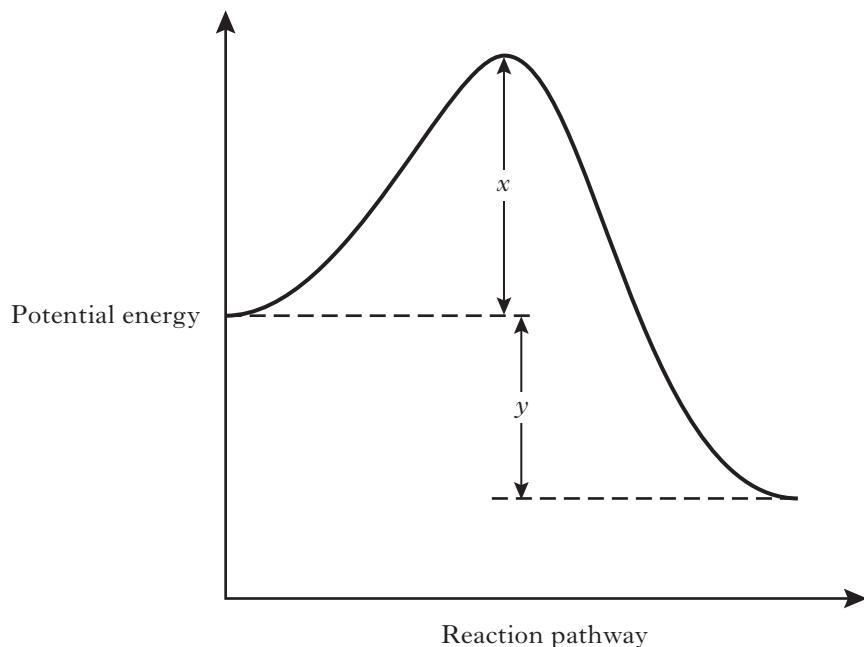
0.05 mol of calcium carbonate was added to a solution containing 0.08 mol of nitric acid.

Which of the following statements is true?

- A 0.05 mol of carbon dioxide is produced.
- B 0.08 mol of calcium nitrate is produced.
- C Calcium carbonate is in excess by 0.01 mol.
- D Nitric acid is in excess by 0.03 mol.

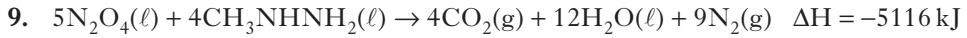
**[Turn over**

8.



The enthalpy change for the forward reaction can be represented by

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



The energy released when 2 moles of each reactant are mixed and ignited is

- A 2046 kJ
- B 2558 kJ
- C 4093 kJ
- D 5116 kJ.

10. Atoms of nitrogen and element **X** form a bond in which the electrons are shared equally.

Element **X** could be

- A carbon
- B oxygen
- C chlorine
- D phosphorus.

11. Which line in the table represents the solid in which only van der Waals' forces are overcome when the substance melts?

	Melting point /°C	Electrical conduction of solid
A	714	non-conductor
B	98	conductor
C	660	conductor
D	44	non-conductor

12. Which of the following does **not** contain covalent bonds?

- A Hydrogen gas
- B Helium gas
- C Nitrogen gas
- D Solid sulphur

13. Which of the following structures is **never** found in compounds?

- A Ionic
- B Monatomic
- C Covalent network
- D Covalent molecular

14. In which of the following solvents is lithium chloride most likely to dissolve?

- A Hexane
- B Benzene
- C Methanol
- D Tetrachloromethane

15. A balloon contains 0.1 mol of oxygen gas, and 0.2 mol of carbon dioxide gas.

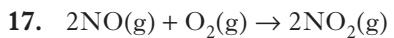
The total number of molecules in the balloon is approximately

- A  $6.0 \times 10^{23}$
- B  $3.6 \times 10^{23}$
- C  $2.4 \times 10^{23}$
- D  $1.8 \times 10^{23}$

16. Which of the following pairs of gases occupy the same volume?

(Assume all measurements are made under the same conditions of temperature and pressure.)

- A 2 g hydrogen and 14 g nitrogen
- B 32 g methane and 88 g carbon dioxide
- C 7 g carbon monoxide and 16 g oxygen
- D 10 g hydrogen chloride and 10 g sulphur dioxide

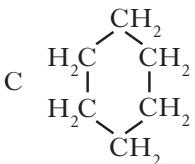
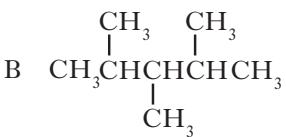


How many litres of nitrogen dioxide gas could theoretically be obtained in the reaction of 1 litre of nitrogen monoxide gas with 2 litres of oxygen gas?

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

- A 1
- B 2
- C 3
- D 4

18. Which of the following hydrocarbons is **least** likely to be added to petrol to improve the efficiency of its burning?



**[Turn over**

19. Biogas is produced under anaerobic conditions by the fermentation of biological materials.

What is the main constituent of biogas?

A Butane  
B Ethane  
C Methane  
D Propane

20. Which equation represents a reaction which takes place during reforming?

A  $C_6H_{14} \rightarrow C_6H_6 + 4H_2$   
B  $C_4H_8 + H_2 \rightarrow C_4H_{10}$   
C  $C_2H_5OH \rightarrow C_2H_4 + H_2O$   
D  $C_8H_{18} \rightarrow C_4H_{10} + C_4H_8$

21. Which of the following is an isomer of 2-methyl pentane?

A 
$$\begin{array}{c} \text{CH}_3 & \text{CH}_3 \\ | & | \\ \text{CH} & - & \text{CH} \\ | & & | \\ \text{CH}_3 & & \text{CH}_3 \end{array}$$

B 
$$\begin{array}{c} \text{CH}_3 \\ | \\ \text{CH} & - & \text{CH}_2 \\ | & & | \\ \text{CH}_3 & & \text{CH}_2 - \text{CH}_3 \end{array}$$

C 
$$\begin{array}{c} & \text{CH}_3 \\ & | \\ \text{CH}_3 & - & \text{CH}_2 & - & \text{CH}_2 & - & \text{CH} \\ & & & & | \\ & & & & \text{CH}_3 \end{array}$$

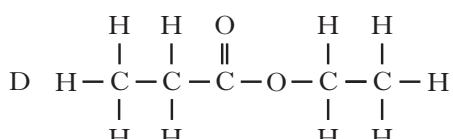
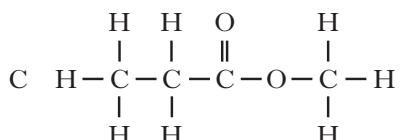
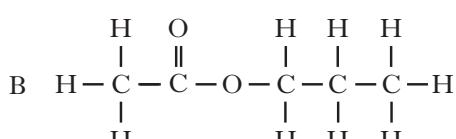
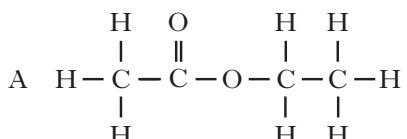
D 
$$\begin{array}{c} \text{CH}_3 & \text{CH}_3 \\ | & | \\ \text{CH}_3 & - & \text{CH} & - & \text{CH}_2 & - & \text{CH}_2 \end{array}$$

22. Which line in the table shows the correct functional group for each homologous series?

	Alkanoic acid	Alkanol	Alkanal
A	$-\text{C}(=\text{O})\text{H}$	$-\text{OH}$	$-\text{C}(=\text{O})\text{OH}$
B	$-\text{C}(=\text{O})\text{OH}$	$-\text{OH}$	$-\text{C}(=\text{O})\text{H}$
C	$-\text{C}(=\text{O})\text{OH}$	$-\text{C}(=\text{O})\text{H}$	$-\text{OH}$
D	$-\text{OH}$	$-\text{C}(=\text{O})\text{OH}$	$-\text{C}(=\text{O})\text{H}$

23. Hydrolysis of an ester gave an alkanol and an alkanoic acid both of which had the same molecular mass of 60.

The structure of the ester was

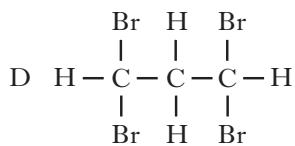
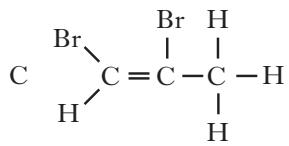
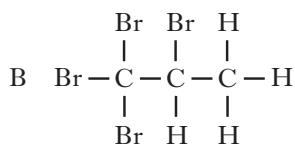
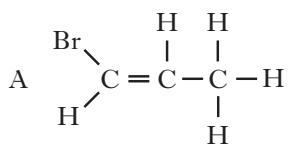


24. Which of the following statements about benzene is true?

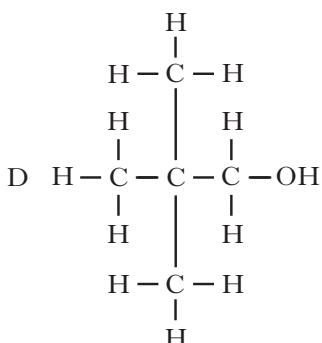
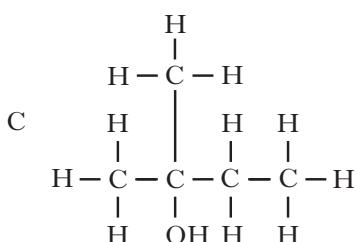
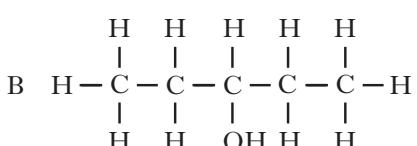
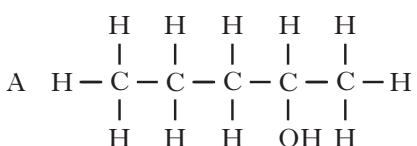
(You may wish to refer to the Data Booklet.)

A Benzene has the same ratio of carbon to hydrogen as ethyne.  
 B Benzene reacts with copper(II) oxide more easily than ethanol.  
 C Benzene is more volatile than ethanal.  
 D Benzene undergoes addition reactions more readily than ethene.

25. Which of the following is a possible product of the reaction of propyne with bromine?



26. Which alcohol could be oxidised to a carboxylic acid?



27. What mixture of gases is known as synthesis gas?

A Methane and oxygen  
 B Carbon monoxide and oxygen  
 C Carbon dioxide and hydrogen  
 D Carbon monoxide and hydrogen

28. Which of the following substances does **not** have delocalised electrons?

A Aluminium  
 B Poly(ethyne)  
 C Poly(ethenol)  
 D Carbon (graphite)

[Turn over

29. The arrangement of amino acids in a peptide is

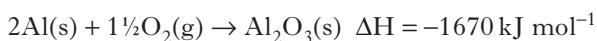


where the letters V, W, X, Y and Z represent amino acids.

On partial hydrolysis of the peptide, which of the following sets of dipeptides is possible?

- A V-Y, Z-X, W-Y, X-W
- B Z-X, V-Y, W-V, X-W
- C Z-X, X-V, W-V, V-Y
- D X-W, X-Z, Z-W, Y-V

30. Aluminium reacts with oxygen to form aluminium oxide.



What is the enthalpy of combustion of aluminium in  $\text{kJ mol}^{-1}$ ?

- A -835
- B -1113
- C -1670
- D +1670

31. A few drops of concentrated sulphuric acid were added to a mixture of 0.1 mol of methanol and 0.2 mol of ethanoic acid. Even after a considerable time, the reaction mixture was found to contain some of each reactant.

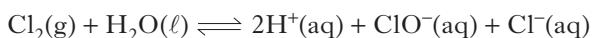
Which of the following is the best explanation for the incomplete reaction?

- A The temperature was too low.
- B An equilibrium mixture was formed.
- C Insufficient methanol was used.
- D Insufficient ethanoic acid was used.

32. Which line in the table applies correctly to the use of a catalyst in a chemical reaction?

	Position of equilibrium	Effect on value of $\Delta H$
A	Moved to right	Decreased
B	Unaffected	Increased
C	Moved to left	Unaffected
D	Unaffected	Unaffected

33. The hypochlorite ion,  $\text{ClO}^-(\text{aq})$ , produced in the reaction shown, is used as a bleach.



The concentration of  $\text{ClO}^-$  ions could be increased by the addition of

- A solid potassium hydroxide
- B concentrated hydrochloric acid solution
- C solid sodium chloride
- D solid potassium sulphate.

34. A solution of hydrochloric acid with a pH of 6 and another of sodium hydroxide with a pH of 8 are each diluted by a factor of 100.

After dilution, when tested using pH indicator paper,

- A the pH of the acid drops by 2
- B the pH of the alkali rises by 2
- C the pH of the acid equals that of the alkali
- D the pH of the acid is 2 below that of the alkali.

35. Equal volumes of four  $1 \text{ mol l}^{-1}$  solutions were compared.

Which of the following  $1 \text{ mol l}^{-1}$  solutions contains the fewest ions?

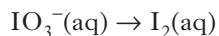
- A Hydrochloric acid
- B Ethanoic acid
- C Sodium chloride
- D Sodium hydroxide

36. Equal volumes of  $0.1 \text{ mol l}^{-1}$  solutions of sodium hydroxide and propanoic acid were mixed together.

The pH of the resulting solution could be

- A 3
- B 5
- C 7
- D 9.

37. During a redox process in acid solution, iodate ions,  $\text{IO}_3^-(\text{aq})$ , are converted into iodine,  $\text{I}_2(\text{aq})$ .

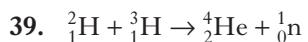


The numbers of  $\text{H}^+(\text{aq})$  and  $\text{H}_2\text{O}(\ell)$  required to balance the ion-electron equation for the formation of 1 mol of  $\text{I}_2(\text{aq})$  are, respectively

- A 3 and 6
- B 6 and 3
- C 6 and 12
- D 12 and 6.

38. One mole of metal would be deposited by passing  $96\,500 \text{ C}$  through a solution of

- A silver(I) nitrate
- B gold(III) nitrate
- C nickel(II) nitrate
- D copper(II) nitrate.



The above process represents

- A nuclear fission
- B nuclear fusion
- C proton capture
- D neutron capture.

40. Naturally occurring nitrogen consists of two isotopes  ${}^{14}\text{N}$  and  ${}^{15}\text{N}$ .

How many different nitrogen molecules will occur in the air?

- A 1
- B 2
- C 3
- D 4

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

**[Turn over**

**[BLANK PAGE]**

*Marks*

## SECTION B

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

1. The elements lithium to neon make up the second period of the Periodic Table.

Li	Be	B	C	N	O	F	Ne
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(a) Name an element from the second period that exists as a covalent network.

1

(b) Why do the atoms decrease in size from lithium to neon?

1

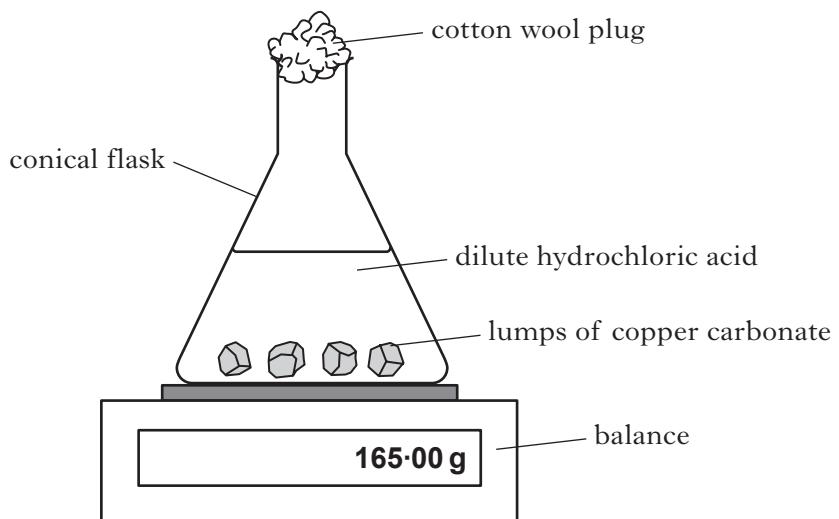
(2)

**[Turn over**

2. Copper(II) carbonate reacts with dilute hydrochloric acid as shown.



A student used the apparatus shown below to follow the progress of the reaction.

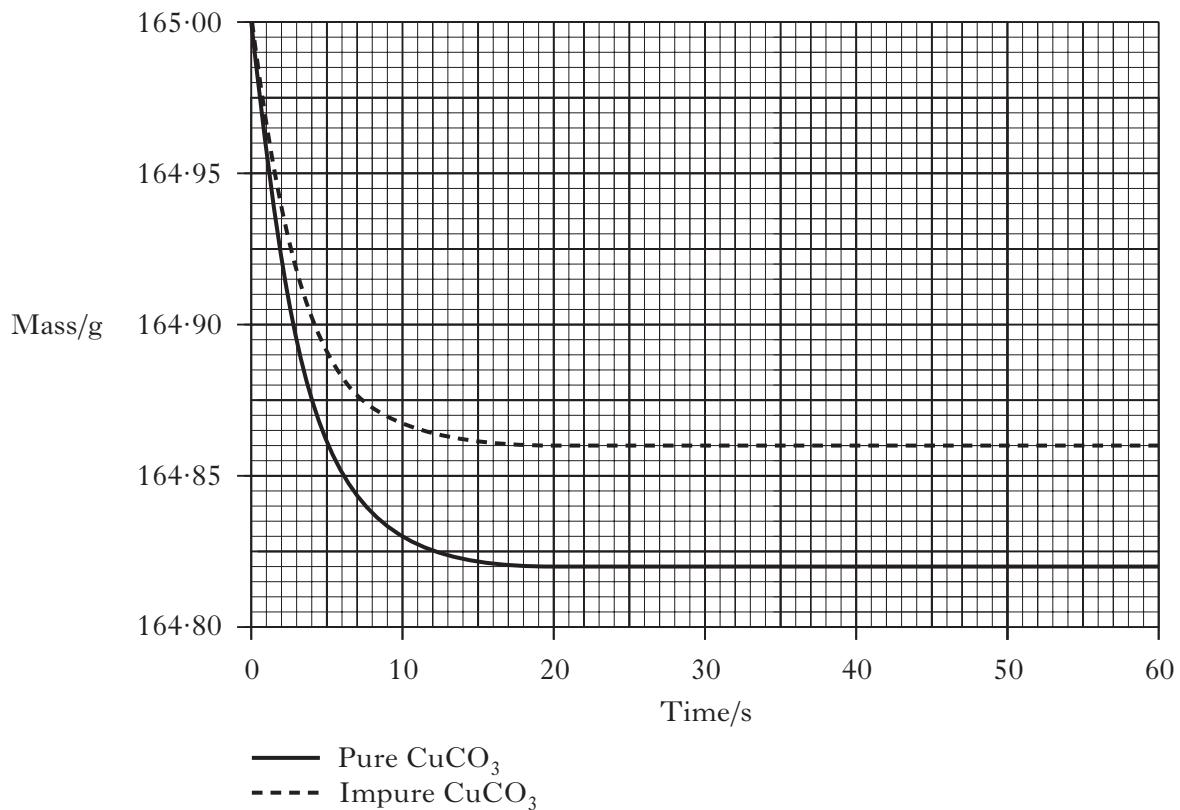


(a) Suggest why a cotton wool plug is placed in the mouth of the conical flask.

1

## 2. (continued)

(b) The experiment was carried out using 0.50 g samples of both pure and impure copper(II) carbonate. The graph below shows the results obtained.



(i) For the sample of pure copper(II) carbonate, calculate the average reaction rate, in g s<sup>-1</sup>, over the first 10 seconds.

1

(ii) Calculate the mass, in grams, of copper(II) carbonate present in the impure sample.

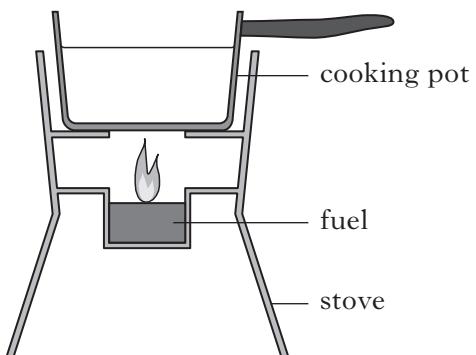
**Show your working clearly.**

1

(3)

Marks

3. Ethanol,  $C_2H_5OH$ , can be used as a fuel in some camping stoves.



(a) The enthalpy of combustion of ethanol is  $-1367 \text{ kJ mol}^{-1}$ .

Using this value, calculate the number of moles of ethanol required to raise the temperature of 500 g of water from 18 °C to 100 °C.

**Show your working clearly.**

2

(b) Suggest **two** reasons why less energy is obtained from burning ethanol in the camping stove than is predicted from its enthalpy of combustion.

2

(4)

Marks

4. Phosphorus-32 and strontium-89 are two radioisotopes used to study how far mosquitoes travel.

(a) Strontium-89 decays by emission of a beta particle.

Complete the nuclear equation for the decay of strontium-89.



1

(b) In an experiment, 10 g of strontium-89 chloride was added to a sugar solution used to feed mosquitoes.

(i) The strontium-89 chloride solution was fed to the mosquitoes in a laboratory at 20 °C. When the mosquitoes were released, the outdoor temperature was found to be 35 °C.

What effect would the increase in temperature have on the half-life of the strontium-89?

1

(ii) Calculate the mass, in grams, of strontium-89 present in the 10 g sample of strontium-89 chloride,  $\text{SrCl}_2$ .

1

(c) A mosquito fed on a solution containing phosphorus-32 is released.

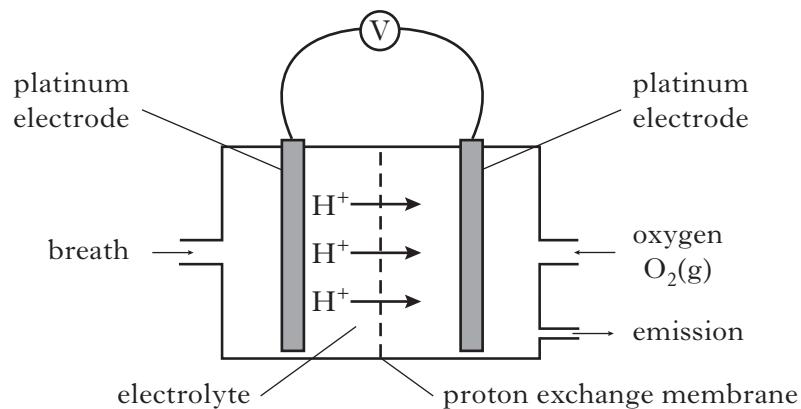
Phosphorus-32 has a half-life of 14 days.

When the mosquito is recaptured 28 days later, what fraction of the phosphorus-32 will remain?

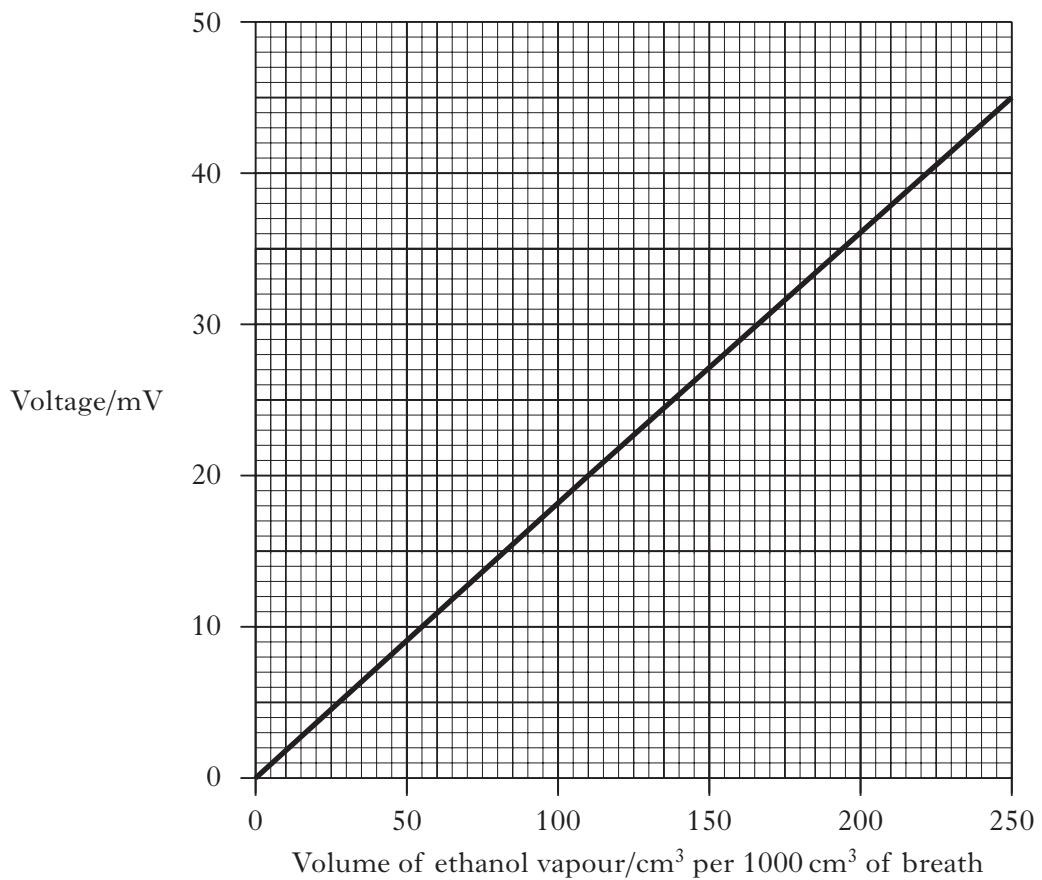
1

(4)

5. The concentration of ethanol in a person's breath can be determined by measuring the voltage produced in an electrochemical cell.



Different ethanol vapour concentrations produce different voltages as is shown in the graph below.



## 5. (continued)

Marks

(a) Calculate the number of ethanol molecules in  $1000\text{ cm}^3$  of breath when a voltage of  $20\text{ mV}$  was recorded.

(Take the molar volume of ethanol vapour to be  $24\text{ litres mol}^{-1}$ .)

**Show your working clearly.**

2

(b) The ion-electron equations for the reduction and oxidation reactions occurring in the cell are shown below.



Write the overall redox equation for the reaction taking place.

1

(c) Platinum metal acts as a heterogeneous catalyst in this reaction.

What is meant by a **heterogeneous catalyst**?

1

(4)

Marks

6. Compounds containing sulphur occur widely in nature.

(a) The compound dimethyldisulphide,  $\text{CH}_3\text{S}_2\text{CH}_3$ , is present in garlic and onions.

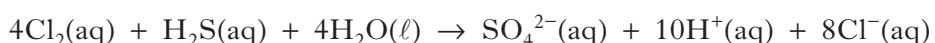
Draw a full structural formula for this compound.

1

(b) Hydrogen sulphide,  $\text{H}_2\text{S}$ , formed by the decomposition of proteins, can cause an unpleasant odour in water supplies.

(i) Chlorine, added to the water, removes the hydrogen sulphide.

The equation for the reaction taking place is



An average of  $29.4 \text{ cm}^3$  of  $0.010 \text{ mol l}^{-1}$  chlorine solution was required to react completely with a  $50.0 \text{ cm}^3$  sample of water.

Calculate the hydrogen sulphide concentration, in  $\text{mol l}^{-1}$ , present in the water sample.

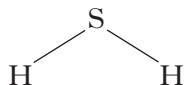
**Show your working clearly.**

2

Marks

## 6. (b) (continued)

(ii) Liquid hydrogen sulphide has a boiling point of  $-60^{\circ}\text{C}$ .



**Explain clearly** why hydrogen sulphide is a gas at room temperature. In your answer, you should name the intermolecular forces involved and indicate how they arise.

2

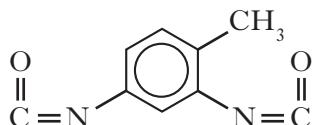
(5)

[Turn over

Marks

7. Polyurethanes are polymers that are widely used in industry. They are produced by the reaction of diisocyanates with diols.

(a) The structure of one such diisocyanate is shown below.



The molecular formula for this compound can be written as  $C_wH_xN_yO_z$ .

Give the values for **w**, **x**, **y** and **z**.

**w** =

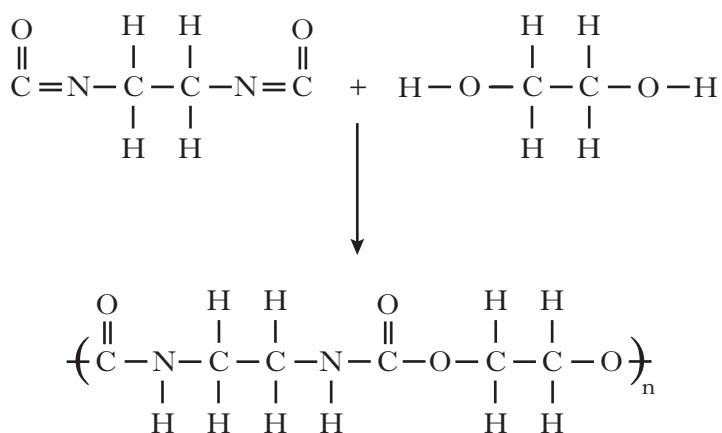
**x** =

**y** =

**z** =

1

(b) Lycra is a polyurethane polymer made by the polymerisation of 2-diisocyanatoethane with ethane-1,2-diol. The reaction to form the repeating unit is shown.

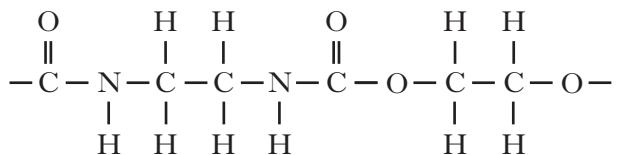
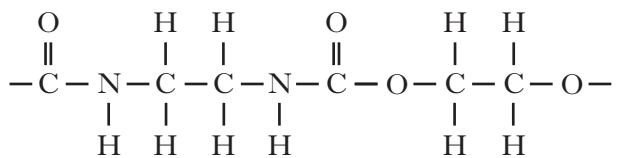


Why is this polymerisation described as an addition reaction?

1

## 7. (continued)

(c) Lycra is strong because of the hydrogen bonding between neighbouring polymer chains.



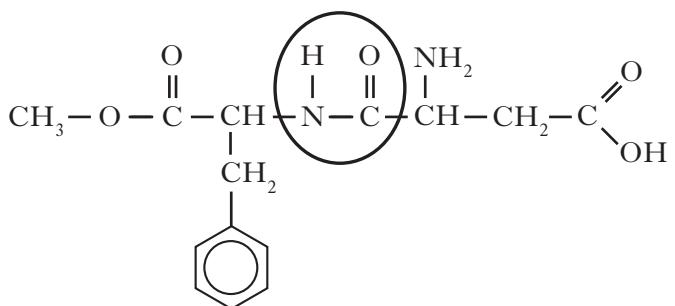
Draw a dotted line to show a hydrogen bond between the polymer chains above.

1  
(3)

[Turn over

Marks

8. Aspartame is an artificial sweetener which has the structure shown below.

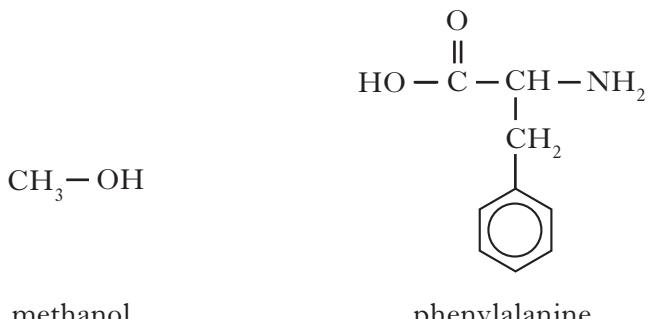


(a) Name the functional group circled.

1

(b) In the stomach, aspartame is hydrolysed by acid to produce methanol and two amino acids, phenylalanine and aspartic acid.

Two of the products of the hydrolysis of aspartame are shown below.



Draw a structural formula for aspartic acid.

1

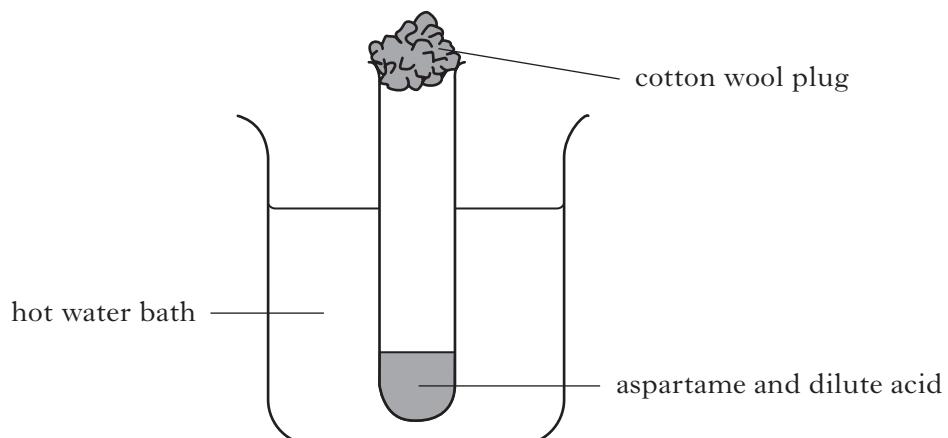
## 8. (continued)

(c) The body cannot make all the amino acids it requires and is dependent on protein in the diet for the supply of certain amino acids.

What term is used to describe the amino acids the body cannot make?

1

(d) To investigate this hydrolysis reaction in the lab, the apparatus shown below is set up. The extent of hydrolysis at a given temperature can be determined by measuring the quantity of methanol produced.



What improvement could be made to the **apparatus** to reduce the loss of methanol by evaporation?

1  
(4)

9. A fatty acid is a long chain carboxylic acid.

Examples of fatty acids are shown in the table below.

Common name	Systematic name	Structure
stearic acid	octadecanoic acid	$\text{CH}_3(\text{CH}_2)_{16}\text{COOH}$
oleic acid	octadec-9-enoic acid	$\text{CH}_3(\text{CH}_2)_7\text{CH}=\text{CH}(\text{CH}_2)_7\text{COOH}$
linoleic acid	octadec-9,12-dienoic acid	$\text{CH}_3(\text{CH}_2)_4\text{CH}=\text{CHCH}_2\text{CH}=\text{CH}(\text{CH}_2)_7\text{COOH}$
linolenic acid		$\text{CH}_3\text{CH}_2\text{CH}=\text{CHCH}_2\text{CH}=\text{CHCH}_2\text{CH}=\text{CH}(\text{CH}_2)_7\text{COOH}$

(a) Describe a chemical test, with the expected result, that could be used to distinguish between stearic and oleic acids.

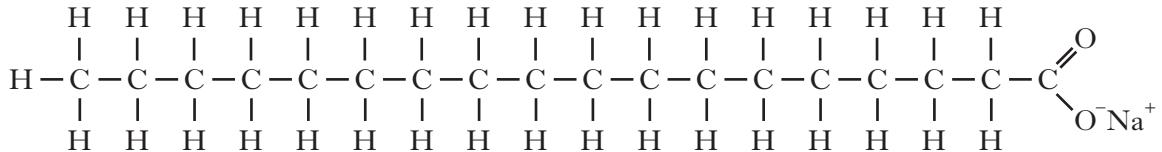
1

(b) What is the systematic name for linolenic acid?

1

(c) Stearic acid can be reacted with sodium hydroxide solution to make a soap.

The structure of the soap is shown.



One part of the soap molecule is soluble in fat and the other part is soluble in water.

Circle the part of the soap molecule which is soluble in water.

1

(3)

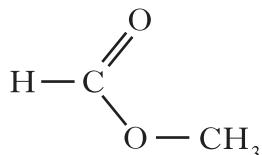
10. Nitrogen and compounds containing nitrogen are widely used in industry.

(a) From which raw material is nitrogen obtained?

## *Marks*

1

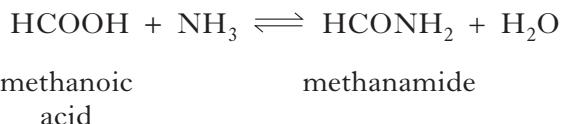
(b) In industry, methanamide,  $\text{HCONH}_2$ , is produced from the ester shown below.



Name the ester.

1

(c) In the lab, methanamide can be prepared by the reaction of methanoic acid with ammonia.



When 1.38 g of methanoic acid was reacted with excess ammonia, 0.945 g of methanamide was produced.

Calculate the percentage yield of methanamide.

**Show your working clearly.**

2

(4)

Marks

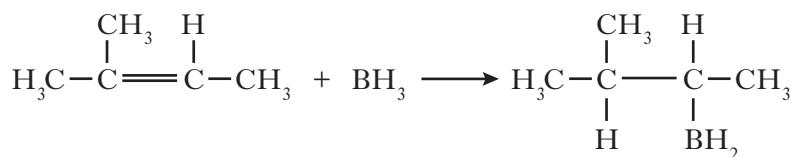
11. The element boron forms many useful compounds.

(a) Borane ( $\text{BH}_3$ ) is used to synthesize alcohols from alkenes.

The reaction occurs in two stages

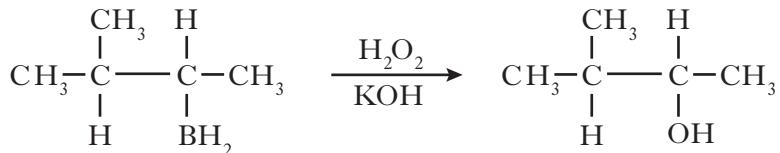
### Stage 1 Addition Reaction

The boron atom bonds to the carbon atom of the double bond which already has the most hydrogens **directly** attached to it.



### Stage 2 Oxidation Reaction

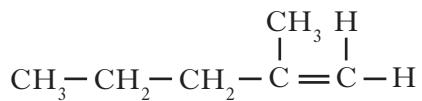
The organoborane compound is oxidised to form the alcohol.



(i) Name the alcohol produced in Stage 2.

1

(ii) Draw a structural formula for the **alcohol** which would be formed from the alkene shown below.



1

Marks

## 11. (continued)

(b) The compound diborane ( $B_2H_6$ ) is used as a rocket fuel.

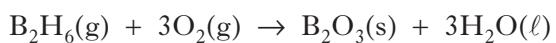
(i) It can be prepared as shown.



Balance this equation.

1

(ii) The equation for the combustion of diborane is shown below.



Calculate the enthalpy of combustion of diborane ( $B_2H_6$ ) using the following data.



2

(c) Diborane can be used to manufacture pentaborane ( $B_5H_9$ ).

Pentaborane was also considered for use as a rocket fuel because its enthalpy of combustion is  $-9037 \text{ kJ mol}^{-1}$ .

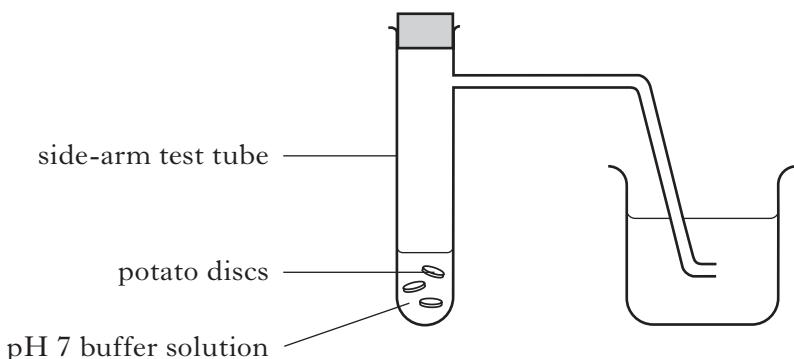
Calculate the energy released, in kJ, when 1 kilogram of pentaborane is completely burned.

1

(6)

12. In the PPA experiment **Factors Affecting Enzyme Activity**, a student investigated the effect of pH on the activity of the enzyme catalase contained in potato discs.

The following apparatus was set up and left for 3 minutes.



(a) Why must the buffer/potato disc mixture be left for 3 minutes before continuing the experiment?

1

(b) Which chemical must then be added to the test tube to investigate the enzyme activity at this pH?

1

(c) The activity of the enzyme was measured at several different pH values by counting the number of bubbles produced in a given time.

Why were no bubbles produced at pH 1?

1

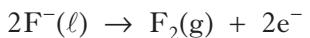
(3)

Marks

13. Fluorine is an extremely reactive element. Its compounds are found in a range of products.

(a) Fluorine gas can be produced by electrolysis.

The ion-electron equation for the production of fluorine gas is:



Calculate the mass, in grams, of fluorine produced when a steady current of 5.0 A is passed through the solution for 32 minutes.

**Show your working clearly.**

2

**[Turn over**

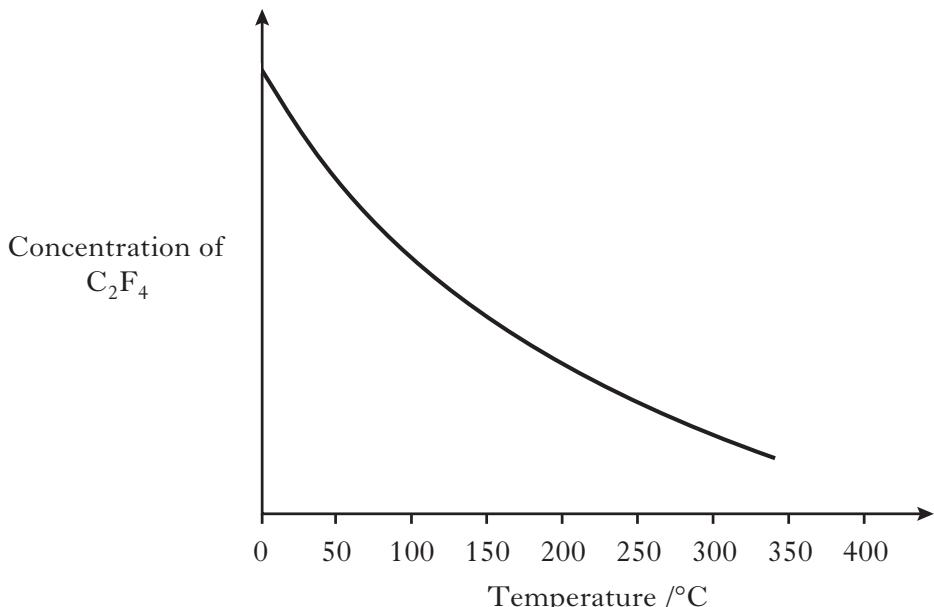
## 13. (continued)

(b) Tetrafluoroethene,  $\text{C}_2\text{F}_4$ , is produced in industry by a series of reactions.

The final reaction in its manufacture is shown below.



(i) The graph shows the variation in the concentration of  $\text{C}_2\text{F}_4$  formed at equilibrium as temperature is increased.

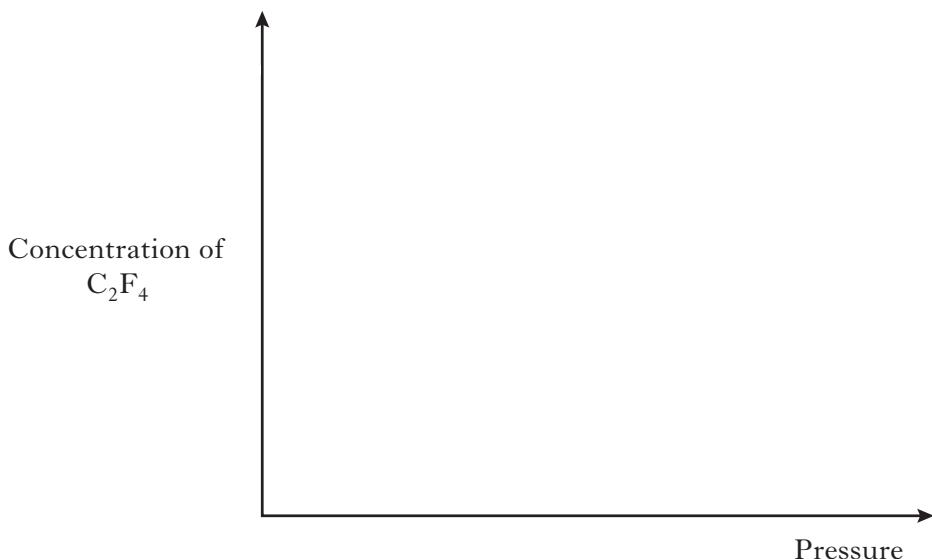


What conclusion can be drawn about the enthalpy change for the formation of tetrafluoroethene?

## 13. (b) (continued)

(ii) Sketch a graph to show how the concentration of  $\text{C}_2\text{F}_4$  formed at equilibrium would vary with increasing pressure.

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



1

(c) Hydrochlorofluorocarbons are used as replacements for chlorofluorocarbons, CFCs.

What environmental problem is associated with the extensive use of CFCs?

1  
(5)

**[Turn over**

Marks

14. Ammonium nitrate ( $\text{NH}_4\text{NO}_3$ ) is widely used as a fertiliser.

(a) An ammonium nitrate solution has a pH of 5.

(i) Calculate the concentration, in  $\text{mol l}^{-1}$ , of  $\text{H}^+(\text{aq})$  ions in the solution.

1

(ii) **Explain clearly** why ammonium nitrate dissolves in water to produce an acidic solution.

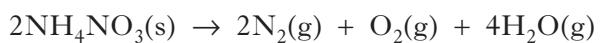
In your answer, you should mention the **two** equilibria involved.

2

## 14. (continued)

Marks

(b) Ammonium nitrate must be stored and transported carefully as it can decompose according to the equation shown below:



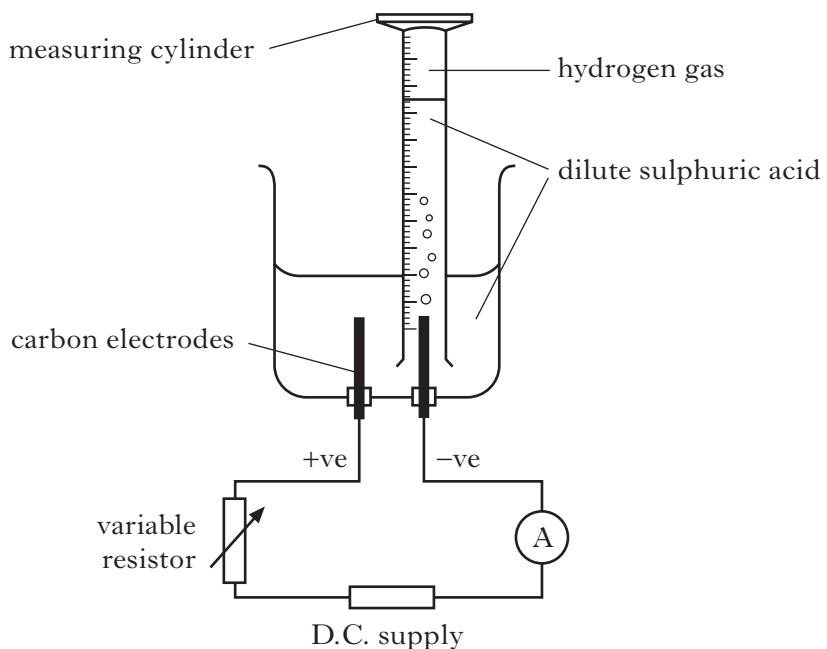
In addition to being very exothermic, suggest another reason why the decomposition of ammonium nitrate can result in an explosion.

1  
(4)

[Turn over

15. Hydrogen gas can be produced in a variety of ways.

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



(i) Why is a variable resistor used?

1

(ii) In addition to measuring the volume of hydrogen gas, which **two** other measurements must be made?

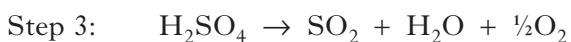
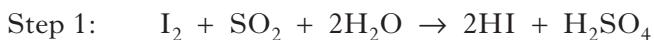
1

## 15. (continued)

Marks

(b) The sulphur-iodine cycle is an industrial process used to manufacture hydrogen.

There are three steps in the sulphur-iodine cycle.



(i) Why does step 3 help to reduce the cost of manufacturing hydrogen?

1

(ii) What is the overall equation for the sulphur-iodine cycle?

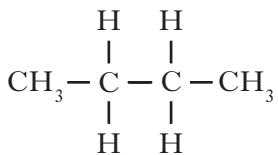
1

(4)

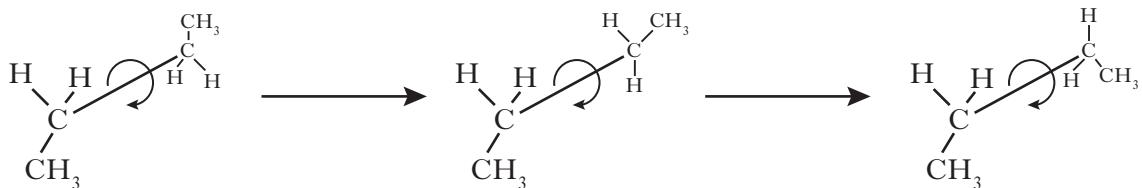
[Turn over

16. In alkane molecules, the chains of carbon atoms are very flexible. The molecules can twist at any carbon-to-carbon bond.

Butane is a typical alkane.

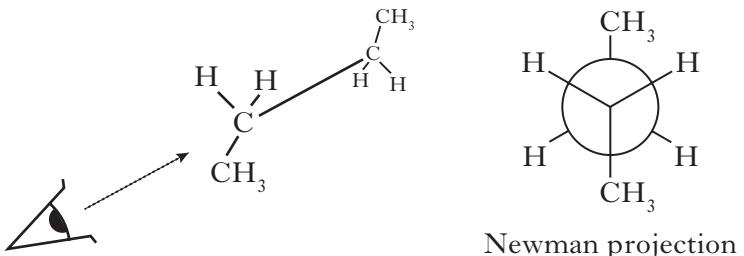


The diagram below shows butane twisting about the central carbon-to-carbon bond.

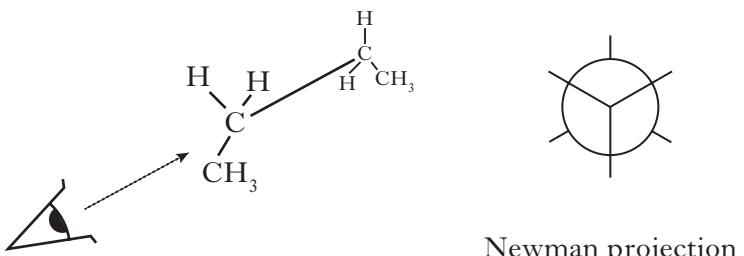


Newman projections are special diagrams used to show the relative position of the different atoms in a molecule.

In the diagram below, a Newman projection has been drawn showing the relative position of the atoms in the butane molecule below.



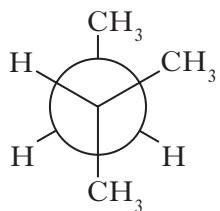
(a) Complete the Newman projection diagram for the butane molecule in the position shown below.



*Marks*

**16. (continued)**

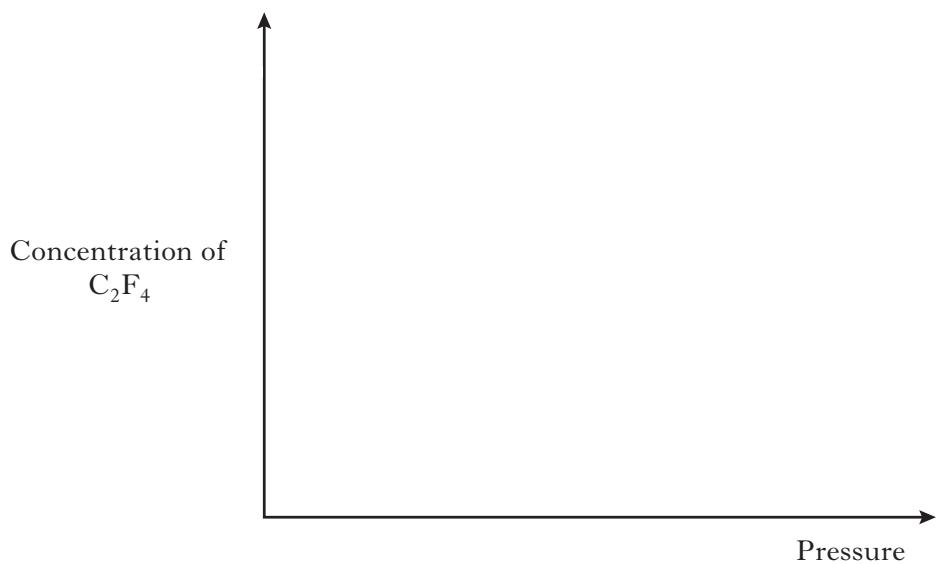
(b) Name the alkane molecule represented by the Newman projection shown below.



1  
(2)

*[END OF QUESTION PAPER]*

**ADDITIONAL GRAPH FOR USE IN QUESTION 13(b)(ii)**



**ADDITIONAL SPACE FOR ANSWERS**

**[BLANK PAGE]**