Total

Section B

X273/12/02

NATIONAL QUALIFICATIONS 2012

MONDAY, 14 MAY 1.00 PM – 3.30 PM

CHEMISTRY HIGHER (REVISED)

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 1–30 (30 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 (70 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.

SQA

©

SECTION A

Read carefully

1 Check that the answer sheet provided is for **Chemistry Higher (Revised) (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).
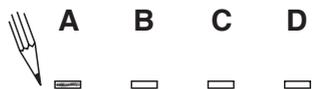
Changing an answer

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. In which of the following molecules will the chlorine atom carry a partial positive charge ($\delta+$)?

   A   Cl–Br

   B   Cl–Cl

   C   Cl–F

   D   Cl–I

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

   A   Hydrogen gas

   B   Helium gas

   C   Nitrogen gas

   D   Solid sulphur

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

   A   Ionic

   B   Monatomic

   C   Covalent network

   D   Covalent molecular

4. 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.

5. 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.

6. Which line in the table represents the solid in which only London dispersion 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

7. Coniceine is a deadly poison extracted from the plant hemlock.
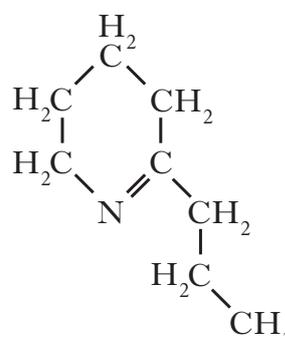
   coniceine

   Which of the following would be the best solvent for coniceine?

   A   Propanoic acid

   B   Propan-l-ol

   C   Heptane

   D   Water

8. One of the reactions taking place within a carbon monoxide sensor is

 $2CO + 2H_2O \rightarrow 2CO_2 + 4H^+ + 4e^-$
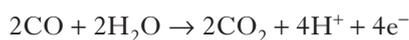
   This reaction is an example of

   A   reduction

   B   redox

   C   oxidation

   D   hydration.

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

$$IO_3^-(aq) \rightarrow I_2(aq)$$
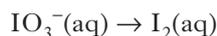
The numbers of H^+(aq) and $H_2O(\ell)$ required to balance the ion-electron equation for the formation of 1 mol of I_2(aq) are, respectively

A   3 and 6

B   6 and 3

C   6 and 12

D 12 and 6.

10.

The above equation represents

A hydration

B hydrogenation

C condensation

D hydrolysis.

11. Hydrolysis of an ester gave an alcohol and a carboxylic acid both of which had the same molecular mass of 60.

The structure of the ester was

12. In which line of the table are fat, protein and soap correctly classified?

	Amides	Salts	Esters
A	Fat	Soap	Protein
B	Fat	Protein	Soap
C	Soap	Fat	Protein
D	Protein	Soap	Fat

13. Fats have higher melting points than oils because comparing fats and oils

A fats have more hydrogen bonds

B fat molecules are more saturated

C fat molecules are more loosely packed

D fats have more cross-links between molecules.

14. The following molecules are found in herbicides.

Which of the following contains an amide link?

**15.** The arrangement of amino acids in a peptide is

Z-X-W-V-Y

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

16. Vanillin and zingerone are flavour molecules.
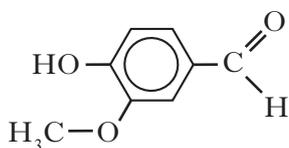
vanillin
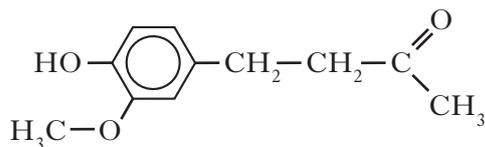
zingerone

Which line in the table correctly compares the properties of vanillin and zingerone?

	More soluble in water	More volatile
A	vanillin	vanillin
B	vanillin	zingerone
C	zingerone	vanillin
D	zingerone	zingerone

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

	Carboxylic acid	Alcohol	Aldehyde
A		$-OH$	
B		$-OH$	
C			$-OH$
D	$-OH$		

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

A

B

C

D
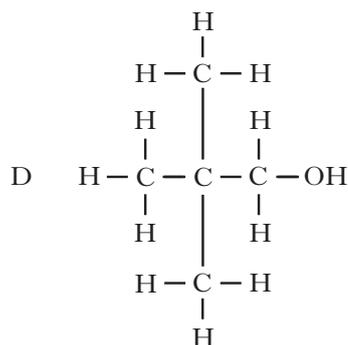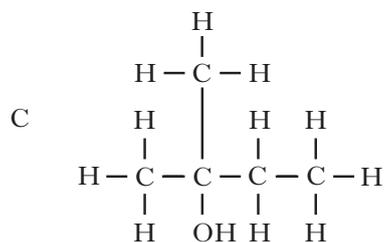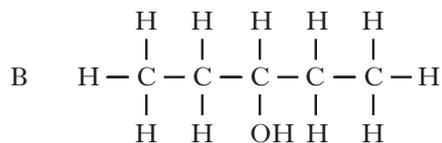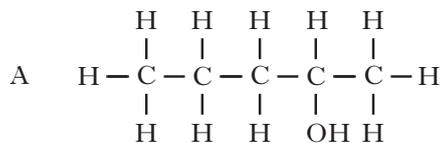
19. Myrcene is a simple terpene.

$$H_3C\diagdown \atop H_3C\diagup C{=}CH \qquad {H_2C \diagdown \atop CH_2-CH_2}C-CH{\diagup CH_2}$$
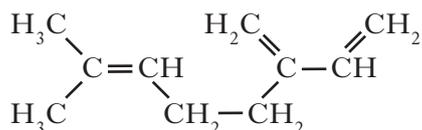
Terpenes contain at least one isoprene unit.

Which of the following shows a correctly highlighted isoprene unit?

A

$$\mathbf{H_3C}\diagdown \atop \mathbf{H_3C}\diagup \mathbf{C{=}CH} \qquad {H_2C \diagdown \atop \mathbf{CH_2-CH_2}}C-CH{\diagup CH_2}$$

B

$$H_3C\diagdown \atop H_3C\diagup \mathbf{C{=}CH} \qquad {H_2C \diagdown \atop \mathbf{CH_2-CH_2}}C-CH{\diagup CH_2}$$

C

$$H_3C\diagdown \atop H_3C\diagup C{=}CH \qquad {\mathbf{H_2C} \diagdown \atop \mathbf{CH_2-CH_2}}\mathbf{C}-CH{\diagup CH_2}$$

D

$$H_3C\diagdown \atop H_3C\diagup C{=}CH \qquad {\mathbf{H_2C} \diagdown \atop CH_2-CH_2}\mathbf{C}-\mathbf{CH}{\diagup \mathbf{CH_2}}$$
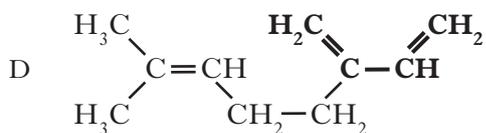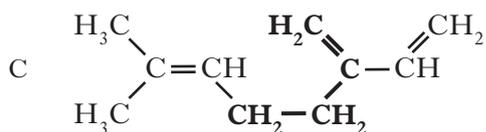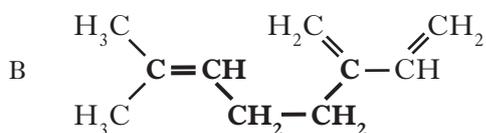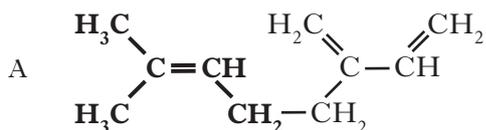
20. $2NO(g) + O_2(g) \rightarrow 2NO_2(g)$

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

21. 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.

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

	Position of equilibrium	**Effect on value of ΔH**
A	Moved to right	Decreased
B	Unaffected	Increased
C	Moved to left	Unaffected
D	Unaffected	Unaffected

23. Calcium carbonate reacts with nitric acid as follows.

$$CaCO_3(s) + 2HNO_3(aq) \rightarrow Ca(NO_3)_2(aq) + H_2O(\ell) + CO_2(g)$$
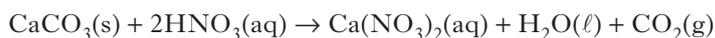
0·05 mol of calcium carbonate was added to a solution containing 0·08 mol of nitric acid.

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.

24.
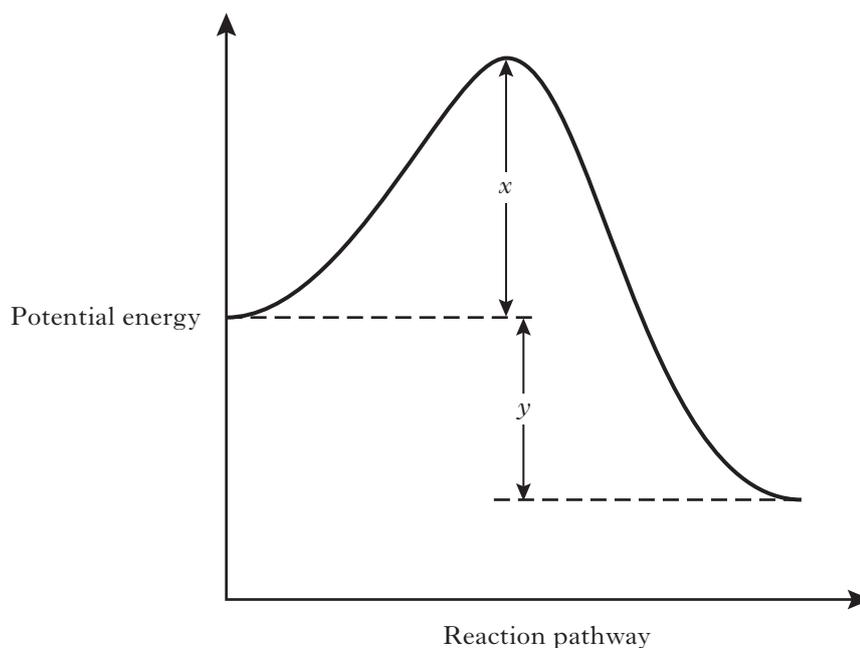
The enthalpy change for the forward reaction can be represented by

A x

B y

C $x + y$

D $x - y$.

25. 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.

26. $5N_2O_4(\ell) + 4CH_3NHNH_2(\ell) \rightarrow 4CO_2(g) + 12H_2O(\ell) + 9N_2(g)$ $\Delta H = -5116\,kJ$

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

A $2046\,kJ$

B $2558\,kJ$

C $4093\,kJ$

D $5116\,kJ$.

27. Aluminium reacts with oxygen to form aluminium oxide.

$2Al(s) + 1\tfrac{1}{2}O_2(g) \rightarrow Al_2O_3(s)$ $\Delta H = -1670\,kJ\,mol^{-1}$

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

A -835

B -1113

C -1670

D $+1670$

28. In the presence of bright light, hydrogen and chlorine react explosively. One step in the reaction is shown below.

$H_2(g) + Cl(g) \rightarrow HCl(g) + H(g)$
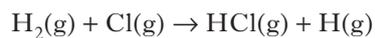
The enthalpy change for this step can be represented as

A   (H-H bond enthalpy) + (Cl-Cl bond enthalpy)

B   (H-H bond enthalpy) − (Cl-Cl bond enthalpy)

C   (H-H bond enthalpy) + (H-Cl bond enthalpy)

D   (H-H bond enthalpy) − (H-Cl bond enthalpy).

29. An organic chemist is attempting to synthesise a fragrance compound by the following chemical reaction.

compound **X** + compound **Y** → fragrance compound

After one hour, a sample is removed and compared with pure samples of compounds **X** and **Y** using thin-layer chromatography.

Which of the following chromatograms shows that the reaction has produced a pure sample of the fragrance compound?

A

X   Y   sample

B

X   Y   sample

C

X   Y   sample

D

X   Y   sample
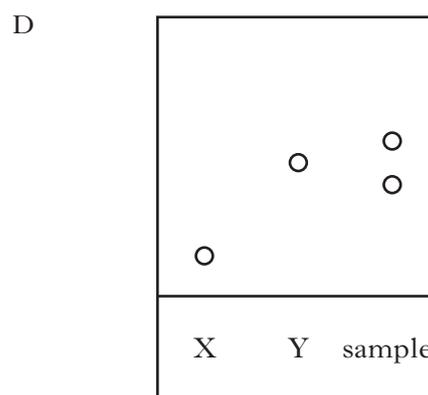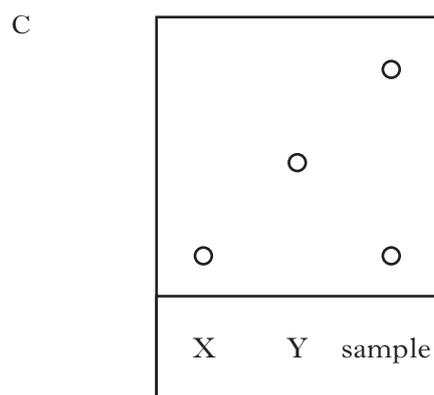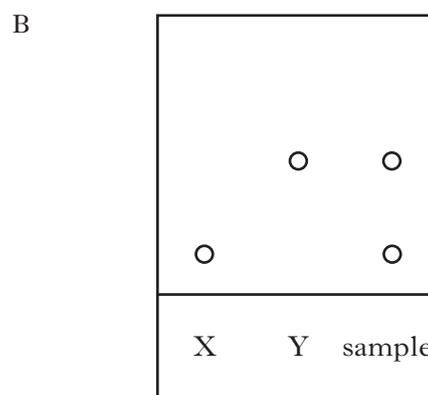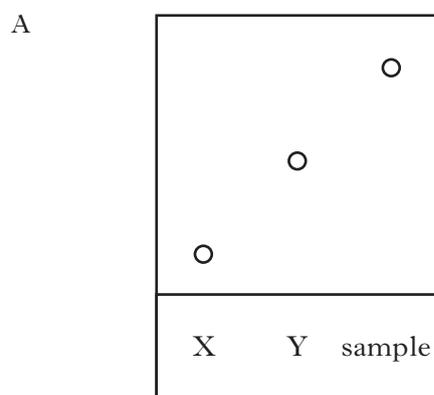
30. The alcohol content of wine was analysed by four students. Each student carried out the experiment three times.

	Experiment 1 (%)	Experiment 2 (%)	Experiment 3 (%)
Student A	10·0	9·0	8·0
Student B	6·4	6·6	6·8
Student C	6·5	6·6	6·6
Student D	9·0	8·5	9·6

The most reproducible results were obtained by

A   Student A

B   Student B

C   Student C

D   Student D.

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

[Turn over

Marks

SECTION B

All answers must be written clearly and legibly in ink.

1. The Periodic Table allows chemists to make predictions about the properties of elements.

   (*a*) The elements lithium to neon make up the second period of the Periodic Table.

Li	Be	B	C	N	O	F	Ne

   (i) Name an element from the second period that exists as a covalent network.

1

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

1

   (iii) Which element in the second period is the strongest reducing agent?

1

   (*b*) On descending Group 1 from lithium to caesium, the electronegativity of the elements decreases.

   Explain clearly why the electronegativity of elements decreases as you go down the group.

2

(5)

Marks

2. Zinc is an essential element for the body and is found in a variety of foods.

(*a*) The mass of zinc in four 100 g samples taken from a cheese spread was measured.

Sample	Mass of Zn/mg
1	4·0
2	21·7
3	3·9
4	4·1

Calculate the average mass of Zn, in mg, in 100 g of this cheese spread.

1

(*b*) The recommended daily allowance of zinc is 9·5 mg for an adult male.

100 g of peanuts contains 3·3 mg of zinc.

Calculate the mass of peanuts which would provide the recommended daily allowance of zinc.

2

(3)

3. Different fuels are used for different purposes.

(*a*) Ethanol, C_2H_5OH, can be used as a fuel in some camping stoves.

cooking pot

fuel

stove
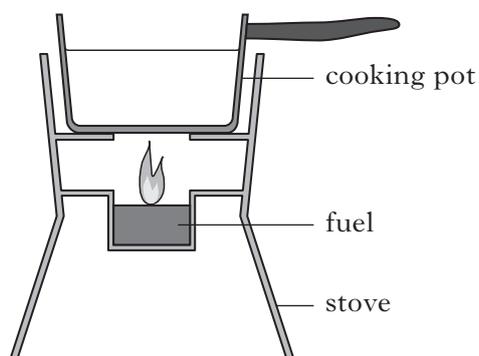
(i) The enthalpy of combustion of ethanol given in the data booklet is -1367 kJ mol^{-1}.

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

Show your working clearly.

3

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

2

3. (continued)

(*b*) Petrol is a fuel used in cars.

Energy released when 1·00 g of petrol burned/kJ	48·0
Volume of 1·00 g of petrol/cm^3	1·45

A car has a 50·0 litre petrol tank.

Calculate the energy, in kJ, released by the complete combustion of one tank of petrol.

2

(7)

[Turn over

4. Two typical compounds that are present in many perfumes are shown.

$C_{10}H_{16}$

limonene

$C_9H_{16}O$
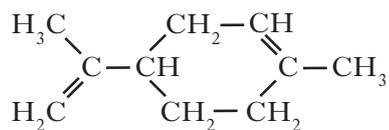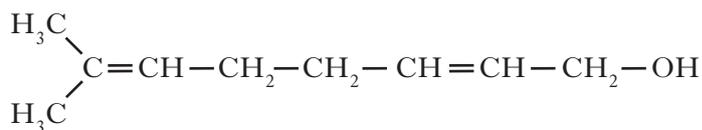
geraniol

(*a*) Why does geraniol evaporate more slowly than limonene?

1

(*b*) The structure of one of the first synthetic scents used in perfume is shown below.

$$H_3C - (CH_2)_8 - \overset{\overset{\displaystyle CH_3}{|}}{\underset{\underset{\displaystyle H}{|}}{C}} - \overset{\overset{\displaystyle O}{\|}}{C} - H$$
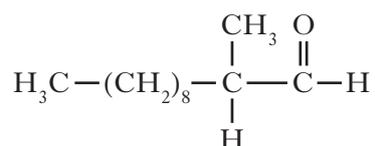
(i) Name the family of carbonyl compounds to which this synthetic scent belongs.

1

(ii) Complete the structure below to show the product formed when this scent is oxidised.

$$H_3C - (CH_2)_8 - \overset{\overset{\displaystyle CH_3}{|}}{\underset{\underset{\displaystyle H}{|}}{C}} -$$

1
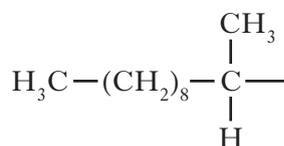
4. **(continued)**

    (*c*) Traces of a liquid were discovered in a bottle believed to contain perfume belonging to Queen Hatshepsut, ruler of Egypt over 3500 years ago.

       Perfumes were made by dissolving plant extracts containing pleasant smelling terpenes and esters in an edible oil. A little ethanol and water may also have been added.

       Using your knowledge of chemistry, comment on the possible smell(s) when such a bottle is opened after being stored for thousands of years.

3

(6)

[Turn over

5. The concentration of ethanol in a person's breath can be determined by measuring the voltage produced in an electrochemical cell.
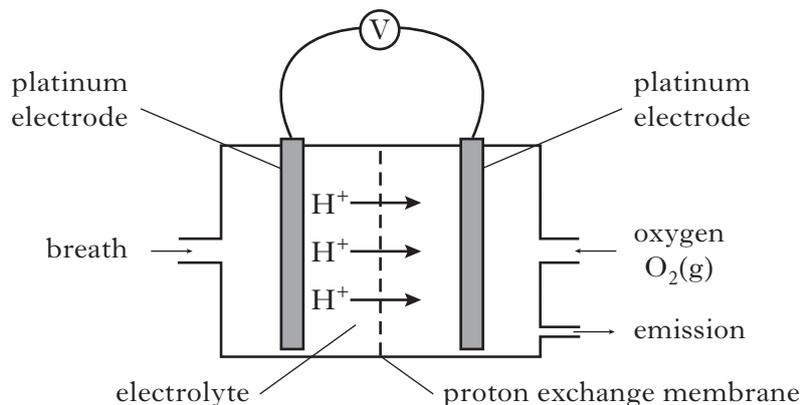
Different ethanol vapour concentrations produce different voltages as is shown in the graph below.
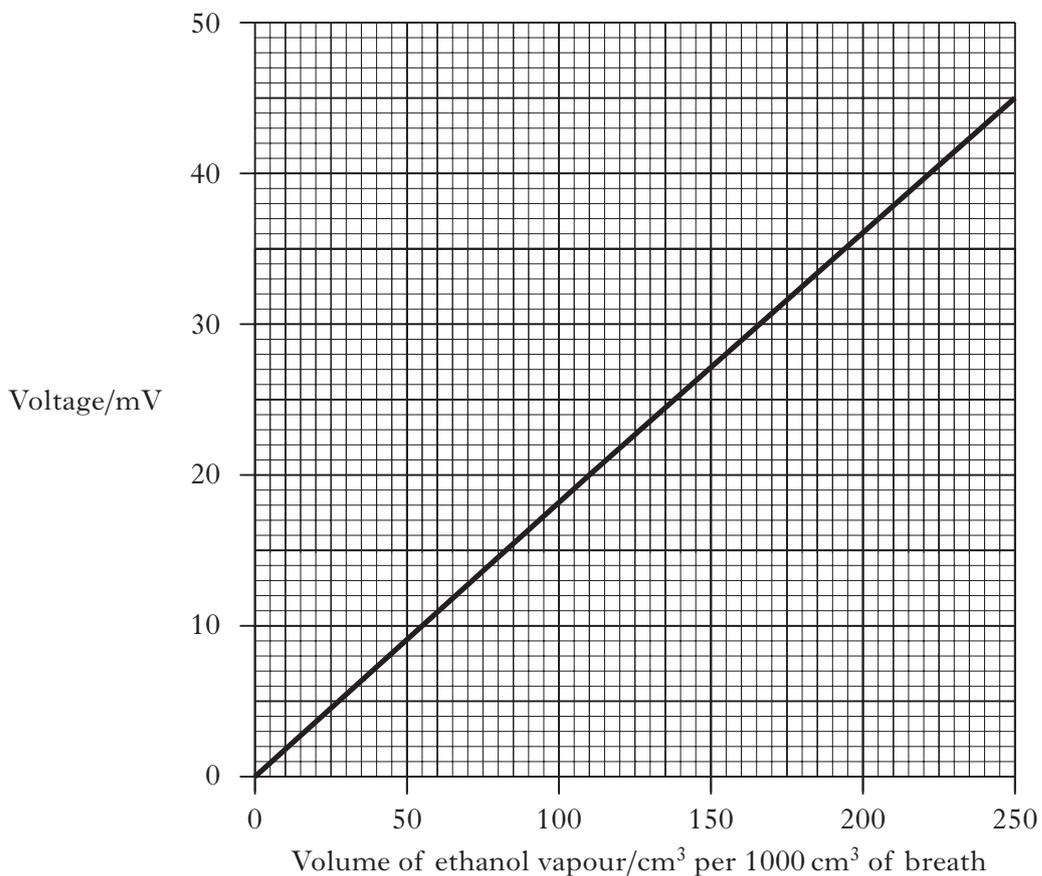
5. (continued)

(*a*) Calculate the mass of ethanol, in g, in $1000\,cm^3$ of breath when a voltage of $20\,mV$ was recorded.

(Take the molar volume of ethanol, C_2H_5OH, vapour to be 24 litres mol^{-1}.)

Show your working clearly.

3

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

$$O_2\ +\ 4H^+\ +\ 4e^-\ \rightarrow\ 2H_2O$$

$$CH_3CH_2OH\ +\ H_2O\ \rightarrow\ CH_3COOH\ +\ 4H^+\ +\ 4e^-$$
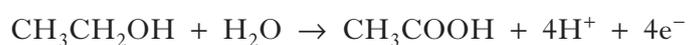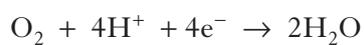
Write the overall redox equation for the reaction taking place.

1

(4)

[Turn over

Marks

6. Compounds containing sulfur occur widely in nature.

(*a*) The compound dimethyldisulfide, $CH_3S_2CH_3$, is present in garlic and onions.

Draw a full structural formula for this compound.

1

(*b*) Liquid hydrogen sulfide has a boiling point of $-60\,°C$.
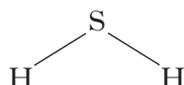
Name the strongest type of intermolecular force present in liquid hydrogen sulfide and state how this force arises.

2

6. **(continued)**

(*c*) Hydrogen sulfide, H_2S, can cause an unpleasant smell in water supplies.

The concentration of hydrogen sulfide can be measured by titrating with a chlorine standard solution.

The equation for the reaction taking place is

$$4Cl_2(aq) + H_2S(aq) + 4H_2O(\ell) \rightarrow SO_4^{2-}(aq) + 10H^+(aq) + 8Cl^-(aq)$$
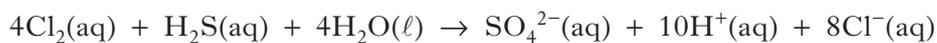
$50\cdot0\,cm^3$ samples of water were titrated using a $0\cdot010$ mol l^{-1} chlorine solution.

(i) Name an appropriate piece of apparatus which could be used to measure out the water samples.

1

(ii) What is meant by the term **standard solution**?

1

(iii) An average of $29\cdot4\,cm^3$ of $0\cdot010$ mol l^{-1} chlorine solution was required to react completely with a $50\cdot0\,cm^3$ sample of water.

Calculate the hydrogen sulfide concentration, in mol l^{-1}, present in the water sample.

Show your working clearly.

3

(8)

7. Electronegativity values can be used to predict the type of bonding present in substances.

The type of bonding between two elements can be predicted using the diagram below.

(Additional graph paper, if required, can be found on *Page thirty-six*.)
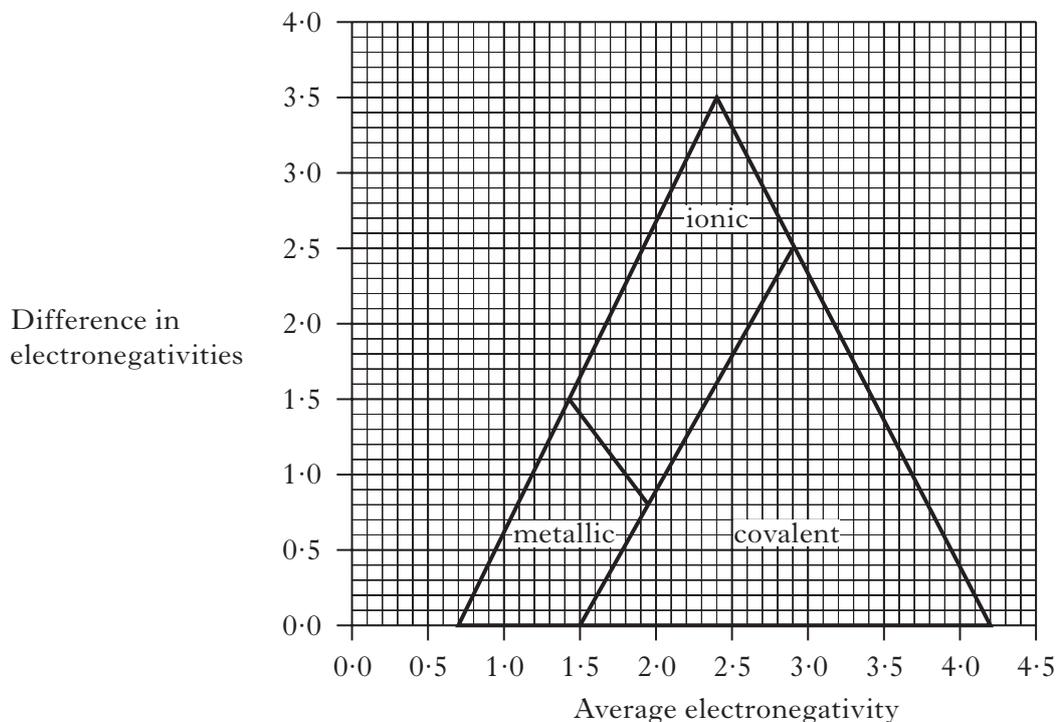
(*a*) Using the information in the diagram, state the highest average electronegativity found in ionic compounds.

1

(*b*) The diagram can be used to predict the bonding in tin iodide.

Electronegativity of tin   =   1·8
Electronegativity of iodine   =   2·6

Average electronegativity   =   2·2
Difference in electronegativity =   0·8

Predict the type of bonding in tin iodide.

1

7.   (continued)

(*c*)   The electronegativities of arsenic and chlorine are shown below.

Electronegativity of arsenic   =   2·2

Electronegativity of chlorine   =   3·0

Place a small cross on the diagram to show the position of arsenic chloride.

Show calculations clearly.

2

(4)

[Turn over

8. Many carbon compounds containing oxygen are very flammable.

The table shows information about two families of isomers.

The lowest temperature at which a compound will ignite is called its flash point.

Structure	Molecular formula	Boiling point /°C	Flash point /°C
$CH_3—CH_2—CH_2—CH_2—O—H$	$C_4H_{10}O$	118	37
$CH_3—CH_2—CH_2—O—CH_3$	$C_4H_{10}O$	39	−20
$CH_3—CH_2—O—CH_2—CH_3$	$C_4H_{10}O$	34	−45
$CH_3—CH_2—CH_2—CH_2—CH_2—O—H$	$C_5H_{12}O$	138	33
$CH_3—CH_2—CH_2—CH_2—O—CH_3$	$C_5H_{12}O$	70	−10
$CH_3—CH_2—CH_2—O—CH_2—CH_3$	$C_5H_{12}O$	63	−20

(a) A compound with the molecular formula $C_6H_{14}O$ has a boiling point of 158 °C.

Draw a structural formula for this compound.

1

(b) For a family of isomers in the table, write a general statement linking the flash points of the compounds to their structures.

1

(2)

9. Soft drinks contain many ingredients.

(*a*) Aspartame is added to many soft drinks as a sweetener. Its structure is shown below.
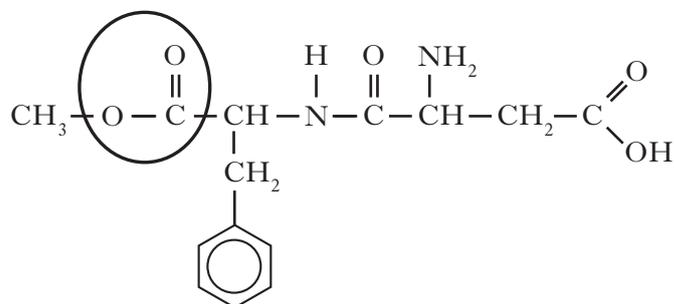
(i) Name the functional group circled.

1

(ii) 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.

CH_3-OH
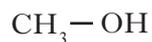
methanol
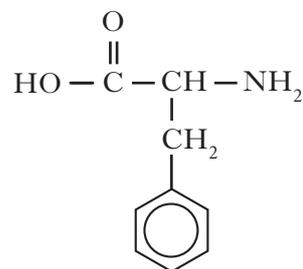
phenylalanine

Draw a structural formula for aspartic acid.

1

9. (*a*) **(continued)**

Marks

(iii) 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

(*b*) Caffeine is also added to some soft drinks. The concentration of caffeine can be found using chromatography.

A chromatogram for a standard solution containing 50 mg l^{-1} of caffeine is shown below.

Retention time of peak / s	Peak area
96	49000
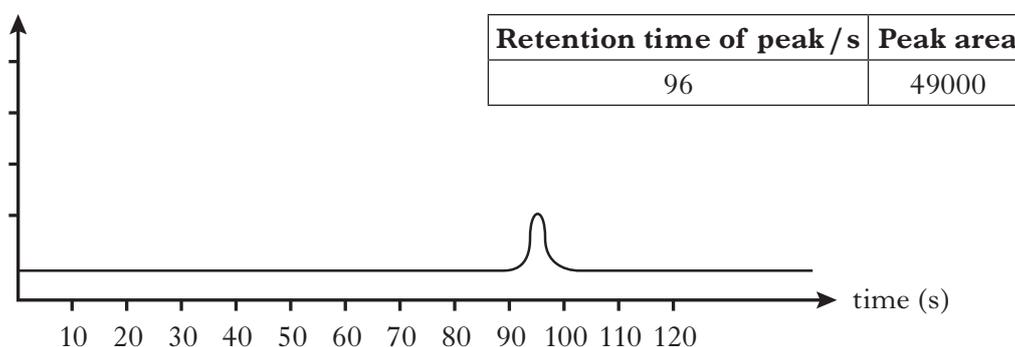
Results from four caffeine standard solutions were used to produce the calibration graph below.
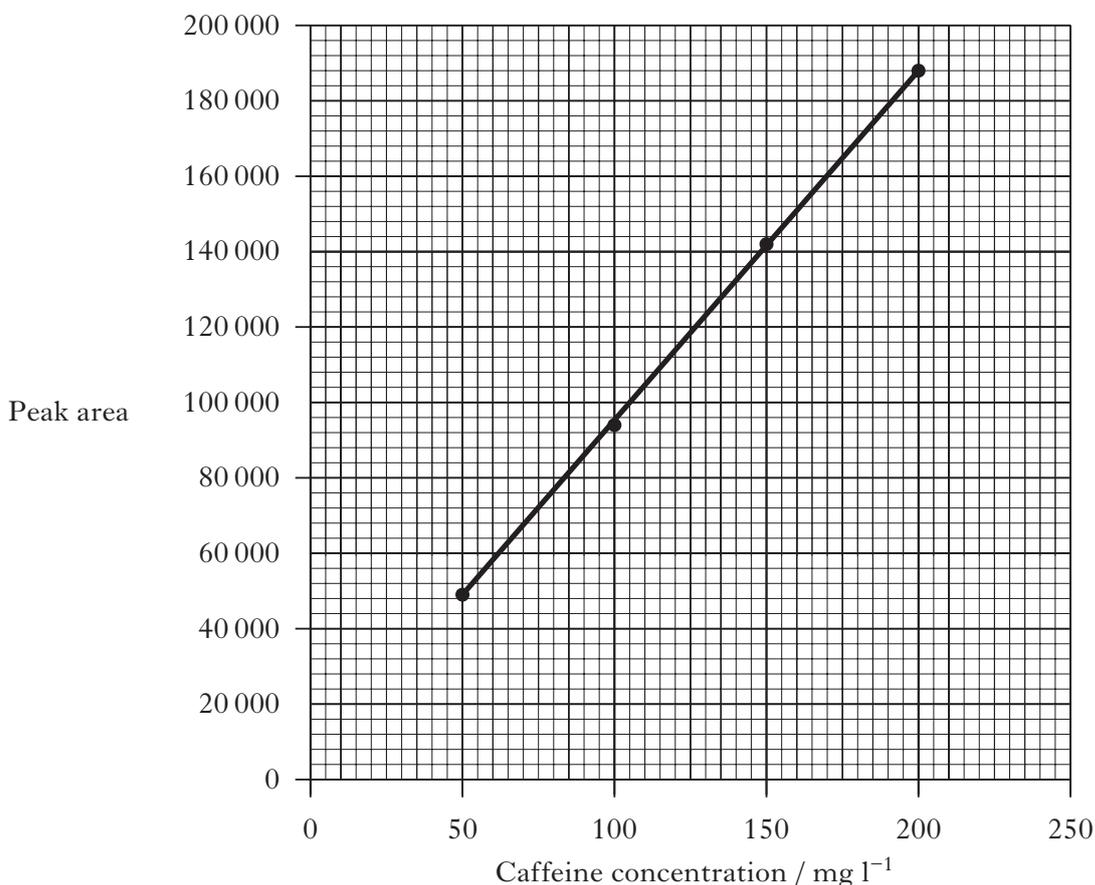
9. (*b*) (continued)

Chromatograms for two soft drinks are shown below.

Soft drink **X**

Retention time of peak / s	Peak area
42	1000
69	1350
96	68000

Time (s)

10 20 30 40 50 60 70 80 90 100 110 120
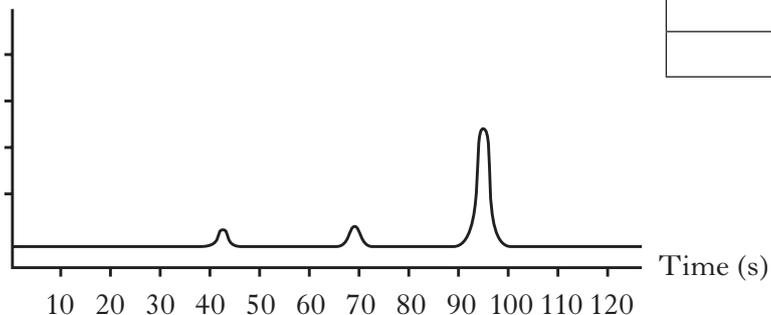
Soft drink **Y**

Retention time of peak / s	Peak area
17	7000
30	4600
43	3000
62	2500
96	————
115	5000

Time (s)

10 20 30 40 50 60 70 80 90 100 110 120
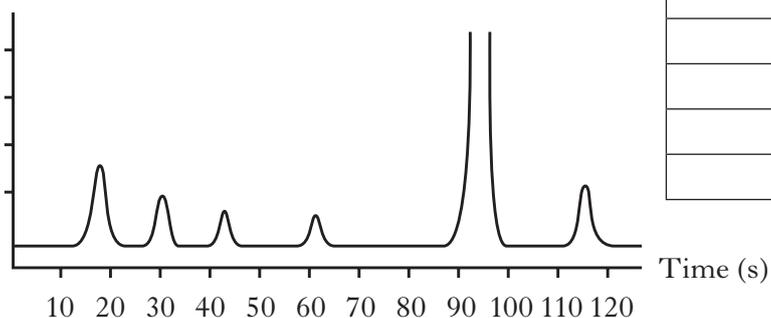
(i) What is the caffeine content, in mg l^{-1} of soft drink **X**?

1

(ii) The caffeine content of the soft drink **Y** cannot be determined from its chromatogram.

What should be done to the sample of soft drink **Y** so that the caffeine content could be reliably calculated?

1

(5)

10. Methanamide, $HCONH_2$, is widely used in industry to make nitrogen compounds. It is also used as a solvent as it can dissolve ionic compounds.

$$\begin{array}{cc} O & H \\ \parallel & \mid \\ H-C- & N-H \end{array}$$

(a) Why is methanamide a suitable solvent for ionic compounds?

1

(b) In industry, methanamide is produced by the reaction of an ester with ammonia.

$HCOOCH_3$	+	NH_3	$\rightarrow$	$HCONH_2$	+	CH_3OH
mass of one mole = 60·0 g		mass of one mole = 17·0 g		mass of one mole = 45·0 g		mass of one mole = 32·0 g
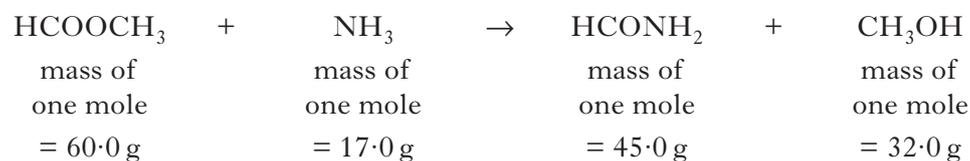
(i) Name the ester used in the industrial manufacture of methanamide.

1

(ii) Calculate the atom economy for the production of methanamide.

1

10. **(continued)**

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

$$HCOOH \quad + \quad NH_3 \quad \rightleftharpoons \quad HCONH_2 \quad + \quad H_2O$$

| mass of one mole = 46·0 g | mass of one mole = 17·0 g | mass of one mole = 45·0 g | mass of one mole = 18·0 g |
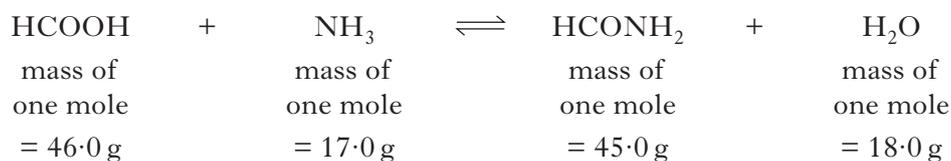
When 1·38 g of methanoic acid was reacted with excess ammonia, 0·945 g of methanamide was produced.

Calculate the percentage yield of methanamide.

Show your working clearly.

2

(5)

[Turn over

Marks

11. The element boron forms many useful compounds.

(*a*) Borane (BH_3) is used to synthesise 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.

$$H_3C-\underset{\underset{H}{|}}{\overset{\overset{CH_3}{|}}{C}}=\underset{}{\overset{\overset{H}{|}}{C}}-CH_3 \ + \ BH_3 \ \longrightarrow \ H_3C-\underset{\underset{H}{|}}{\overset{\overset{CH_3}{|}}{C}}-\underset{\underset{BH_2}{|}}{\overset{\overset{H}{|}}{C}}-CH_3$$
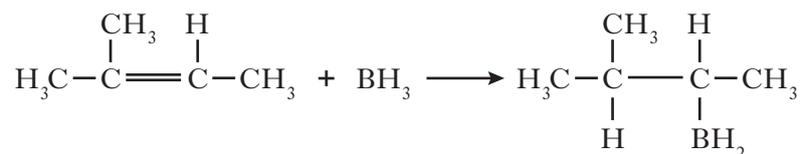
Stage 2 Oxidation Reaction

The organoborane compound is oxidised to form the alcohol.

$$CH_3-\underset{\underset{H}{|}}{\overset{\overset{CH_3}{|}}{C}}-\underset{\underset{BH_2}{|}}{\overset{\overset{H}{|}}{C}}-CH_3 \ \xrightarrow[KOH]{H_2O_2} \ CH_3-\underset{\underset{H}{|}}{\overset{\overset{CH_3}{|}}{C}}-\underset{\underset{OH}{|}}{\overset{\overset{H}{|}}{C}}-CH_3$$
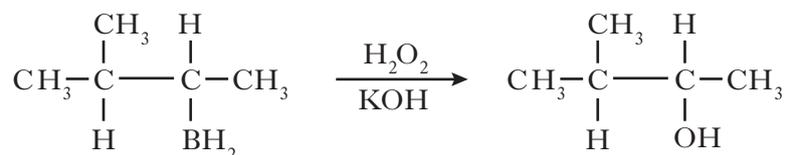
(i) Name the alcohol produced in Stage 2.

1

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

$$CH_3-CH_2-CH_2-\underset{}{\overset{\overset{CH_3}{|}}{C}}=\underset{}{\overset{\overset{H}{|}}{C}}-H$$

1

Page twenty-eight
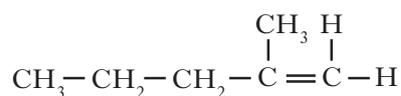
11. (continued)

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

(i) It can be prepared as shown.

$$BF_3 \ + \ \quad NaBH_4 \ \rightarrow \quad B_2H_6 \ + \quad NaBF_4$$

Balance this equation.

1

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

$$B_2H_6(g) \ + \ 3O_2(g) \ \rightarrow \ B_2O_3(s) \ + \ 3H_2O(\ell)$$
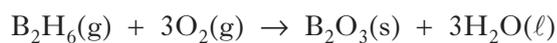
Calculate the enthalpy of combustion of diborane (B_2H_6) in kJ mol^{-1}, using the following data.

$$2B(s) \ + \ 3H_2(g) \quad \rightarrow \quad B_2H_6(g) \quad \Delta H = 36 \text{ kJ mol}^{-1}$$
$$H_2(g) \ + \ \tfrac{1}{2}O_2(g) \quad \rightarrow \quad H_2O(\ell) \quad \Delta H = -286 \text{ kJ mol}^{-1}$$
$$2B(s) \ + \ 1\tfrac{1}{2}O_2(g) \quad \rightarrow \quad B_2O_3(s) \quad \Delta H = -1274 \text{ kJ mol}^{-1}$$

2
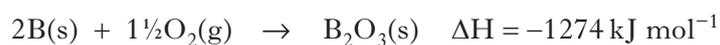
**(5)**

[Turn over

Marks

12. Potatoes contain a protein that acts as a catalyst in the breakdown of hydrogen peroxide.

$$2H_2O_2(aq) \rightarrow 2H_2O(\ell) + O_2(g)$$

A student wanted to measure the volume of oxygen gas given off, over a five minute period, when samples of potato were added to a solution of hydrogen peroxide.

(*a*) Complete the diagram below to show how the volume of oxygen gas given off could be measured.

side-arm test tube

potato sample

hydrogen peroxide solution

1
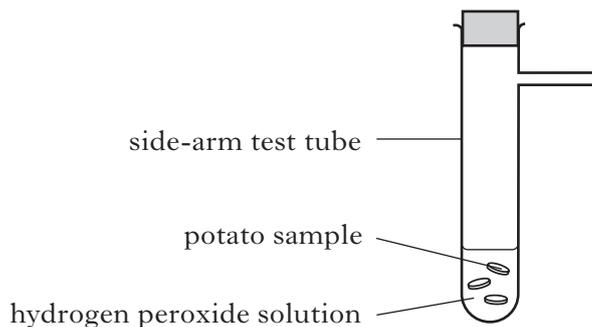
(*b*) The student wanted to be able to repeat the experiment at various temperatures between 20 °C and 70 °C to investigate the effect of temperature on the protein catalysing the reaction.

(i) What is the most appropriate way of heating the side-arm test tube to control the temperature accurately over this range?

1

(ii) At 70 °C the protein structure changes so that it no longer works as a catalyst.

What change happens to the structure of all proteins when they are heated?

1

(3)

Marks

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

(*a*) Iodine can be extracted from iodide salts by reacting them with acidified permanganate solution.

$$10I^-(aq) + 2MnO_4^-(aq) + 16H^+(aq) \rightarrow 5I_2(aq) + 2Mn^{2+}(aq) + 8H_2O(\ell)$$
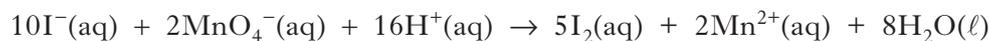
Why can fluorine not be produced from fluoride salts using acidified permanganate?

1

(*b*) Fluorine reacts with methane via a free radical chain reaction.

Some steps in the chain reaction are shown in the table below.

Reaction step	Name of step
$F_2 \rightarrow 2F\bullet$	
$F\bullet + CH_4 \rightarrow HF + \bullet CH_3$ $\bullet CH_3 + F_2 \rightarrow CH_3F + F\bullet$	propagation
$\bullet CH_3 + F\bullet \rightarrow CH_3F$	termination
	termination

Complete the table by:

(i) inserting the missing name for the first step;   1

(ii) showing another possible termination reaction in the final row of the table.   1

[Turn over

Marks

13. **(continued)**

(c) Tetrafluoroethene, C_2F_4, is produced in industry by a series of reactions.

The final reaction in its manufacture is shown below.

$$2CHClF_2(g) \rightleftharpoons C_2F_4(g) + 2HCl(g)$$

The graph shows the variation in concentration of C_2F_4 formed as temperature is increased.
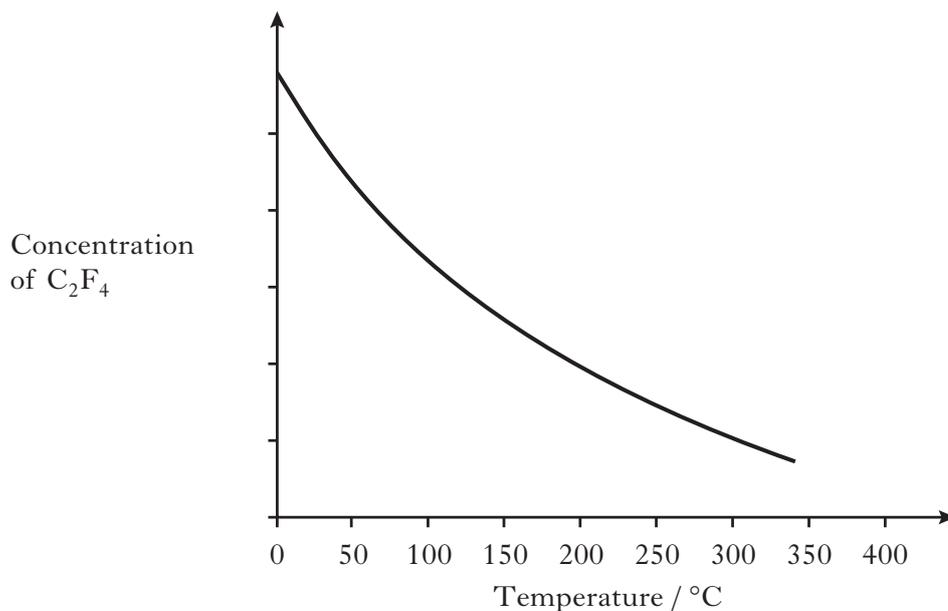
(i) What conclusion can be drawn about the enthalpy change for the formation of tetrafluoroethene?

1

13. (c) (continued)

(ii) Sketch a graph to show how the concentration of tetrafluoroethene formed would vary with increasing pressure.

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

Concentration of C_2F_4

Pressure
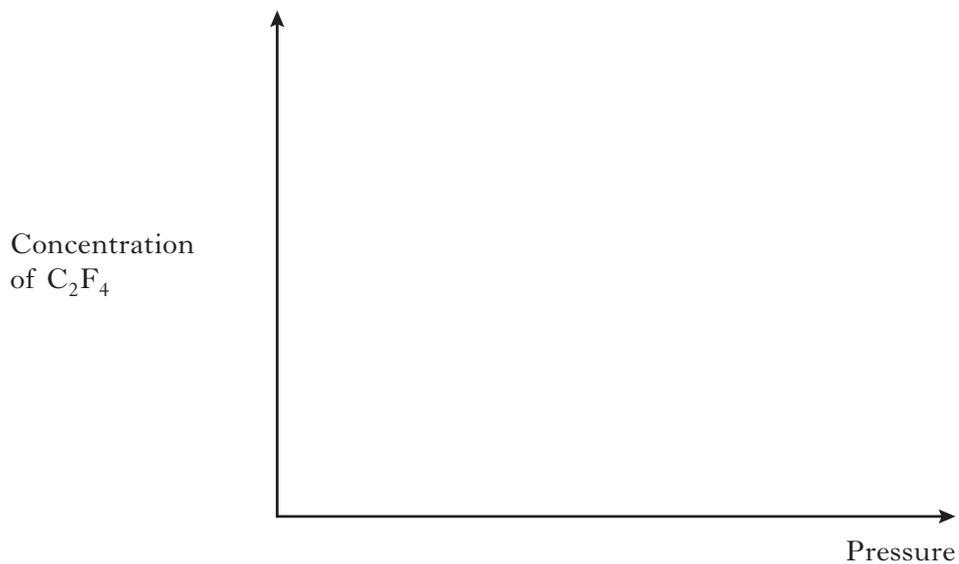
1

(5)

[Turn over

Marks

14. 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	$CH_3(CH_2)_{16}COOH$
oleic acid	octadec-9-enoic acid	$CH_3(CH_2)_7CH=CH(CH_2)_7COOH$
linoleic acid	octadec-9,12-dienoic acid	$CH_3(CH_2)_4CH=CHCH_2CH=CH(CH_2)_7COOH$
linolenic acid		$CH_3CH_2CH=CHCH_2CH=CHCH_2CH=CH(CH_2)_7COOH$

(*a*) What is the systematic name for linolenic acid?

1

(*b*) Stearic acid reacts with sodium hydroxide solution to form sodium stearate.
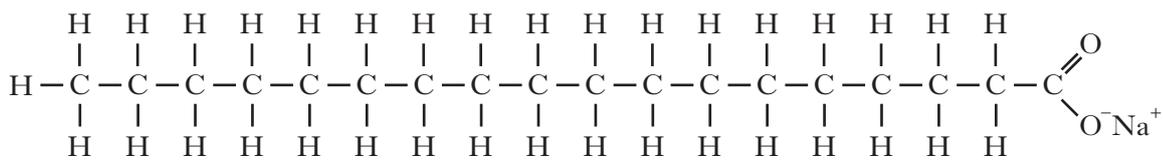
sodium stearate

(i) Name the type of reaction taking place when stearic acid reacts with sodium hydroxide.

1

(ii) **Explain fully** how sodium stearate acts to keep grease and non-polar substances suspended in water during cleaning.

3

(5)

Marks

15. Hydrogels are used in disposable nappies. They are fine powders that can absorb up to 500 times their own weight in water.

A hydrogel is a very long molecule with carboxyl groups at regular intervals along its length. A short section of a hydrogel molecule is shown below.
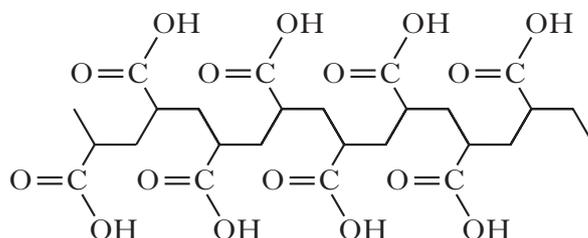

Hydrogels are extremely good at soaking up water because the water molecules are strongly attracted to them.

Using your knowledge of chemistry, comment on how suitable hydrogels would be for absorbing liquids or solutions spilled in a chemistry lab.

(3)

[*END OF QUESTION PAPER*]

ADDITIONAL GRAPH PAPER FOR USE IN QUESTION 7(*c*)

Difference in
electronegativities

Average electronegativity
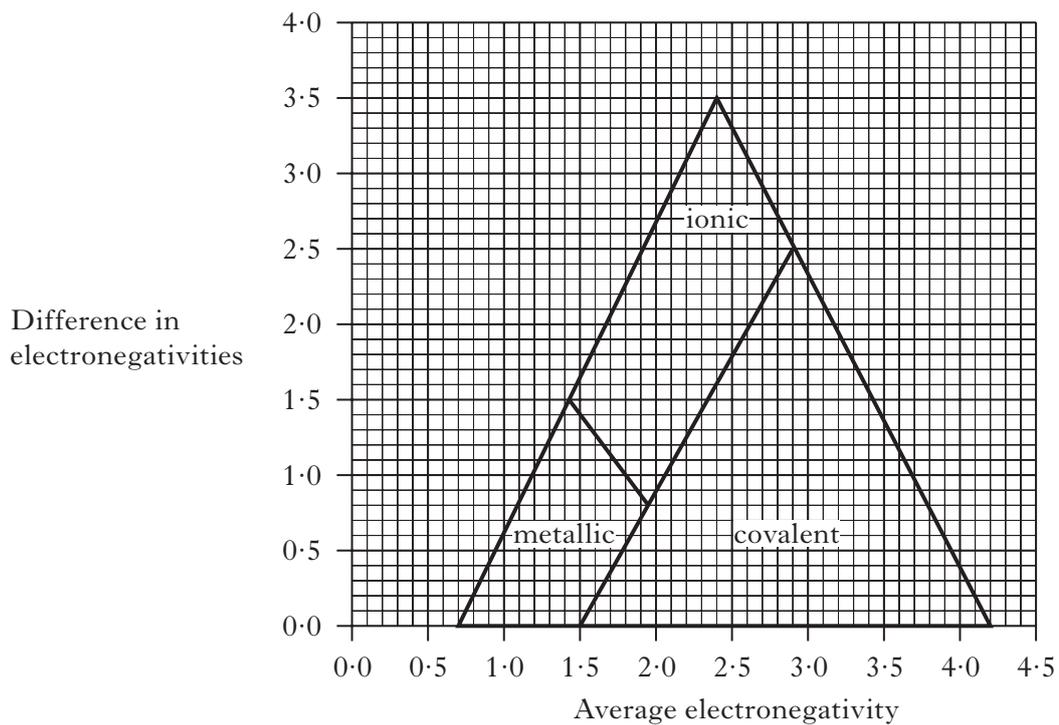
ADDITIONAL GRAPH FOR USE IN QUESTION 13(*c*)

Concentration
of C_2F_4

Pressure
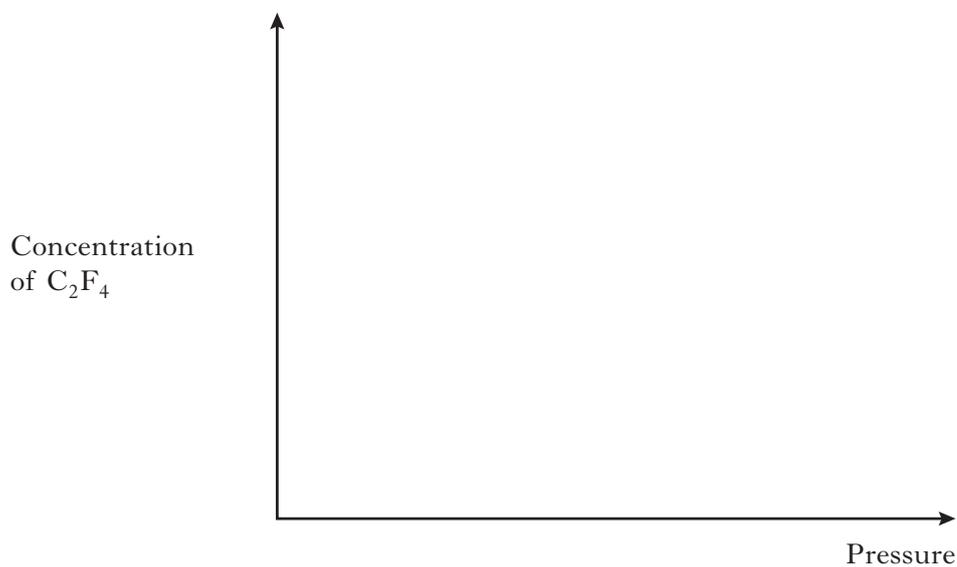
ADDITIONAL SPACE FOR ANSWERS

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