

FOR OFFICIAL USE

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Total  
Section B

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**X012/301**

NATIONAL  
QUALIFICATIONS  
2010

WEDNESDAY, 2 JUNE  
9.00 AM – 11.30 AM

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)

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Surname

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Date of birth

Day    Month    Year

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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

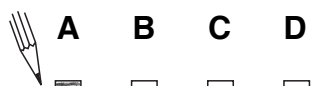
- 1 Check that the answer sheet provided is for **Chemistry Higher (Section A)**.
- 2 For this section of the examination you must use an **HB pencil** and, where necessary, an eraser.
- 3 Check that the answer sheet you have been given has **your name, date of birth, SCN** (Scottish Candidate Number)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

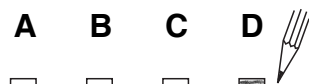
- A chromatography
- B fractional distillation
- C fractional crystallisation
- D filtration.

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



### Changing an answer

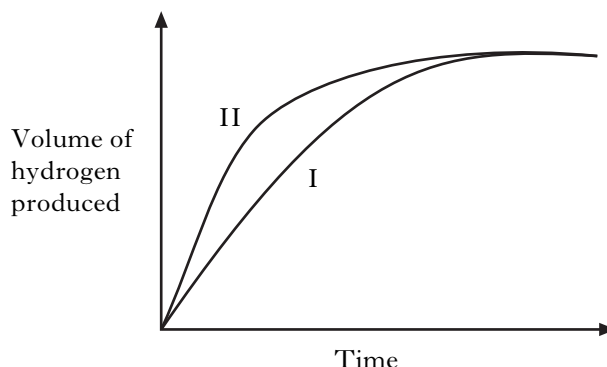
If you decide to change your answer, carefully erase your first answer and using your pencil, fill in the answer you want. The answer below has been changed to **D**.



1. Which of the following gases would dissolve in water to form an alkali?
- A HBr  
B NH<sub>3</sub>  
C CO<sub>2</sub>  
D CH<sub>4</sub>
2. Which of the following pairs of solutions is most likely to produce a precipitate when mixed?
- A Magnesium nitrate + sodium chloride  
B Magnesium nitrate + sodium sulphate  
C Silver nitrate + sodium chloride  
D Silver nitrate + sodium sulphate
3. 0.5 mol of copper(II) chloride and 0.5 mol of copper(II) sulphate are dissolved together in water and made up to 500 cm<sup>3</sup> of solution.  
What is the concentration of Cu<sup>2+</sup>(aq) ions in the solution in mol l<sup>-1</sup>?
- A 0.5  
B 1.0  
C 2.0  
D 4.0
4. For any chemical, its temperature is a measure of
- A the average kinetic energy of the particles that react  
B the average kinetic energy of all the particles  
C the activation energy  
D the minimum kinetic energy required before reaction occurs.
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. Excess zinc was added to 100 cm<sup>3</sup> of hydrochloric acid, concentration 1 mol l<sup>-1</sup>.

Graph I refers to this reaction.



Graph II could be for

- A excess zinc reacting with 100 cm<sup>3</sup> of hydrochloric acid, concentration 2 mol l<sup>-1</sup>  
B excess zinc reacting with 100 cm<sup>3</sup> of sulphuric acid, concentration 1 mol l<sup>-1</sup>  
C excess zinc reacting with 100 cm<sup>3</sup> of ethanoic acid, concentration 1 mol l<sup>-1</sup>  
D excess magnesium reacting with 100 cm<sup>3</sup> of hydrochloric acid, concentration 1 mol l<sup>-1</sup>.
7. Which of the following is **not** a correct statement about the effect of a catalyst?
- The catalyst
- A provides an alternative route to the products  
B lowers the energy that molecules need for successful collisions  
C provides energy so that more molecules have successful collisions  
D forms bonds with reacting molecules.
8. A potential energy diagram can be used to show the activation energy ( $E_A$ ) and the enthalpy change ( $\Delta H$ ) for a reaction.  
Which of the following combinations of  $E_A$  and  $\Delta H$  could **never** be obtained for a reaction?
- A  $E_A = 50 \text{ kJ mol}^{-1}$  and  $\Delta H = -100 \text{ kJ mol}^{-1}$   
B  $E_A = 50 \text{ kJ mol}^{-1}$  and  $\Delta H = +100 \text{ kJ mol}^{-1}$   
C  $E_A = 100 \text{ kJ mol}^{-1}$  and  $\Delta H = +50 \text{ kJ mol}^{-1}$   
D  $E_A = 100 \text{ kJ mol}^{-1}$  and  $\Delta H = -50 \text{ kJ mol}^{-1}$

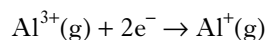
[Turn over

9. As the relative atomic mass in the halogens increases
- A the boiling point increases
  - B the density decreases
  - C the first ionisation energy increases
  - D the atomic size decreases.

10. The table shows the first three ionisation energies of aluminium.

Ionisation energy/kJ mol <sup>-1</sup>		
1st	2nd	3rd
584	1830	2760

Using this information, what is the enthalpy change, in kJ mol<sup>-1</sup>, for the following reaction?



- A +2176
  - B -2176
  - C +4590
  - D -4590
11. When two atoms form a non-polar covalent bond, the two atoms **must** have
- A the same atomic size
  - B the same electronegativity
  - C the same ionisation energy
  - D the same number of outer electrons.
12. In which of the following liquids does hydrogen bonding occur?
- A Ethanoic acid
  - B Ethyl ethanoate
  - C Hexane
  - D Hex-1-ene

13. Which line in the table shows the correct entries for tetrafluoroethene?

	Polar bonds?	Polar molecules?
A	yes	yes
B	yes	no
C	no	no
D	no	yes

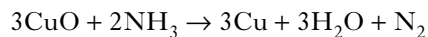
14. Element **X** was found to have the following properties.

- (i) It does not conduct electricity when solid.
- (ii) It forms a gaseous oxide.
- (iii) It is a solid at room temperature.

Element **X** could be

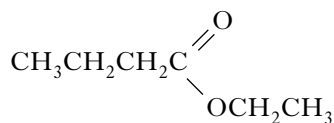
- A magnesium
  - B silicon
  - C nitrogen
  - D sulphur.
15. The Avogadro Constant is the same as the number of
- A molecules in 16 g of oxygen
  - B ions in 1 litre of sodium chloride solution, concentration 1 mol l<sup>-1</sup>
  - C atoms in 24 g of carbon
  - D molecules in 2 g of hydrogen.
16. Which of the following contains one mole of neutrons?
- A 1 g of  ${}^1_1\text{H}$
  - B 1 g of  ${}^{12}_6\text{C}$
  - C 2 g of  ${}^{24}_{12}\text{Mg}$
  - D 2 g of  ${}^{22}_{10}\text{Ne}$

17.  $20 \text{ cm}^3$  of ammonia gas reacted with an excess of heated copper(II) oxide.



Assuming all measurements were made at  $200^\circ\text{C}$ , what would be the volume of gaseous products?

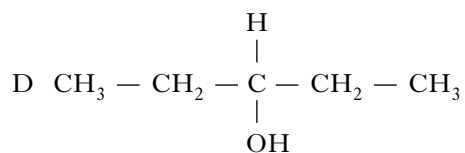
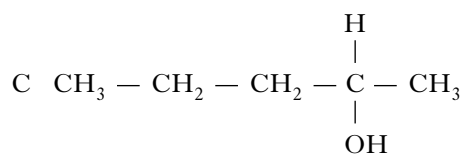
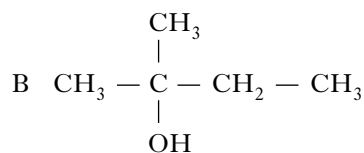
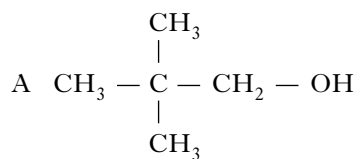
- A  $10 \text{ cm}^3$   
B  $20 \text{ cm}^3$   
C  $30 \text{ cm}^3$   
D  $40 \text{ cm}^3$
18. Which of the following fuels can be produced by the fermentation of biological material under anaerobic conditions?
- A Methane  
B Ethane  
C Propane  
D Butane
19. Rum flavouring is based on the compound with the formula shown.



It can be made from

- A ethanol and butanoic acid  
B propanol and ethanoic acid  
C butanol and methanoic acid  
D propanol and propanoic acid.

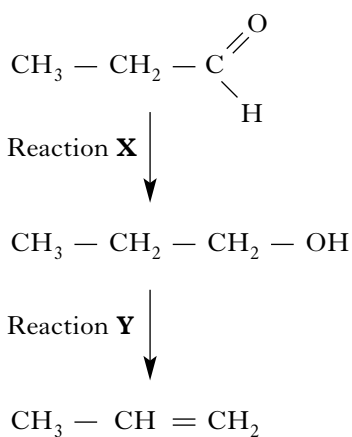
20. Which of the following structural formulae represents a tertiary alcohol?



21. What is the product when one mole of chlorine gas reacts with one mole of ethyne?
- A 1,1-Dichloroethene  
B 1,1-Dichloroethane  
C 1,2-Dichloroethene  
D 1,2-Dichloroethane

[Turn over

22.



Which line in the table correctly describes reactions **X** and **Y**?

	Reaction X	Reaction Y
A	oxidation	dehydration
B	oxidation	condensation
C	reduction	dehydration
D	reduction	condensation

23. Ozone has an important role in the upper atmosphere because it

- A absorbs ultraviolet radiation
- B absorbs certain CFCs
- C reflects ultraviolet radiation
- D reflects certain CFCs.

24. Synthesis gas consists mainly of

- A CH<sub>4</sub> alone
- B CH<sub>4</sub> and CO
- C CO and H<sub>2</sub>
- D CH<sub>4</sub>, CO and H<sub>2</sub>.

25. Ethene is used in the manufacture of addition polymers.

What type of reaction is used to produce ethene from ethane?

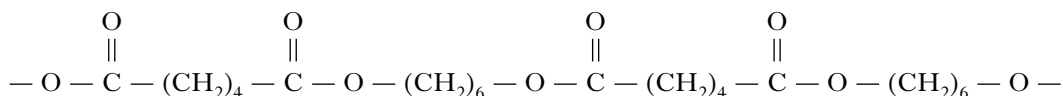
- A Cracking
- B Addition
- C Oxidation
- D Hydrogenation

26. Polyester fibres and cured polyester resins are both very strong.

Which line in the table correctly describes the structure of these polyesters?

	Fibre	Cured resin
A	cross-linked	cross-linked
B	linear	linear
C	cross-linked	linear
D	linear	cross-linked

27. Part of a polymer chain is shown below.



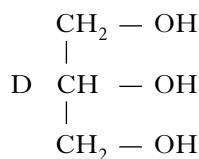
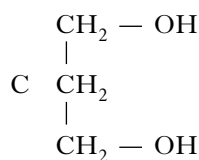
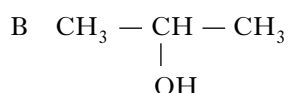
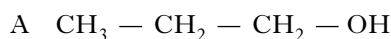
Which of the following compounds, when added to the reactants during polymerisation, would stop the polymer chain from getting too long?

- A  $\text{HO} - \overset{\text{O}}{\parallel} \text{C} - (\text{CH}_2)_4 - \overset{\text{O}}{\parallel} \text{C} - \text{OH}$
- B  $\text{HO} - (\text{CH}_2)_6 - \text{OH}$
- C  $\text{HO} - (\text{CH}_2)_5 - \overset{\text{O}}{\parallel} \text{C} - \text{OH}$
- D  $\text{CH}_3 - (\text{CH}_2)_4 - \text{CH}_2 - \text{OH}$

28. Which of the following fatty acids is unsaturated?

- A  $C_{19}H_{39}COOH$
- B  $C_{21}H_{43}COOH$
- C  $C_{17}H_{31}COOH$
- D  $C_{13}H_{27}COOH$

29. Which of the following alcohols is likely to be obtained on hydrolysis of butter?



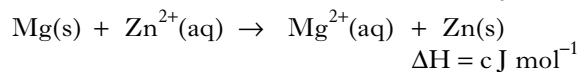
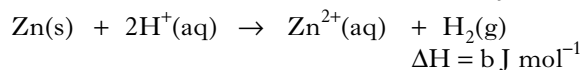
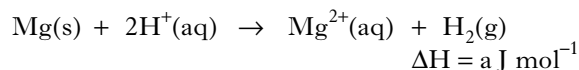
30. Amino acids are converted into proteins by

- A hydration
- B hydrolysis
- C hydrogenation
- D condensation.

31. Which of the following compounds is a raw material in the chemical industry?

- A Ammonia
- B Calcium carbonate
- C Hexane
- D Nitric acid

32. Given the equations



then, according to Hess's Law

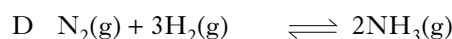
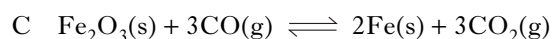
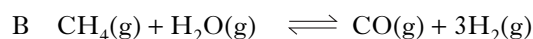
A  $c = a - b$

B  $c = a + b$

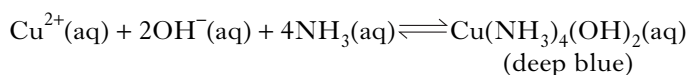
C  $c = b - a$

D  $c = -b - a$ .

33. In which of the following reactions would an increase in pressure cause the equilibrium position to move to the left?



34. If ammonia is added to a solution containing copper(II) ions an equilibrium is set up.



If acid is added to this equilibrium system

A the intensity of the deep blue colour will increase

B the equilibrium position will move to the right

C the concentration of  $Cu^{2+}(aq)$  ions will increase

D the equilibrium position will not be affected.

35. Which of the following is the best description of a  $0.1 \text{ mol l}^{-1}$  solution of hydrochloric acid?

A Dilute solution of a weak acid

B Dilute solution of a strong acid

C Concentrated solution of a weak acid

D Concentrated solution of a strong acid

[Turn over

36. A solution has a negative pH value.  
This solution
- A neutralises  $\text{H}^+(\text{aq})$  ions
  - B contains no  $\text{OH}^-(\text{aq})$  ions
  - C has a high concentration of  $\text{H}^+(\text{aq})$  ions
  - D contains neither  $\text{H}^+(\text{aq})$  ions nor  $\text{OH}^-(\text{aq})$  ions.
37. When a certain aqueous solution is diluted, its conductivity decreases but its pH remains constant.  
It could be
- A ethanoic acid
  - B sodium chloride
  - C sodium hydroxide
  - D nitric acid.
38. Equal volumes of four  $1 \text{ mol l}^{-1}$  solutions were compared.  
Which of the following  $1 \text{ mol l}^{-1}$  solutions contains the most ions?
- A Nitric acid
  - B Hydrochloric acid
  - C Ethanoic acid
  - D Sulphuric acid
39. In which reaction is hydrogen gas acting as an oxidising agent?
- A  $\text{H}_2 + \text{CuO} \rightarrow \text{H}_2\text{O} + \text{Cu}$
  - B  $\text{H}_2 + \text{C}_2\text{H}_4 \rightarrow \text{C}_2\text{H}_6$
  - C  $\text{H}_2 + \text{Cl}_2 \rightarrow 2\text{HCl}$
  - D  $\text{H}_2 + 2\text{Na} \rightarrow 2\text{NaH}$
40. Which particle will be formed when an atom of  ${}^{211}_{83}\text{Bi}$  emits an  $\alpha$ -particle and the decay product then emits a  $\beta$ -particle?
- A  ${}^{207}_{82}\text{Pb}$
  - B  ${}^{208}_{81}\text{Tl}$
  - C  ${}^{209}_{80}\text{Hg}$
  - D  ${}^{210}_{79}\text{Au}$

**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. The elements lithium, boron and nitrogen are in the second period of the Periodic Table.

Complete the table below to show **both** the bonding and structure of these three elements at room temperature.

Name of element	Bonding	Structure
lithium		lattice
boron		
nitrogen	covalent	

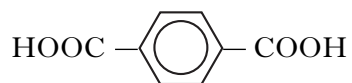
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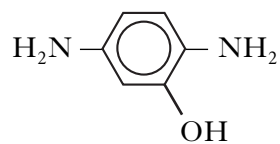
Marks

2. (a) Polyhydroxyamide is a recently developed fire-resistant polymer.

The monomers used to produce the polymer are shown.



diacid



diamine

- (i) How many hydrogen atoms are present in a molecule of the diamine molecule?

1

- (ii) Draw a section of polyhydroxyamide showing **one** molecule of each monomer joined together.

1

- (b) Poly(ethenol), another recently developed polymer, has an unusual property for a plastic.

What is this unusual property?

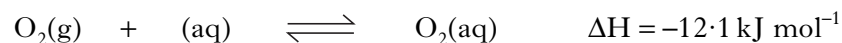
1

(3)

Marks

3. Atmospheric oxygen,  $O_2(g)$ , dissolves in the Earth's oceans forming dissolved oxygen,  $O_2(aq)$ , which is essential for aquatic life.

An equilibrium is established.



- (a) (i) What is meant by a reaction at "equilibrium"?

1

- (ii) What would happen to the concentration of dissolved oxygen if the temperature of the Earth's oceans increased?

1

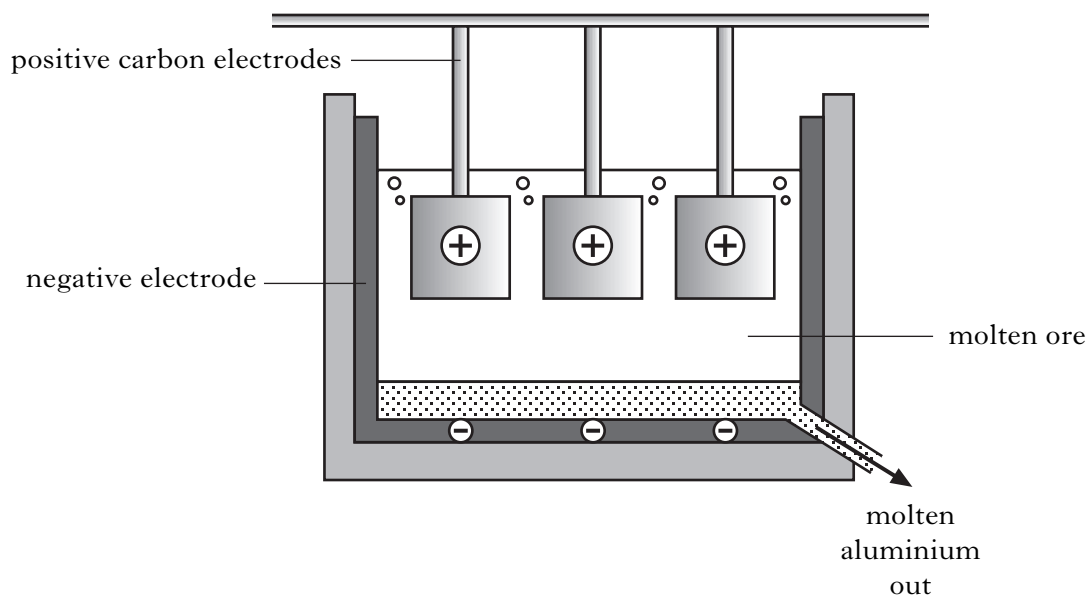
- (b) A sample of oceanic water was found to contain 0.010 g of dissolved oxygen. Calculate the number of moles of dissolved oxygen present in the sample.

1

(3)

Marks

4. In the Hall-Heroult Process, aluminium is produced by the electrolysis of an ore containing aluminium oxide.



- (a) Suggest why the positive carbon electrodes need to be replaced regularly.

1

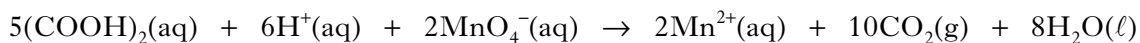
- (b) Calculate the mass of aluminium, in grams, produced in 20 minutes when a current of 50 000 A is used.

**Show your working clearly.**

3  
(4)

Marks

5. The reaction of oxalic acid with an acidified solution of potassium permanganate was studied to determine the effect of temperature changes on reaction rate.



The reaction was carried out at several temperatures between 40 °C and 60 °C. The end of the reaction was indicated by a colour change from purple to colourless.

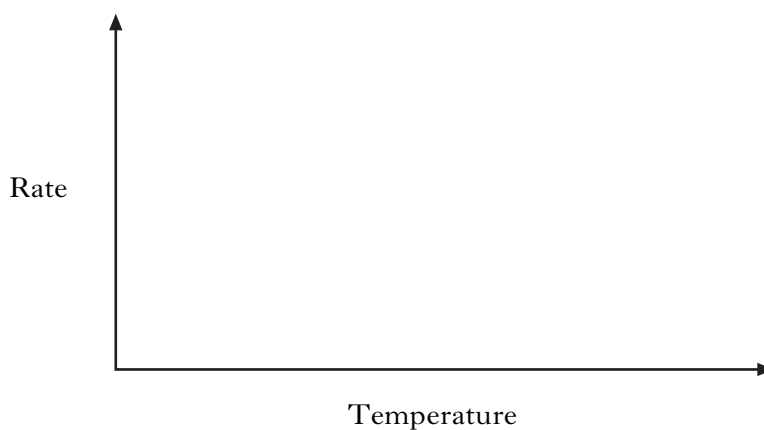
- (a) (i) State **two** factors that should be kept the same in these experiments.

1

- (ii) Why is it difficult to measure an accurate value for the reaction time when the reaction is carried out at room temperature?

1

- (b) Sketch a graph to show how the rate varied with increasing temperature.

1  
(3)

[Turn over

Marks

6. Positron emission tomography, PET, is a technique that provides information about biochemical processes in the body.

Carbon-11,  $^{11}\text{C}$ , is a positron-emitting radioisotope that is injected into the bloodstream.

A positron can be represented as  ${}^0_1\text{e}$ .

- (a) Complete the nuclear equation for the decay of  $^{11}\text{C}$  by positron-emission.



1

- (b) A sample of  $^{11}\text{C}$  had an initial count rate of  $640 \text{ counts min}^{-1}$ . After 1 hour the count rate had fallen to  $80 \text{ counts min}^{-1}$ .

Calculate the half-life, in minutes, of  $^{11}\text{C}$ .

1

- (c)  $^{11}\text{C}$  is injected into the bloodstream as glucose molecules ( $\text{C}_6\text{H}_{12}\text{O}_6$ ). Some of the carbon atoms in these glucose molecules are  $^{11}\text{C}$  atoms.

The intensity of radiation in a sample of  $^{11}\text{C}$  is compared with the intensity of radiation in a sample of glucose containing  $^{11}\text{C}$  atoms. Both samples have the same mass.

Which sample has the higher intensity of radiation?

Give a reason for your answer.

1  
(3)

Marks

7. Hydrogen cyanide, HCN, is highly toxic.

(a) Information about hydrogen cyanide is given in the table.

Structure	$\text{H}-\text{C}\equiv\text{N}$
Molecular mass	27
Boiling point	$26^\circ\text{C}$

Although hydrogen cyanide has a similar molecular mass to nitrogen, it has a much higher boiling point. This is due to the permanent dipole–permanent dipole attractions in liquid hydrogen cyanide.

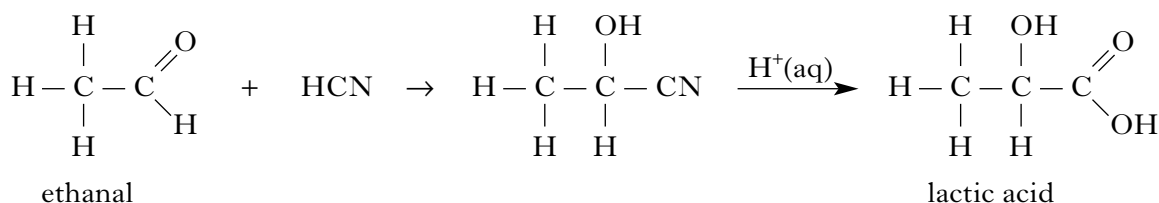
What is meant by permanent dipole–permanent dipole attractions?

Explain how they arise in liquid hydrogen cyanide.

2

(b) Hydrogen cyanide is of great importance in organic chemistry. It offers a route to increasing the chain length of a molecule.

If ethanal is reacted with hydrogen cyanide and the product hydrolysed with acid, lactic acid is formed.



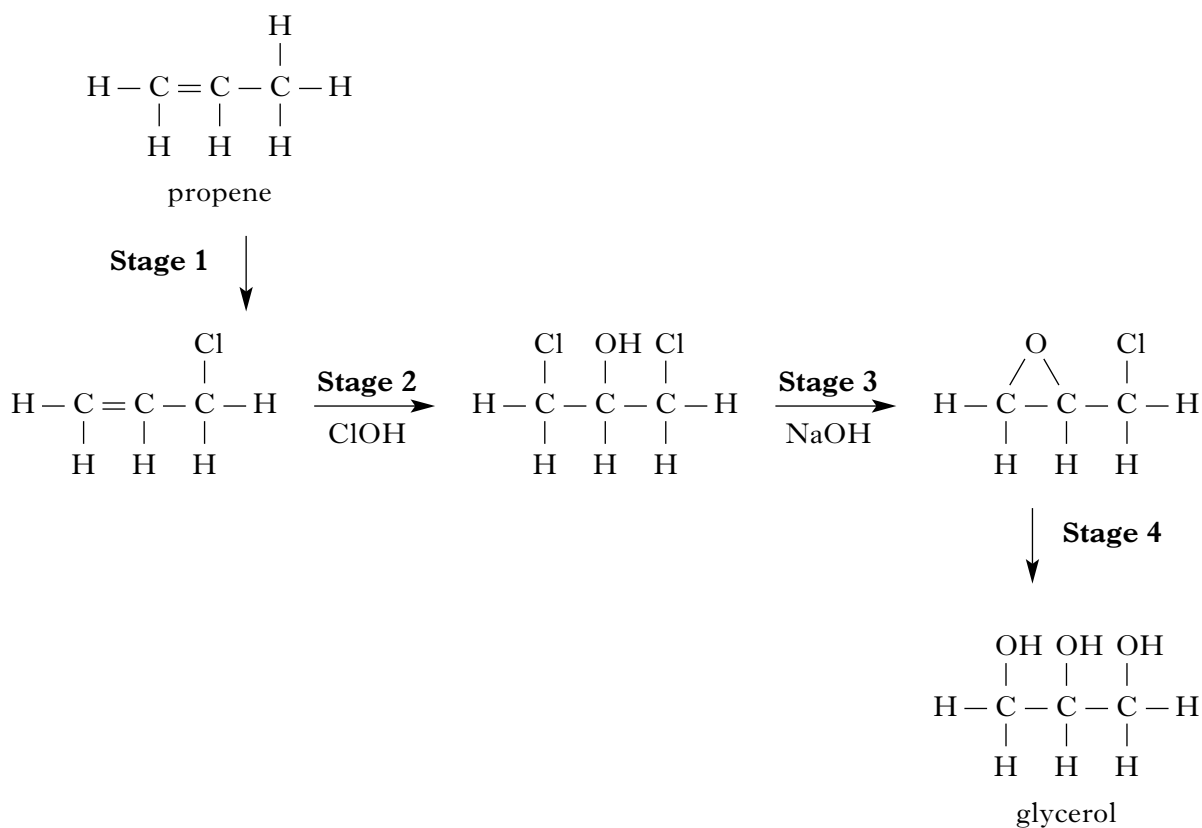
Draw a structural formula for the acid produced when propanone is used instead of ethanal in the above reaction sequence.

1  
(3)

Marks

8. Glycerol,  $C_3H_8O_3$ , is widely used as an ingredient in toothpaste and cosmetics.

(a) Glycerol is mainly manufactured from fats and oils. Propene can be used as a feedstock in an alternative process as shown.



(i) What is meant by a feedstock?

1

(ii) Name the type of reaction taking place in **Stage 2**.

1

(iii) In **Stage 3**, a salt and water are produced as by-products.

Name the salt produced.

1



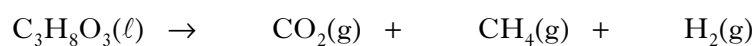
Marks

## 8. (a) (continued)

- (iv) Apart from cost, state **one** advantage of using fats and oils rather than propene in the manufacture of glycerol.

1

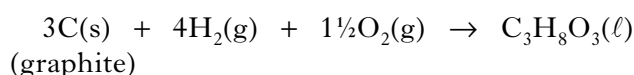
- (b) Hydrogen has been named as a 'fuel for the future'. In a recent article researchers reported success in making hydrogen from glycerol:



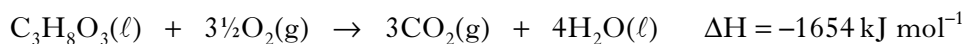
Balance this equation.

1

- (c) The enthalpy of formation of glycerol is the enthalpy change for the reaction:



Calculate the enthalpy of formation of glycerol, in  $\text{kJ mol}^{-1}$ , using information from the data booklet and the following data.



Show your working clearly.

2  
(7)

[Turn over

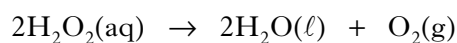
Marks

9. Enzymes are biological catalysts.

(a) Name the **four** elements present in all enzymes.

1

(b) The enzyme catalase, found in potatoes, can catalyse the decomposition of hydrogen peroxide.



A student carried out the Prescribed Practical Activity (PPA) to determine the effect of pH on enzyme activity.

Describe how the activity of the enzyme was measured in this PPA.

1

(c) A student wrote the following **incorrect** statement.

*When the temperature is increased, enzyme-catalysed reactions will always speed up because more molecules have kinetic energy greater than the activation energy.*

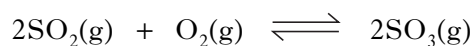
Explain the mistake in the student's reasoning.

1

**(3)**

Marks

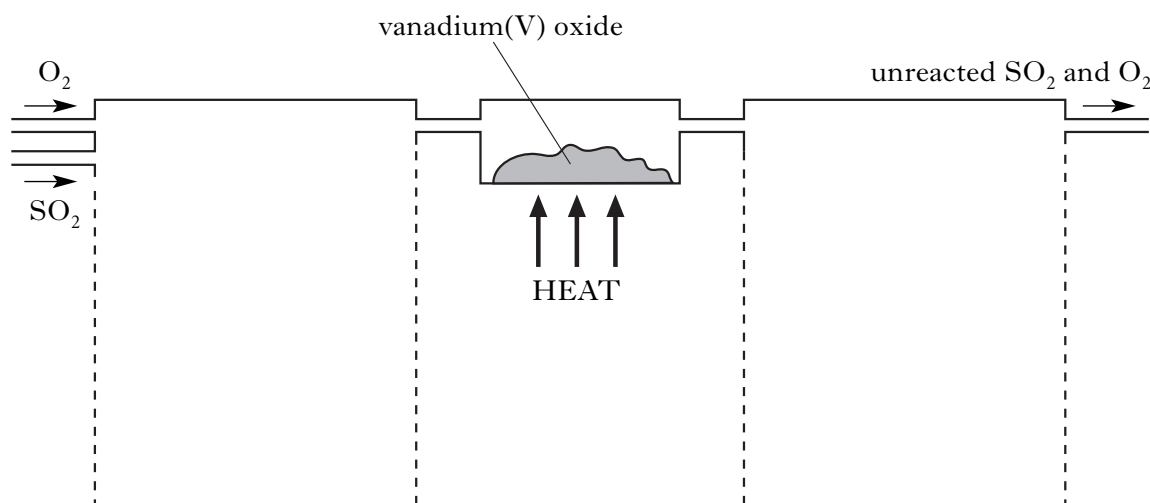
10. Sulphur trioxide can be prepared in the laboratory by the reaction of sulphur dioxide with oxygen.



The sulphur dioxide and oxygen gases are dried by bubbling them through concentrated sulphuric acid. The reaction mixture is passed over heated vanadium(V) oxide.

Sulphur trioxide has a melting point of  $17^\circ\text{C}$ . It is collected as a white crystalline solid.

- (a) Complete the diagram to show how the reactant gases are dried and the product is collected.



2

- (b) Under certain conditions, 43.2 tonnes of sulphur trioxide are produced in the reaction of 51.2 tonnes of sulphur dioxide with excess oxygen.

Calculate the percentage yield of sulphur trioxide.

**Show your working clearly.**

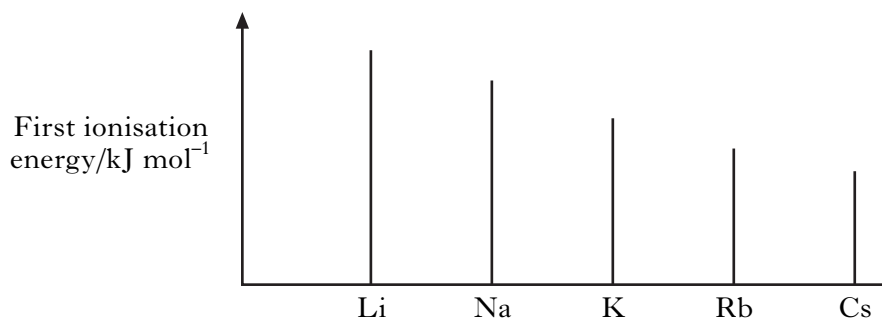
2  
(4)

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Marks

11. (a) The first ionisation energy of an element is defined as the energy required to remove one mole of electrons from one mole of atoms in the gaseous state.

The graph shows the first ionisation energies of the Group 1 elements.



- (i) Clearly explain why the first ionisation energy decreases down this group.

2

- (ii) The energy needed to remove one electron from one helium atom is  $3.94 \times 10^{-21}$  kJ.

Calculate the first ionisation energy of helium, in  $\text{kJ mol}^{-1}$ .

1

- (b) The ability of an atom to form a negative ion is measured by its Electron Affinity.

The Electron Affinity is defined as the energy change when one mole of gaseous atoms of an element combines with one mole of electrons to form gaseous negative ions.

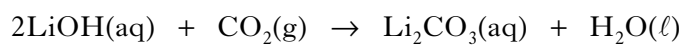
Write the equation, showing state symbols, that represents the Electron Affinity of chlorine.

1  
(4)

Marks

12. (a) A student bubbled  $240\text{ cm}^3$  of carbon dioxide into  $400\text{ cm}^3$  of  $0.10\text{ mol l}^{-1}$  lithium hydroxide solution.

The equation for the reaction is:



Calculate the number of moles of lithium hydroxide that would **not** have reacted.

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

**Show your working clearly.**

2

- (b) What is the pH of the  $0.10\text{ mol l}^{-1}$  lithium hydroxide solution used in the experiment?

1

- (c) Explain why lithium carbonate solution has a pH greater than 7.  
In your answer you should mention the **two** equilibria involved.

2

(5)

Marks

13. (a) A sample of petrol was analysed to identify the hydrocarbons present. The results are shown in the table.

Number of carbon atoms per molecule	Hydrocarbons present in the sample
4	2-methylpropane
5	2-methylbutane
6	2,3-dimethylbutane
7	2,2-dimethylpentane 2,2,3-trimethylbutane

- (i) Draw a structural formula for 2,2,3-trimethylbutane.

1

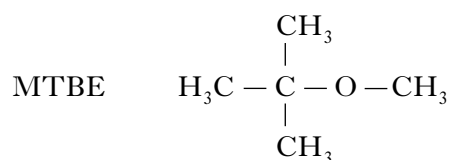
- (ii) The structures of the hydrocarbons in the sample are similar in a number of ways.

What similarity in structure makes these hydrocarbons suitable for use in unleaded petrol?

1

- (b) In some countries, organic compounds called 'oxygenates' are added to unleaded petrol.

One such compound is MTBE.



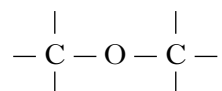
- (i) Suggest why oxygenates such as MTBE are added to unleaded petrol.

1

Marks

## 13. (b) (continued)

- (ii) MTBE is an example of an ether. All ethers contain the functional group:

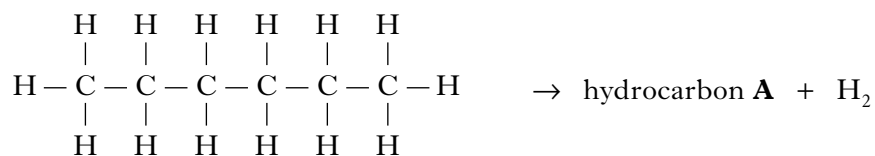


Draw a structural formula for an isomer of MTBE that is also an ether.

1

- (c) Some of the hydrocarbons that are suitable for unleaded petrol are produced by a process known as reforming.

One reforming reaction is:



hexane

Hydrocarbon **A** is non-aromatic and does **not** decolourise bromine solution.

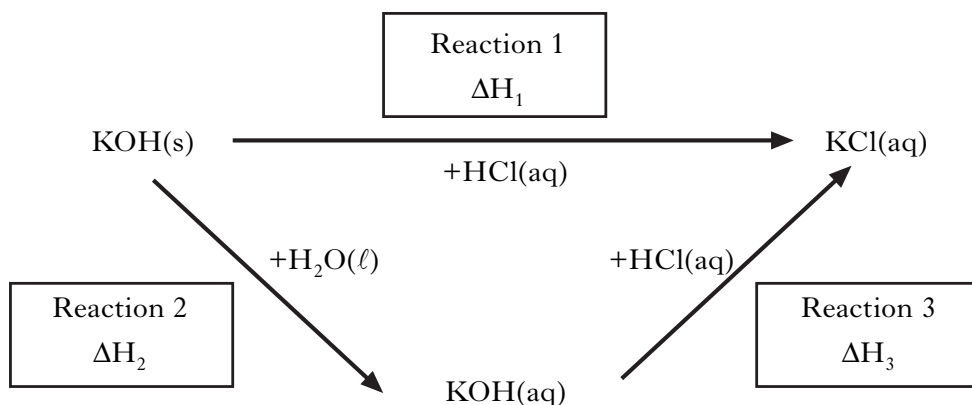
Give a possible name for hydrocarbon **A**.

1  
(5)

[Turn over

Marks

14. (a) Hess's Law can be verified using the reactions summarised below.



- (i) Complete the list of measurements that would have to be carried out in order to determine the enthalpy change for Reaction 2.

**Reaction 2**

- Using a measuring cylinder, measure out  $25\text{ cm}^3$  of water into a polystyrene cup.
- 
- Weigh out accurately about  $1.2\text{ g}$  of potassium hydroxide and add it to the water, with stirring, until all the solid dissolves.
- 

1

- (ii) Why was the reaction carried out in a polystyrene cup?

1



Marks

## 14. (a) (continued)

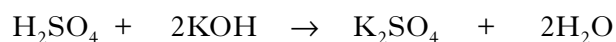
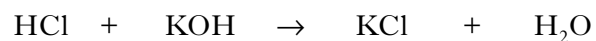
- (iii) A student found that 1.08 kJ of energy was **released** when 1.2 g of potassium hydroxide was dissolved completely in water.

Calculate the enthalpy of solution of potassium hydroxide.

1

- (b) A student wrote the following **incorrect** statement.

*The enthalpy of neutralisation for hydrochloric acid reacting with potassium hydroxide is less than that for sulphuric acid reacting with potassium hydroxide because fewer moles of water are formed as shown in these equations.*



Explain the mistake in the student's statement.

1  
(4)

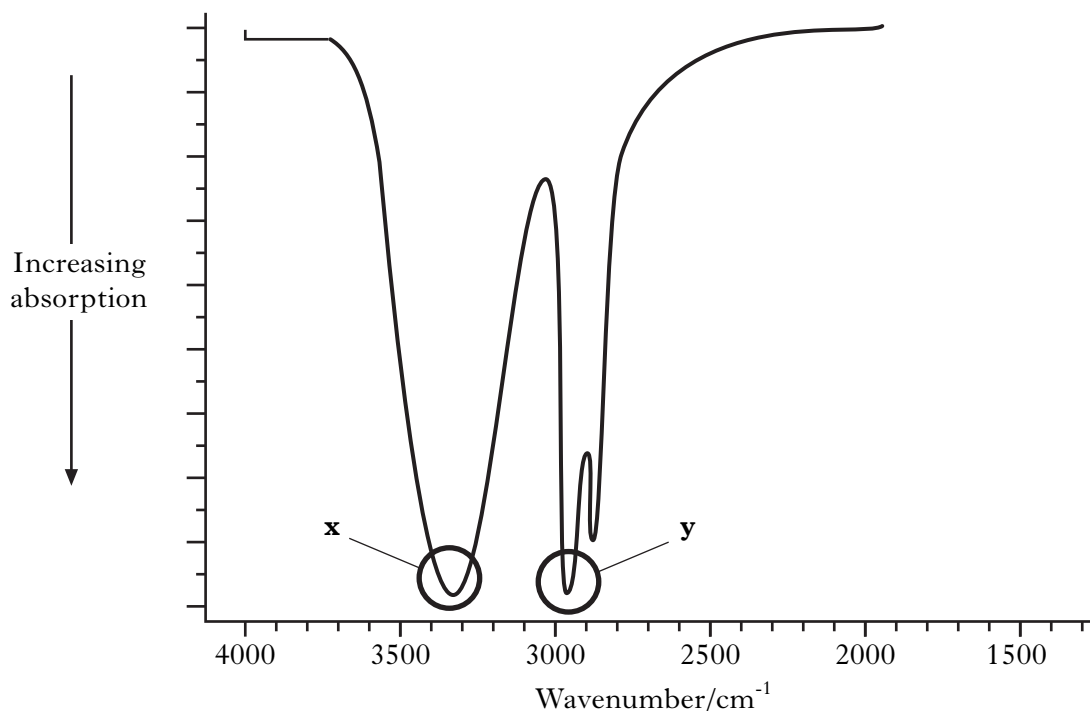
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Marks

15. Infra-red spectroscopy is a technique that can be used to identify the bonds that are present in a molecule.

Different bonds absorb infra-red radiation of different wavenumbers. This is due to differences in the bond 'stretch'. These absorptions are recorded in a spectrum.

A spectrum for propan-1-ol is shown.



The correlation table on page 13 of the data booklet shows the wavenumber ranges for the absorptions due to different bonds.

- (a) Use the correlation table to identify the bonds responsible for the two absorptions, **x** and **y**, that are circled in the propan-1-ol spectrum.

**x**:

**y**:

1

- (b) Propan-1-ol reacts with ethanoic acid.

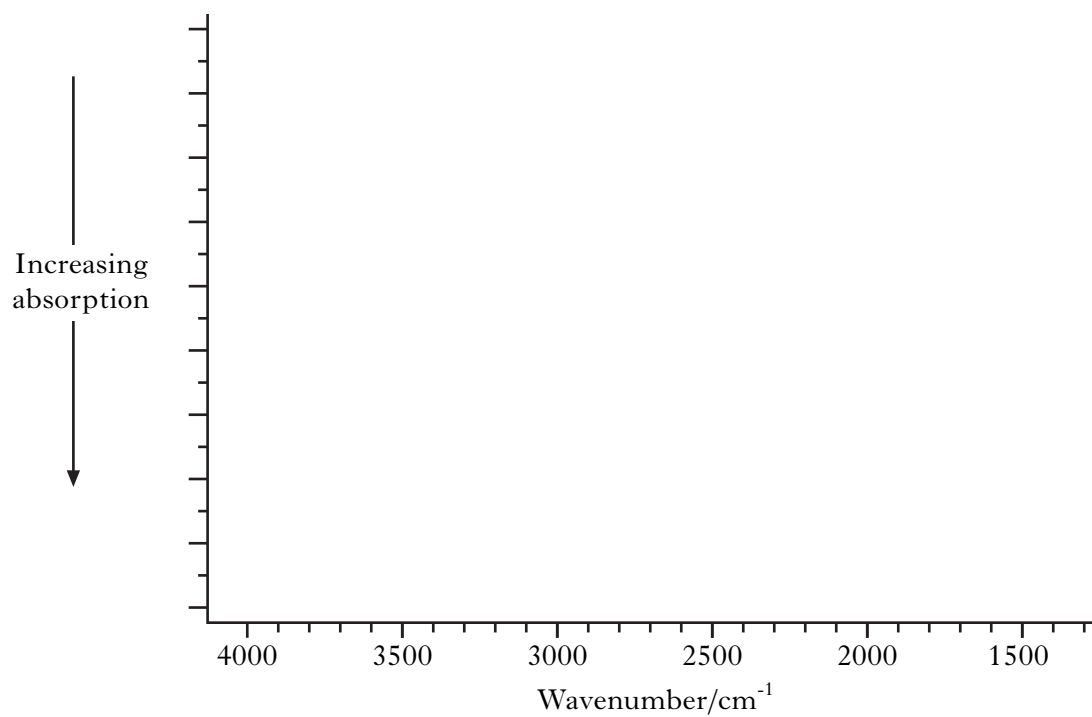
- (i) What name is given to this type of reaction?

1

Marks

15. (b) (continued)

- (ii) Draw a spectrum that could be obtained for the organic product of this reaction.



1  
(3)

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Marks

16. A major problem for the developed world is the pollution of rivers and streams by nitrite and nitrate ions.

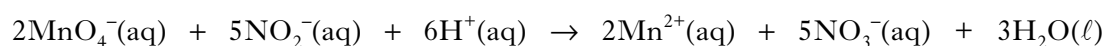
The concentration of nitrite ions,  $\text{NO}_2^-(\text{aq})$ , in water can be determined by titrating samples against acidified permanganate solution.

- (a) Suggest **two** points of good practice that should be followed to ensure that an accurate end-point is achieved in a titration.

1

- (b) An average of  $21.6 \text{ cm}^3$  of  $0.0150 \text{ mol l}^{-1}$  acidified permanganate solution was required to react completely with the nitrite ions in a  $25.0 \text{ cm}^3$  sample of river water.

The equation for the reaction taking place is:



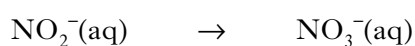
- (i) Calculate the nitrite ion concentration, in  $\text{mol l}^{-1}$ , in the river water.

**Show your working clearly.**

2

- (ii) During the reaction the nitrite ion is oxidised to the nitrate ion.

Complete the ion-electron equation for the oxidation of the nitrite ions.



1

(4)

[END OF QUESTION PAPER]

**ADDITIONAL SPACE FOR ANSWERS**

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**ADDITIONAL SPACE FOR ANSWERS**

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