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Centre Number		Candidate Number	
Candidate Signature			

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General Certificate of Secondary Education  
June 2005



**CHEMISTRY (MODULAR) SPECIFICATION A 3423/H**  
**Written Paper**  
**Higher Tier**

**H**

Thursday 16 June 2005 9.00 am to 10.30 am

<p><b>In addition to this paper you will require:</b></p> <ul style="list-style-type: none"> <li>the Data Sheet (enclosed);</li> <li>a ruler.</li> </ul> <p>You may use a calculator.</p>
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For Examiner's Use			
Number	Mark	Number	Mark
1		10	
2		11	
3		12	
4		13	
5		14	
6		15	
7		16	
8		17	
9		18	
Total (Column 1)	→		
Total (Column 2)	→		
TOTAL			
Examiner's Initials			

Time allowed: 1 hour 30 minutes

**Instructions**

- Use blue or black ink or ball-point pen. Pencil should only be used for drawing.
- Fill in the boxes at the top of this page.
- Answer **all** questions in the spaces provided.
- Do all rough work in this book. Cross through any work you do not want marked.
- Show all your working in calculations.

**Information**

- The maximum mark for this paper is 90.
- Mark allocations are shown in brackets.
- You are reminded of the need for good English and clear presentation in your answers.

**NO QUESTIONS APPEAR ON THIS PAGE**

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**PATTERNS OF CHEMICAL CHANGE**

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**1** The enzyme isomerase is used in industry to convert glucose syrup into fructose syrup.

- (a) State **one** advantage of using enzymes in industrial processes.

.....  
.....  
*(1 mark)*

- (b) Fructose syrup is sweeter than glucose syrup and is used to sweeten fruit drinks.

Suggest **one** other reason for using fructose syrup instead of glucose syrup.

.....  
.....  
*(1 mark)*

- (c) Glucose can also be changed into ethanoic acid,  $\text{CH}_3\text{COOH}$ .

- (i) How many different elements are present in ethanoic acid?

.....  
*(1 mark)*

- (ii) Calculate the relative formula mass of ethanoic acid.

Relative atomic masses: H = 1; C = 12; O = 16

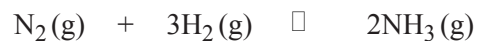
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*(2 marks)*

5

Turn over ►

2 Ammonia is manufactured from nitrogen and hydrogen.

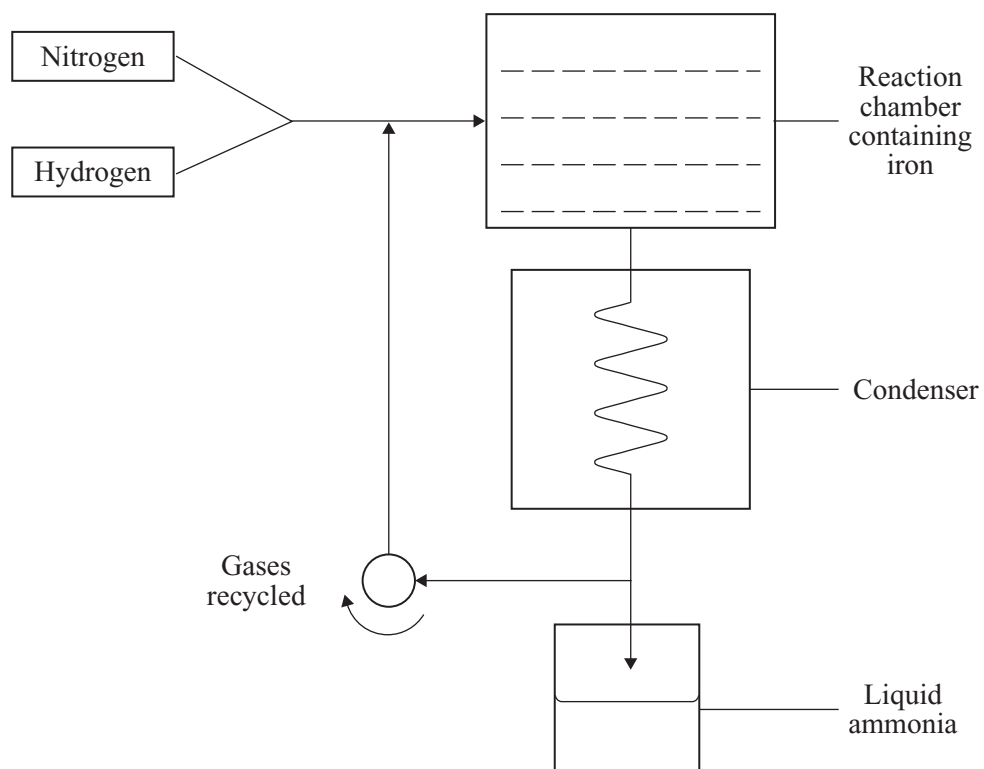
The equation for the reaction is:



(a) Name the industrial process by which ammonia is manufactured.

.....  
(1 mark)

(b) Here is a flow diagram of the industrial process for making ammonia.



Use the diagram to help you to explain the main stages in the manufacture of ammonia.

Your answer should include:

- details of the reaction conditions inside the reaction chamber;
- why iron is present in the reaction chamber;
- why it is necessary to recycle some of the gases.

*To gain full marks in this question you should write your ideas in good English. Put them into a sensible order and use the correct scientific words.*

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(5 marks)

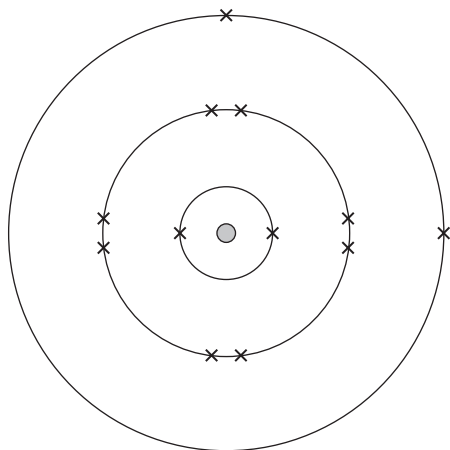
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**TURN OVER FOR THE NEXT QUESTION**

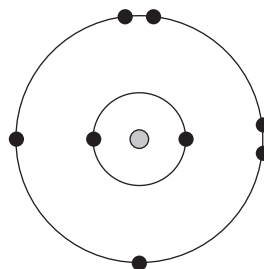
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## STRUCTURES AND BONDING

- 3 Magnesium and oxygen react to make the compound magnesium oxide.  
The electronic structures of magnesium and oxygen atoms are shown below.



A magnesium atom



An oxygen atom

- (a) Explain what happens to magnesium and oxygen atoms when they make magnesium oxide.  
(You may draw diagrams to help with your explanation.)

.....

.....

.....

.....

.....

.....

*(2 marks)*

- (b) Name the type of bond in magnesium oxide.

.....

*(1 mark)*

- (c) What forces hold the particles together in magnesium oxide?

.....

*(1 mark)*

- 4 During the 19<sup>th</sup> century, the Russian chemist, Dmitri Mendeleev, produced a periodic table of the elements.

	Group 1		Group 2		Group 3		Group 4		Group 5		Group 6		Group 7	
Period 1	H (1)													
Period 2	Li (7)		Be (9)		B (11)		C (12)		N (14)		O (16)		F (19)	
Period 3	Na (23)		Mg (24)		Al (27)		Si (28)		P (31)		S (32)		Cl (35.5)	
Period 4	K (39)	Cu (63)	Ca (40)	Zn (65)	?	?	Ti (48)	?	V (51)	As (75)	Cr (52)	Se (78)	Mn (55)	Br (80)
Period 5	Rb (85)	Ag (108)	Sr (87)	Cd (112)	Y (88)	In (113)	Zr (90)	Sn (118)	Nb (94)	Sb (122)	Mo (96)	Te (125)	?	I (127)

There were some gaps in Mendeleev's periodic table. These are shown as ? in the table. Mendeleev suggested that his periodic table allowed scientists to predict the properties of some elements.

Use the information above and the periodic table on the Data Sheet to help you answer these questions.

- (a) Why were there gaps in Mendeleev's periodic table?

.....  
 .....  
 (1 mark)

- (b) Which important Group of elements was missing from Mendeleev's periodic table?

.....  
 (1 mark)

- (c) Mendeleev used "atomic weights" (now called relative atomic masses) to arrange the elements in his periodic table. "Atomic weights" are shown in brackets in the table above.

Use Mendeleev's "atomic weight" values to predict a value for the "atomic weight" of the element missing from Group 4 of his table.

.....  
 .....  
 .....  
 (2 marks)

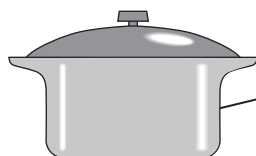
- (d) Use the periodic table on the Data Sheet to identify the missing element in Group 4.

.....  
 (1 mark)

Turn over ►

## CHEMISTRY IN ACTION

- 5 Aluminium can be treated so that its surface can be coloured with a dye.



An aluminium pot  
with a coloured lid

- (a) Name the substance on the surface of aluminium that protects it from corrosion.

.....  
(1 mark)

- (b) When aluminium objects are to be coloured, the protective layer needs to be made thicker. The process used is summarised below.

<b>Stage 1</b>	The aluminium object is placed in sodium hydroxide solution.
<b>Stage 2</b>	The object is rinsed with water.
<b>Stage 3</b>	<p>The object is placed in the following apparatus for 30 minutes.</p>
<b>Stage 4</b>	The object is rinsed in water and placed in a container of dye for 10 minutes.
<b>Stage 5</b>	The object is put into boiling water for a few minutes to seal the dye in place.



- (i) Name this process for increasing the thickness of the protective surface layer on aluminium objects.

.....  
(1 mark)

- (ii) What happens during **Stage 1**?

.....  
.....  
(1 mark)

- (iii) To which terminal of the battery should the aluminium object be attached?

.....  
(1 mark)

- (iv) Which gas is produced around the aluminium object during **Stage 3**?

.....  
(1 mark)

5

- 6 (a) Steel is an *alloy*.

What is meant by the term *alloy*?

.....  
.....  
(1 mark)

- (b) Steel contains up to 2 % carbon.

How does the amount of carbon present in a steel affect the hardness of the steel?

.....  
.....  
(1 mark)

- (c) Steel can be changed into stainless steel by adding small amounts of transition metals.

Name a transition metal that is added to steel to make stainless steel.

.....  
(1 mark)

- (d) The elements present in steels can be identified using instrumental methods.

Name **one** instrumental method used to identify elements.

.....  
(1 mark)

4

Turn over ►

**QUESTIONS RELATING TO PREVIOUSLY TESTED MODULES**

7 Explain what is meant by *hard* water.

Your answer should include:

- how the water becomes *hard*;
- the name of one substance that causes the hardness;
- one method for removing hardness.

*To gain full marks in this question you should write your ideas in good English. Put them into a sensible order and use the correct scientific words.*

.....

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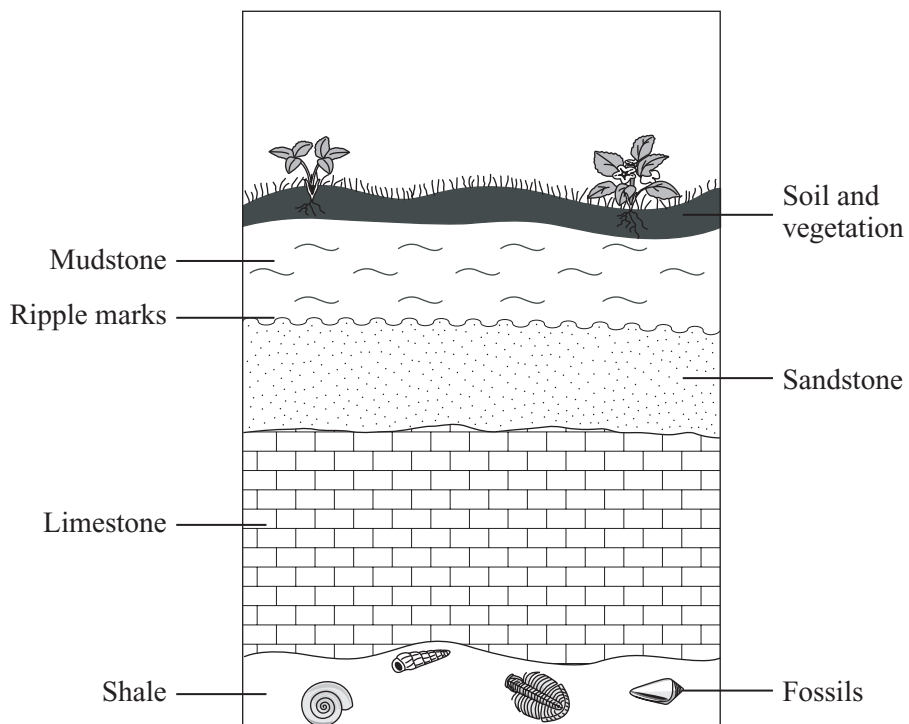
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.....

(4 marks)



8 The diagram shows part of a rock face.



(a) Which is most likely to be the oldest rock in the diagram?

..... (1 mark)

(b) There are ripple marks in the sandstone.

How have these ripple marks been formed?

.....  
..... (1 mark)

(c) All the rocks shown are of the same type.

Name the type of rock.

..... (1 mark)

- 9 Iron railway lines may be joined together using molten iron. This is made by reacting aluminium powder and iron(III) oxide.

Use the information from the Data Sheet to help you to answer these questions.

- (a) Why can aluminium powder convert iron(III) oxide into iron?

.....  
.....

(1 mark)

- (b) It is not possible to produce calcium metal by heating zinc powder and calcium oxide.

Explain why.

.....  
.....  
.....

(2 marks)

- (c) Transition metals are found in the centre of the periodic table.

Mark with a cross (×) the statement that is **not** true for transition metals.

They usually have high melting points.	
They react very vigorously with water.	
They are often used as catalysts in chemical reactions.	
Their compounds are often coloured.	

(1 mark)



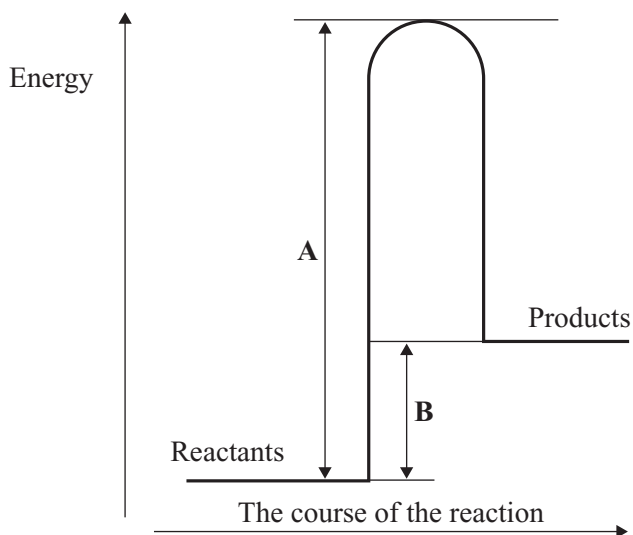
**NO QUESTIONS APPEAR ON THIS PAGE**

**TURN OVER FOR THE NEXT QUESTION**

**Turn over ►**

## PATTERNS OF CHEMICAL CHANGE

- 10 The energy changes that take place during an *endothermic* reaction are shown in the following diagram.



- (a) What do the letters **A** and **B** in the diagram represent?

**A** .....

.....

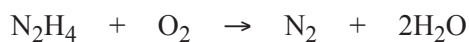
(1 mark)

**B** .....

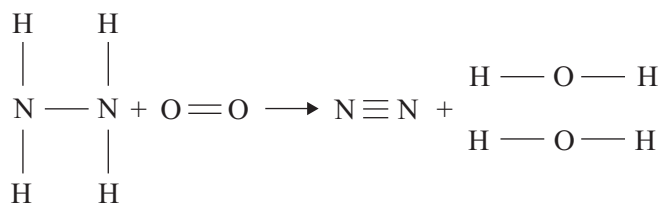
.....

(1 mark)

- (b) Hydrazine,  $\text{N}_2\text{H}_4$ , is often used as a rocket fuel.  
The equation for the reaction between hydrazine and oxygen is:



The bonds in all the reactant and product molecules are shown below.



Bond energy values show the amount of energy needed to break an existing chemical bond or the amount of energy released when a new chemical bond is formed.

The bond energy value of each bond in these molecules is shown below.

Chemical bond	Bond energy (kJ/mol)
N — H	390
N — N	163
O = O	496
N ≡ N	945
H — O	463

- (i) How much energy is needed to break the bonds in the reactants?

.....  
 .....  
 ..... kJ/mol  
 (2 marks)

- (ii) How much energy is released as the bonds in the products are formed?

.....  
 .....  
 ..... kJ/mol  
 (2 marks)

- (iii) Using your answers to parts (b)(i) and (b)(ii) above, calculate the overall energy change during the reaction.

.....  
 ..... kJ/mol  
 (1 mark)

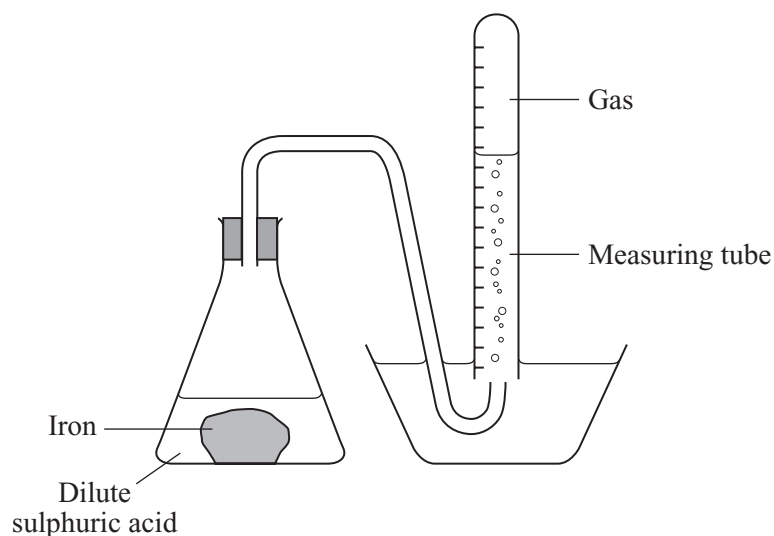
- (iv) State whether the reaction is exothermic or endothermic.

.....  
 (1 mark)

8

Turn over ►

- 11 Iron reacts with dilute sulphuric acid to make hydrogen gas and iron(II) sulphate. This apparatus can be used for the reaction.



In an experiment, a large lump of iron (an excess) was added to  $50\text{ cm}^3$  of dilute sulphuric acid. The gas produced was collected as shown above.

- (a) Which **two** of the following changes would increase **both** the rate of reaction **and** the amount of gas produced during the experiment?

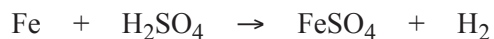
Put a tick (✓) in the boxes next to the **two** correct answers.

Use the same amount of iron in lots of small pieces.	
Use $75\text{ cm}^3$ of a more concentrated solution of sulphuric acid.	
Add a catalyst.	
Use $75\text{ cm}^3$ of the original dilute sulphuric acid with the same amount of iron in small pieces.	
Heat the $50\text{ cm}^3$ of dilute sulphuric acid before using it.	

(2 marks)



- (b) The equation for the reaction between iron and dilute sulphuric acid is



During an experiment, 0.56 g of iron reacted with dilute sulphuric acid.

- (i) Calculate the mass of iron(II) sulphate,  $\text{FeSO}_4$ , formed.

Relative atomic masses: H = 1; O = 16; S = 32; Fe = 56

.....  
.....  
.....  
.....  
.....

(2 marks)

- (ii) Calculate the volume of hydrogen gas produced.

1 mole of hydrogen gas has a volume of  $24 \text{ dm}^3$  at room temperature and pressure.

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.....  
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.....

(2 marks)

**TURN OVER FOR THE NEXT QUESTION**

6

**Turn over** ►

## STRUCTURES AND BONDING

- 12 (a) The Data Sheet may help you when answering this question.

Diagram P shows the arrangement of the particles in solid sodium chloride, NaCl.  
Diagram Q shows a beaker containing a solution of sodium chloride in water.

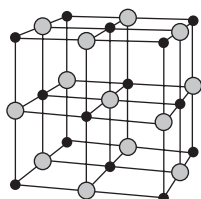


Diagram P

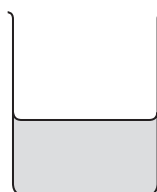


Diagram Q

The types of particles in substances can be either atoms, molecules or ions.

- (i) Give the formula of each particle in solid sodium chloride.

.....  
(1 mark)

- (ii) Give the formula of each particle in the solution of sodium chloride in water.

.....  
(2 marks)

- (iii) Explain, in terms of particles, why a solution of sodium chloride in water will conduct electricity but solid sodium chloride will not.

.....  
.....  
.....  
.....  
(2 marks)

- (iv) Give the name of a **non-metal** element that is a very good conductor of electricity in the solid state.

.....  
(1 mark)

- (b) Draw a diagram to show the arrangement of electrons when hydrogen and chlorine atoms are joined in a molecule of hydrogen chloride, HCl.

(2 marks)

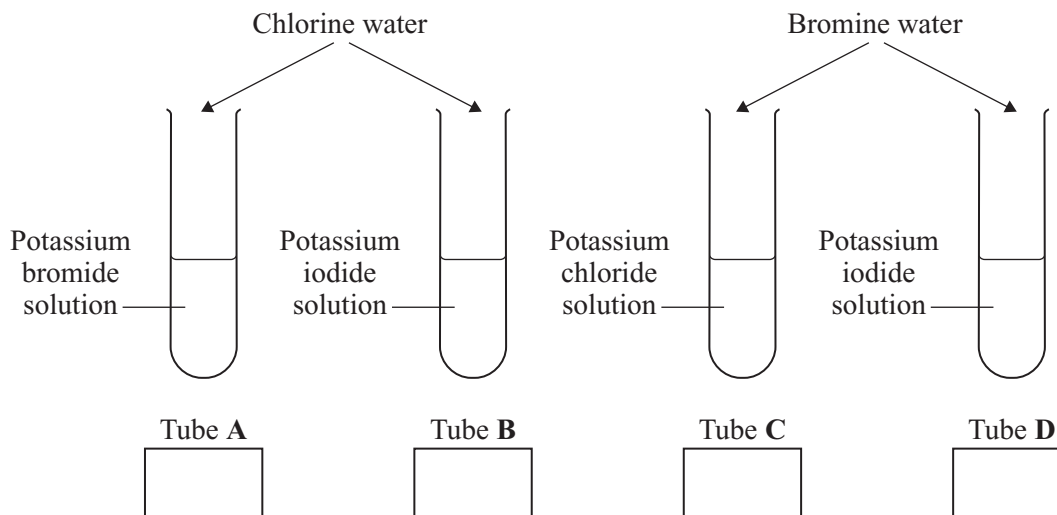


**TURN OVER FOR THE NEXT QUESTION**

**Turn over** ►

13 The Data Sheet may help you when answering this question.

The following diagrams show a series of experiments carried out using chlorine water (a solution of chlorine in water) and bromine water (a solution of bromine in water).



(a) In the boxes above, put a tick (✓) where there was a reaction and a cross (✗) where there was no reaction. (2 marks)

(b) Choose a tube where there was a reaction and explain why the reaction took place.

.....  
 .....  
(1 mark)

(c) The word equation for the reaction between potassium bromide solution and silver nitrate solution is:



Write a balanced symbol equation for this reaction.

..... + ..... → ..... + .....  
(2 marks)

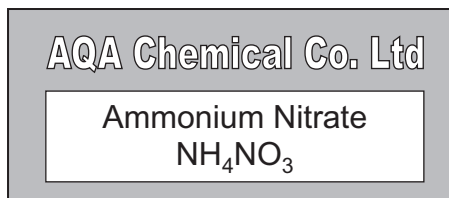
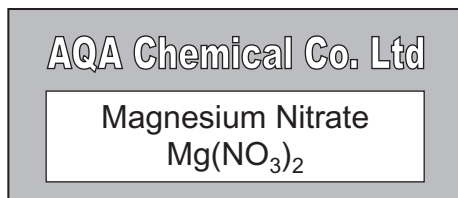
(d) The silver bromide formed in part (c) is initially pale cream in colour but it slowly darkens when exposed to light.

Give **one** use for this reaction.

.....  
(1 mark)

## CHEMISTRY IN ACTION

- 14 (a) The labels have fallen off two jars of chemicals. The labels are shown below.



Both substances are white crystalline solids.

Sodium hydroxide solution may be used to identify the chemicals.

Sodium hydroxide solution was added separately to a solution of some crystals from each jar.

Complete the table to show the results that would be obtained.

	Result when sodium hydroxide solution is added
Magnesium nitrate solution	
Ammonium nitrate solution	

(2 marks)

- (b) Describe a test for nitrate ions,  $NO_3^-$ , in solution. Give the result if the test is positive.

Test .....

.....

Result.....

.....

(2 marks)

4

Turn over ►

15 When concentrated sulphuric acid is added to blue copper sulphate crystals,  $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ , they turn white.

(a) Name the white solid formed.

.....  
(1 mark)

(b) What property of sulphuric acid is demonstrated during this change?

.....  
(1 mark)

(c) State a large scale use for sulphuric acid.

.....  
(1 mark)

16 Titanium is a transition metal. It is extracted from its ore, rutile. Rutile contains titanium dioxide,  $\text{TiO}_2$ , which can be *reduced* to titanium in a two stage process.

<b>Stage 1</b>	Titanium dioxide is converted to titanium chloride, $\text{TiCl}_4$ .
<b>Stage 2</b>	Titanium chloride is heated with magnesium or sodium to form titanium and either magnesium chloride or sodium chloride. This stage is carried out in an atmosphere of argon.

(a) Why is the conversion of titanium dioxide to titanium described as *reduction*?

.....  
.....  
(1 mark)

(b) Why is the reaction in **Stage 2** carried out in an atmosphere of argon?

.....  
.....  
(1 mark)

(c) Why are some spectacle frames now made from titanium metal?

.....  
(1 mark)

3

3

**QUESTIONS RELATING TO PREVIOUSLY TESTED MODULES**

- 17 When ethanoic acid, ethanol and a little concentrated sulphuric acid are warmed gently together, an ester is formed.

The equation for the reaction is:



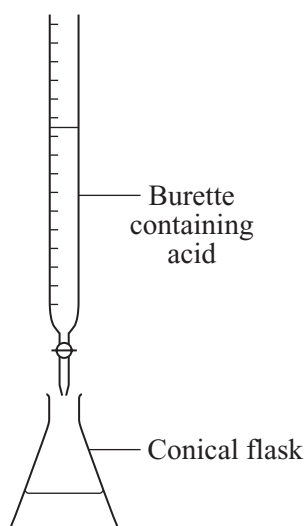
- (a) Name the compound  $\text{CH}_3\text{COOC}_2\text{H}_5$ .

.....  
(1 mark)

- (b) What is the formula of the *functional group* in all alcohols?

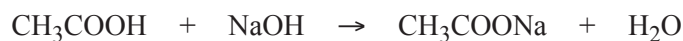
.....  
(1 mark)

- (c) The amount of ethanoic acid in a solution can be found by titration using the following apparatus:



In a titration,  $20.0 \text{ cm}^3$  of a solution containing  $0.10 \text{ mol per dm}^3$  sodium hydroxide needed  $25.0 \text{ cm}^3$  of a solution containing ethanoic acid for neutralisation.

The equation for the reaction between ethanoic acid and sodium hydroxide is:



Calculate the concentration of the ethanoic acid solution.

.....  
 .....  
 .....  
 .....  
 .....  
 ..... mol per  $\text{dm}^3$

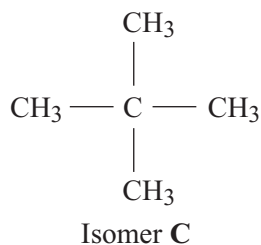
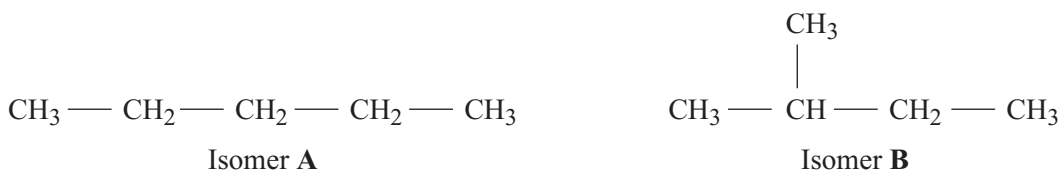
(3 marks)

Turn over ►

- 18 (a) What is the general formula of the alkane series of hydrocarbons?

.....  
(1 mark)

- (b) Pentane,  $C_5H_{12}$ , has three isomers. The structural formula of each isomer is shown below.



Which isomer, **A**, **B** or **C**, will have the lowest boiling point?

Explain your answer.

Isomer .....

Explanation.....

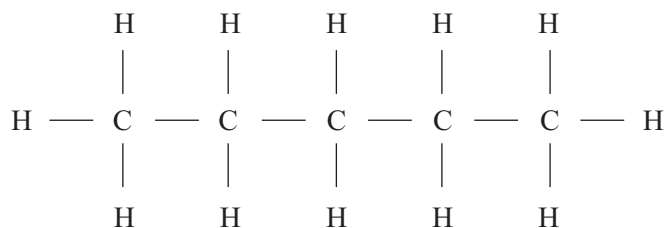
.....  
.....

(2 marks)

- (c) When pentane is heated strongly, it can decompose as follows:

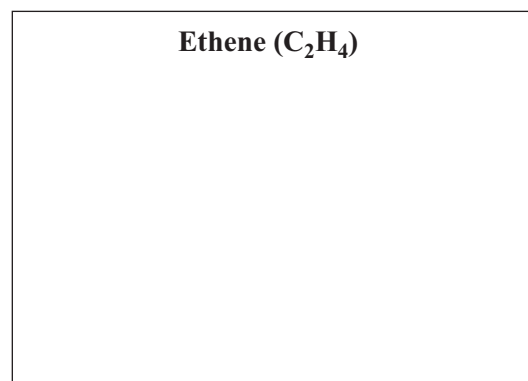
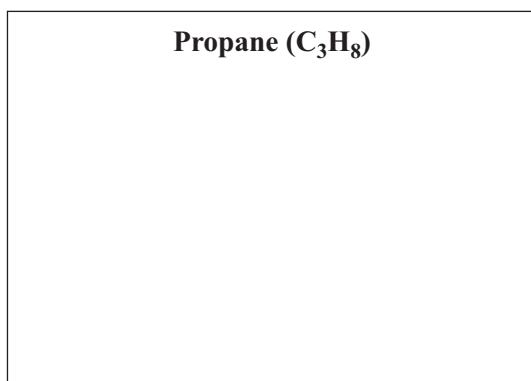


The full structural formula for pentane is:





In a similar way, show, in the boxes, the full structural formula of propane,  $C_3H_8$ , and of ethene,  $C_2H_4$ .



(2 marks)

(d) Draw the structure of the polymer poly(ethene) showing **three** of the repeating units.

(2 marks)

**END OF QUESTIONS**

7

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