

**Preliminary Examination
Secondary Four**

CANDIDATE NAME

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CLASS

4		
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REGISTER
NUMBER

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CENTRE
NUMBER

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INDEX NUMBER

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CHEMISTRY

5073/01

Paper 1 Multiple Choice

12 August 2016

1 hour

Additional Materials: **Multiple Choice Answer Sheet**

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.

Do not use staples, paper clips, glue or correction fluid.

Write your name, class and index number on the Question Paper and Answer Sheet in the spaces provided.

There are forty questions in this paper. Answer all questions. For each question, there are four possible answers, A, B, C, D.

Choose the one you consider correct and record your choice in soft pencil on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

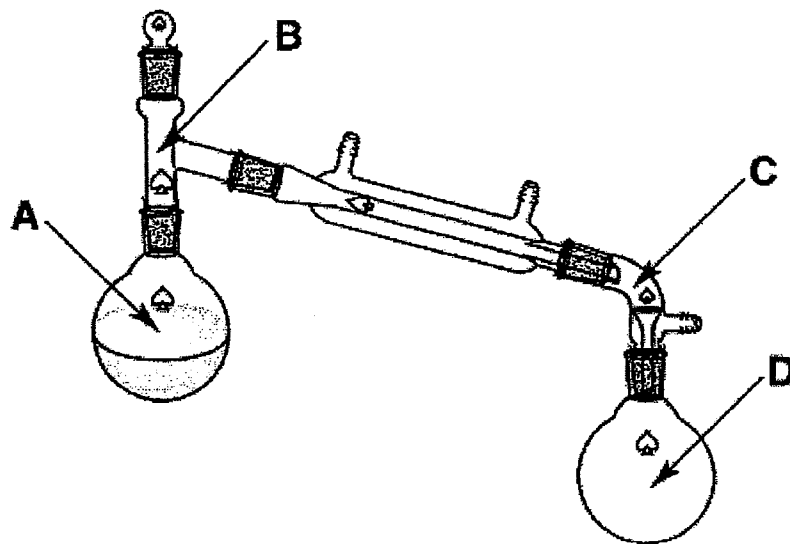
Each correct answer will score one mark. A mark will not be deducted for a wrong answer.

Any rough working should be done in this booklet.

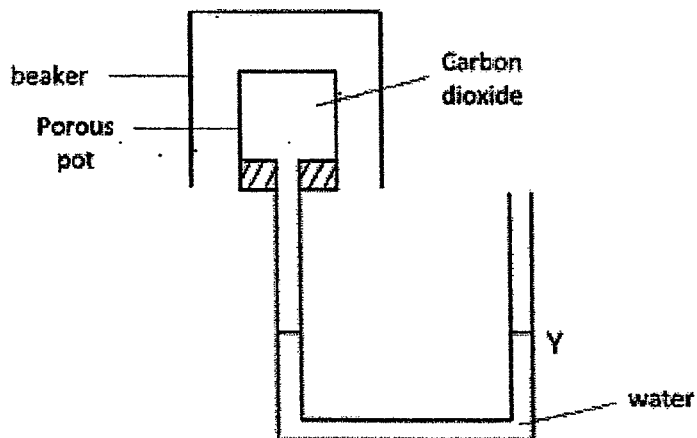
A copy of the Periodic Table is printed on page 2.

The use of an approved scientific calculator is expected, where appropriate.

- 1 A student is distilling a mixture of iodine in ethanol (boiling point of ethanol = 78°C). She has just begun to collect the distillate in the receiving flask. At which position in the experimental set-up will the temperature be 78°C ?



- 2 A beaker containing gas X is placed over a porous pot filled with carbon dioxide gas as shown. The level of water at Y rises after a short time. What is a possible identity of gas X?



- A Chlorine
- B Oxygen
- C Nitrogen dioxide
- D Sulfur dioxide

3 The atomic number of element X is 16. Which statement(s) concerning X is/are correct?

- I. X can react with calcium to form an ionic compound.
- II. The oxide of X dissolves in water to form an acidic solution.
- III. X can conduct electricity in its molten state.

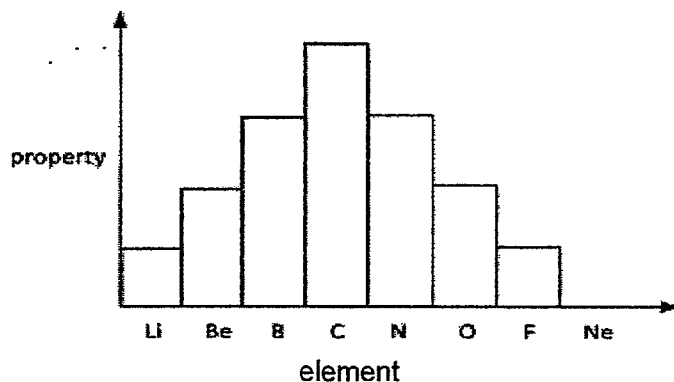
- A I and II only
- B I and III only
- C II and III only
- D I, II and III

4 T is an element. It can form a cation T^{2+} , which has an electronic arrangement 2.8.8. Which statements about T are correct?

- I. T is a strong oxidising agent.
- II. T is in Period 4 of the Periodic Table.
- III. T burns in oxygen to form a white solid.

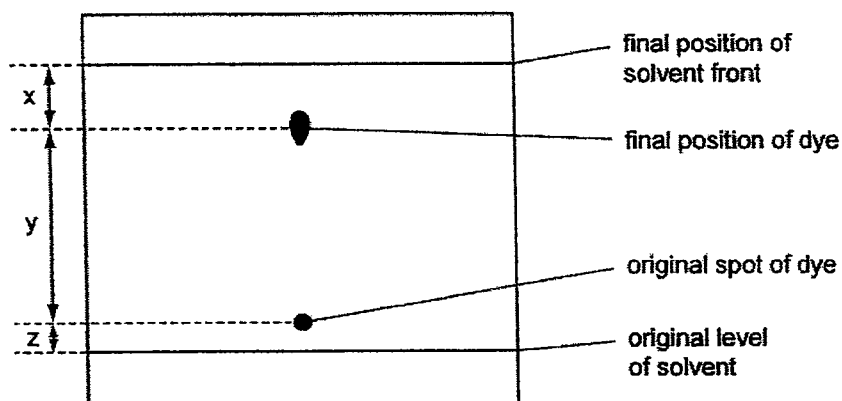
- A I and II only
- B I and III only
- C II and III only
- D I, II and III

5 The bar chart shows the variation of a specific property of elements in Period 2 from lithium to neon. Which property of these elements is shown in the chart?



- A The number of electrons used in bonding
- B The number of shells holding electrons
- C The melting point
- D The atomic radius

- 6 The diagram shows the chromatogram obtained by analysis of a single dye. Three measurements are shown.



How is the R_f value of the dye calculated?

A $\frac{x}{x+y}$

B $\frac{y}{x+y}$

C $\frac{x}{x+y+z}$

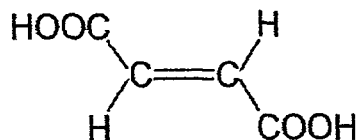
D $\frac{y}{x+y+z}$

- 7 Silicon carbide, SiC, has a structure similar to diamond. Boron nitride, BN, has a structure similar to graphite. Bronze is an alloy of copper and tin. Which statements about silicon carbide, boron nitride and bronze are correct?

- I. All are bonded covalently.
- II. All except silicon carbide conduct electricity when solid.
- III. All have high melting points.

- A I and II only
B I and III only
C II and III only
D I, II and III

8 The diagram shows the structure an organic compound.



Which of the following statements is false for the compound?

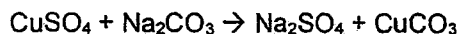
- A It is immiscible in water.
 - B It reacts with alcohol under suitable conditions.
 - C It decolorises aqueous bromine rapidly.
 - D It reacts with steam.
- 9 The atmosphere of Venus contains mainly oxygen, argon and nitrogen. The melting and boiling points of these gases are shown in the table below.

Gas	Melting point/ °C	Boiling point/ °C
Oxygen	-219	-183
Argon	-189	-186
Nitrogen	-210	-196

If only liquid oxygen is to be obtained, what temperature should the sample of air be decreased to?

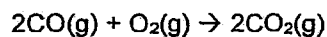
- A -180°C
- B -185°C
- C -187°C
- D -198°C

- 10 In an experiment, 4.0 cm³ of 1.0 mol/dm³ aqueous copper(II) sulfate was mixed with 8.0 cm³ of 1.0 mol/dm³ aqueous sodium carbonate. The equation for the reaction is as shown below.



What did the reaction vessel contain when the reaction was completed?

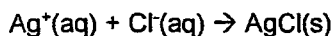
- A A blue solution only
 - B A green precipitate and a blue solution
 - C A green precipitate and a colourless solution
 - D A white precipitate and a blue solution
- 11 A 10.00 g sample of a compound containing only carbon, hydrogen and oxygen forms 23.98 g CO₂ and 4.91 g H₂O upon complete combustion. What is the empirical formula of the compound?
- A C₂H₃O
 - B C₃H₃O
 - C C₆H₃O₂
 - D C₆H₆O
- 12 Carbon monoxide reacts with oxygen according to the equation shown below.



If all volumes of gases are measured at the same temperature and pressure, what is the total volume of the resulting gas(es), after 50 cm³ of carbon monoxide reacts with 50 cm³ of oxygen?

- A 100 cm³
- B 75 cm³
- C 50 cm³
- D 25 cm³

13 Silver ions react with chloride ions as follows:



It is found that 5 cm³ of a 0.1 mol/dm³ solution of the chloride of metal X needs 10 cm³ of 0.1 mol/dm³ silver nitrate for complete reaction. What is the formula of the chloride?

- A XCl₄
- B XCl₂
- C XCl
- D X₂Cl

14 An aqueous solution of the organic compound methylamine has a pH greater than 7. Which one of the following statements about methylamine is correct?

- A It neutralises an aqueous solution of sodium hydroxide.
- B It reacts with copper(II) carbonate to give carbon dioxide.
- C It reacts with hydrochloric acid to form a salt.
- D It turns blue litmus red.

15 Which equation describes the most suitable reaction for making lead(II) sulfate?

- A $\text{Pb} + \text{H}_2\text{SO}_4 \rightarrow \text{PbSO}_4 + \text{H}_2$
- B $\text{PbCO}_3 + \text{H}_2\text{SO}_4 \rightarrow \text{PbSO}_4 + \text{CO}_2 + \text{H}_2\text{O}$
- C $\text{Pb}(\text{NO}_3)_2 + \text{H}_2\text{SO}_4 \rightarrow \text{PbSO}_4 + 2\text{HNO}_3$
- D $\text{Pb}(\text{OH})_2 + \text{H}_2\text{SO}_4 \rightarrow \text{PbSO}_4 + 2\text{H}_2\text{O}$

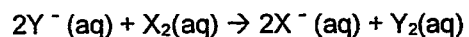
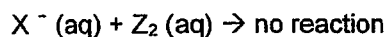
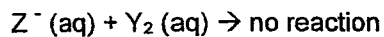
16 The table below shows the properties of some elements, W, X, Y and Z in Period 3.

	W	X	Y	Z
Appearance at room temperature	Silvery grey solid	Yellow solid	Silvery grey solid	Yellowish-green gas
Reaction with cold water	Extremely violent reaction	No reaction	No reaction	Slow reaction
Nature of oxide	Reacts with acids	Reacts with bases	Reacts with acids and bases	Reacts with bases

Which of the following shows the arrangement of these elements in the Periodic Table in **increasing** order of group number, from the smallest to the largest?

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

17 Three experiments are carried out to determine the reactivity of three unknown halogens. The ionic equations of the three experiments are shown below.



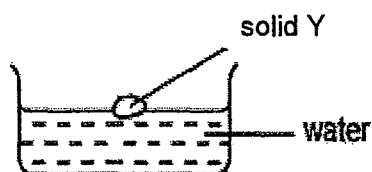
Predict the reactivity of the halogens in **decreasing** order.

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

18 When heated, solid X gives off gas. When this gas is bubbled through limewater, a white precipitate is formed. The residue after heating solid X reacts with dilute acid and also with aqueous alkali. What is X?

- A Magnesium carbonate
- B Aluminium oxide
- C Calcium hydroxide
- D Zinc carbonate

19 When solid Y reacts with water, a solution and a gas are produced.

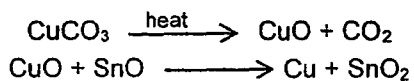


The universal indicator changed from green to purple and the gas extinguished a lighted splint with a 'pop' sound.

What is the identity of solid Y and the explanation for the test for the gas formed?

	Identity of solid Y	Is gas flammable?
A	Calcium	Yes
B	Calcium	No
C	Sodium	No
D	Sodium	Yes

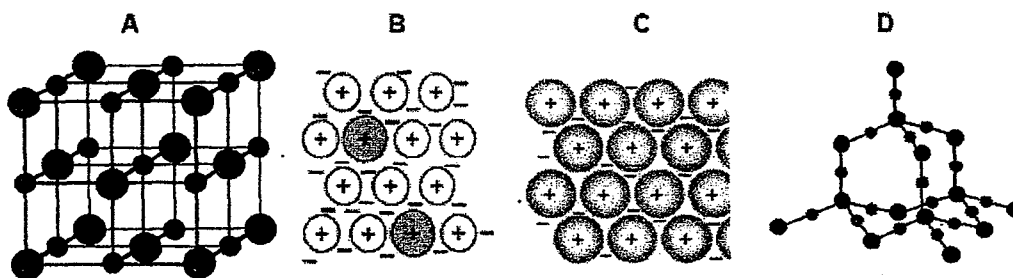
20 The red colour in some pottery glazes may be formed as a result of the reactions shown.



These equations show that1..... is oxidised and2..... is reduced.
Which substances correctly complete gaps 1 and 2 in the above sentence?

	1	2
A	CO ₂	SnO ₂
B	CuCO ₃	CuO
C	CuO	SnO
D	SnO	CuO

21 Which diagram represents the structure of an alloy?



22 An element has the following properties.

- It forms coloured compounds.
- It acts as a catalyst.
- It melts at 1539°C.

In which Period is the element likely to be found?

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

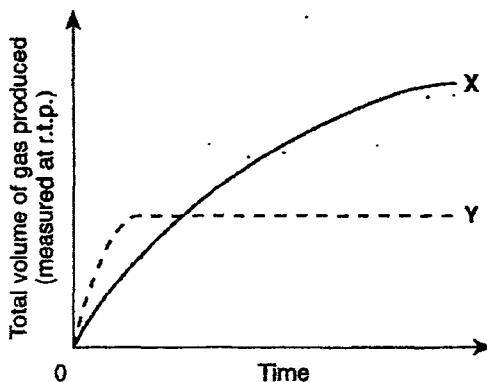
23 Calcium carbonate reacts with dilute hydrochloric acid as shown:



Which option shows the correct effect on the rate of the reaction when a factor is changed?

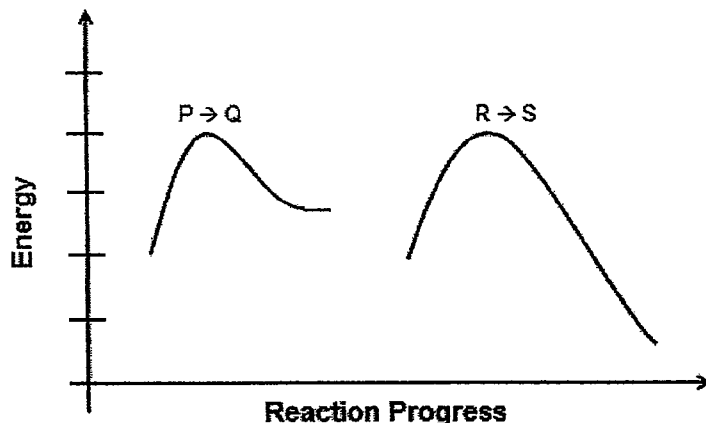
	Factor changed	Rate of reaction
A	Particle size of calcium carbonate increased	Increased
B	Concentration of hydrochloric acid increase	Increased
C	Pressure of carbon dioxide increased	Increased
D	Temperature increased	Decreased

24 In the graph shown below, curve X represents the results of the reaction between 2g of zinc granules and excess acid at 25°C. Which of the following changes would produce curve Y?



- A Using 1 g of zinc powder at 25°C
- B Using 2 g of zinc powder at 30°C
- C Using 1 g of zinc granules at 25°C
- D Using 2 g of zinc granules at 30°C

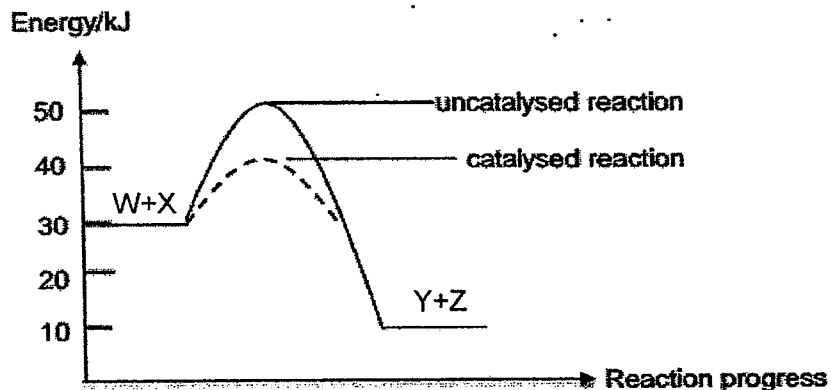
- 25 From the energy profiles for the two reactions below, how will the rates of the two reactions compare if the temperature of each reaction is increased from 25°C to 75°C?



- A The rate of reaction $P \rightarrow Q$ will increase more than the rate of $R \rightarrow S$.
 B The rate of $P \rightarrow Q$ will decrease but the rate of $R \rightarrow S$ will increase.
 C The rate of reaction $R \rightarrow S$ will increase more than the rate of $P \rightarrow Q$.
 D The rates of the two reactions will increase by the same amount.

- 26 A reversible reaction is represented by the equation $W + X \rightleftharpoons Y + Z$.

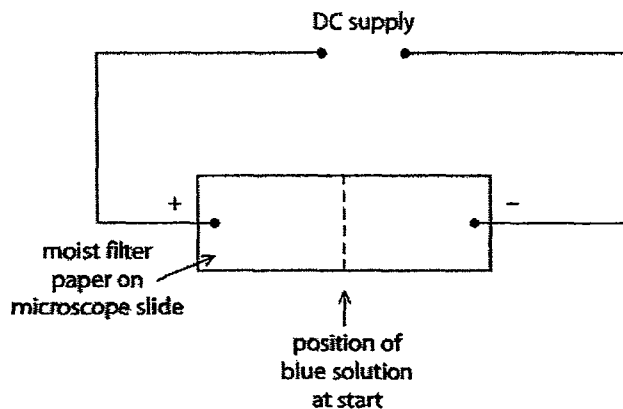
The energy profiles for the reversible reaction under catalysed and uncatalysed conditions are shown below.



What is the activation energy of the reverse reaction that is catalysed?

- A -40kJ
 B -10kJ
 C +30kJ
 D +40kJ

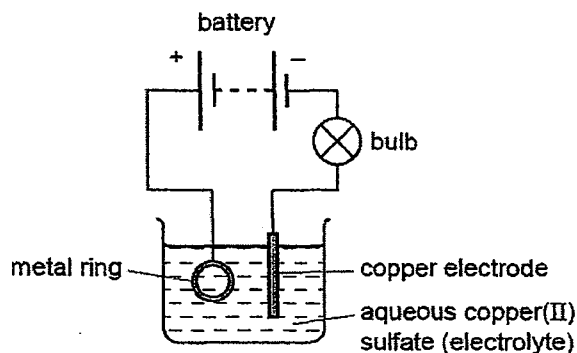
- 27 A spot of blue solution was placed in the centre of a piece of moist filter paper supported on a microscope slide and a DC voltage applied across the filter paper.



After some time, a blue colour moved towards the negative terminal and no change was visible in the region of the positive terminal. What statement best describes this observation?

- A The negative ions in the solution were colourless and the positive ions were blue.
- B The positive ions in the solution were colourless and the negative ions were blue.
- C The negative ions in the solution had not moved but the positive ions had moved.
- D The positive ions in the solution had not moved but the negative ions had moved.

- 28 The diagram shows the apparatus used in an attempt to electroplate a metal ring with copper.



The experiment did not work.

Which change is needed in the experiment to make it work?

- A Add solid copper(II) sulfate to the electrolyte.
 - B Increase the temperature of the electrolyte.
 - C Replace the copper electrode with a carbon electrode.
 - D Reverse the connection to the battery.
- 29 Metal X reacts with dilute hydrochloric acid. It is used in the building of bridges and beams in buildings.

Metal Y does not corrode easily. It can be used for jewellery.

Metal Z reacts rapidly with water to form hydrogen.

Which method of extraction of the metals from their ores is most likely to be used?

	Electrolysis of molten ore	Heating with carbon
A	X and Y	Z
B	X and Z	Y
C	Y	X and Z
D	Z	X and Y

- 30 Three electrochemical cells are set up using copper metal as one electrode and one of three unknown metals, U, V and W as the second electrode, immersed in aqueous sodium nitrate of the same concentration.

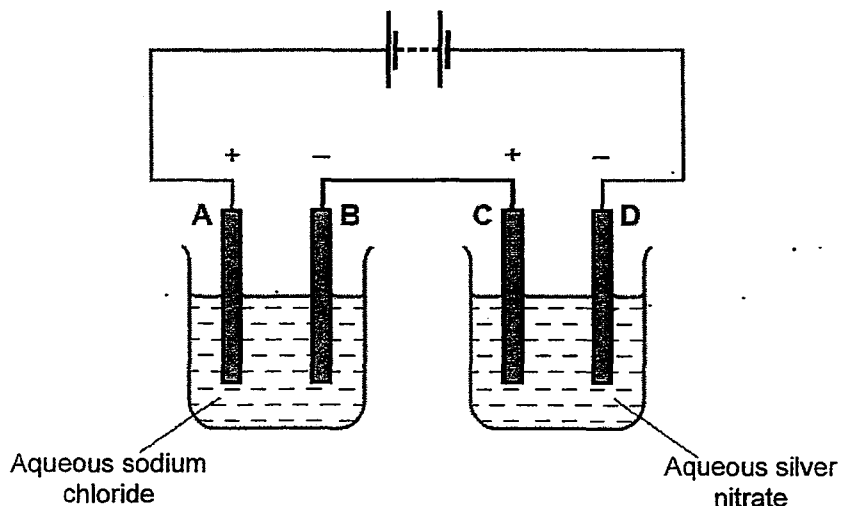
The potential differences between the metals are given in the table below.

Electrochemical cell	Metals used	Voltage/ V	Negative electrode
1	Cu, U	-0.45	Cu
2	Cu, V	+1.11	V
3	Cu, W	+2.71	W

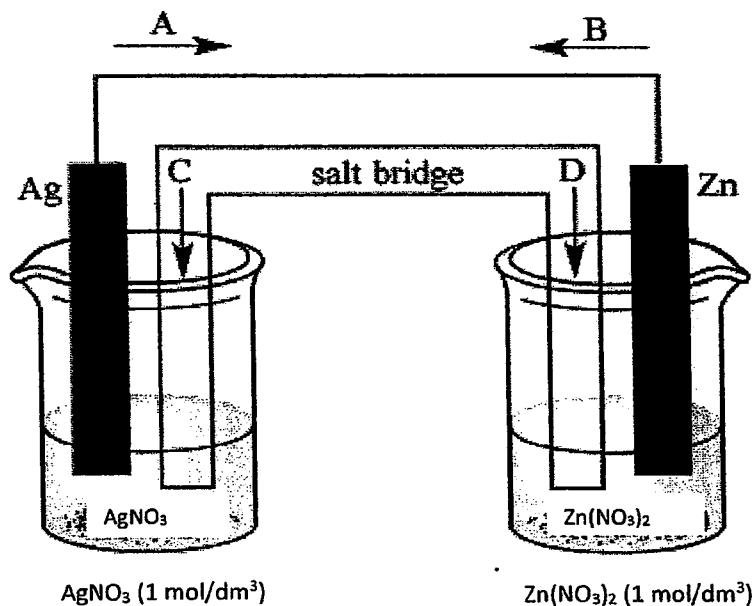
Which of the following correctly lists the metals in order of increasing reactivity?

- A U V Cu W
- B U Cu V W
- C W V Cu U
- D W Cu V U

- 31 The diagram shows an electrolysis circuit. At which electrode is hydrogen formed?



32 In an electrochemical cell shown below, which arrow indicates the spontaneous electron flow?



33 Hydrazine has the formula H_2NNH_2 and has similar properties to ammonia. Which statement correctly describes the property of hydrazine?

- A It reacts with hydrogen chloride to form a compound with the chemical formula $\text{ClH}_3\text{NNH}_3\text{Cl}$.
- B It reacts with sodium hydroxide to form a compound with the chemical formula NaHNNHNa .
- C It is an ionic compound.
- D It dissolves in water to form hydrogen ions.

34 To reduce atmospheric pollution, the following waste gases are passed through powdered calcium carbonate.

Carbon monoxide	Carbon dioxide	Nitrogen monoxide
Nitrogen dioxide	Sulphur dioxide	Phosphorus (V) oxide

How many waste gases will **not** be removed by the powdered calcium carbonate?

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

35 What environmental effects do chlorofluorocarbons, methane and nitrogen dioxide result in?

	chlorofluorocarbons	methane	nitrogen dioxide
A	Acid rain	Depletion of the ozone layer	Global warming
B	Depletion of the ozone layer	Acid rain	Global warming
C	Depletion of the ozone layer	Global warming	Acid rain
D	Global warming	Depletion of the ozone layer	Acid rain

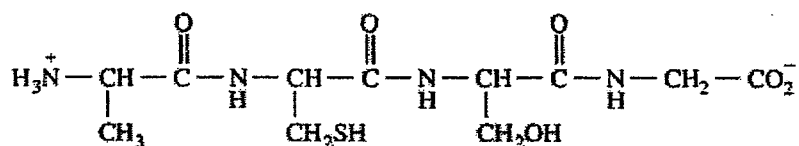
- 36 The table below shows some data about the composition of the mixtures of exhaust gases from two cars, one fitted with a catalytic converter and one without.

	% by volume of nitrogen monoxide	% by volume of carbon dioxide	% by volume of water vapour
Car without catalytic converter	67.60	12.00	11.00
Car with catalytic converter	23.60	32.35	41.10

Which statement does **not** explain the above data?

- A The percentage of nitrogen monoxide decreases as it is oxidised to form harmless nitrates, carbon dioxide and water in the catalytic converter.
- B The percentage of nitrogen monoxide decreases as it is reduced to form nitrogen in the catalytic converter.
- C The percentage of carbon dioxide increases as unburnt hydrocarbons undergo complete combustion in the catalytic converter.
- D The percentage of water vapour increases as unburnt hydrocarbons undergo complete combustion in the catalytic converter.
- 37 Ammonia is produced by the Haber process. Which statement is **not** correct?
- A A catalyst of iron(II) oxide is used.
- B Each nitrogen molecule reacts with three hydrogen molecules to form two molecules of ammonia.
- C Hydrogen for the process can be obtained by cracking of some fractions of crude oil.
- D Two ammonia molecules decompose to form one nitrogen molecule and three hydrogen molecules.

- 38 What is the total number of amide linkages in the structure shown below?



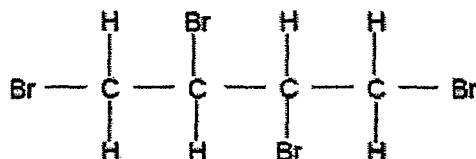
- A 1
- B 2
- C 3
- D 4

- 39 An ester is made by reacting alcohol **P** with a carboxylic acid **Q**. Alcohol **P** can be oxidised to form **Q** by warming with acidified potassium manganate(VII), under reflux.

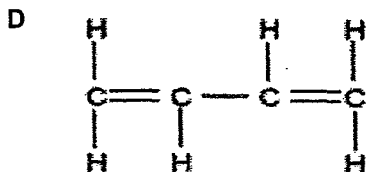
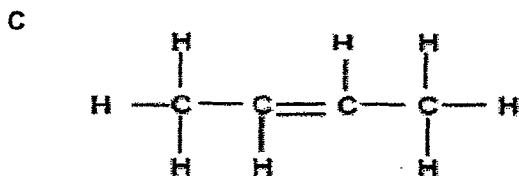
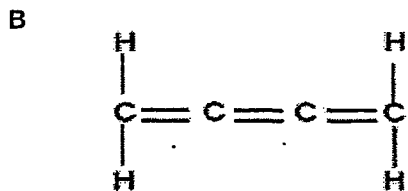
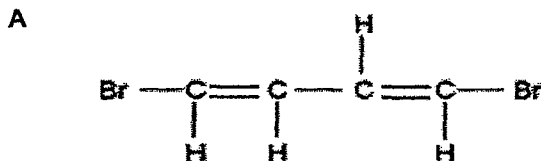
What might be the structural formula for the ester made?

- A CH_3OOCH_3
- B $\text{CH}_3\text{COOCH}_2\text{CH}_3$
- C $\text{CH}_3\text{CH}_2\text{COOCH}_2\text{CH}_3$
- D $\text{CH}_3\text{CH}_2\text{CH}_2\text{COOCH}_2\text{CH}_3$

- 40 When an organic compound **R** reacts with aqueous bromine, the product formed is shown below.



Which of the following structures is the organic compound **R** most likely to be?



Preliminary Examination 2016

CHEMISTRY
PAPER 1 Multiple Choice ANSWER

5073/01

Friday

12 AUGUST 2016

1	2	3	4	5	6	7	8	9	10
B	B	A	C	A	B	C	A	B	C
11	12	13	14	15	16	17	18	19	20
B	B	B	C	C	B	B	D	D	D
21	22	23	24	25	26	27	28	29	30
B	D	B	A	D	C	A	D	D	B
31	32	33	34	35	36	37	38	39	40
B	B	D	B	C	A	A	C	B	D

**Preliminary Examination
Secondary Four**

CANDIDATE
NAME

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CLASS

4			
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REGISTER
NUMBER

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CENTRE
NUMBER

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INDEX NUMBER

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Chemistry

5073/02

Paper 2 Theory

Thursday

4 August 2016

1 hour 45 minutes

Candidates answer on the Question Paper.

No Additional materials are required.

READ THESE INSTRUCTIONS FIRST

Write your class, index number and name on all the work you hand in.

Write in dark blue or black pen.

You may use a soft pencil for any diagrams or graphs.

Do not use staples, paper clips, highlighters, glue or correction fluid/tape.

Section A

Answer **all** questions in the spaces provided.

Section B

Answer **all** questions, the last question is in the form either/or.

Answer **all** questions in the spaces provided.

At the end of the examination, fasten all your work securely together.

The number of marks is given in brackets [] at the end of each question or part question.

A copy of the Periodic Table is printed on page 20.

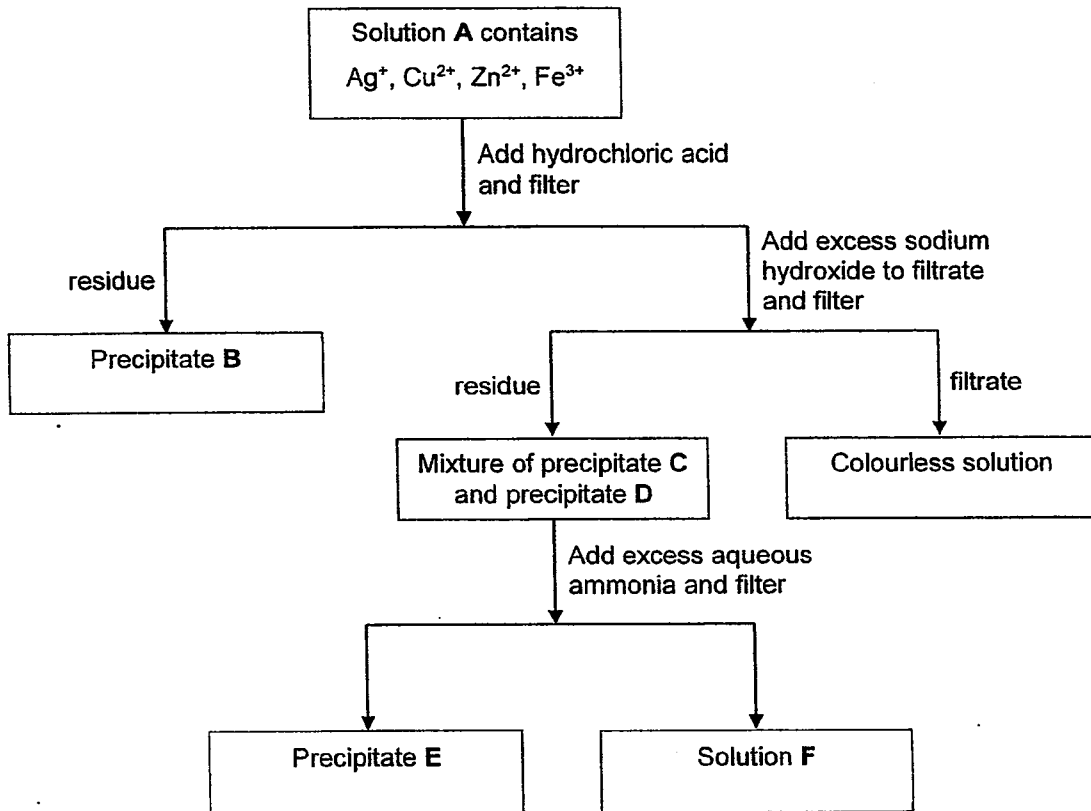
The use of an approved scientific calculator is expected, where appropriate.

For Examiner's Use	
Section A	50
B8	12
B9	8
B10	10
Total	80

Section A

Answer all questions in this section in the spaces provided.
The total mark for this section is 50.

A1 The flowchart below shows how the ions present in solution A are separated.



- (a) It is known that solution A contains 1 anion. Suggest the identity of this anion. Give a reason for your answer.

Identity of anion :

Reason : [2]

- (b) Describe a test to confirm the anion you named in part (a).

.....

.....

..... [2]

(c) Name the precipitates **B**, **C** and **D**.

B :

C :

D :

[3]

(d) What are the colours of precipitate **E** and Solution **F**?

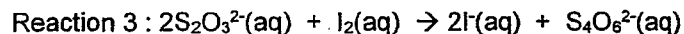
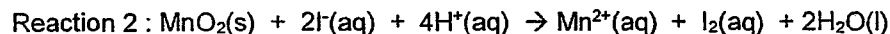
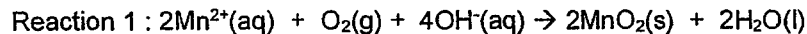
Precipitate **E** :

Solution **F** :

[2]

[Total: 9]

A2 The level of dissolved oxygen is used as an indicator to gauge the health of a water body. Generally, the higher the concentration of dissolved oxygen, the less polluted the water and the more likely it is able to support living organisms. To measure the level of oxygen in a sample of water, the Winkler Method is used. This technique makes use of redox reactions and is carried out in the 3 steps shown below.



(a) Define a redox reaction.

.....

[1]

(b) Choose any **one** of the above reactions and explain why it is a redox reaction, making reference to oxidation states.

Reaction

Explanation :

.....

.....

.....

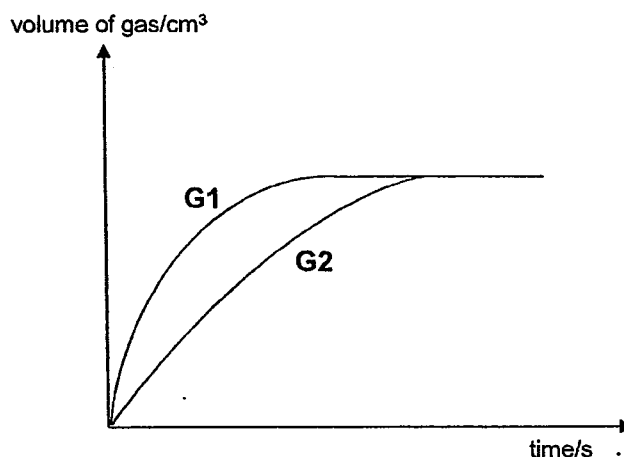
[2]

- (c) 100 cm³ of water was taken from the school's koi pond and analysed using this method. It was found that 0.0008 mole of iodide ions was formed in step 3. Calculate the mass of oxygen dissolved in this sample of pond water.

[2]

[Total: 5]

- A3** A sample of 3.36 g of magnesium carbonate powder was divided equally into two portions. One portion was added into hydrochloric acid and the other portion was added into sulfuric acid. The volume and concentration of acids used were both 25.0 cm³ and 5.00 mol/dm³ respectively. The graphs below (G1 and G2) show the volume of the gas collected over time.



- (a) Which graph represents the results for hydrochloric acid? Explain your answer in terms of particle collision.

Graph

Explanation :

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.....

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.....

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.....

.....

[4]

(b) Another experiment was carried out by adding 2.00 g calcium carbonate powder into 25.0 cm³ of sulfuric acid of concentration 5.00 mol/dm³. On the same axes, sketch the graph you will expect to obtain and label it C. [1]

(c) Explain the shape of your graph.

.....

.....

.....

.....

.....

[2]

[Total: 7]

A4 Astatine, At, is an element in Group VII of the Periodic Table. It exists as diatomic molecules similar to the other elements in the same Group. 2 isotopes of astatine are known to exist: astatine-210 and astatine-211. It reacts with strontium (Sr) to form the compound strontium astatide.

symbol	number of protons	number of electrons	number of neutrons
$^{210}_{85}\text{At}$
$^{211}_{85}\text{At}$

(a) Complete the table above.

[1]

(b) What are isotopes?

.....

.....

.....

[1]

(c) Draw the 'dot-and-cross' diagram for an astatine molecule, showing only the outer shell electrons.

[1]

- (d) Draw the "dot-and-cross" diagram of strontium astatide, showing only the outer shell electrons. Hence write the chemical formula of this compound.

Formula of strontium astatide : [3]

- (e) Predict 2 properties of strontium astatide. Give a reason for each of the properties which you state.

Property 1 :

Reason :

..... [2]

Property 2 :

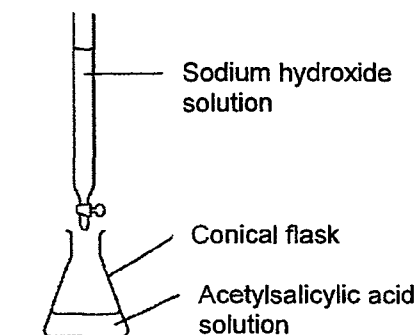
Reason :

..... [2]

[Total: 10]

- A5** The drug aspirin is used to relieve pain, fever and inflammation. However, if taken in high doses, it can cause gastric ulcers and bleeding in the stomach. The active ingredient is acetylsalicylic acid which is a monobasic acid. The formula of the acid can be represented by HA and its relative molecular mass is 180.

A student was interested in determining the percentage of the acid in an aspirin tablet. An aspirin tablet was first weighed and then dissolved in water to make a solution in a conical flask. A few drops of indicator were then added and dilute sodium hydroxide solution was run in from a burette until the indicator changed colour.



The results were as follows :

Mass of aspirin tablet taken	0.50 g
Volume of dilute sodium hydroxide added	23.0 cm ³
Concentration of the dilute sodium hydroxide added	0.01 mol/dm ³

- (a) Acetylsalicylic acid is a weak acid. Explain what is a *weak* acid.
-
- [1]
- (b) Explain why it is **not** important to know the volume of the aspirin solution originally taken.
-
- [1]
- (c) Calculate the number of moles of sodium hydroxide solution added. Hence, calculate the percentage of acetylsalicylic acid in the aspirin tablet.

- (d) The student wanted to make a crystalline sample of sodium acetylsalicylate, the salt formed in the reaction. This salt decomposes on strong heating. Describe briefly how this might be carried out using a solution of pure acetylsalicylic acid.

.....

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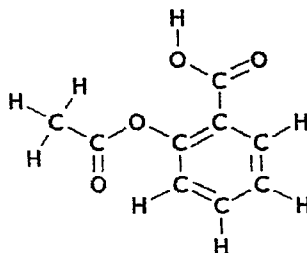
.....

.....

.....

[3]

- (e) The structure of acetylsalicylic acid is given below.



Draw the structure of sodium acetylsalicylate.

[1]

[Total: 9]

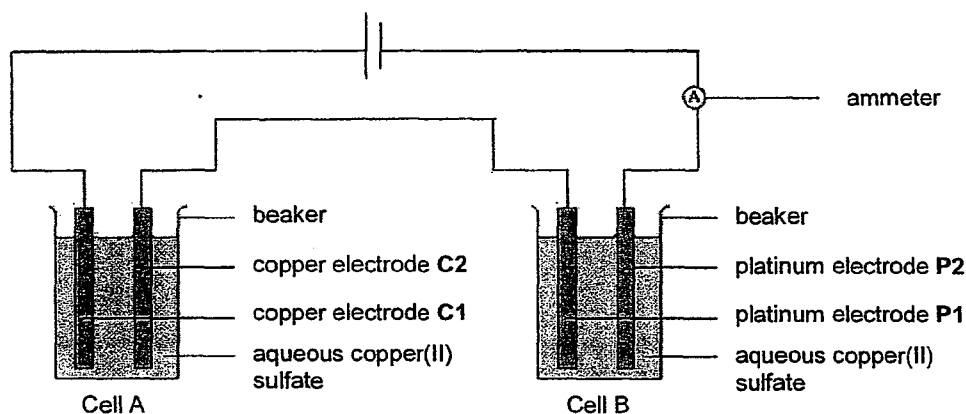
A6 A student carried out electrolysis of dilute potassium chloride and molten potassium chloride using platinum electrodes to determine what products are formed.

(a) Complete the table below.

Electrolyte	Ions in Electrolyte	Product at anode	Product at cathode
Dilute potassium chloride		oxygen	
Molten potassium chloride	K^+ , Cl^-		

[2]

In another investigation, the electrolysis of aqueous copper(II) sulfate was carried out using the apparatus shown in the diagram below.



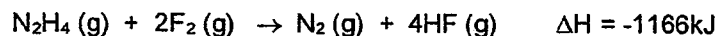
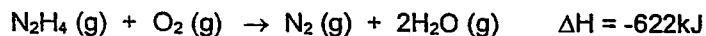
(b) Briefly describe the change(s), if any, which take place at the electrodes and electrolytes at the end of the experiment in the table below.

	Change(s), if any		Change(s), if any
Electrode C1		Electrode P1	
Electrode C2		Electrode P2	
Electrolyte (Cell A)		Electrolyte (Cell B)	

[3]

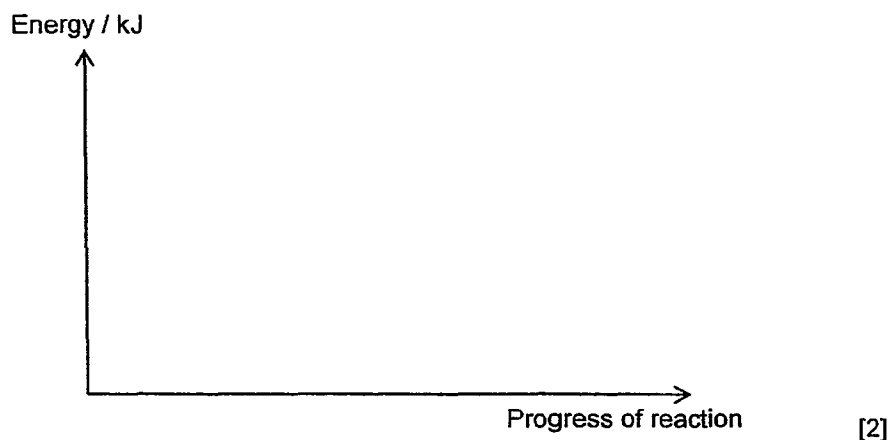
[Total: 5]

- A7** Hydrazine (N_2H_4) is often used as a rocket fuel. It can react with oxygen or fluorine to release large amounts of heat. The equations for the 2 reactions are shown below.



The ΔH values represent the energy change per mole of hydrazine reacted.

- (a) Draw the energy profile diagram for the reaction between hydrazine and oxygen, showing the activation energy and the enthalpy change clearly.



- (b) Based only on the information provided above, which other reactant (oxygen or fluorine) would have made a better choice for usage as a rocket fuel together with hydrazine? Briefly explain your answer.

.....

.....

.....

.....

.....

.....

[2]

- (c) State 1 other factor that should be taken into consideration when deciding which fuel to use.

..... [1]

[Total: 5]

Section B

Answer all **three** questions in this section.

The last question is in the form of an either/or and only one of the alternatives should be attempted.

- B8** The table below gives the current estimated percentage by mass of some of the elements found in the Earth's crust and the Earth's core.

Earth's Crust		Earth's Core	
Element	% by Mass	Element	% by Mass
Oxygen	40.6	Iron	31.0
Silicon	24.7	Oxygen	24.0
Nickel	8.1	Magnesium	16.0
Aluminium	8.1	Silicon	13.0
Iron	5.0	Nickel	11.7
Calcium	3.6	Aluminium	0.1
Sodium	2.8	Sodium	0.1
Potassium	2.6	Hydrogen	0.05
Magnesium	2.1	Potassium	0.04
Zinc	0.0078	Calcium	0.04
Copper	0.0068		
Tin	0.00022		

- (a) Which metallic elements are more abundant in the Earth's crust compared to the Earth's core?

..... [1]

- (b) Suggest a reason why oxygen is the most abundant element in the earth's crust.

.....

 [1]

- (c) The estimated mass of the earth's crust is 2.125×10^{16} kg. The annual production of iron is 3.32×10^9 tonnes. Assuming that the demand for this metal is the same each year, determine the number of years before the supply of iron from the Earth's crust runs out. (1 tonne = 1000 kg)

- (d) Briefly describe one advantage and one disadvantage of recycling metals.

Advantage :

.....

Disadvantage :

..... [2]

- (e) Globally, iron and aluminium are the most recycled metals because of the ease of recycling them. Suggest a property of each of these 2 metals that accounts for this.

Iron :

.....

Aluminium :

..... [2]

A student studied the action of heat on 4 different substances (A, B, C and D). He knew that two of them were metals, and the other two were carbonates of the same two metals. He weighed out 5.00 g of each of the four solids and heated them in separate crucibles.

The table below shows the appearances and masses of the four solids before and after strong heating for some time.

Solid	Appearance		Mass/g	
	Before	After	Before	After
A	Brown	Black	5.00	6.25
B	Green	Black	5.00	3.22
C	White	White	5.00	5.00
D	Silvery	White	5.00	6.73

- (f) Based on the data given above, suggest which 2 were the metals and which 2 were the metal carbonates. Explain your answers.

Metals : Solid and Solid

Metal carbonates : Solid and Solid [1]

Explanation :

.....

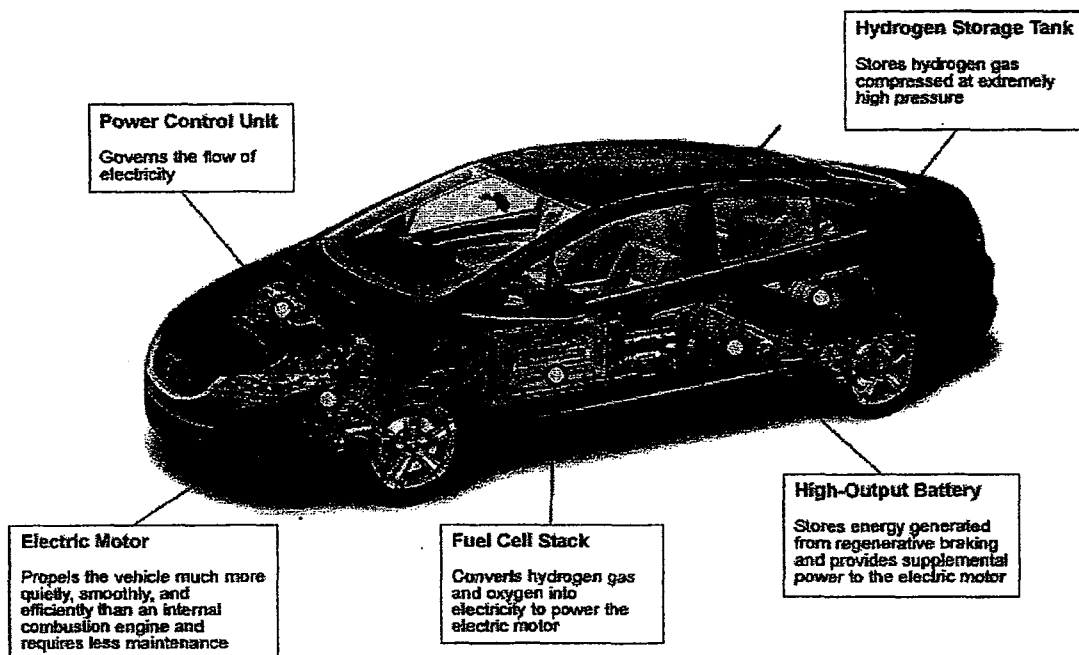
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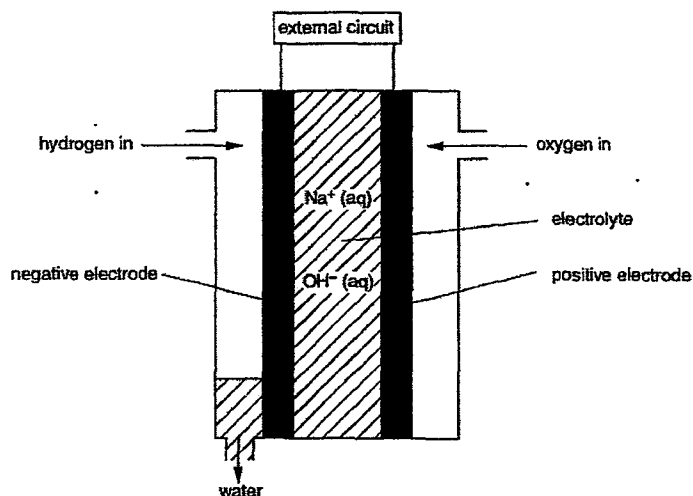
..... [3]

[Total 12]

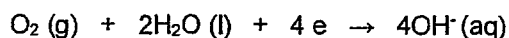
- B9 The diagram below shows the internal setup of a modern eco-friendly car powered by hydrogen-oxygen fuel cells. The main advantages of the use of fuels cells is that hydrogen is an efficient source of energy and it does not cause pollution at the point of use.



The diagram below shows the hydrogen-oxygen fuel cell used in such a car.



At the positive electrode, the reaction which takes place is :



At the negative electrode, the reaction which takes place is :



- (a) Write the overall equation for the reaction in the fuel cell.
..... [1]
- (b) Briefly explain why the use of fuel cells does not cause pollution at the point of use.
..... [1]
- (c) Suggest why the use of fuel cells may still generate pollution.
.....
..... [1]
- (d) Manufacturers claim that hydrogen is a renewable fuel. Do you agree? Explain your answer.
.....
..... [1]
- (e) Give a source of oxygen.
..... [1]
- (f) Suggest why the hydrogen and oxygen must be kept apart.
.....
..... [1]
- (g) Briefly describe one advantage and one disadvantage of compressing hydrogen fuel at high pressure.
Advantage :
.....
Disadvantage :
..... [2]

[Total 8]

EITHER

B10 One of the components in crude oil is undecane, $C_{11}H_{24}$. This molecule may be broken down into butene and one other product. The reaction is carried out in the oil refinery.

(a) What is the name of this type of reaction?

..... [1]

(b) Write the equation for this reaction.

..... [1]

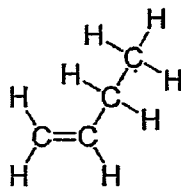
(c) Suggest 2 conditions required for this reaction to take place

..... [1]

(d) When the reaction is carried out, 1.00 mol of undecane gives 25.2 g of butene. Calculate the percentage yield of butene.

[2]

Butene can exist as 3 isomers. One of the isomers, but-1-ene, is shown in the diagram below.



(e) Draw the structures of the other 2 isomers of butene.

[2]

- (f) The isomers of butene can undergo addition polymerization. Draw the structure of the polymer formed by any 1 of the isomers in part (e), showing 3 repeating units.

[1]

Butan-2-ol is manufactured by the reaction between steam and butene. An isomer of butan-2-ol is also formed at the same time. The 2 isomers are miscible.

- (g) Suggest, with reason, a method suitable for separating the components of the mixture of products.

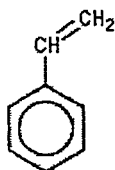
Method :

Reason : [2]

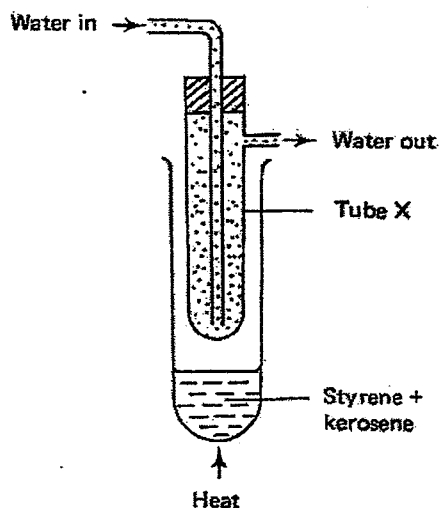
[Total 10]

OR

B10 The compound styrene (chemical formula C_8H_8) has the following structure



It can undergo addition polymerisation to form polystyrene, a non-biodegradable thermoplastic polymer used for making disposable utensils such as styrofoam cups and plates. The polymerisation process is carried out by mixing styrene and kerosene and refluxing the mixture at about 150°C using the setup shown below.



After cooling, the reaction mixture is poured into methanol. Polystyrene, which appears as a waxy white solid will then form under the surface of the methanol.

(a) Suggest the function of

(i) tube X and

..... [1]

(ii) kerosene.

..... [1]

- (b) Draw the structural formula of polystyrene formed, showing 3 repeating units.

[1]

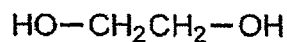
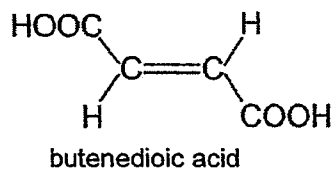
- (c) What is meant by the term "non-biodegradable"?

.....
 [1]

- (d) Suggest a reason why polystyrene produces a lot of soot when burnt.

.....
 [1]

The structural formulae of two organic compounds, butenedioic acid and ethane-1,2-diol are shown below.



ethane-1,2-diol

- (e) Butenedioic acid reacts with aqueous bromine and also with aqueous sodium carbonate. State an observation for each reaction and briefly explain why it is observed.

Reactant	Observation	Explanation
Aqueous bromine		
Aqueous sodium carbonate		

[4]

- (f) Butenedioic acid and ethane-1,2-diol can polymerize under the right conditions to form a polymer W. Draw the repeating unit of this polymer.

[1]

[Total 10]

DATA SHEET
The Periodic Table of the Elements

		Group																									
I	II	III	IV	V	VI	VII	0																				
1 H Hydrogen 1											2 He Helium 2																
3 Li Lithium 3	4 Be Beryllium 4											5 B Boron 5	6 C Carbon 6	7 N Nitrogen 7	8 O Oxygen 8	9 F Fluorine 9	10 Ne Neon 10										
11 Na Sodium 11	12 Mg Magnesium 12											13 Al Aluminum 13	14 Si Silicon 14	15 P Phosphorus 15	16 S Sulfur 16	17 Cl Chlorine 17	18 Ar Argon 18										
19 K Potassium 19	20 Ca Calcium 20											21 Sc Scandium 21	22 Ti Titanium 22	23 V Vanadium 23	24 Cr Chromium 24	25 Mn Manganese 25	26 Fe Iron 26	27 Co Cobalt 27	28 Ni Nickel 28	29 Cu Copper 29	30 Zn Zinc 30	31 Ga Gallium 31	32 Ge Germanium 32	33 As Arsenic 33	34 Se Selenium 34	35 Br Bromine 35	36 Kr Krypton 36
37 Rb Rubidium 37	38 Sr Strontium 38											39 Y Yttrium 39	40 Zr Zirconium 40	41 Nb Niobium 41	42 Mo Molybdenum 42	43 Tc Technetium 43	44 Ru Ruthenium 44	45 Rh Rhodium 45	46 Pd Palladium 46	47 Ag Silver 47	48 Cd Cadmium 48	49 In Indium 49	50 Sn Tin 50	51 Sb Antimony 51	52 Te Tellurium 52	53 I Iodine 53	54 Xe Xenon 54
55 Cs Cesium 55	56 Ba Barium 56											57 La Lanthanum 57	58 Hf Hafnium 58	59 Ta Tantalum 59	60 W Tungsten 60	61 Re Rhenium 61	62 Os Osmium 62	63 Pt Platinum 63	64 Au Gold 64	65 Hg Mercury 65	66 Tl Thallium 66	67 Pb Lead 67	68 Bi Bismuth 68	69 Po Polonium 69	70 At Astatine 70	71 Rn Radon 71	
87 Fr Francium 87	88 Ra Radium 88											89 Ac Actinium 89															

*58-71 Lanthanoid series		190-103 Actinoid series	
72 La Lanthanum 72	73 Ce Cerium 73	84 Pr Praseodymium 84	85 Nd Neodymium 85
74 Sm Samarium 74	75 Eu Europium 75	86 Gd Gadolinium 86	87 Tb Terbium 87
76 Dy Dysprosium 76	77 Ho Holmium 77	88 Er Erbium 88	89 Tm Thulium 89
90 Yb Ytterbium 90	91 Lu Lutetium 91	92 Th Thorium 92	93 Pa Protactinium 93
94 U Uranium 94	95 Np Neptunium 95	96 Pu Plutonium 96	97 Am Americium 97
98 Cm Curium 98	99 Bk Berkelium 99	100 Cf Californium 100	101 Es Einsteinium 101
102 Fm Fermium 102	103 Md Mendelevium 103	104 No Nobelium 104	105 Lr Lawrencium 105

a	X
b	b

Key

a = relative atomic mass
 X = atomic symbol
 b = proton (atomic) number

The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.).

**Preliminary Examination
Secondary Four**

CANDIDATE
NAME

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CLASS

4		
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REGISTER
NUMBER

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CENTRE
NUMBER

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INDEX NUMBER

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Chemistry

5073/02

Paper 2 Theory

Thursday

4 August 2016

1 hour 45 minutes

Candidates answer on the Question Paper.

No Additional materials are required.

READ THESE INSTRUCTIONS FIRST

Write your class, index number and name on all the work you hand in.

Write in dark blue or black pen.

You may use a soft pencil for any diagrams or graphs.

Do not use staples, paper clips, highlighters, glue or correction fluid/tape.

Section A

Answer **all** questions in the spaces provided.

Section B

Answer **all** questions, the last question is in the form either/or.

Answer **all** questions in the spaces provided.

At the end of the examination, fasten all your work securely together.

The number of marks is given in brackets [] at the end of each question or part question.

A copy of the Periodic Table is printed on page 20.

The use of an approved scientific calculator is expected, where appropriate.

Answers

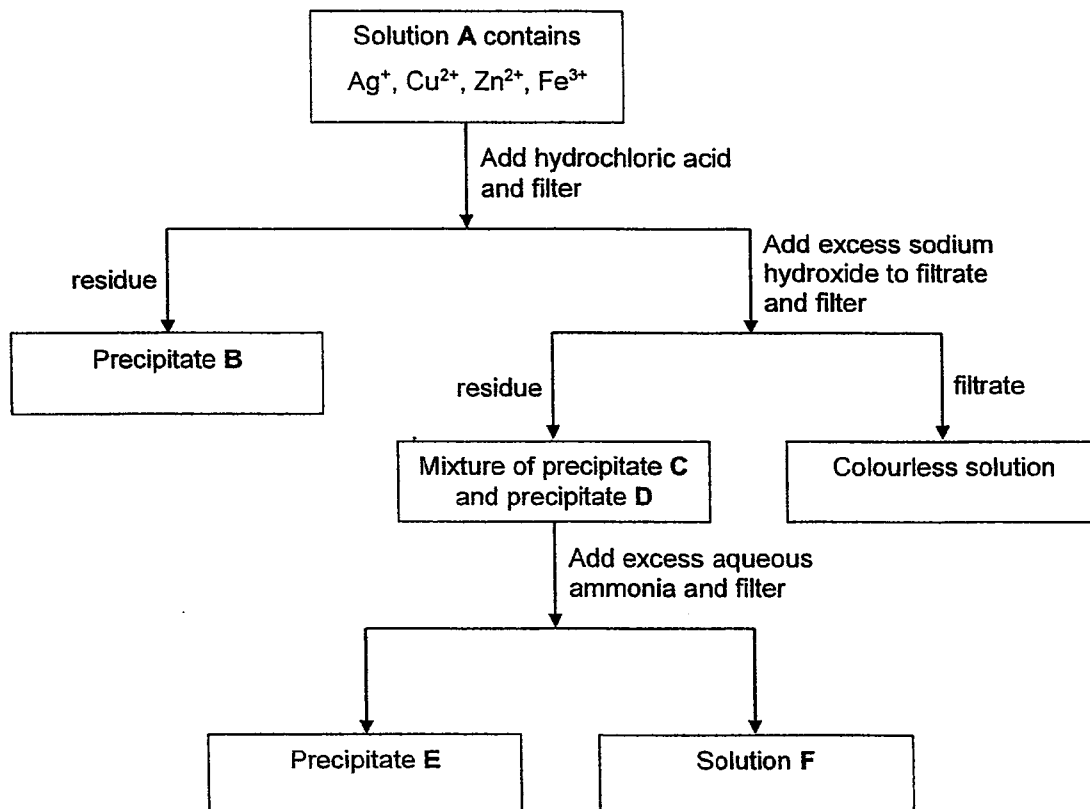
For Examiner's Use	
Section A	50
B8	12
B9	8
B10	10
Total	80

This question paper consists of 20 printed pages.

Section A

Answer all questions in this section in the spaces provided.
The total mark for this section is 50.

A1 The flowchart below shows how the ions present in solution A are separated.



- (a) It is known that solution A contains 1 anion. Suggest the identity of this anion. Give a reason for your answer.

Identity of anion : Nitrate 1m

Reason : All nitrates are soluble 1m

[2]

- (b) Describe a test to confirm the anion you named in part (a).

Add aqueous sodium hydroxide, Devarda's alloy/aluminium and warm; 1m

Gas given off turns moist red litmus paper blue 1m

[2]

(c) Name the precipitates B, C and D.

B : silver chloride 1m

C : copper(II) hydroxide 1m

D : iron(III) hydroxide 1m

Answers to C and D interchangeable

[3]

(d) What are the colours of precipitate E and Solution F?

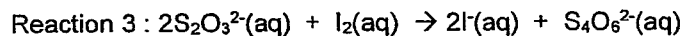
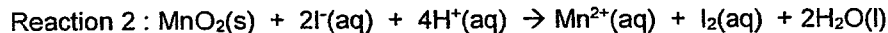
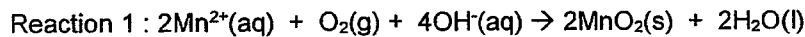
Precipitate E : reddish brown 1m

Solution F : dark blue 1m

[2]

[Total: 9]

A2 The level of dissolved oxygen is used as an indicator to gauge the health of a water body. Generally, the higher the concentration of dissolved oxygen, the less polluted the water and the more likely it is able to support living organisms. To measure the level of oxygen in a sample of water, the Winkler Method is used. This technique makes use of redox reactions and is carried out in the 3 steps shown below.



(a) Define a redox reaction.

Reaction which involves oxidation and reduction simultaneously 1m

.....
.....

[1]

(b) Choose any **one** of the above reactions and explain why it is a redox reaction, making reference to oxidation states.

Reaction 1 : Oxidation state of Mn increases from +2 in Mn^{2+} to +4 in MnO_2 1m
Oxidation state of O decreases from 0 in O_2 to -2 in $\text{MnO}_2/\text{H}_2\text{O}$ 1m

Reaction 2 : Oxidation state of Mn decreases from +4 in MnO_2 to +2 in Mn^{2+} 1m
Oxidation state of I increases from -1 in I^{-} to 0 in I_2 1m

Reaction 3 : Oxidation state of S increases from +2 in $\text{S}_2\text{O}_3^{2-}$ to +2.5 in $\text{S}_4\text{O}_6^{2-}$ 1m
Oxidation state of I decreases from 0 in I_2 to -1 in I^{-} 1m

[2]

Any 1 of above

- (c) 100 cm³ of water was taken from the school's koi pond and analysed using this method. It was found that 0.0008 mole of iodide ions was formed in step 3. Calculate the mass of oxygen dissolved in this sample of pond water.

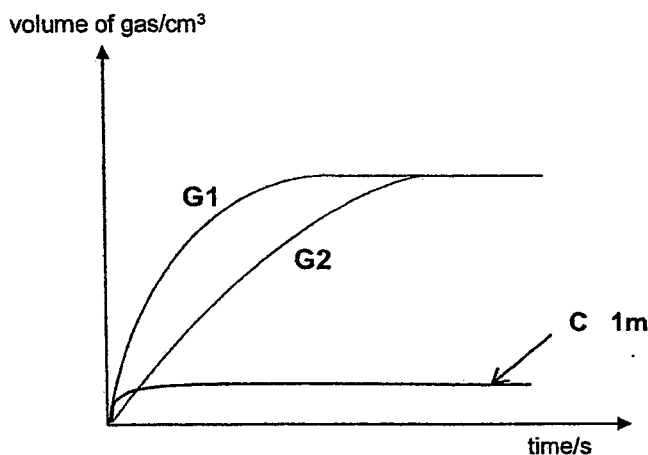
0.0008 moles of I⁻ is produced by 0.0004 mole of I₂
 0.0004 moles of I₂ is produced by 0.0004 mole of MnO₂
 0.0004 moles of MnO₂ is produced by 0.0002 mole of O₂ } Explanation 1m

Mass of oxygen dissolved = 0.0002 x 32 = 0.0064 g 1m

[2]

[Total: 5]

- A3 A sample of 3.36 g of magnesium carbonate powder was divided equally into two portions. One portion was added into hydrochloric acid and the other portion was added into sulfuric acid. The volume and concentration of acids used were both 25.0 cm³ and 5.00 mol/dm³ respectively. The graphs below (G1 and G2) show the volume of the gas collected over time.



- (a) Which graph represents the results for hydrochloric acid? Explain your answer in terms of particle collision.

Graph G2 1m

Explanation : sulfuric acid is dibasic while hydrochloric acid is monobasic acid,

concentration of hydrogen ions in HCl is half that of H₂SO₄ ; 1m

frequency of collisions is lower and hence number of effective collisions per

unit time is less in HCl compared to H₂SO₄; 1m

rate of reaction is slower, graph is less steep: 1m

MgCO₃ is the same limiting reactant 1m

Any 4 out of 5 points 4m

..... [4]

(b) Another experiment was carried out by adding 2.00 g calcium carbonate powder into 25.0 cm³ of sulfuric acid of concentration 5.00 mol/dm³. On the same axes, sketch the graph you will expect to obtain and label it C. [1]

(c) Explain the shape of your graph.

Calcium carbonate reacts with sulfuric acid to form calcium sulfate which is insoluble ; 1m

layer of calcium sulfate around calcium carbonate prevents further reaction with the acid 1m

..... [2]

[Total: 7]

A4 Astatine, At, is an element in Group VII of the Periodic Table. It exists as diatomic molecules similar to the other elements in the same Group. 2 isotopes of astatine are known to exist : astatine-210 and astatine-211. It reacts with strontium (Sr) to form the compound strontium astatide.

symbol	number of protons	number of electrons	number of neutrons
²¹⁰ ₈₅ At 85 85 125
²¹¹ ₈₅ At 85 85 126

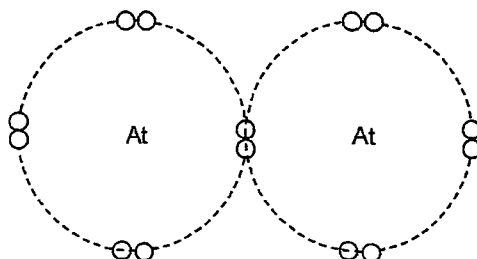
(a) Complete the table above. All correct 1m [1]

(b) What are isotopes?

Atoms of same element with same number of protons but different number of neutrons 1m

..... [1]

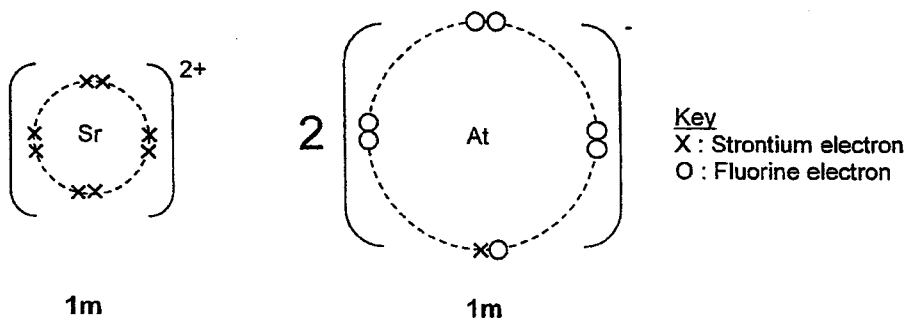
(c) Draw the 'dot-and-cross' diagram for an astatine molecule, showing only the outer shell electrons.



Correct number of electrons and 1 pair of shared electrons 1m

[1]

- (d) Draw the "dot-and-cross" diagram of strontium astatide, showing only the outer shell electrons. Hence write the chemical formula of this compound.



Formula of strontium astatide : SrAt₂ 1m [3]

- (e) Predict 2 properties of strontium astatide. Give a reason for each of the properties which you state.

Property 1 : high melting/boiling point 1m

Reason : strong electrostatic forces of attraction between ions, a lot of energy

required to overcome them 1m [2]

Property 2 : can conduct electricity in the molten/aqueous state 1m

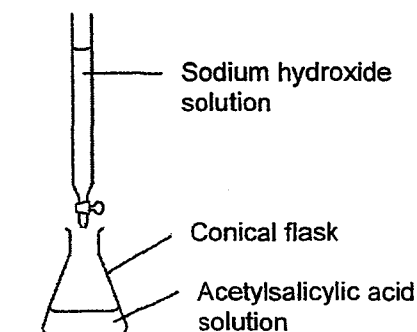
Reason : mobile ions in the molten/aqueous state 1m

[2]

[Total: 10]

- A5** The drug aspirin is used to relieve pain, fever and inflammation. However, if taken in high doses, it can cause gastric ulcers and bleeding in the stomach. The active ingredient is acetylsalicylic acid which is a monobasic acid. The formula of the acid can be represented by HA and its relative molecular mass is 180.

A student was interested in determining the percentage of the acid in an aspirin tablet. An aspirin tablet was first weighed and then dissolved in water to make a solution in a conical flask. A few drops of indicator were then added and dilute sodium hydroxide solution was run in from a burette until the indicator changed colour.



The results were as follows :

Mass of aspirin tablet taken	0.50 g
Volume of dilute sodium hydroxide added	23.0 cm ³
Concentration of the dilute sodium hydroxide added	0.01 mol/dm ³

- (a) Acetylsalicylic acid is a weak acid. Explain what is a *weak acid*.

Acid undergoes partial ionization in water 1m

..... [1]

- (b) Explain why it is **not** important to know the volume of the aspirin solution originally taken.

All the acetylsalicylic acid is dissolved in the water regardless of its volume 1m

..... [1]

- (c) Calculate the number of moles of sodium hydroxide solution added. Hence, calculate the percentage of acetylsalicylic acid in the aspirin tablet.

No of moles of NaOH = $(23.0/1000) \times 0.01 = 0.00023$

Hence, no of moles of acid present = 0.00023 1m

Mass of acetylsalicylic acid present = $0.00023 \times 180 = 0.0414$ g 1m

Hence, percentage of acetylsalicylic acid in tablet = $(0.0414/0.50) \times 100\%$
= 8.28% 1m

[3]

- (d) The student wanted to make a crystalline sample of sodium acetylsalicylate, the salt formed in the reaction. This salt decomposes on strong heating. Describe briefly how this might be carried out using a solution of pure acetylsalicylic acid.

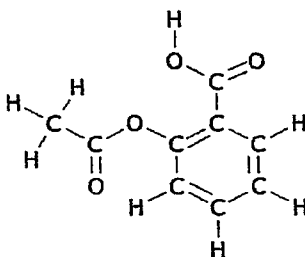
Determine the exact volume of sodium hydroxide required to neutralize a fixed volume of acetylsalicylic acid by titration using a suitable indicator. Repeat a few times to obtain accurate result ;

Add exact volume of sodium hydroxide into fixed volume of acetylsalicylic acid but do not add indicator, 1m heat to obtain saturated solution and cool solution to allow crystallization to take place; 1m filter to obtain crystals and dry between pieces of filter paper. 1m

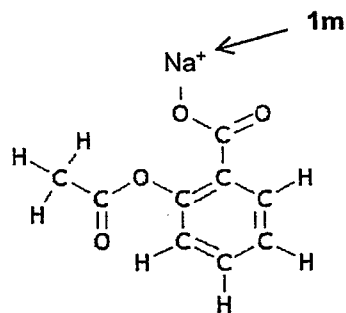
.....

[3]

- (e) The structure of acetylsalicylic acid is given below.



Draw the structure of sodium acetylsalicylate.



[1]

[Total: 9]

A6 A student carried out electrolysis of dilute potassium chloride and molten potassium chloride using platinum electrodes to determine what products are formed.

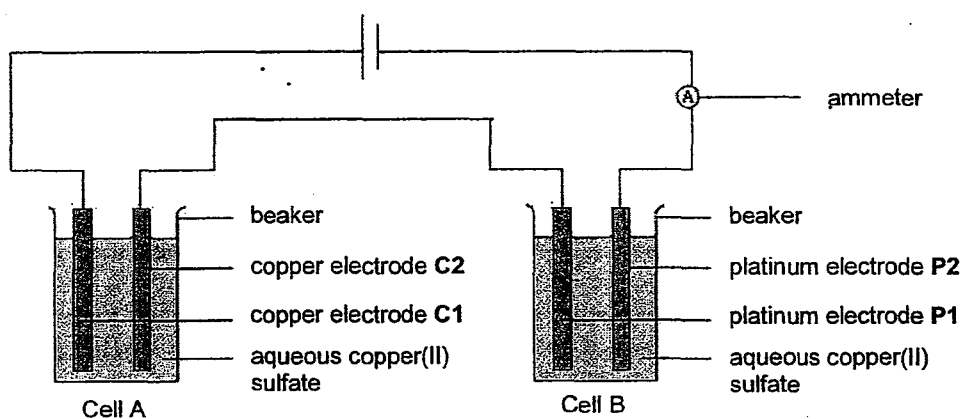
(a) Complete the table below.

Electrolyte	Ions in Electrolyte	Product at anode	Product at cathode
Dilute potassium chloride	H^+ , OH^- , K^+ , Cl^-	oxygen	<u>hydrogen</u>
Molten potassium chloride	K^+ , Cl^-	<u>chlorine</u>	<u>potassium</u>

All correct 2m, 2-3 correct 1m, 0-1 correct 0m

[2]

In another investigation, the electrolysis of aqueous copper(II) sulfate was carried out using the apparatus shown in the diagram below.



(b) Briefly describe the change(s), if any, which take place at the electrodes and electrolytes at the end of the experiment in the table below.

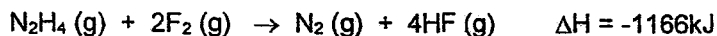
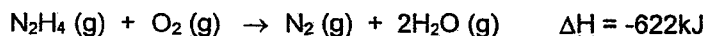
	Change(s), if any		Change(s), if any
Electrode C1	Copper electrode becomes <u>thinner/smaller</u>	Electrode P1	<u>Bubbles of gas observed, colourless gas given off</u>
Electrode C2	Copper electrode becomes <u>thicker/bigger</u>	Electrode P2	<u>Brown solid appears on the electrode</u>
Electrolyte (Cell A)	<u>No visible change, solution remains blue</u>	Electrolyte (Cell B)	<u>Blue solution becomes pale blue/colourless</u>

All correct 3m, 4-5 correct 2m, 2-3 correct 1m, 0-1 correct 0m

[3]

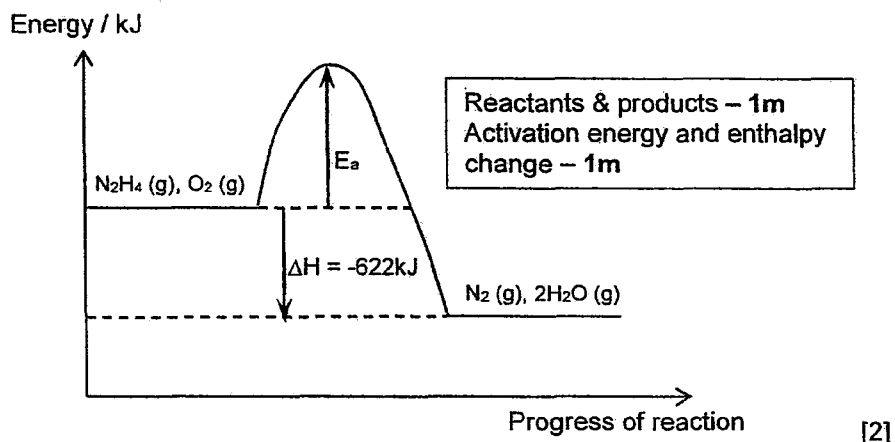
[Total: 5]

- A7 Hydrazine (N_2H_4) is often used as a rocket fuel. It can react with oxygen or fluorine to release large amounts of heat. The equations for the 2 reactions are shown below.



The ΔH values represent the energy change per mole of hydrazine reacted.

- (a) Draw the energy profile diagram for the reaction between hydrazine and oxygen, showing the activation energy and the enthalpy change clearly.



- (b) Based only on the information provided above, which other reactant (oxygen or fluorine) would have made a better choice for usage as a rocket fuel together with hydrazine? Briefly explain your answer.

Fluorine would be a better choice ;

Reaction with fluorine is more exothermic/releases more energy compared 1m

to reaction with oxygen, enabling the rocket to travel further 1m

.....

[2]

- (c) State 1 other factor that should be taken into consideration when deciding which fuel to use.

Cost/availability of gas/how "clean" reaction is/toxicity of gas/mass of gas [1]

Any 1 of above 1m

[Total: 5]

Section B

Answer all **three** questions in this section.

The last question is in the form of an either/or and only one of the alternatives should be attempted.

- B8** The table below gives the current estimated percentage by mass of some of the elements found in the Earth's crust and the Earth's core.

Earth's Crust		Earth's Core	
Element	% by Mass	Element	% by Mass
Oxygen	40.6	Iron	31.0
Silicon	24.7	Oxygen	24.0
Nickel	8.1	Magnesium	16.0
Aluminium	8.1	Silicon	13.0
Iron	5.0	Nickel	11.7
Calcium	3.6	Aluminium	0.1
Sodium	2.8	Sodium	0.1
Potassium	2.6	Hydrogen	0.05
Magnesium	2.1	Potassium	0.04
Zinc	0.0078	Calcium	0.04
Copper	0.0068		
Tin	0.00022		

- (a) Which metallic elements are more abundant in the Earth's crust compared to the Earth's core?

Aluminium, calcium, sodium, potassium (can include zinc, copper, tin) 1m [1]

- (b) Suggest a reason why oxygen is the most abundant element in the earth's crust.

Oxygen, though a gas, is combined with other elements such as metals and silicon in the form of oxides 1m

..... [1]

- (c) The estimated mass of the earth's crust is 2.125×10^{16} kg. The annual production of iron is 3.32×10^9 tonnes. Assuming that the demand for this metal is the same each year, determine the number of years before the supply of iron from the Earth's crust runs out. (1 tonne = 1000 kg)

Mass of iron in Earth's crust = $(5/100) \times 2.125 \times 10^{16} = \underline{1.0625 \times 10^{15} \text{kg}}$ 1m

3.32×10^9 tonnes = 3.32×10^{12} kg

Hence no. of years Earth's crust can supply iron = $1.0625 \times 10^{15} \text{kg} \div 3.32 \times 10^{12}$

= 320 years 1m

- (d) Briefly describe one advantage and one disadvantage of recycling metals.

Advantage : conserve natural resources/reduce environmental problems

related to mining of land/ save cost of extracting metals from ores Any 1, 1m

Disadvantage : High costs related to get people to do recycling/ environmental

issues related to release of harmful substances into environment Any 1, 1m [2]

- (e) Globally, iron and aluminium are the most recycled metals because of the ease of recycling them. Suggest a property of each of these 2 metals that accounts for the ease of recycling them.

Iron : magnetic property of iron enables it to be separated easily using

electromagnets 1m

Aluminium : not easily corroded due to the layer of oxide 1m

[2]

A student studied the action of heat on 4 different substances (A, B, C and D). He knew that two of them were metals, and the other two were carbonates of the same two metals. He weighed out 5.00 g of each of the four solids and heated them in separate crucibles.

The table below shows the appearances and masses of the four solids before and after strong heating for some time.

Solid	Appearance		Mass/g	
	Before	After	Before	After
A	Brown	Black	5.00	6.25
B	Green	Black	5.00	3.22
C	White	White	5.00	5.00
D	Silvery	White	5.00	6.73

- (f) Based on the data given above, suggest which 2 were the metals and which 2 were the metal carbonates. Explain your answers.

Metals : Solid A and Solid D

Metal carbonates : Solid B and Solid C ALL 4 correct, 1m

[1]

Explanation : A and D has increased in mass due to reaction with oxygen in

the air to form metal oxide ; 1m B has decreased in mass as carbonate

decompose on heating to form metal oxide and carbon dioxide; 1m

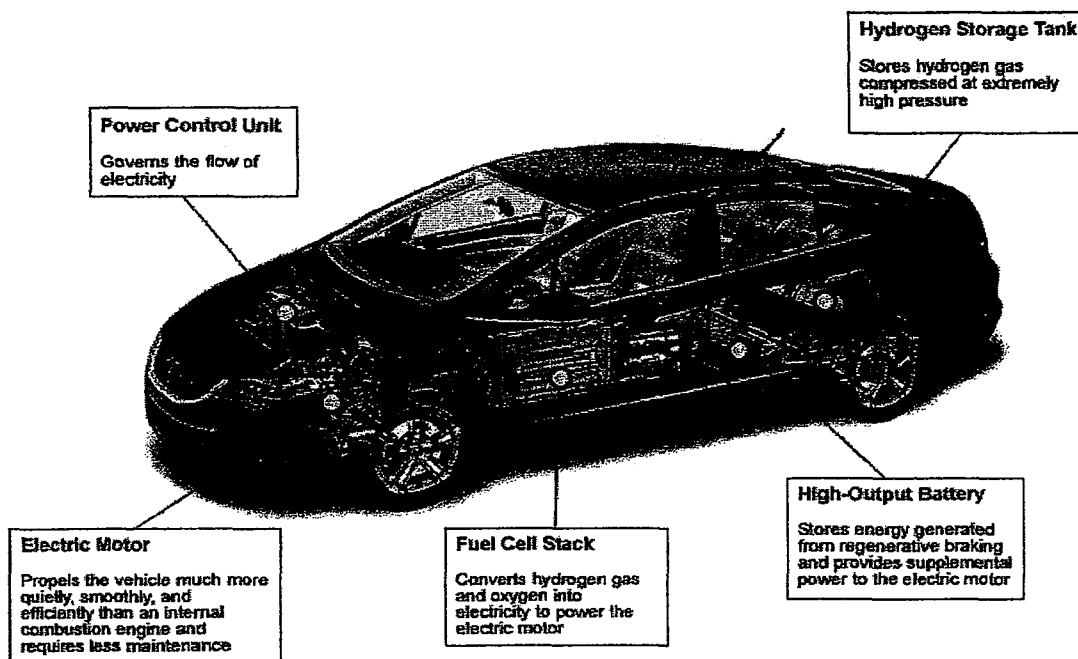
C is carbonate of reactive metal as it is stable and does not decompose on

heating 1m

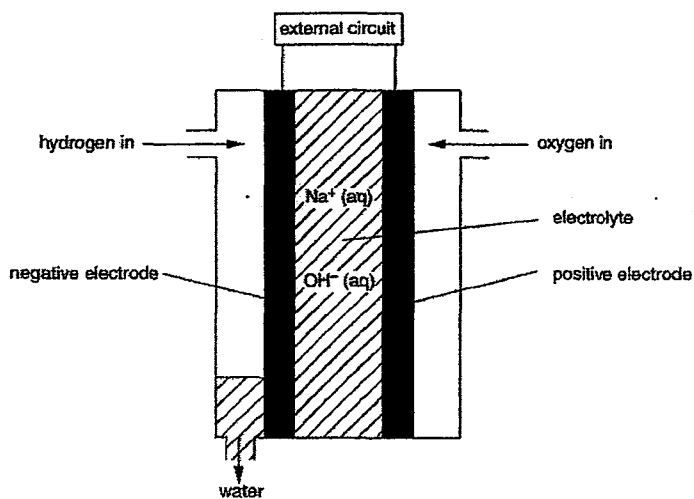
[3]

[Total 12]

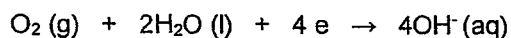
- B9** The diagram below shows the internal setup of a modern eco-friendly car powered by hydrogen-oxygen fuel cells. The main advantages of the use of fuels cells is that hydrogen is an efficient source of energy and it does not cause pollution at the point of use.



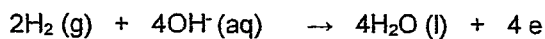
The diagram below shows the hydrogen-oxygen fuel cell used in such a car.



At the positive electrode, the reaction which takes place is :



At the negative electrode, the reaction which takes place is :



- (a) Write the overall equation for the reaction in the fuel cell.



- (b) Briefly explain why the use of fuel cells does not cause pollution at the point of use.

Only product of reaction is water which is harmless 1m [1]

- (c) Suggest why the use of fuel cells may still generate pollution.

Hydrogen obtained from cracking/electrolysis still requires a lot of heat/electricity
which comes from burning of fossil fuels 1m [1]

- (d) Manufacturers claim that hydrogen is a renewable fuel. Do you agree? Explain your answer.

No, hydrogen is not renewable. It is obtained from cracking of long-chained
alkanes which is not renewable. 1m [1]

- (e) Give a source of oxygen.

oxygen from the air/fractional distillation of liquid air 1m [1]

- (f) Suggest why the hydrogen and oxygen must be kept apart.

Hydrogen and oxygen can react explosively if a spark is present 1m
..... [1]

- (g) Briefly describe one advantage and one disadvantage of compressing hydrogen fuel at high pressure.

Advantage : Hydrogen is a gas, compression will allow a greater mass to
be carried in the tank so travel longer distances 1m

Disadvantage : Hydrogen needs highly pressurized containers which are heavy
hence difficult to transport 1m [2]

[Total 8]

EITHER

B10 One of the components in crude oil is undecane, $C_{11}H_{24}$. This molecule may be broken down into butene and one other product. The reaction is carried out in the oil refinery.

- (a) What is the name of this type of reaction?

Cracking 1m [1]

- (b) Write the equation for this reaction.

$C_{11}H_{24} \rightarrow C_4H_8 + C_7H_{16}$ 1m [1]

- (c) Suggest 2 conditions required for this reaction to take place

Catalyst, high temperature Both points 1m [1]

- (d) When the reaction is carried out, 1.00 mol of undecane gives 25.2 g of butene. Calculate the percentage yield of butene.

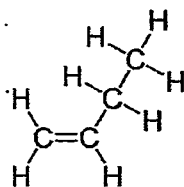
1 mole of undecane gives 1 mole of butene

Molar mass of butene is 56 g 1m

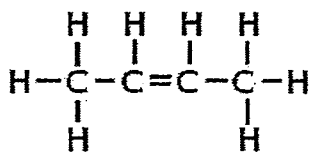
Hence percentage yield = $(25.2/56) \times 100\% = \underline{45.0\%}$ 1m

[2]

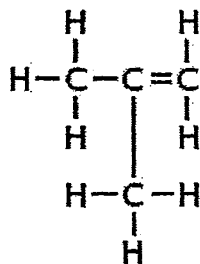
Butene can exist as 3 isomers. One of the isomers, but-1-ene, is shown in the diagram below.



- (e) Draw the structures of the other 2 isomers of butene.



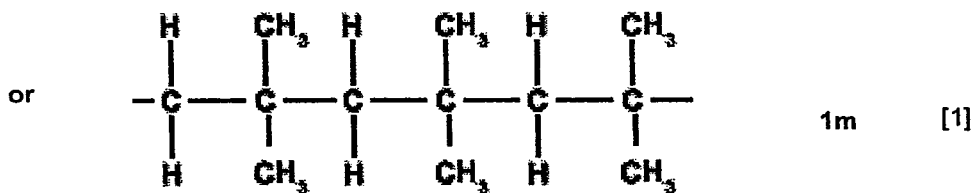
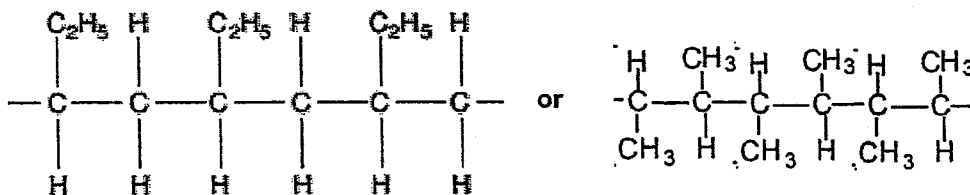
1m



1m

[2]

- (f) The isomers of butene can undergo addition polymerization. Draw the structure of the polymers formed by any 1 of the isomers in part (e), showing 3 repeating units.



[1]

Butan-2-ol is manufactured by the reaction between steam and butene. An isomer of butan-2-ol is also formed at the same time. The 2 isomers are miscible.

- (g) Suggest, with reason, a method suitable for separating the components of the mixture of products.

Method : Fractional distillation 1m

Reason : They have different boiling points 1m

[2]

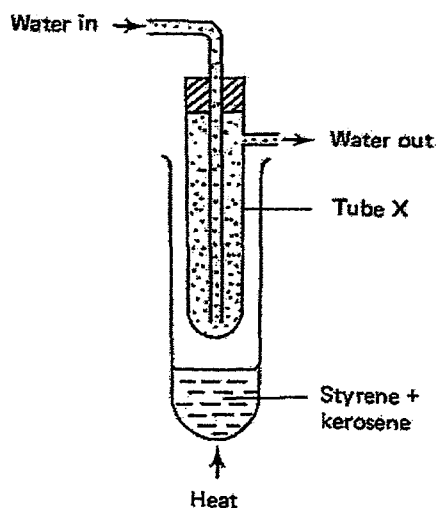
[Total 10]

OR

B10 The compound styrene (chemical formula C_8H_8) has the following structure



It can undergo addition polymerisation to form polystyrene, a non-biodegradable thermoplastic polymer used for making disposable utensils such as styrofoam cups and plates. The polymerisation process is carried out by mixing styrene and kerosene and refluxing the mixture at about 150°C using the setup shown below.



After cooling, the reaction mixture is poured into methanol. Polystyrene, which appears as a waxy white solid will then form under the surface of the methanol.

(a) Suggest the function of

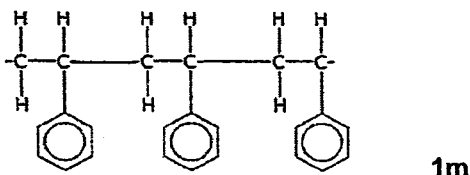
(i) tube X and

Provide cool surface to allow styrene/kerosene to condense 1m [1]

(ii) kerosene.

Solvent. catalyst (Any 1, 1m) [1]

- (b) Draw the structural formula of polystyrene formed, showing 3 repeating units.



[1]

- (c) What is meant by the term "non-biodegradable"?

Cannot be broken down by bacteria 1m

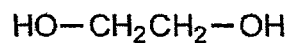
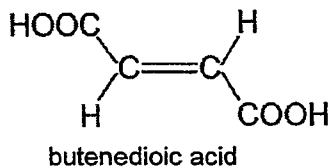
[1]

- (d) Suggest a reason why polystyrene produces a lot of soot when burnt.

High percentage of carbon in the compound 1m

[1]

The structural formulae of two organic compounds, butenedioic acid and ethane-1,2-diol are shown below.



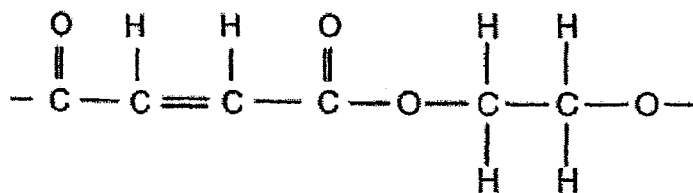
ethane-1,2-diol

- (e) Butenedioic acid reacts with aqueous bromine and also with aqueous sodium carbonate. State an observation for each reaction and briefly explain why it is observed.

Reactant	Observation	Explanation
Aqueous bromine	<u>Reddish brown bromine decolourised</u> 1m	<u>Addition reaction takes place to form colourless products</u> 1m
Aqueous sodium carbonate	<u>Effervescence</u> 1m	Acid reacts with carbonates to form <u>carbon dioxide gas which appear as bubbles</u> 1m

[4]

- (f) Butenedioic acid and ethane-1,2-diol can polymerize under the right conditions to form a polymer W. Draw the repeating unit of this polymer.



1m

[1]

[Total 10]

DATA SHEET
The Periodic Table of the Elements

		Group																																																								
I	II	III	IV	V	VI	VII	O																																																			
7 Li Lithium 3	8 Be Beryllium 4	<table border="1"> <tr> <td>1 H Hydrogen</td> </tr> </table>										1 H Hydrogen																																														
1 H Hydrogen																																																										
23 Na Sodium 11	24 Mg Magnesium 12	11 B Boron 5	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	18 F Fluorine 9	20 Ne Neon 10	27 Al Aluminium 13	28 Si Silicon 14	31 P Phosphorus 15	32 S Sulfur 16	35.5 Cl Chlorine 17	40 Ar Argon 18	49 K Potassium 19	50 Ca Calcium 20	55 Mn Manganese 25	56 Fe Iron 26	59 Co Cobalt 27	58 Ni Nickel 28	64 Cu Copper 29	65 Zn Zinc 30	73 Ge Germanium 32	75 As Arsenic 33	76 Se Selenium 34	80 Br Bromine 35	84 Kr Krypton 36	85 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	101 Ru Ruthenium 44	102 Rh Rhodium 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	118 Sn Tin 50	122 Sb Antimony 51	126 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54	133 Cs Cesium 55	137 Ba Barium 56	138 La Lanthanum 57	178 Hf Hafnium 72	180 Os Osmium 76	182 Ir Iridium 77	186 Pt Platinum 78	187 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	208 Bi Bismuth 83	209 Po Polonium 84	210 At Astatine 85	210 Rn Radon 86	226 Ra Radium 88	227 Ac Actinium 89
139 Cs Cesium 55	137 Ba Barium 56	140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	145 Pm Promethium 61	146 Sm Samarium 62	147 Eu Europium 63	150 Gd Gadolinium 64	152 Tb Terbium 65	157 Dy Dysprosium 66	162 Ho Holmium 67	165 Er Erbium 68	167 Tm Thulium 69	169 Yb Ytterbium 70	173 Lu Lutetium 71	232 Th Thorium 90	231 Pa Protactinium 91	238 U Uranium 92	237 Np Neptunium 93	237 Pu Plutonium 94	239 Am Americium 95	241 Cm Curium 96	244 Bk Berkelium 97	247 Cf Californium 98	251 Es Einsteinium 99	252 Fm Fermium 100	257 Md Mendelevium 101	259 No Nobelium 102	261 Lr Lawrencium 103																													

*58-71 Lanthanoid series
†90-103 Actinoid series

Key

a	X
b	

 a = relative atomic mass
 X = atomic symbol
 b = proton (atomic) number

The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.).