XINMIN SECONDARY SCHOOL
新民中学
SEKOLAH MENENGAH XINMIN

Preliminary Examination 2017

CANDIDATE NAME

CLASS | | | | INDEX NUMBER | |

CHEMISTRY

5073/01

Paper 1 Multiple Choice

28 August 2017

Secondary 4 Express

1 hour

Setter: Mr. Kuo Yu Hsuan
Vetter: Mrs. Annie Ng

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, 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.

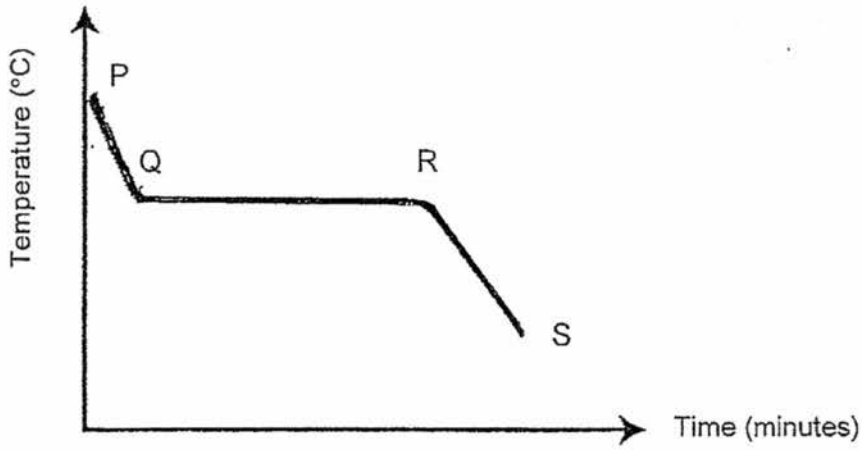
Read the instructions on the Answer Sheet very carefully.

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

For Examiner's Use	
Total	/40
Parent's Signature	

This document consists of **15** printed pages including this cover page.

1 A sample of solid **X** was heated until it was completely melted. The graph shows how its temperature varies with time as molten **X** is cooled.

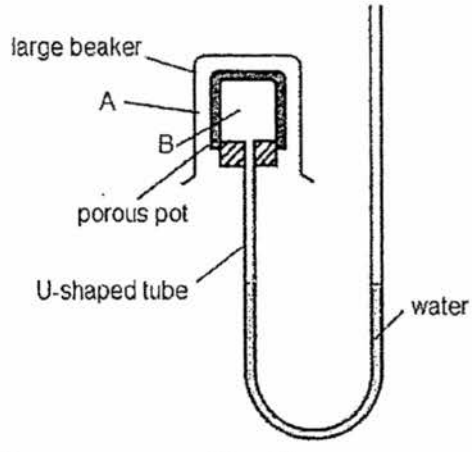


Which of the following statements are **true** about the particles in **X**?

I They are closer to each other at stage RS than at stage PQ.
II The forces of attraction are stronger at stage P than at stage S.
III The arrangement is more orderly at stage RS than at stage PQ.
IV Their total energy content at stage QR is lower than at stage RS.

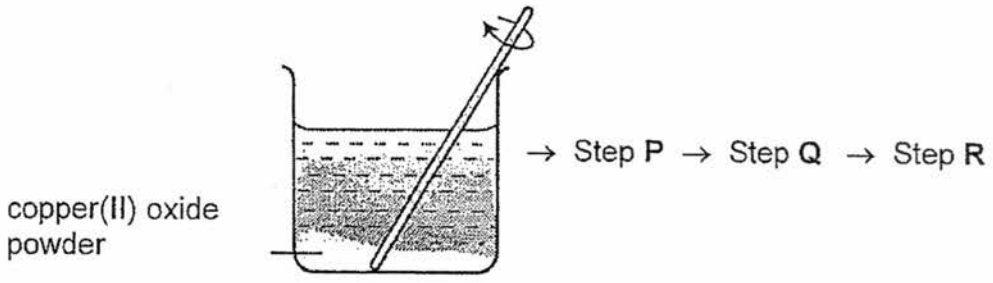
A I and II only are correct.
B I and III only are correct.
C II and III only are correct.
D II and IV only are correct.

2 The following diagram shows a set up. Which pair of gases would cause a fall in the water level at the right side of the U-shaped tube?



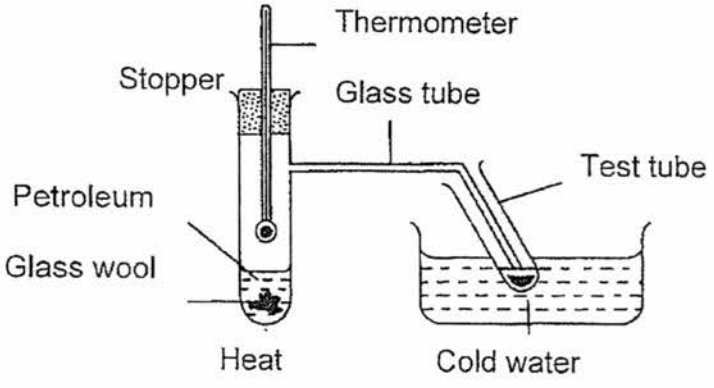
	Gas A	Gas B
A	Nitrogen dioxide	Chlorine gas
B	Carbon Monoxide	Nitrogen gas
C	Oxygen gas	Neon
D	Fluorine gas	Argon

3 The figure below shows excess copper(II) oxide powder after it has dissolved in dilute sulfuric acid. Starting from the beaker, which is the **correct** set of steps to obtain copper(II) sulfate crystals?



	Step P	Step Q	Step R
A	filtration	evaporation	cooling
B	cooling	filtration	evaporation
C	evaporation	cooling	filtration
D	filtration	cooling	evaporation

4 The diagram below shows the experimental set-up for fractional distillation of petroleum. However, there is an error in the set-up.



What is the error?

A The thermometer should be placed at the junction of the glass tube.
B The test-tube should be placed higher up from the cold water.
C The glass wool should be placed above the petroleum.
D The stopper should be removed to prevent pressure from building up.

5 Which of the following statements concerning molecules is **not** correct?

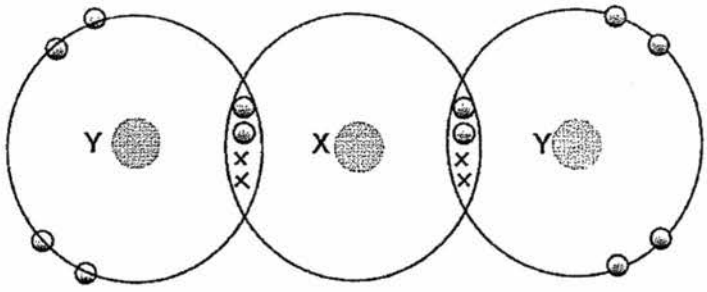
A A molecule can be attracted to another separate molecule with intermolecular forces.
B A molecule always contains two or more atoms from different elements.
C The atoms in a molecule achieve stable valence electron configurations by sharing of electrons.
D Molecules by themselves do not conduct electricity.

[Turn over

6 When magnesium reacts with oxygen to form magnesium oxide, which of the following is **not** true?

A A magnesium atom loses two electrons.
B An oxygen atom gains one electron.
C Forces of attraction between ions of magnesium and oxygen are strong.
D The chemical formula of the compound is MgO.

7 The figure shows the electron arrangement of a molecule of compound XY_2. (Only the valence electrons are shown).



What are the possible identities of **X** and **Y**?

	X	Y
A	carbon	chlorine
B	carbon	oxygen
C	carbon	hydrogen
D	oxygen	carbon

8 Chlorine and oxygen react to form a compound. The compound formed

A has the formula OCl_2.
B will be able to conduct electricity by itself.
C is insoluble in organic solvent.
D has a high melting point.

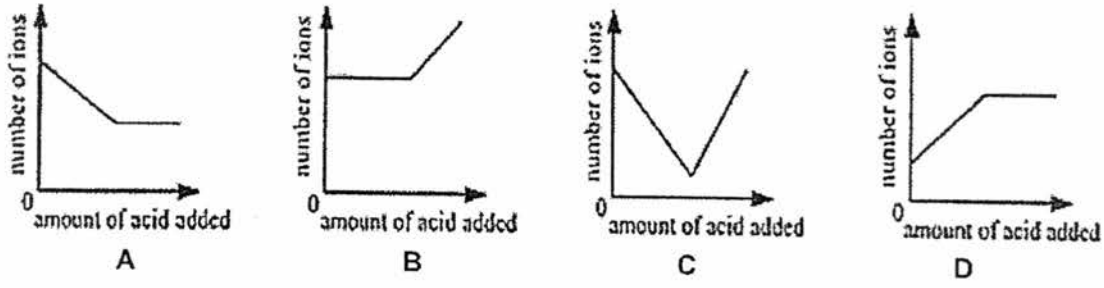
9 A hydrocarbon compound contains 86% carbon and 14% hydrogen by mass. The likely molecular formula is

A CH_4
B C_4H_8
C C_6H_6
D C_8H_{18}

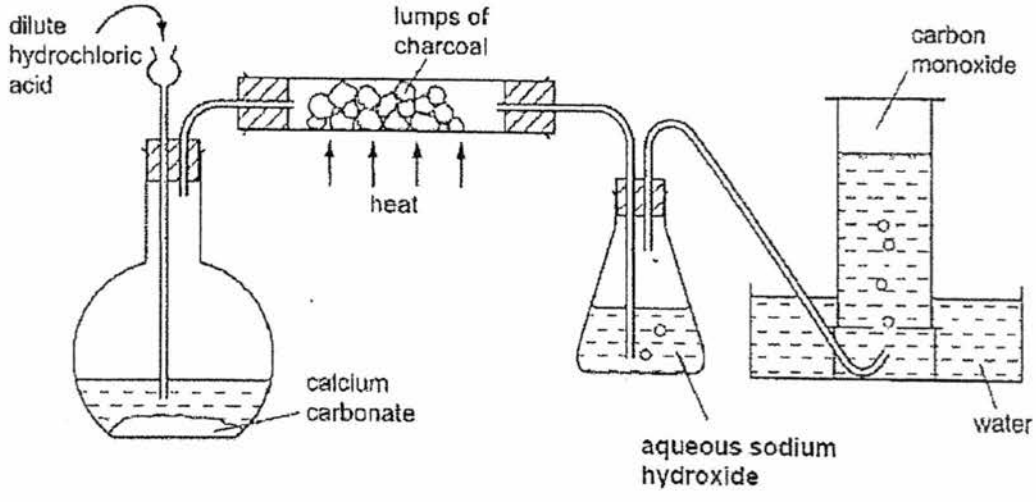
10 If x electrons are needed to deposit 108 g of silver from a solution containing silver ions, how many electrons are needed to deposit 27 g of aluminium from a solution containing aluminium ions?

A x
B 2x
C 3x
D 4x

11 Dilute sulfuric acid was added to aqueous barium hydroxide until the acid was in excess. Which graph best represents the variation in the *total number of ions in solution?*



12 The diagram below is a set-up used to obtain carbon monoxide.



What is the main purpose of the charcoal?

A To remove the oxygen present
B To remove the excess acid
C To reduce the carbon dioxide present
D To remove moisture from the carbon monoxide

13 Substance **X** is mixed with ammonium chloride and heated. The equation below represents part of the reaction.

$$X + \text{ammonium chloride} \rightarrow \text{ammonia gas}$$

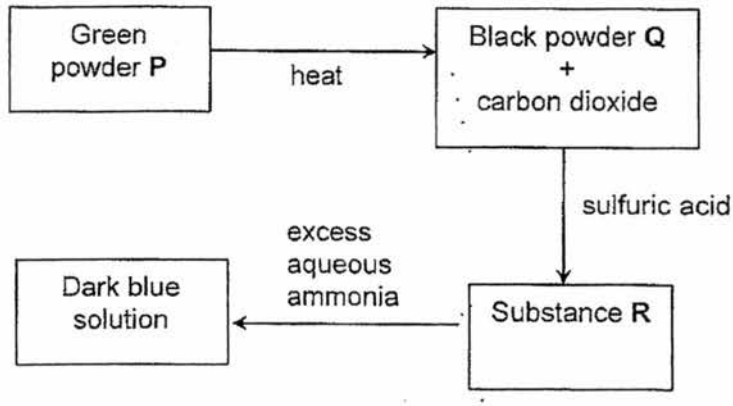
Substance **X** could be:

A sodium metal.
B zinc carbonate.
C calcium hydroxide.
D sulfuric acid.

14 The best substance that can be used to differentiate hydrochloric acid and nitric acid solutions is

A zinc metal.
B barium nitrate solution.
C silver nitrate solution.
D sodium carbonate solution.

15 The diagram below shows a series of tests starting with substance **P**.



Which of the following statements is **true**?

A **P** can react directly with dilute sulfuric acid to give **R**.
B **Q** reacts with acids to liberate hydrogen gas.
C Substance **R** is also green in colour
D **R** forms a green precipitate with aqueous sodium hydroxide.

16 The equation shows the reaction between copper(II) oxide and carbon.

$$2\,CuO\,(s) + C\,(s) \rightarrow 2\,Cu\,(s) + CO_2\,(g)$$

What is the function of the copper(II) oxide in the reaction?

A catalyst
B oxidising agent
C reducing agent
D dehydrating agent

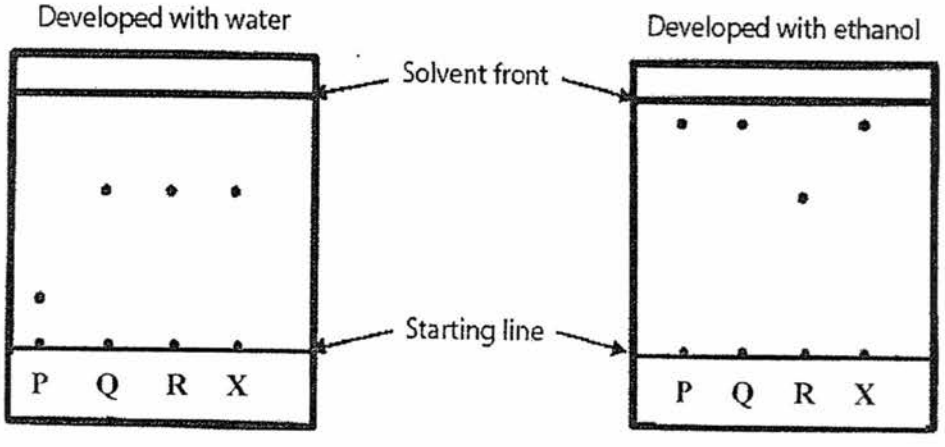
17 Small portions of aqueous potassium iodide and acidified potassium manganate(VII) solution were added to four solutions. The colour changes are seen as shown in the table.

solution	potassium iodide	potassium manganate (VII)
1	colourless to brown	purple to colourless
2	colourless to brown	no change
3	no change	purple to colourless
4	no change	no change

Which solution/s contain/s an oxidising agent **only**?

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

18 Chromatography was used to identify four substances. The solvent used for one of the chromatography was water while the other was ethanol. Which substances are the same?



A P and Q
B Q and X
C Q, R and X
D P, Q and X

19 $A + B \rightleftharpoons C + D$

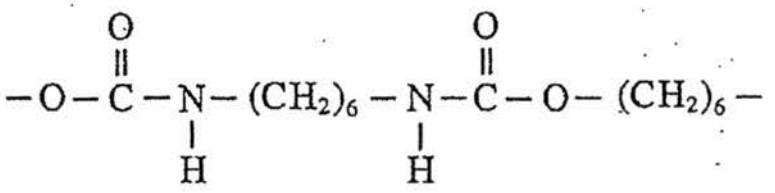
The equation above represents a certain type of chemical reaction. Which of the following is true regarding this reaction?

A The reaction produces heat and light when **C** and **D** are formed.
B As **C** and **D** are formed, they will react to produce **A** and **B**.
C **A** and **B** require a large amount of activation energy to produce **C** and **D**.
D The rate of reaction to give **C** and **D** will be very slow.

20 To reduce the effect of acid rain, the best way is to

A introduce more ammonia into the atmosphere.
B ensure all power stations using fossil fuels adopt flue gas desulfurisation.
C stop using fossil fuels.
D enforce a total ban coal-firing power stations.

21 The diagram shows the structure of a synthetic polymer **P**.



Which of the following air pollutants could be released when polymer **P** is burnt in air?

A sulfur dioxide
B soot particles and methane
C nitrogen dioxide and carbon monoxide
D carbon monoxide, oxygen and hydrogen gas

22 Going down Group I from lithium to caesium,

A the reactivity decreases.
B the number of electron shells increases.
C the number of valence electrons increases.
D the melting point increases.

23 The table below represents 8 elements **P**, **Q**, **R**, **S**, **T**, **U**, **V** and **W** across Period 2 of the Periodic Table.

P	Q	R	S	T	U	V	W

Which of the following is **correct**?

A The chloride of **T** has a high melting point whereas the chloride of **P** has a low melting point.
B The oxide of **S** is alkaline whereas the oxide of **Q** is acidic.
C **P** and **Q** are metals whereas **V** and **W** are non-metals.
D Element **W** forms the most stable compounds.

24 In the fractional distillation of crude oil, bitumen is collected at the bottom of the fractionating column. This is because

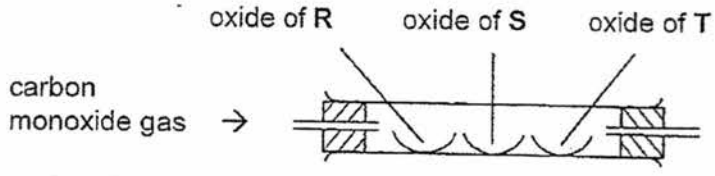
A it is the first substance to condense from a gas to a liquid in the column.
B it was never vaporized in the heating chamber.
C bitumen is a substance that has little or no commercial value.
D bitumen is not flammable.

25 Steel is harder than iron because steel has

A larger atoms.
B atoms that are more closely arranged.
C atoms of different sizes.
D stronger bonds between the atoms.

26 Three metallic oxide powders containing metals **R**, **S** and **T** are heated strongly in a hard glass tube as shown below. At the same time carbon monoxide gas is directed through the tube.

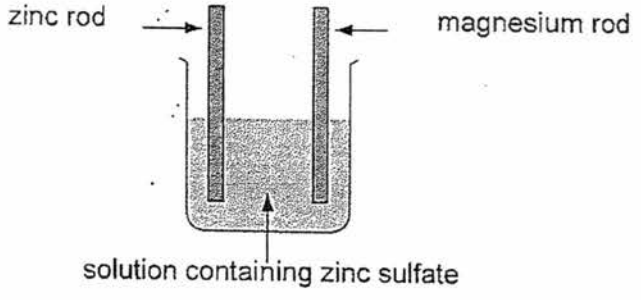
Oxide of **R** reacts slowly, oxide of **T** glows strongly while oxide of **S** does not undergo any changes.



Based on these observations, arrange **R**, **S**, **T** and carbon in descending order of reactivity (most reactive first) is

A **R**, **S**, **T**, carbon
B **T**, **R**, carbon, **S**
C **S**, carbon, **R**, **T**
D **T**, carbon, **R**, **S**

27 The table below shows an experimental set-up.

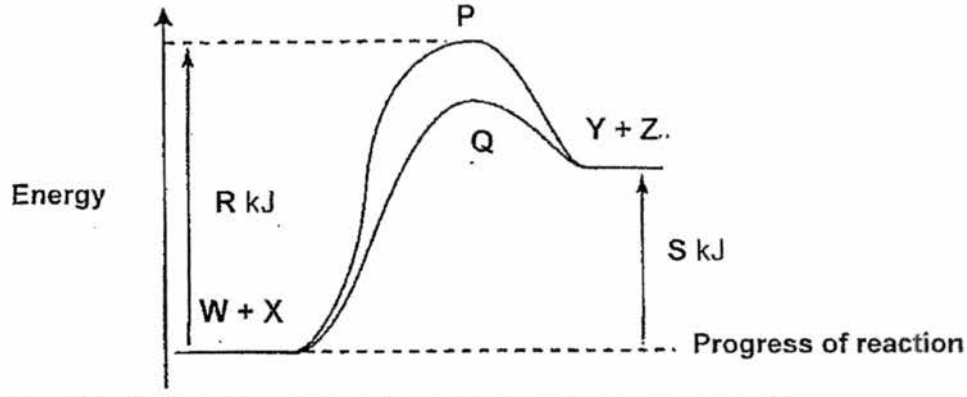


Which of the following correctly describes the experimental setup?

A If a wire is connected between the magnesium and zinc rods, electrons will flow from zinc to magnesium.
B Bubbles of a colourless gas will appear next to the magnesium rod.
C The concentration of the zinc ions in the solution will increase.
D Greyish deposits can be immediately observed at the zinc rod.

28 The diagram shows different energy paths, **P** and **Q**, and energy levels for a reaction represented by the following equation :

$$W + X \rightarrow Y + Z$$



Which of the following conclusions can be made based on the diagram?

A the temperature of the surrounding increases when **Y** and **Z** are formed
B enthalpy change of the reaction equals (**R** – **S**) kJ/mol
C more products **Y** and **Z** are formed through path **Q** than through path **P**
D the pathway **Q** is achieved by using a catalyst

29 Hydrogen reacts with oxygen forming water according to the equation :

$$2H_2 + O_2 \rightarrow 2H_2O$$

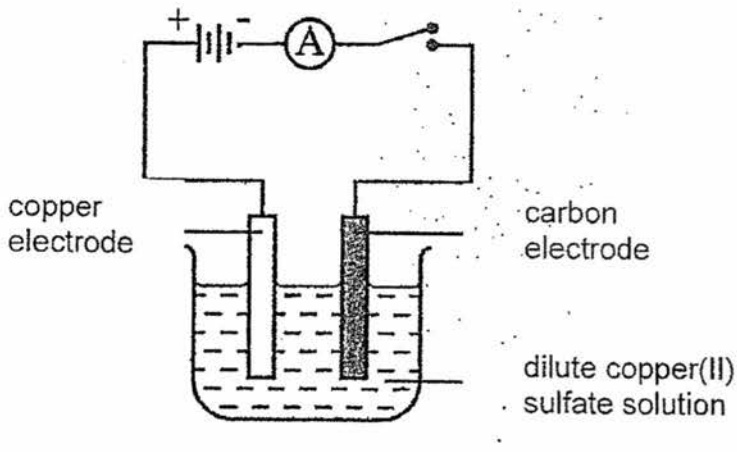
Using the bond energies given below, calculate ΔH of the reaction.

Chemical Bond	Bond Energy, kJ/mol
O – H	110
O = O	142
H - H	104

The enthalpy change for the reaction is:

A –440 kJ/mol
B +90 kJ/mol
C –350 kJ/mol
D –90 kJ/mol

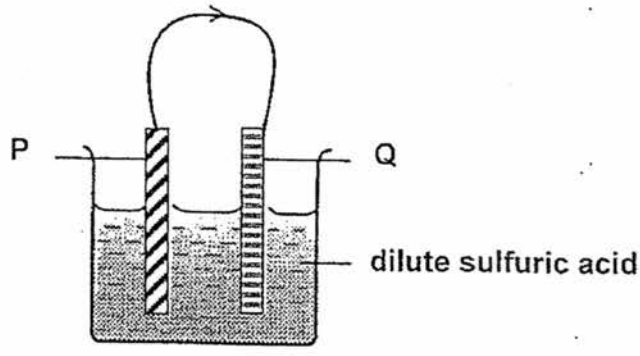
30 The figure below shows the set-up of an electrolytic process.



What is the half-equation for the reaction at the anode?

A $4OH^-(aq) \rightarrow O_2(g) + 2H_2O(l) + 4e$
B $2H^+(aq) + 2e \rightarrow H_2(g)$
C $Cu^{2+}(aq) + 2e \rightarrow Cu(s)$
D $Cu(s) \rightarrow Cu^{2+}(aq) + 2e$

31 The diagram below shows a simple electrochemical cell.



Which of the following electrodes will give the smallest potential difference (voltage) for this electric cell?

	P	Q
A	magnesium	copper
B	zinc	silver
C	zinc	copper
D	lead	silver

32 When concentrated sodium chloride solution is electrolysed, gas **X** is formed at the anode followed by gas **Y**. Identify gas **X** and gas **Y**.

	gas **X**	gas **Y**
A	chlorine	oxygen
B	oxygen	chlorine
C	hydrogen	oxygen
D	oxygen	hydrogen

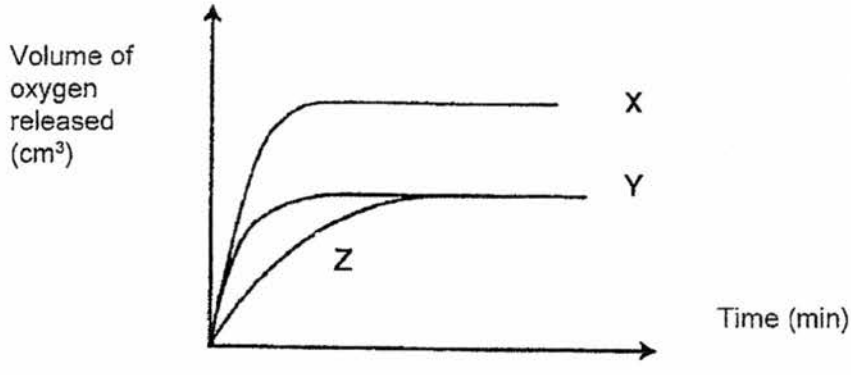
33 Which statement about the characteristic of catalysts is **not** true?

A Catalysts increase the rate of a reaction.
B The effect of catalysts depends on the amount of the catalyst used.
C The mass of catalysts does not change after a reaction.
D Catalysts increase the final amount of products of a reaction.

34 The rate of reaction increases as the temperature increases. Which of the following statements provides the **best** explanation for this?

A At lower temperatures, the proportion of particles having sufficient energy to react is greater.
B At higher temperatures the particles move faster and collide less often.
C Increasing the temperature increases the number of moving particles, so they collide more often.
D Increasing the temperature allows more particles to possess the minimum activation energy required when they collide.

35 The graph below shows the rate of decomposition of potassium chromate(V) to release oxygen gas using copper (II) oxide as a catalyst. There were three experiments conducted (I, II and III).



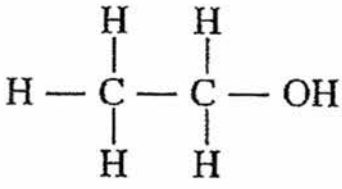
I adding copper(II) oxide powder to 10 cm^3 of 2.0 mol/dm^3 potassium chromate(V) solution
II adding copper(II) oxide pieces to 20 cm^3 of 1.0 mol/dm^3 potassium chromate(V) solution
III adding copper(II) oxide powder to 20 cm^3 of 2.0 mol/dm^3 potassium chromate(V) solution

Which of the curves, X, Y, Z in the graph are associated with experiments I, II and III?

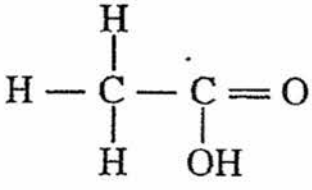
	I	II	III
A	X	Z	Y
B	X	Y	Z
C	Y	Z	X
D	Z	Y	X

36 A neutral organic liquid is burnt in air completely, producing carbon dioxide and water. Which of the following is most likely to be that liquid?

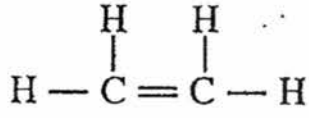
A



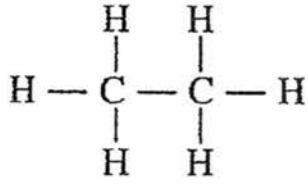
B



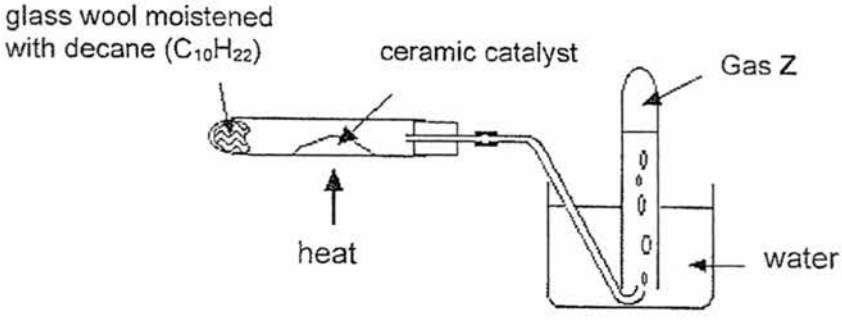
C



D



37 The diagram below shows the apparatus set-up used to produce gas Z.



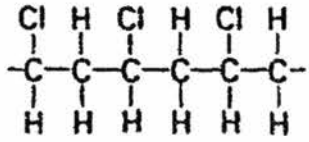
Which of the following is a property of the gas Z?

A reacts with ethanol to form an ester
B soluble in water
C forms white precipitate with limewater
D decolourises bromine water

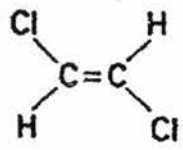
38 What is the formula of the ester formed when propanoic acid reacts with ethanol?

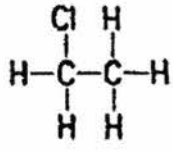
A $CH_3CO_2C_3H_7$
B $C_2H_5CO_2C_2H_5$
C C_4H_9COOH
D C_5H_9OH

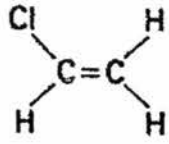
39 A polymer formed by addition polymerisation has the following structure:

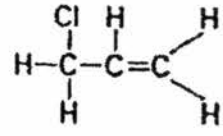


What is the structure of the monomer?

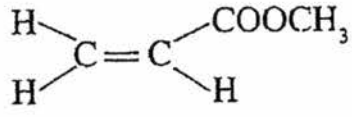
A 

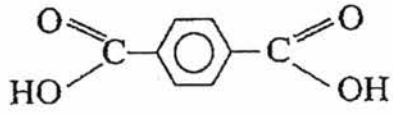
B 

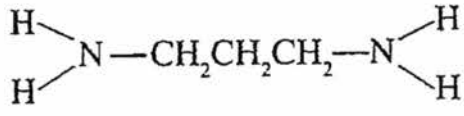
C 

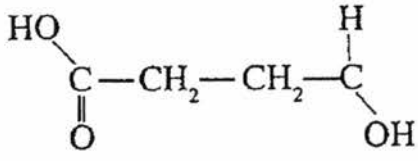
D 

40 The following are monomers of a few compounds. Which of them can be used to produce a polymer via condensation polymerisation?

I 

II 

III 

IV 

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

End of Paper

XINMIN SECONDARY SCHOOL
新民中学
SEKOLAH MENENGAH XINMIN

Preliminary Examination 2017

CANDIDATE NAME

CLASS

INDEX NUMBER

CHEMISTRY

5073/02

Paper 2

17 August 2017

Secondary 4 Express

1 hour 45 minutes

Setter: Mrs. Annie Ng
Vetter: Mr. Kuo YH & Mr. Lim BP

Candidates answer on the Question Paper.
No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name, class and index number on the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

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

Section B
Answer all **three** 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 2.
The use of an approved scientific calculator is expected, where appropriate.

For Examiner's Use	
Section A	/50
Section B	/30
Total	/80
Parent's Signature	

This document consists of **22** printed pages.

The Periodic Table of the Elements

Group I	Group II						Group III						
						1 H Hydrogen 1							
7 Li Lithium 3	9 Be Beryllium 4						11 B Boron 5						
23 Na Sodium 11	24 Mg Magnesium 12						27 Al Aluminium 13						
39 K Potassium 19	40 Ca Calcium 20	45 Sc Scandium 21	48 Ti Titanium 22	51 V Vanadium 23	52 Cr Chromium 24	55 Mn Manganese 25	56 Fe Iron 26	59 Co Cobalt 27	59 Ni Nickel 28	64 Cu Copper 29	65 Zn Zinc 30	70 Ga Gallium 31	
85 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	43 Tc Technetium	101 Ru Ruthenium 44	103 Rh Rhodium 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	
133 Cs Caesium 55	137 Ba Barium 56	139 La Lanthanum 57 *	178 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	
223 Fr Francium 87	226 Ra Radium 88	227 Ac Actinium 89 †											

140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	147 Pm Promethium 61	150 Sm Samarium 62	152 Eu Europium 63	157 Gd Gadolinium 64	159 Tb Terbium 65	162 Dy Dysprosium 66	
232 Th Thorium 90	231 Pa Protactinium 91	238 U Uranium 92	237 Np Neptunium 93	244 Pu Plutonium 94	243 Am Americium 95	247 Cm Curium 96	247 Bk Berkelium 97	251 Cf Californium 98	

*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 dm^3 at room temperature and press

For Examiner's Use

Section A

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

A1 Magnesium is best known for burning with a characteristic brilliant white light. The metal itself was first produced by Sir Humphry Davy in 1808 by the electrolysis of a molten mixture of magnesia (MgO) and mercury oxide. Mercury oxide was added as an impurity to lower the melting point of magnesia, and inert electrodes were used during the electrolysis.

(a) **(i)** Davy obtained magnesium at the cathode.
Write an ionic equation to show how magnesium was formed at the cathode.
Suggest a reason why the magnesium was obtained as a mixture at the cathode.

ionic equation .....

reason .....

[2]

(ii) What product did Davy obtain at the anode?
Write an ionic equation for the reaction at the anode.

product .....

ionic equation .....

[2]

(b) Table 1.2 below lists the natural abundances for the three stable isotopes of magnesium.

Table 1.2

isotope	^{24}Mg	^{25}Mg	^{26}Mg
natural abundance (%)	78.99	10.00	

(i) Calculate and complete Table 1.2 with the natural abundance of ^{26}Mg. [1]

(ii) Using the values in the Table 1.2, calculate the average relative mass for an atom of magnesium. Leave your answer in 3 significant figures.

[2]
[Total 7 marks]

For Examiner's Use

A2 **X**, **Y** and **Z** are organic compounds from three homologous series.

X can be converted to **Y** by oxidation.
Z and water are produced when **X** and **Y** react together.
Z is an isomer of ethanoic acid.

M_r of compound **X** = 32

M_r of compound **Y** = 46

M_r of compound **Z** = 60

(a) Using the information provided, complete the boxes by drawing the structures of **X**, **Y** and **Z**. [3]

(b) Suggest a reagent in the laboratory that can be used to convert compound **X** to compound **Y**.

.....

[1]

(c) Draw a 'dot-and-cross' diagram for compound **X**. Show the outer shell electrons only.

[2]

For Examiner's Use

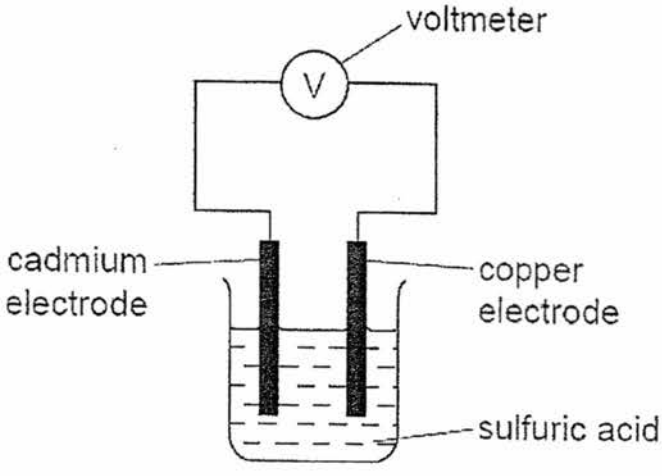
(d) The reaction mole ratio for **X** : **Y** : **Z** = 1 : 1 : 1.
Calculate the mass of **Z** produced when 100 kg of **X** reacts with 100 kg of **Y**.

[3]

[Total 9 marks]

A3

(a) A reactivity series can be established by measuring the voltage of simple cells.
The diagram shows a simple cell.



Results from cells using the metals tin, cadmium, zinc and copper are given in the table.

cell	electrode 1 (–)	electrode 2 (+)	voltage / volts
1	cadmium	copper	0.74
2	tin	copper	0.48
3	zinc	copper	1.10

For Examiner's Use

(i) What is a simple cell?

.....

.....

[2]

(ii) Place the four metals in order of increasing reactivity and explain how you used the data in the table to arrive at this order.

least reactive .....

.....

.....

most reactive .....

.....

.....

.....

.....

[3]

(b) Cadmium is in the same group of the Periodic Table as zinc. Cadmium carbonate is insoluble in water and reacts in the same way as zinc carbonate with dilute acids. Cadmium sulfate is soluble in water.

Describe how you would prepare a pure, dry sample of cadmium carbonate, starting from cadmium sulfate.

.....

.....

.....

.....

.....

.....

.....

[4]

[Total 9 marks]

For Examiner's Use

A4 One of the main stages in the manufacture of sulfuric acid is the reaction between sulfur dioxide and oxygen to produce sulfur trioxide, SO_3. The reaction is reversible.

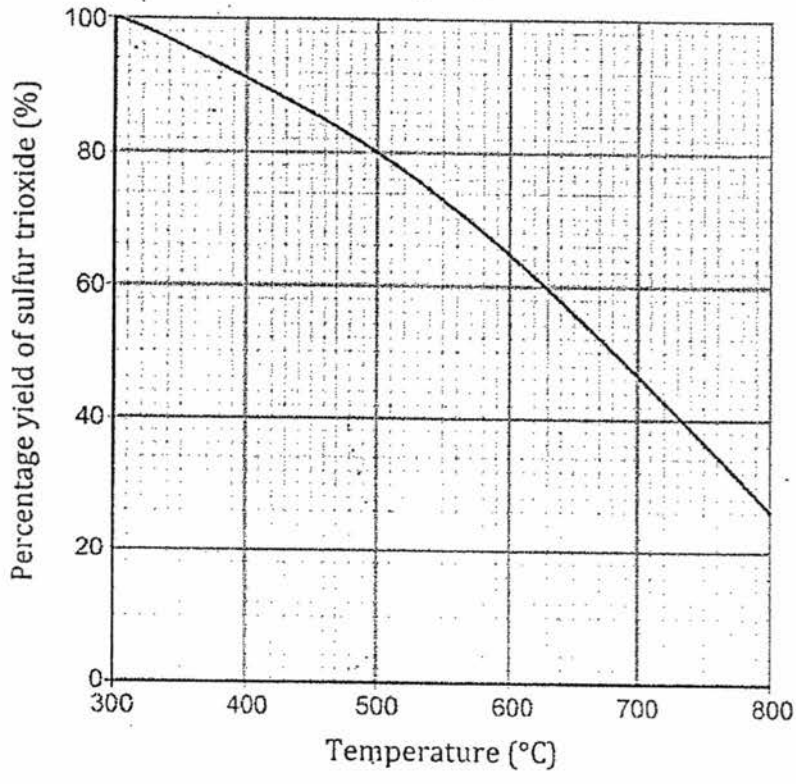
(a) Write a balanced chemical equation for this reaction.

.....

[2]

(b) The percentage yield of sulfur trioxide against temperature is shown in Graph 4.1.

Graph 4.1



(i) Using information from the graph, describe how the percentage **yield** of sulfur trioxide changes with temperature.

.....

.....

[1]

(ii) Using ideas about collisions between particles, explain how the **rate** of sulfur trioxide production changes with temperature.

.....

.....

.....

[3]

For Examiner's Use

(c) The enthalpy change of reaction (ΔH) for the conversion of sulfur dioxide to sulfur trioxide is '– 196 kJ / mol'.

(i) Use ideas about breaking and forming bonds to explain why the value is negative.

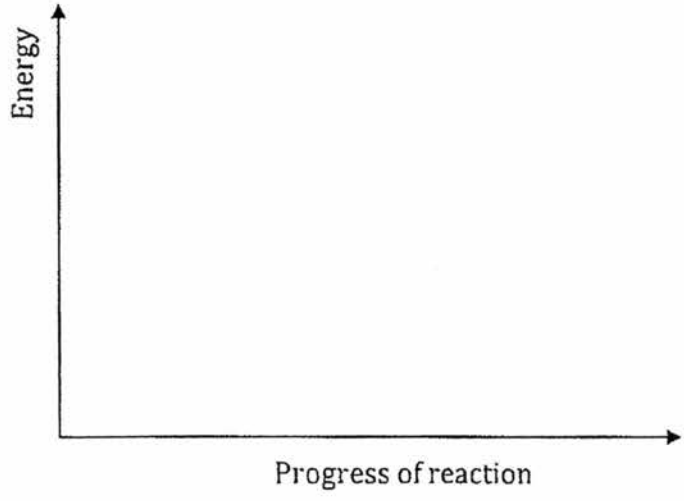
.....

.....

.....

..... [3]

(ii) Draw the energy profile diagram for this reaction, clearly indicating the **formulae** of the reactants and products, and the *enthalpy change* and *activation energy* in your diagram.



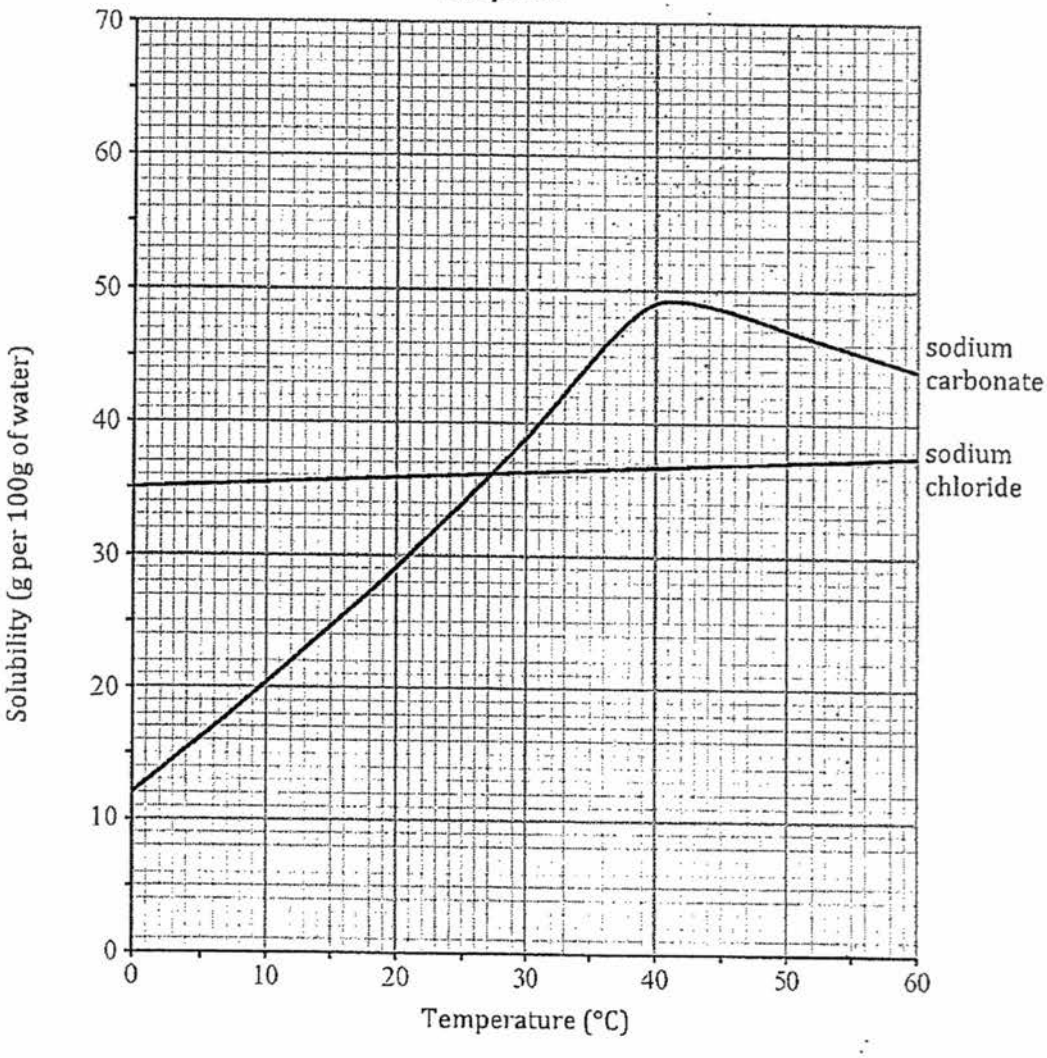
[3]

[Total 12 marks]

For Examiner's Use

A5 Graph 5.1 shows the solubility of sodium carbonate and sodium chloride in water at different temperatures.

Graph 5.1



The table gives the solubility data of sodium bromate in water at different temperatures.

Temperature (°C)	0	10	20	30	40	50	60
Solubility (g per 100g of water)	25	29	35	41	48	55	64

For Examiner's Use

(a) Use the information from the graph and the table to answer the following questions.

(i) Determine the order of solubility of the three sodium compounds in water at temperatures below 20 °C.

most soluble .....

.....

least soluble ..... [1]

(ii) A student makes a comment about the solubilities.
'Between room temperature and 60 °C, the solubility of all three sodium compounds increases with temperature.' Explain whether the student is correct.

.....

.....

.....

[2]

(b) Aqueous sodium carbonate and aqueous sodium chloride are both colourless solutions. An unlabelled bottle of a colourless solution has been found. You are told that the bottle contains either sodium carbonate or sodium chloride.

Describe a chemical test you can perform to identify the contents of the bottle, stating clearly the reagent(s) used and giving an equation for any reaction that occurs.

.....

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.....

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[3]

[Total 6 marks]

For Examiner's Use

A6 Oxides of nitrogen in the upper atmosphere cause damage to the ozone layer.

Nitrogen monoxide, NO, damages the ozone layer by reacting with ozone in a two-step reaction.

$$NO + O_3 \rightarrow NO_2 + O_2 \qquad \text{step 1}$$
$$NO_2 + O_3 \rightarrow NO + 2O_2 \qquad \text{step 2}$$

(a) Use oxidation states to identify which element is **oxidised** in step 1.

element .....

change in oxidation state ..... [2]

(b) One nitrogen monoxide molecule can destroy thousands of ozone molecules.
Use the equations for steps 1 and 2 to explain why.

.....

.....

.....

.....

.....

[2]

(c) Using the equations for steps 1 and 2, derive the equation for the **overall** reaction.

.....

[1]

(d) Oxides of nitrogen are removed from car exhaust emissions by catalytic converters.
In a converter, the oxides of nitrogen react with carbon monoxide.
Nitrogen and carbon dioxide are produced and released into the atmosphere.

Suggest **two** potential environmental hazards that may arise from the car exhaust emissions, should the catalytic converters fail to work.

.....

.....

.....

.....

[2]

[Total 7 marks]

Section B

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

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

For Examiner's Use

B7 Ionisation energy is the amount of energy needed to remove an electron from an atom or ion. It is usually measured in kilojoules (kJ). The closer the electron to be removed is to the nucleus, the higher the ionisation energy.

The ionisation energies for sodium are listed in Table 7.1.

Table 7.1

Ionisation energy number	Energy needed (kJ)
1st	495.8
2nd	4562
3rd	6910.3
4th	9543
5th	13354
6th	16613
7th	20117
8th	25496
9th	28932
10th	141362
11th	159075

Source: https://www.webelements.com/sodium/atoms.html

Typically, the *n*th ionisation of an atom or ion (**X**) can be expressed as:

$$X^{n-1} \rightarrow X^{n+} + e$$

where *e* represents electron removed

Thus for the 1st ionisation of sodium:

$Na \rightarrow Na^{+} + e$ energy needed = 495.8 kJ

2nd ionisation of sodium:

$Na^{+} \rightarrow Na^{2+} + e$ energy needed = 4562 kJ

3rd ionisation of sodium:

$Na^{2+} \rightarrow Na^{3+} + e$ energy needed = 6910.3 kJ

For Examiner's Use

(a) The electronic configuration for a sodium atom may be written as 2,8,1.

State, in a similar way, the electronic configuration for a

- Na^+ ion .....
- Na^{2+} ion ..... [1]

(b) Based on your understanding of ionisation energy and electronic configurations, suggest why the value for the 2nd ionisation energy of sodium is much higher than the 1st.

.....

.....

.....

.....

.....

.....

.....

[2]

(c) (i) Write an expression for the **10th** ionisation of sodium, in a manner similar to the first three ionisations of sodium as shown in the given data.

.....

[1]

(ii) By considering the location of the electron to be removed, explain why the value for the 10th ionisation energy for sodium is much higher than the 2nd to 9th ionisation energies.

.....

.....

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.....

.....

.....

[2]

For Examiner's Use

Table 6.2 lists the 1st ionisation energy (in kJ) for the first twenty elements in the Periodic Table.

Table 6.2

H 1312							He 2372
Li 520	Be 900	B 801	C 1087	N 1402	O 1314	F 1681	Ne 2081
Na 496	Mg 738	Al 578	Si 787	P 1012	S 1000	Cl 1251	Ar 1521
K 419	Ca 590						

Source: http://www.sciencegeek.net/tables/IonisationNRG.pdf

(d) Describe the trends in the 1st ionisation energy **across a period** and **down a group** in the Periodic Table.

(i) Across a period:

.....

(ii) Down a group:

.....

[2]

(e) Explain why the 1st ionisation energy is generally higher for non-metals than metals.

.....

.....

.....

.....

.....

.....

[2]

[10 marks]

For Examiner's Use

B8 Aspirin is a medicine that is used as a painkiller. It is made from salicylic acid.

(a) A student makes a sample of aspirin. He thinks it contains some impurities.

(i) The student tests the melting point of his sample of aspirin.

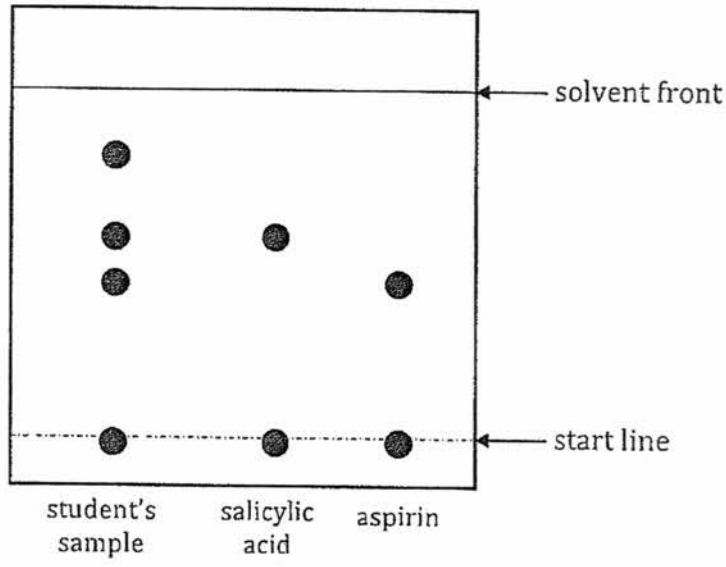
Explain how he can use the result of the test to find out whether his sample contains impurities.

.....

.....

[2]

(ii) The student uses chromatography to produce a chromatogram.
He uses his own aspirin and pure samples of aspirin and salicylic acid.
The diagram shows his chromatogram.



Is the student's sample of aspirin pure? Explain your answer.

.....

.....

.....

.....

[2]

For Examiner's Use

(iii) In another chromatography using pure samples of aspirin and salicylic acid, the solvent was allowed to travel 9 cm from the start line.

Table 8.1

Substance	aspirin	salicylic acid
R_f values	0.56	0.654

Using the R_f values provided in Table 8.1, calculate the distance travelled by aspirin.

[1]

(b) The student tests some aspirin tablets bought from a store.
He performs a titration using a crushed tablet and aqueous sodium hydroxide.

The formula for aspirin can be represented as  . The equation for the reaction between aspirin and aqueous sodium hydroxide is shown below.

Table 8.2 shows the results of the student's titration.

Table 8.2

concentration of aqueous NaOH used	0.10 mol/dm^3
volume of aqueous NaOH needed for neutralisation	15.90 cm^3
relative molecular mass of aspirin	180

(i) Calculate the mass of aspirin, **in mg**, in one tablet. Leave your answer in 3 significant figures. (1 g = 1000 mg)

[3]

For Examiner's Use

(ii) Some tablets that contain aspirin also contain citric acid.
The student does another titration using one of these tablets.
Explain why the mass of aspirin he calculates from his titration results is incorrect.

.....

.....

.....

.....

[2]

[10 marks]

EITHER

For Examiner's Use

B9 A student carried out some experiments to place four metals, **V**, **W**, **Y** and **Z** in order of reactivity.

Table 9.1 shows the results.

Key ✓ shows a reaction happened

× shows no reaction happened

– shows the experiment was not performed

Table 9.1

	metal **V**	metal **W**	metal **Y**	metal **Z**
solution of **V** nitrate	–	×	×	×
solution of **W** nitrate	✓	–	✓	✓
solution of **Y** nitrate	✓	×	–	✓
solution of **Z** nitrate	✓	×	×	–

(a) Place the metals in order of reactivity, starting with the most reactive.

.....

[2]

(b) Metal **Z** reacts with nitric acid.

What would you **see** when metal **Z** reacts with nitric acid?

Explain your reasoning.

.....

.....

.....

.....

[2]

(c) The student carried out further experiments to place metal **N** in the list.

She used dilute nitric acid and samples of the metals.

She found out that metal **N** is the second most reactive metal.

Describe the experiments that the student carried out. Your answer should include

- the experiments that she carried out using dilute nitric acid and the samples of the metals,
- the measurements that she made,
- how the results showed that metal **N** is the second most reactive metal.

.....

.....

For Examiner's Use

.....

.....

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.....

.....

[3]

(d) The five metals, **V**, **W**, **Y**, **Z** and **N** are extracted from their ores in three different ways.
Two of the metals are extracted from their ores by electrolysis.
Two of the metals are extracted by heating their ores with carbon.
One of the metals occurs uncombined.

(i) Suggest which metal occurs uncombined. Explain your answer.

.....

.....

.....

.....

.....

[2]

(ii) Suggest the name of metal **Z**. .....

[1]

[10 marks]

OR

B9 Polystyrene and Kevlar are examples of useful synthetic polymers.

Polystyrene is an addition polymer used as a foam material.

Kevlar is a condensation polymer used to make bullet proof vests.

For Examiner's Use

(a) Describe the differences between addition polymers and condensation polymers.

.....

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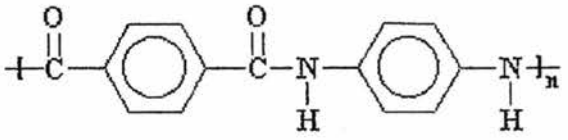
[3]

(b) Diagram 9.1 shows the repeating unit of Kevlar.

Diagram 9.1



Source: http://web.mit.edu/3.082/www/team2_f01/chemistry.html

(i) Draw the structures of the **two** monomers that react to form Kevlar.

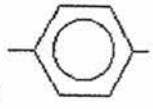
monomer 1

monomer 2

[2]

For Examiner's Use

(ii) During the manufacturing process, the chain length of Kevlar is controlled so that the Kevlar polymer molecules have an average relative molecular mass in the range of 12 000 to 20 000.

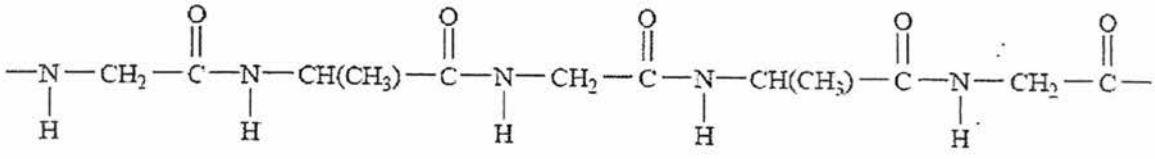
Each  (known as a benzene ring) is made up of 6 carbon atoms and 6 hydrogen atoms.

What is the range of the average number of repeating units in the Kevlar molecules? Show your working.

[2]

(c) Proteins are also condensation polymers.
Diagram 9.2 shows the structure of a protein, which is made from two monomers.

Diagram 9.2



protein

(i) Draw the structure for **one** of the monomers of the protein in diagram 9.2.

[1]

For Examiner's Use

(ii) Give one similarity and one difference between the structures of Kevlar (diagram 9.1) and protein (diagram 9.2).

one similarity .....

.....

.....

one difference .....

.....

.....

[2]

[10 marks]

********** *End of Paper* **********

MCQ answers Chemistry Prelim P1 2017

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

Answers and Marking Scheme
Preliminary Examination 2017
Secondary 4 Express / **5073** Chemistry (SPA) / **Paper 2** (as at 17 Aug)

A1 (a)(i) $Mg^{2+} + 2e \rightarrow Mg$ [1]

Mercury was obtained with the magnesium [1]

(ii) oxygen [1]

$2O^{2-} \rightarrow O_2 + 4e$ [1]

(b) (i) **11.01%** (exact) or **11.0%** (to 3 s.f.) [1]

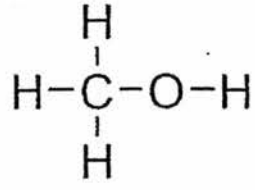
(ii) $\frac{(78.99\times24)+(10.00\times25)+(11.01\times26)}{100} \approx$ **24.3** (to 3 s.f.)

Award 1m for correct method.
Award 1m for answer correctly left in 3 s.f. [2]

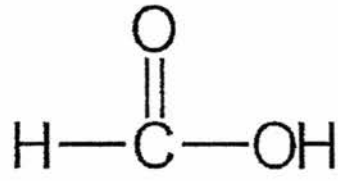
[7 marks]

A2 (a) Structural formula for

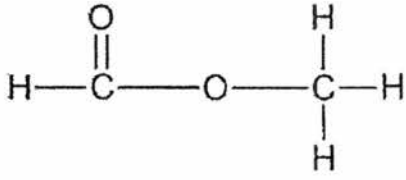
compound **X** (methanol)



compound **Y** (methanoic acid)



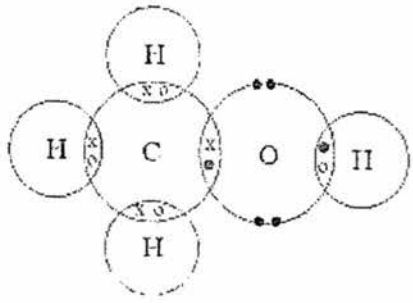
compound **Z** (methyl methanoate)

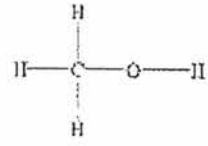


Award 1m for each correct structural formula drawn.
*Naming of compound **X**, **Y** and **Z** is not required.* [3]

(b) *Award 1m for any oxidising agent found in chemistry lab.*
E.g. <u>acidified</u> potassium manganate(VII) / <u>acidified</u> potassium dichromate (VI) / hydrogen peroxide [1]

A2 (c) 'Dot-and-cross' diagram for X: [2]





Award 1m for correct pairs of shared electrons.
Award 1m for octet for O atom.

(d) 100 kg of **X** = 3.125×10^3 moles
100 kg of **Y** = 2.174×10^3 moles
Limiting reagent is **Y** (or that **X** is in excess)
Mass of **Z** produced = $(2.174 \times 10^3) \times 60$ = **130 kg** (to 3 s.f.)

*Award 1m for calculating number of moles in 100 kg of **X** or **Y**.*
*Award 1m for correctly identified which reagent (**X** or **Y**) is in excess / is the limiting reagent.*
Award 1m for final answer. [3]

[9 marks]

A3

(a) (i) device which changes chemical energy [1] into electrical energy; [1]
OR
produces a voltage / potential difference / electricity [1] due to difference in reactivity of two metals; [1]
OR
produces a voltage / potential difference / electricity [1] by redox reactions [1]

(ii) Cu Sn Cd Zn (i.e. all 4 in correct order) [1]
relates order to voltage [1]
one relevant comment from: [1]
higher reactivity metals form the negative electrode or pole / copper is least reactive because it is the positive electrode or pole in all the cells / the bigger the difference in reactivity, the bigger the voltage / zinc has highest voltage because it is most reactive / more reactive metals give higher voltage

(b) 1. Add aqueous cadmium sulfate to aqueous sodium carbonate (or any soluble carbonate).
2. Filter the mixture to obtain the precipitate (cadmium carbonate).
3. Wash the residue.
4. Dry the residue (using sheets of filter paper). [4]

[9 marks]

A4 (a) $2SO_2 + O_2 \rightleftharpoons 2SO_3$ [2]

Award 1m for all correct symbols and balanced equation.
Award 1m for the '⇌' reversible arrow.

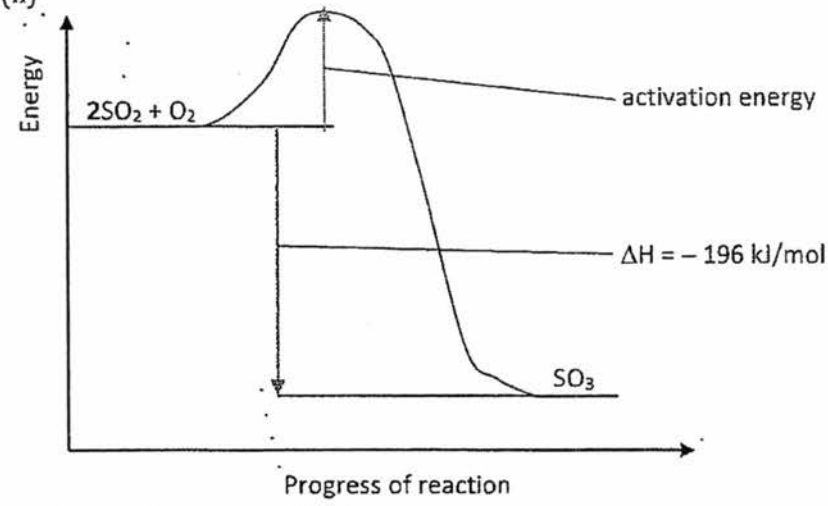
(b) (i) Percentage yield decreases as temperature increases. [1]

Accept any answers to the same effect.

(ii) Reacting particles have more energy and move faster /
More reacting particles have energy to overcome the activation energy [1]
Particles collide more frequently / Frequency of collision increases [1]
Rate of reaction increases / Reaction goes faster [1] [3]

(c) (i) Energy absorbed in breaking bonds is less than [1[the energy released [1] in forming bonds. Hence the reaction is exothermic. [1] [3]

(ii)



[3]

Award 1m for correct energy profile diagram.
Allow for ECF from (c)(i).
In event 'endothermic' reaction is stated in (c)(i), the profile for (ii) must match.
Award 1m for correctly labelling enthalpy change or ΔH (including ↓ arrow) and activation energy (including ↑ arrow).
Award 1m for correctly labelling reactants and products.

[12 marks]

A5 (a) (i) (most) sodium chloride, sodium bromate, sodium carbonate (least) [1]

(ii) Student is partially correct / incorrect (no mark)
While the solubility of sodium chloride and bromate increases [1], the solubility of sodium carbonate decreases after 40 °C [1] [2]

(b) Method 1:

- Add dilute hydrochloric acid (or any named acid) to a sample of the contents in the bottle. [1]
- If effervescence observed, the bottle contains sodium carbonate.
- If no effervescence observed, the bottle contains sodium chloride. [1]

$Na_2CO_3 + 2HCl \rightarrow 2NaCl + CO_2 + H_2O$ [1]

Method 2:

- Add acidified silver nitrate to a sample of the contents in the bottle. [1]
- If a white precipitate is seen, the bottle contains sodium chloride. [1]
- If no precipitate is seen, the bottle contains sodium carbonate.

$AgNO_3 + NaCl \rightarrow AgCl + NaNO_3$ [1]

Note: Use of silver nitrate solution is not accepted as silver carbonate (also a white precipitate) will be produced with sodium carbonate solution.

[6 marks]

A6 (a) Nitrogen [1]; from +2 (in NO) to +4 (in NO_2) [1] [2]

(b) No loss in NO molecules. [1]
The NO molecules removed in step 1 (after reacting with ozone) are regenerated in step 2 (in reaction with more ozone). [1]

(c) $2O_3 \rightarrow 3O_2$ [1]

(d) *'Catalytic converters fail to work' means release of oxides of nitrogen and carbon monoxide into the atmosphere.*
Accept any valid health or environmental hazards due to oxides of nitrogen and carbon monoxide.

Suggested answers:

- Release of carbon monoxide poses danger of carbon monoxide poisoning. Inhalation of carbon monoxide prevents haemoglobin from absorbing oxygen and may lead to suffocation / organ failure / headaches. [1]
- Release of oxides of nitrogen may result in formation of acid rain, which leads to corrosion of buildings / structures. [1]

[7 marks]

B7 Compulsory Data-Based Question (10 marks)

(a) Na^+ ion : 2, 8 [½]
Na^{2+} ion : 2, 7 [½]

(b) 1st ionisation energy is the energy required for a sodium atom to lose 1 valence electron, and obtaining a stable octet / stable electronic structure. [1]
2nd ionisation energy is the energy required to remove an electron from the stable octet. This **disrupts the stable electronic configuration.** Hence more energy is needed. [1]

(c) (i) $Na^{9+} \rightarrow Na^{10+} + e$ [1]

(ii) The 10th ionisation energy involves the removal of an electron from the 1st shell
The 2nd to 9th ionisation energy involves removing electrons from the 2nd shell.
Electrons in 1st shell are closer to the positively charged nucleus than those in the 2nd shell;
Attraction (between electron and nucleus) is stronger;
A larger amount of energy is needed to remove that electron (in the 1st shell).
[2]

Award 1m for describing removal of electrons from 1st / 2nd shell.
Award 1m for stating being closer to nucleus requires larger amount of energy.
Allow 1m should student describe shielding effect instead of proximity to nucleus.

(d) (i) Increases across the period [1]

(ii) Decreases down the group [1]

(e) Metals tend to lose electrons (to gain stability with full most outer shell) and form positively charged ions (or cations);
non-metals tend to gain electrons and form negatively charged ions (or anions).
Removing electrons from an atom of non-metal makes its electronic structure less stable.
[2]

[10 marks]

B8

(a) (i) If his sample is pure, the melting point should be a fixed temperature. [1]
If his sample is not pure, the aspirin should melt over a range of temperatures. [1]
or
Look up the melting point of aspirin. [1]
If the melting points are the same, the sample is pure. / Impure aspirin would have a different (lower) melting point. [1] [2]

(ii) Sample is not pure. (no mark)
Sample contains **two** impurities. [1]
The impurities are salicylic acid and an unidentified/unknown substance. [1]

(iii) $0.56 \times 9 =$ **5.04 cm** [1]

(b) (i) mole ratio of aspirin : NaOH = 1:1 (from equation)
Mass of aspirin = $\left(\frac{15.80}{1000} \times 0.10\right) \times \frac{1}{1} \times 180 = 0.286\text{ g} =$ **286 mg**
Award 1m for calculating number of moles of aspirin using 'M = C × V'.
Award 1m for calculating mass of aspirin using 'mass = molar mass × moles'.
Award 1m for giving final answer in mg and 3 s.f. [3]

(ii) Citric acid (in the tablets) will also **react with / be neutralised** by sodium hydroxide during the titration. [1]
Hence **more** sodium hydroxide would be used / the calculated mass of aspirin will be **greater** than actual. [1]

[10 marks]

EITHER B9

(a) (most reactive) **V, Z, Y,** and **W** [2]
Award 1m for at least 2 metals in correct order.

(b) Effervescence / Bubbling of gas seen. [1]
Z will displace / produce hydrogen from the acid. [1]

(c) [New order: **V, N, Z, Y,** and **W**]
Add a fixed mass of each metal sample to a fixed volume of HNO_3 (aq). [1]
Measure the volume of gas collected over regular time intervals (i.e. reaction rate). [1]
Rate of reaction of **N** with the acid should be slower than **V** but faster than **Z**. [1]

(d) (i) **W** [1]
W is the least reactive of the 5 metals. Unreactive metals are usually found uncombined. [1]

(ii) zinc / iron [1]

[10 marks]

OR B9

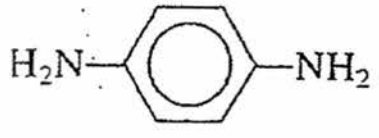
(a) *For clarity of marking scheme, the answer is presented in a table.*

Any 3 points

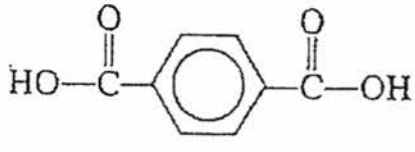
Addition polymer	Condensation polymer
Monomers must be unsaturated / contain C=C double bond. [1]	Monomers contain 2 functional groups (e.g. –COOH, –OH, $–NH_2$). [1]
No loss in atoms during polymerisation. [1] **or** Only 1 product is formed. [1]	Loss of small molecules (e.g. water) during polymerisation. [1] **or** 2 products formed (i.e. polymer and small molecules). [1]
Mass of addition polymer <u>equals</u> sum of its monomers' masses. [1]	Mass of condensation polymer is <u>less than</u> sum of its monomers' masses. [1]
Polymer contains C -C linkages. [1]	Polymer contains ester or amide linkages. [1]

[3]

(b) (i)



[1]



[1]

(ii) Formula of repeating unit for Kevlar = $C_{14}H_{14}N_2O_2$

M_r of repeating unit for Kevlar = $(14 \times 12) + (14 \times 1) + (2 \times 14) + (2 \times 16)$ = **242**

Number of units if average mass is 12 000 = $(12\,000 \div 242) = 49.6 \approx 50$

Number of units if average mass is 20 000 = $(20\,000 \div 242) = 82.6 \approx 82$

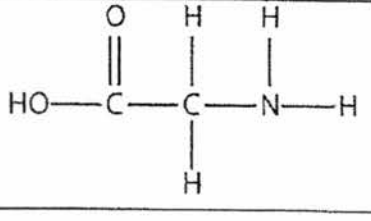
Range is <u>between 50 to 82</u> repeating units.

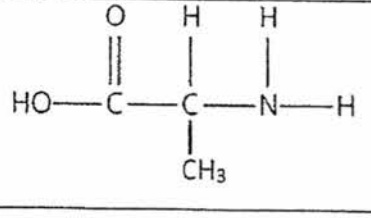
Working [1]

Answer [1]

[2]

(c) (i) *Either one of the following monomers:*





[1]

(ii) Similarity – Both contain amide linkages. / Both are polyamides. [1]

Difference – Absence of benzene ring in protein. / Amide linkage is in the same order in protein but not in Kevlar. [1]

Vague answer such as 'The structures are different.' is not accepted.

[10 marks]

********** **End of Answers and Marking Scheme** **********