Name.		Index Number		Class	

CATHOLIC HIGH SCHOOL
Preliminary Examination
Secondary 4

CHEMISTRY **5073/1**

Paper 1 **18 September 2015**
1 hour

Additional Materials Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write your name, index number and class on the Multiple Choice Answer Sheet provided

There are **forty** questions in this Paper Answer **all** questions For each question there are four possible answers **A, B, C** and **D** Choose the most appropriate **one** and record your choice in soft pencil on the Multiple Choice Answer Sheet provided

A copy of the Periodic Table is given on page **24**

You may use a calculator.

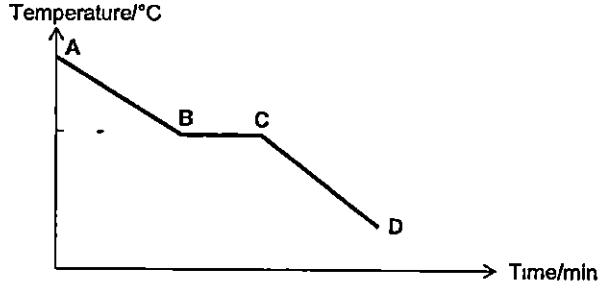
For examiner's use only

Paper 1	/ 40
Total	/ 40

This document consists of **24** printed pages, including this cover page
Page **23** is a blank page.

Paper 1: Multiple Choice Questions [40 marks]

1 A sample of nitrogen dioxide gas is cooled and the temperature is measured every minute The following graph is obtained



Which describes the arrangement and movement of the particles in the region C – D?

	Arrangement of particles	Movement of particles
A	Closely packed in orderly arrangement	Vibrate about fixed positions
B	Closely packed in disorderly arrangement	Moving at high speeds
C	Closely packed in disorderly arrangement	Moving freely over each other
D	Mixture of particles closely packed in orderly and disorderly arrangement	Some particles are vibrating about fixed positions while some are moving freely over each other

2 At -200°C, a mixture of liquid oxygen, nitrogen and xenon is heated up by 15°C. The boiling points of some gases are given in the table below.

Gases	Boiling point / °C
Nitrogen	-196
Xenon	-108
Oxygen	-183

Which of the substances will be in the liquid state at this higher temperature?

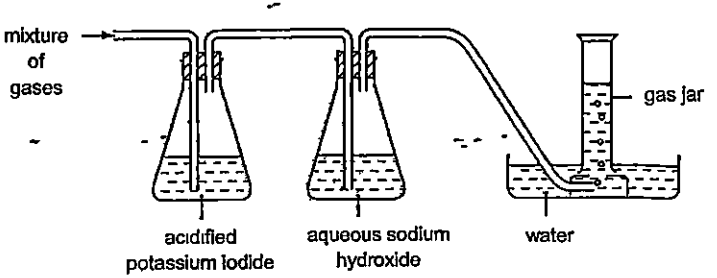
A nitrogen only

B xenon only

C a mixture of nitrogen and oxygen

D a mixture of xenon and oxygen

3 A gaseous mixture of ammonia, oxygen, carbon dioxide and chlorine was passed through the set-up shown in the diagram below Only one gas was collected in the gas jar



Which statement describes a property of the gas collected in the gas jar?

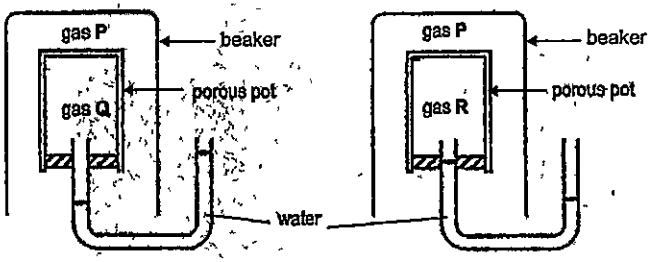
A It bleaches moist blue litmus paper

B It forms a white precipitate when bubbled into limewater

C It relights a glowing splint.

D It turns moist red litmus paper blue

4 The apparatus can be used to show the diffusion of gases Two beakers containing gas P were placed over two porous pots containing gases Q and R respectively The results are shown below.



What is the correct order of the relative molecular mass of gases P, Q and R?

	Lowest M_r	⟶	Highest M_r
A	R	P	Q
B	R	Q	P
C	Q	P	R
D	P	Q	R

58

5 Solid samples of ammonium chloride, lead(II) chloride and sodium chloride were accidentally mixed together. Which of the following sequences outlines the best method to obtain the pure dry sample for each substance?

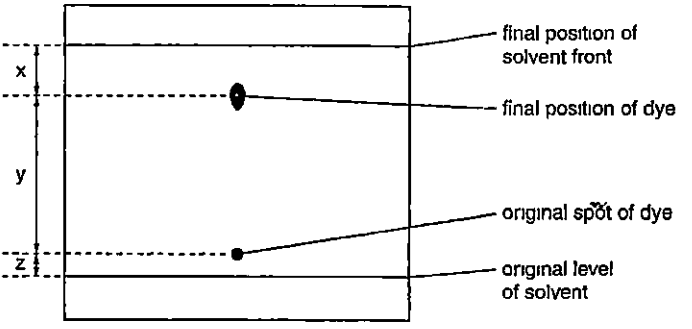
A dissolving, filtration, sublimation, crystallisation

B dissolving, fractional distillation, filtration, evaporation

C sublimation, dissolving, filtration, evaporation

D sublimation, filtration, evaporation, crystallisation

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



Which expression shows the R_f value of the dye?

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

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

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

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

7 When a saturated solution of copper(II) sulfate is allowed to cool from 80°C to room temperature, crystals separate out from the solution

The following statements were made about crystallisation

1 The concentration of the solution remains the same
2 The mass of the dissolved copper(II) sulfate in the solution changes
3 The mass of the solvent in the solution remains the same.
4 The solubility of copper(II) sulfate decreases as the temperature falls

Which statement(s) is/are correct?

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

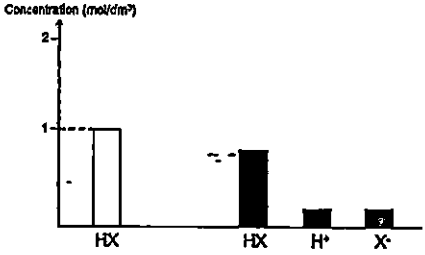
8 Which of the following substances contain delocalised mobile electrons?

I Copper
II Graphite
III Molten copper(II) chloride
IV Solid copper(II) chloride

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

9 Which graph shows the solution formed when one mole of a **weak acid**, HX is dissolved in 1 dm^3 of water?

A



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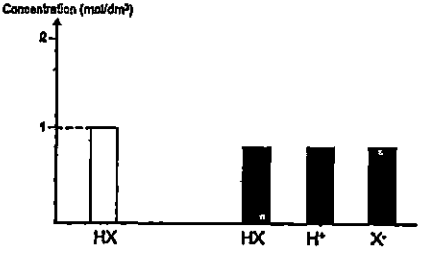

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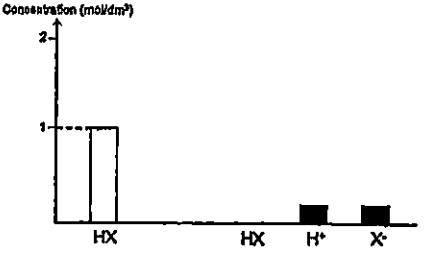

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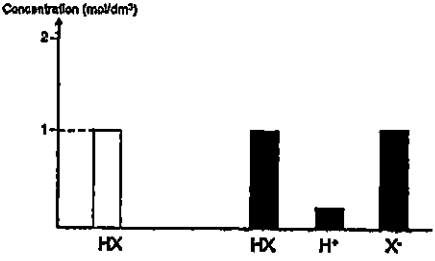


10 Phosphine has the formula PH_3 It has similar properties to ammonia What are the ions produced when phosphine dissolves in water?

A PH_3^+, H^+

B PH_4^+, H^+

C PH_3^+,OH^-

D PH_4^+,OH^-

11 A new indicator has just been produced in the laboratory It changes colours according to the table below

pH	Colour
0 - 3	Red
4 - 7	Green
8 - 14	Dark blue

This indicator would be suitable to distinguish between

A aqueous ammonia and sodium hydroxide

B aqueous sodium chloride and water

C aqueous sodium nitrate and sodium hydroxide

D dilute hydrochloric acid and dilute sulfuric acid

12 When excess calcium carbonate pieces are added to dilute hydrochloric acid, the reaction gradually becomes slower and finally stops

Which statement best explains why the rate of reaction becomes slower?

A An insoluble layer of calcium chloride is formed on calcium carbonate

B The concentration of hydrochloric acid gradually reduces to zero

C The mass of calcium carbonate decreases throughout the reaction

D The pieces of calcium carbonate gradually become smaller

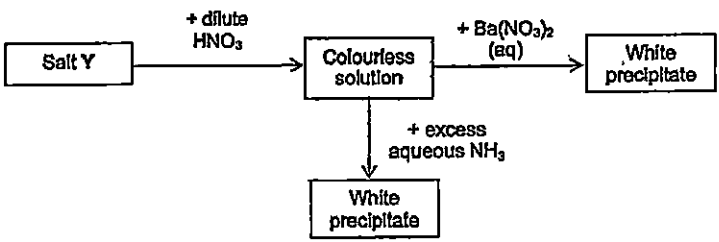
13 Three substances were added separately to aqueous potassium sulfate and aqueous potassium carbonate. The three substances were

I aqueous ammonia
II barium nitrate solution
III dilute hydrochloric acid

Which substance(s) would give different observations when added separately to aqueous potassium sulfate and aqueous potassium carbonate?

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

14 The scheme below shows some reactions of salt Y



What is salt Y?

A aluminium sulfate
B calcium chloride
C lead(II) chloride
D zinc sulfate

15 When a mixture of iron(II) sulfate, potassium hydroxide and barium chloride is stirred with some water, a mixture of green and white solids is formed

What are the identities of the solids?

	Green solid	White solid
A	iron(II) chloride	barium hydroxide
B	iron(II) hydroxide	barium sulfate
C	barium sulfate	iron(II) chloride
D	potassium chloride	barium sulfate

16 A textbook writes 'Nitric acid, HNO_3, is a strong oxidising agent'

Which of the following **cannot** be a product of nitric acid in its reaction with a reducing agent?

A N_2

B N_2O_5

C NO

D NO_2

17 Zinc oxide is produced by heating zinc carbonate

$$ZnCO_3 \rightarrow ZnO + CO_2$$

What is the percentage yield of zinc oxide if 125 g zinc carbonate produces 75 g of zinc oxide when heated?

A $\frac{75}{81} \times 100$

B $\frac{81}{75} \times 100$

C $125 \times \frac{81}{75} \times 100$

D $125 \times \frac{75}{81} \times 100$

18 A pure compound contains 24 g of carbon, 4 g of hydrogen and 32 g of oxygen What is the empirical formula of the compound?

A CHO

B CH_2O

C CH_4O

D C_2H_2O

19 5 0 dm^3 of sulfur dioxide is reacted with 3.0 dm^3 of oxygen at room temperature and pressure The equation for the reaction is given below.

$$2SO_2\,(g) + O_2\,(g) \rightarrow 2SO_3\,(g)$$

What is the total volume of gas(es) at the end of the reaction?
(Assume that the reaction goes to completion)

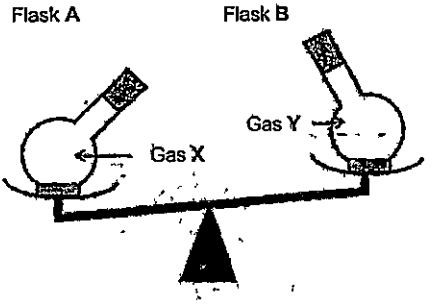
A 4 0 dm^3

B 5.0 dm^3

C 5 5 dm^3

D 6 0 dm^3

20 Two identical flasks, A and B, have been filled up with gases X and Y and they are placed on a balance at room temperature and pressure The results are shown below



Which of the following statements can be deduced from the results?

A The molar mass of gas particles in flask A is greater than the molar mass of gas particles in flask B

B The molar volume of gas particles in flask A is greater than the molar volume of gas particles in flask B.

C The number of gas particles in flask A is greater than the number of gas particles in flask B

D The number of moles of gas particles in flask A is greater than the number of moles of gas particles in flask B

21 The scheme shows four stages I to IV in the conversion of solid candlewax $C_{30}H_{62}$ into carbon dioxide and water

$$C_{30}H_{62}(s) \xrightarrow{I} C_{30}H_{62}(l) \xrightarrow{II} C_{30}H_{62}(g) \xrightarrow{III} 30CO_2(g) + 31H_2O(g) \xrightarrow{IV} 30CO_2(g) + 31H_2O(l)$$

Which of the following stages are exothermic?

A I and II

B I, II and III

C I and IV

D III and IV

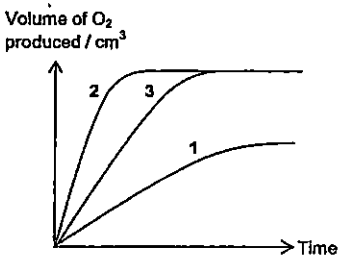
22 The decomposition of hydrogen peroxide is carried out under different conditions in three experiments at room temperature and pressure. A common catalyst used for decomposition reaction is manganese(IV) oxide (MnO_2). An equation for the reaction is given below

$$2\,H_2O_2(aq) \xrightarrow{MnO_2} 2\,H_2O(l) + O_2(g)$$

Experiment	Conditions
1	Absence of catalyst
2	Presence of MnO_2 powder
3	Presence of MnO_2 lumps

Which graph shows how the volume of oxygen gas produced varies with time in each experiment?

A



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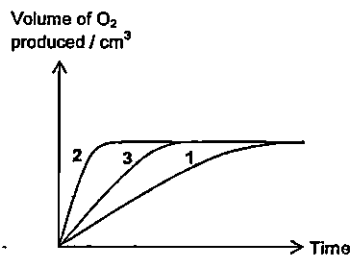

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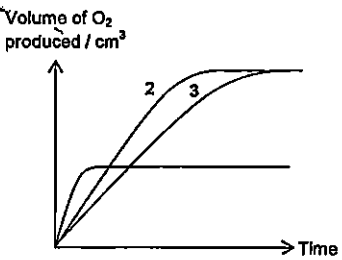
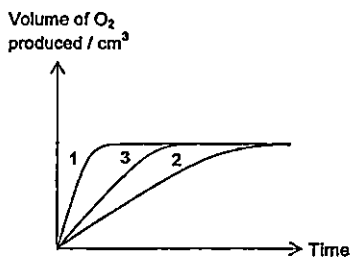
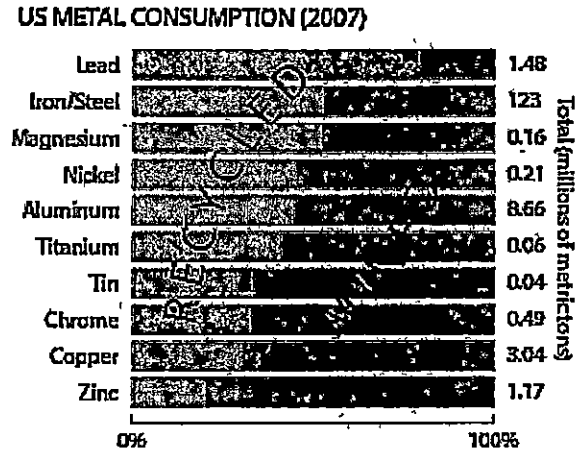


D



23 The graph shows the consumption of different metals in United States in 2007 It also shows the percentage of metals recycled and mined in order to meet the consumption levels



Which of the following statements may be true?

A Demand for nickel is higher than for copper

B Less pollution is generated when lead is recycled compared to when it is mined

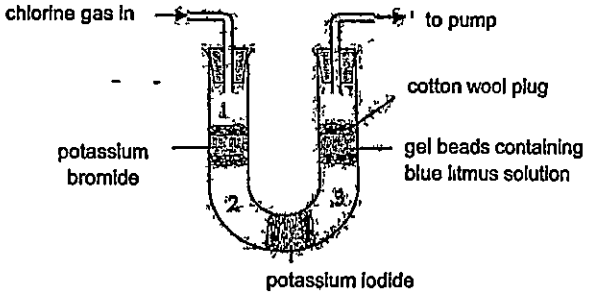
C Recycling zinc is cheaper than extracting zinc from its ore.

D The mass of magnesium mined is approximately equal to the mass of iron mined.

24 Equal masses of iron(II) oxide were heated separately in oxygen and hydrogen What changes (if any) would you expect in the masses of the iron(II) oxide after heating?

	Mass after heating in oxygen	Mass after heating in hydrogen
A	decrease	increase
B	increase	decrease
C	increase	increase
D	unchanged	decrease

25 Gaseous chlorine was passed through the following apparatus The apparatus was continuously heated and the observations were recorded below



Which of the following observations would be made at regions 1, 2 and 3?

	Region 1	*Region 2*	*Region 3*
A	red-brown gas	black solid	violet gas
B	red-brown gas	violet gas	black solid
C	yellow-green gas	red-brown gas	violet gas
D	yellow-green gas	violet gas	brown gas

26 Rubidium is an element in Group I of the Periodic Table The following statements were made about rubidium

1 Rubidium conducts electricity only when it is in solid state
2 Rubidium is soft and can be cut easily with a knife
3 Rubidium reacts with chlorine to form a white compound rubidium chloride.
4 Rubidium reacts explosively with water to form an acidic solution

Which statements about rubidium are true?

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

27 Which statement about groups in the Periodic Table is correct?

A All groups contain both metals and non-metals

B Atoms of elements in the same group have the same number of electron shells

C In Group I, reactivity decreases with increasing proton (atomic) number.

D In Group VII, the melting point of the elements increases with increasing proton (atomic) number

28 Which one of the following properties is true for all metals?

A All metals are good electrical conductors.

B All metals form coloured compounds

C All metals react with dilute acids to produce hydrogen

D All metals show variable oxidation states

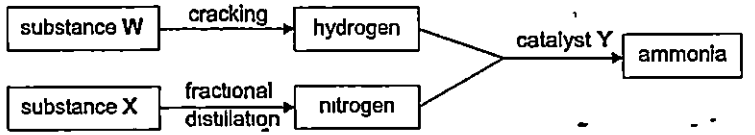
29 The table below shows some properties of four metals and their compounds

Metal	Action of dilute sulfuric acid on metal	Effect of hydrogen on heated metal oxide	Action of metal on a solution of the sulfate of J
G	hydrogen evolved	reduced	no reaction
H	no reaction	reduced	no reaction
I	hydrogen evolved	no reaction	J formed
J	hydrogen evolved	no reaction	no reaction

Which of the following shows a **descending** order of the thermal stability of the metal carbonates?

	Most stable ⟶			Least stable
A	H	G	J	I
B	H	J	G	I
C	I	J	G	H
D	I	H	G	J

30 The diagram shows the processes that take place during the production of ammonia



What are substances W, X and Y?

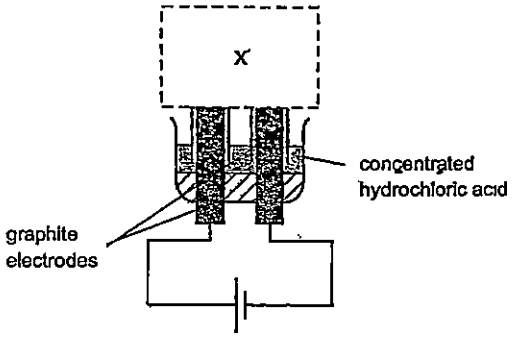
	W	X	Y
A	air	oil	iron
B	air	oil	nickel
C	oil	air	iron
D	oil	air	nickel

31 Methane, sulfur dioxide and carbon dioxide are gases which affect the atmosphere and the environment

In what ways do these gases affect the environment?

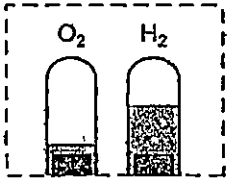
	Methane	Sulfur dioxide	Chlorofluorocarbons
A	Global warming	Acid rain	Ozone layer depletion
B	Global warming	Ozone layer depletion	Acid rain
C	Ozone layer depletion	Acid rain	Global warming
D	Photochemical smog	Global warming	Acid rain

32 The diagram shown is **not** complete



What would be shown at X after the solution has been electrolysed for some time?

A



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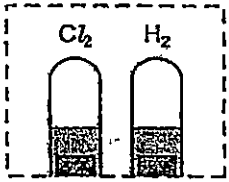
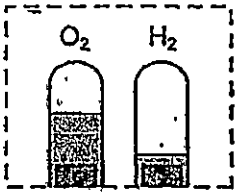


C



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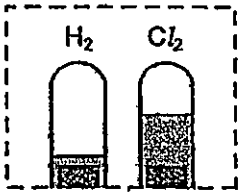
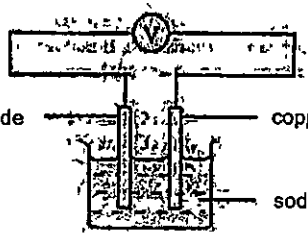


33 Consider the following chemical cell.



Which of the following changes would lead to an increase in the voltage of the cell?

I The copper electrode is replaced with an iron electrode
II The sodium chloride solution is replaced with a sugar solution
III The zinc electrode is replaced with a magnesium electrode

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

34 In an electrolysis experiment, the same amount of charge deposited 54 0 g of silver and 14 9 g of tin

What was the charge on the tin ion?

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

35 Which row correctly describes the electrodes and electrolyte used during the electroplating of a chromium bracelet with silver?

	Anode	Cathode	Electrolyte
A	bracelet	silver	chromium nitrate
B	bracelet	silver	silver nitrate
C	silver	bracelet	chromium nitrate
D	silver	bracelet	silver nitrate

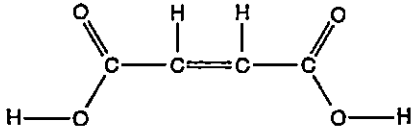
36 Four alkanes, H, I, J and K were extracted from a sample of crude oil. Some properties of the alkanes are listed below

- K is more viscous compared to I
- J burns with a less sooty flame compared to I and K
- H is less flammable than K.

What is the order in which the alkanes were collected from the fractional distillation?

	Alkane collected first →			Alkane collected last
A	H	K	I	J
B	J	H	K	I
C	J	I	K	H
D	K	H	J	I

37 The structure of an organic compound is shown below



Which one of the following statements is not correct?

A Its aqueous solution reacts with sodium carbonate

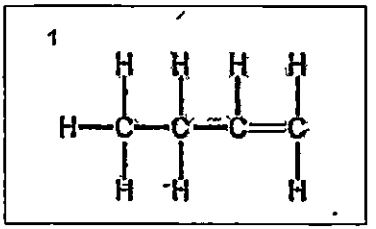
B It decolourises an aqueous solution of bromine.

C It turns acidified potassium dichromate(VI) from orange to green

D It is an unsaturated compound

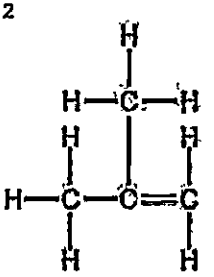
38 Compound 1 has a structure shown below.

1



Which of the compounds below are isomers of structure 1?

2



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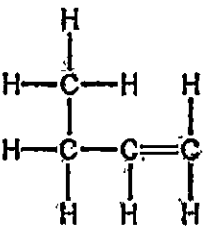

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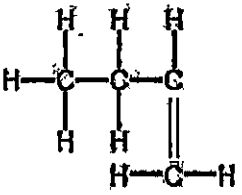
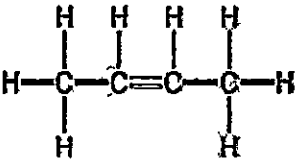
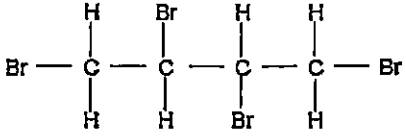


5

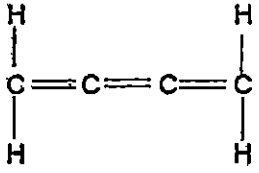


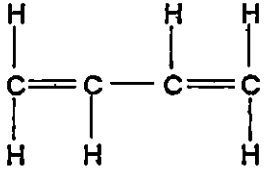
A 2 and 3 B 2 and 5 C 3 and 4 D 4 and 5

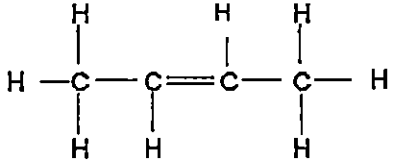
39 When an alkene reacts with two moles of bromine, the product formed is

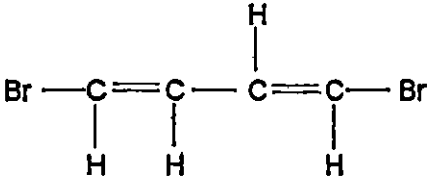


This implies that the original structure of the alkene is

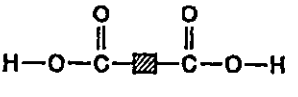
A 

B 

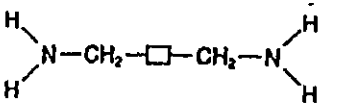
C 

D 

40 A condensation polymer is made from the two monomers below

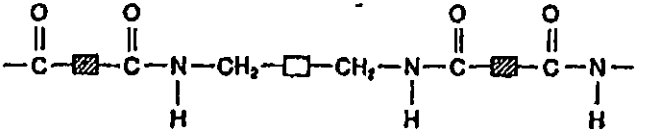


and



Which diagram shows part of the structure of the polymer formed?

A



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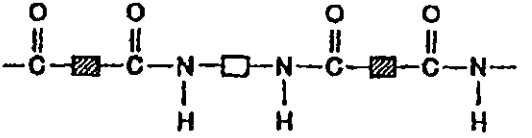

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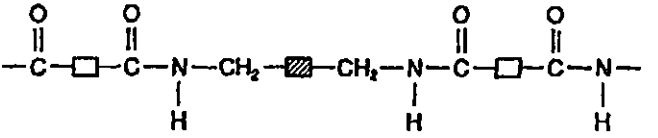

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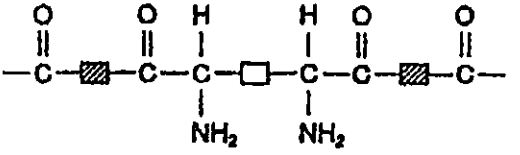

- End of Paper 1 -

67

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The Periodic Table of the Elements

Group I	Group II											Group III	Group IV	Group V	Group VI	Group VII	Group 0
							1 H hydrogen 1										4 He helium 2
7 Li lithium 3	9 Be beryllium 4											11 B boron 5	12 C carbon 6	14 N nitrogen 7	16 O oxygen 8	19 F fluorine 9	20 Ne neon 10
23 Na sodium 11	24 Mg magnesium 12											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
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	73 Ge germanium 32	75 As arsenic 33	79 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	93 Nb niobium 41	96 Mo molybdenum 42	– Tc technetium 43	101 Ru ruthenium 44	103 Rh rhodium 45	106 Pd palladium 46	108 Ag silver 47	112 Cd cadmium 48	115 In indium 49	119 Sn tin 50	122 Sb antimony 51	128 Te tellurium 52	127 I iodine 53	131 Xe xenon 54
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	207 Pb lead 82	209 Bi bismuth 83	– Po polonium 84	– At astatine 85	– Rn radon 86
– Fr francium 87	– Ra radium 88	– Ac actinium 89 †															

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

140 Ce cerium 58	141 Pr praseodymium 59	144 Nd neodymium 60	– Pm promethium 61	150 Sm samarium 62	152 Eu europium 63	157 Gd gadolinium 64	159 Tb terbium 65	162 Dy dysprosium 66	165 Ho holmium 67	167 Er erbium 68	169 Tm thulium 69	173 Yb ytterbium 70	175 Lu lutetium 71
232 Th thorium 90	– Pa protactinium 91	238 U uranium 92	– Np neptunium 93	– Pu plutonium 94	– Am americium 95	– Cm curium 96	– Bk berkelium 97	– Cf californium 98	– Es einsteinium 99	– Fm fermium 100	– Md mendelevium 101	– No nobelium 102	– Lr lawrencium 103

Key: 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 pressure (r.t.p.)

Answers for Paper 1

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

Name:		Index Number:		Class:	

CATHOLIC HIGH SCHOOL
Preliminary Examination
Secondary 4

CHEMISTRY **5073/2**

Paper 2 **16 September 2015**

1 hour 45 minutes

Additional Materials: NIL

READ THESE INSTRUCTIONS FIRST

Write your name, index number and class on all the work you hand in.
Write in dark blue or black pen.
You may use a soft pencil for any rough working. You may use a calculator.
Do not use staples, paper clips, highlighters, glue or correction fluid.
DO NOT WRITE ON THE MARGINS.
A copy of the Periodic Table is printed on page 11.

Section A
Answer all questions in the spaces provided.

For examiner's use only: **Section A / 50**

At the end of the examination, fasten all your work for each section securely together.
Hand in each section separately.
The number of marks is given in brackets [ ] at the end of each question or part question.

This document consists of 11 printed pages, **including** this cover page.
Page 12 has been intentionally left blank.

[Turn over]

Section A (50 marks)

Answer all questions in the spaces provided.

A1 The data in the table below describe two properties of some substances.
The letters are **not** the actual symbols of the elements in the Periodic Table.

Element / Compound	Appearance at room temperature and pressure	Products of burning in oxygen
A	Black solid	Carbon dioxide
B	Colourless gas	Water
C	Colourless gas	(Does not burn in oxygen)
D	Yellow solid	Sulfur Dioxide
E	Colourless liquid	Carbon Dioxide and water

You may use the letter once, more than once or none at all to answer the questions below.

(a) **(i)** Which substance is mostly likely to be hydrogen? .... **[1]**

(ii) Which substance is most likely to be a compound? ... . **[1]**

(b) Carbon monoxide is an atmospheric pollutant that may be produced when substance **A** burn in oxygen.
What harmful effect does carbon monoxide have on human health? **[2]**

. ...

....

....

(c) (i) Gas **C** is an element that does not burn in oxygen. Suggest the name of this substance **C**. [1]

... .

(ii) Explain your answer in (c)(i). [1]

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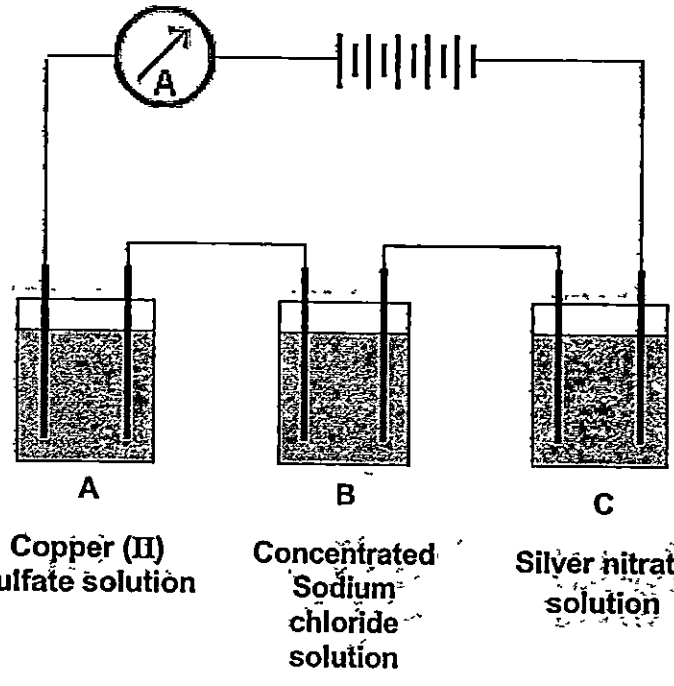
....

[Total marks: 6]

A2 The diagram shows the electrolysis of three different solutions using inert electrodes.



(a) (i) Write equations for the reactions that happen at each electrode in Cell **B** during electrolysis. Include state symbols. [2]

....

....

(ii) Describe two observations that take place in Cell **B**. Explain your observations. [4]

....

....

....

.. . .

....

(b) If 6.0 dm^3 of oxygen is liberated from Cell **A** at room temperature pressure,

(i) Calculate the increase in mass of the cathodes in Cell **A** and Cell **C** [3]

(ii) What is another observation in Cell **A**? Explain your observation. [2]

....

. ...

....

(c) The experiment is repeated and the electrodes in Cell **C** have been changed to silver electrodes. How would you expect the results for this experiment to differ from the first experiment? Explain your answer. [2]

....

... .

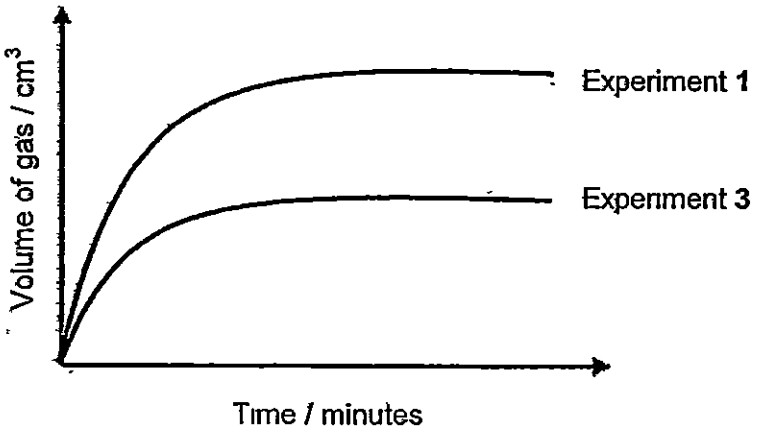
....

[Total marks: 13]

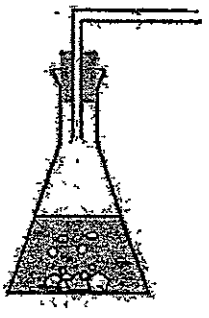
A3 A student carried out a series of experiments to determine the rate of reaction between zinc and dilute hydrochloric acid (HCl) by measuring the volume of gas produced per unit time.
In Experiment **1**(conducted at 25 °C), he used 5 g of zinc granules and 30 cm^3 of 0.5 mol/dm^3 dilute hydrochloric acid.
The experiments were repeated two more times, with different variables.

Experiment **2**: 5 g of zinc powder and 30 cm^3 of 0 5 mol/dm^3 of HCl, 25 °C
Experiment **3**: 5 g of zinc granules and **y** cm^3 of **z** mol/dm^3 of HCl, 25 °C

The graph below shows the volume of gas produced over time.



(a) Complete the diagram below with the appropriate apparatus used in the experiment. **[1]**



(b) Write a balance equation for the reaction between zinc and dilute hydrochloric acid. [1]

....

(c) On the graph above, sketch and label the graph for Experiment 2. [1]

(d) Taking reference from the graph above, suggest appropriate values for y and z. [2]

y = ... cm^3

z = ... mol/dm^3

(e) The student repeated the experiment at 50 °C. Explain in terms of energy and particle collisions how an increase in temperature increases the rate of a reaction. [3]

....

....

... ...

.. ..

[Total marks: 8]

A4 The table below shows the results of some of the chemical reactions of **four** unknown metals.

Metals	Thermal decomposition of metal carbonates	Reaction of metal with cold water
A	Greenish-blue solid turns black. White precipitate formed when gas produced is being passed through limewater	No reaction
B	White solid remains. No gas was produced.	Very vigorous reaction
C	White solid turns yellow, turns back to white after when cooled. White precipitate formed when gas produced is being passed through limewater	No reaction
D	White solid remains white. White precipitate formed when gas produced is being passed through limewater	Little bubbles formed on the surface of the metal

(a) Arrange the metals in ascending order of their chemical reactivity. **[1]**

.....

(b) Metal **A** and **D** are placed into two separate beakers of iron(III) sulfate solution. Describe the observations you will see in each beaker. **[3]**

.....

.....

.....

.....

(c) Pure iron can be extracted using the Blast furnace in the presence of carbon monoxide.

(i) State the three raw materials needed for the extraction of pure iron using the Blast furnace. [2]

.....

(ii) Write a balanced equation, with state symbols, for the reaction mentioned in (c). [2]

.....

(d) Iron oxidises to form iron(III) oxide, which is also known as rust.

(i) State the conditions needed for rusting to take place. [1]

.....

(ii) Using your knowledge of the reactivity series of metals, describe and explain how rusting can be prevented. [2]

.....

.....

.....

[Total marks: 11]

A5 Hydrazine, N_2H_4, is used as rocket fuel. The equation for the combustion of hydrazine is as follows:

$$N_2H_4\,(g) + O_2\,(g) \rightarrow 2H_2O\,(g) + N_2\,(g) \qquad \Delta H = -622\ kJ/mol$$

(a) Explain, in terms of bond breaking and bond forming, why the above reaction is an exothermic reaction. [3]

.....

.....

.....

.....

(b) Draw the energy profile diagram, for the reaction between hydrazine and oxygen. Label clearly, the **[3]**

- ΔH of reaction,
- activation energy, E_a,
- reactants and products.

(c) Hydrazine also undergoes another reaction with fluorine

$$N_2H_4\,(g) + 2\,F_2\,(g) \rightarrow 4\,HF\,(g) + N_2\,(g)$$

Use the following data to answer the question that follows:

Bond	Bond Energy (kJ/mol)
N – N	163
N – H	390
F – F	158
H – F	565
N ≡ N	945

Calculate the ΔH for the reaction between hydrazine and fluorine. **[3]**

(d) Hydrogen fluoride is a highly dangerous gas, forming corrosive and penetrating hydrofluoric acid upon contact with living tissue. The gas can also cause blindness by rapid destruction of the corneas.

(i) Hydrofluoric acid is a strong acid. Define the term strong acid. [1]

.....

.....

(ii) A student claims that hydrofluoric acid conducts electricity, therefore hydrogen fluoride is an ionic compound. Do you agree with the student? Explain your reasoning. [2]

.....

.....

[Total marks: 12]

- End of Section A -

The Periodic Table of the Elements

Group I	Group II											Group III	Group IV	Group V	Group VI	Group VII	Group 0
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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	73 Ge germanium 32	75 As arsenic 33	79 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	93 Nb niobium 41	96 Mo molybdenum 42	– Tc technetium 43	101 Ru ruthenium 44	103 Rh rhodium 45	106 Pd palladium 46	108 Ag silver 47	112 Cd cadmium 48	115 In indium 49	119 Sn tin 50	122 Sb antimony 51	128 Te tellurium 52	127 I iodine 53	131 Xe xenon 54
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	207 Pb lead 82	209 Bi bismuth 83	– Po polonium 84	– At astatine 85	– Rn radon 86
– Fr francium 87	– Ra radium 88	– Ac actinium 89 †															

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

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232 Th thorium 90	– Pa protactinium 91	238 U uranium 92	– Np neptunium 93	– Pu plutonium 94	– Am americium 95	– Cm curium 96	– Bk berkelium 97	– Cf californium 98	– Es einsteinium 99	– Fm fermium 100	– Md mendelevium 101	– No nobelium 102	– Lr lawrencium 103

Key: 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 pressure (r.t.p.).

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Name:		Index Number:		Class:	

CATHOLIC HIGH SCHOOL
Preliminary Examination
Secondary 4

B

CHEMISTRY **5073/2**

Paper 2

16 September 2015
1 hour 45 minutes

READ THESE INSTRUCTIONS FIRST

Write your name, index number and class on all the work you hand in.
Write in dark blue or black pen.
You may use a soft pencil for any rough working. You may use a calculator.
Do not use staples, paper clips, highlighters, glue or correction fluid.
DO **NOT** WRITE ON THE MARGINS

Section B
Answer all questions in the foolscap paper provided.

For examiner's use only: **Section B / 30**

At the end of the examination, fasten all your work for each section securely together.
Hand in each section separately.
The number of marks is given in brackets [ ] at the end of each question or part question.

This document consists of **11** printed pages, **including** this cover page.
Page 12 has been intentionally left blank.

[Turn over]

Section B (30 marks)

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.

B6 Mass spectrometry is an important technique which can identify the amount and type of chemicals present in a sample by using a machine called a mass spectrometer. In general, the two quantities that can be measured are the **mass/charge ratio (m/z)** and the **relative abundance** of particles in the sample.

Mass/charge (m/z) ratio: this is calculated by dividing the mass of an ion by its charge. E.g. a sodium-23 ion, $^{23}Na^{+}$, would have a **m/z** value of 23. Hence, the **m/z** of an ion with a charge of 1+ is effectively its relative mass.

Relative abundance: this refers to the percentage of a particular isotope which occurs in nature. E.g. in a sample of chlorine, the relative abundance of chlorine-35 is 75% and chlorine-37 is 25%.

The steps below show how mass spectrometry is done:

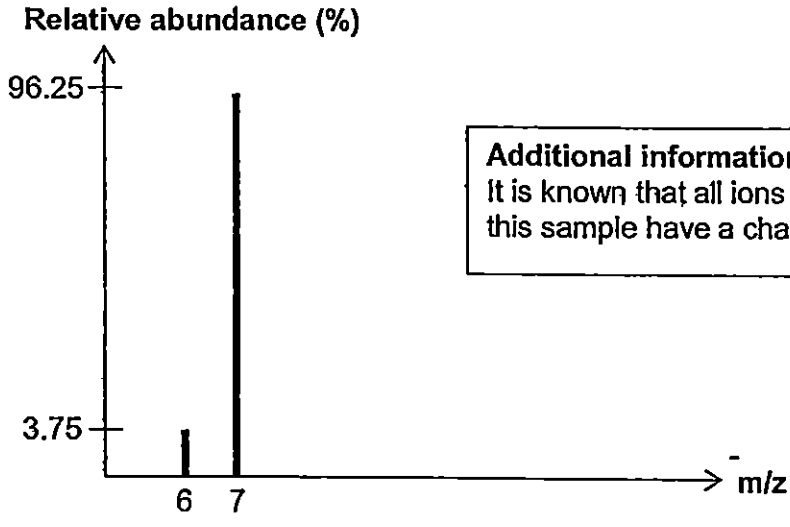
Step 1: Ionisation – the sample is vapourised. Energy is then used to knock off one or more electrons from atoms or molecules in the sample, changing them into positive ions. If enough energy is supplied, some bonds of molecules are broken and smaller positive ions are formed.

Step 2: Acceleration – the ions formed from Step 1 are accelerated through the spectrometer by the use of negatively-charged plates.

Step 3: Deflection and detection – the ions are deflected by a magnetic field and are detected electrically.

Step 4: Mass spectrum – the mass spectrometer records the **m/z** and **relative abundance** of all ions in the form of a histogram, called a mass spectrum.

Figure 1 below shows the mass spectrum of a pure sample of **lithium:**



Additional information
It is known that all ions analysed in this sample have a charge of 1+.

Figure 1:** Mass spectrum of a pure sample of **lithium

Figure 2 below shows the mass spectrum of a pure sample of **chlorine:**

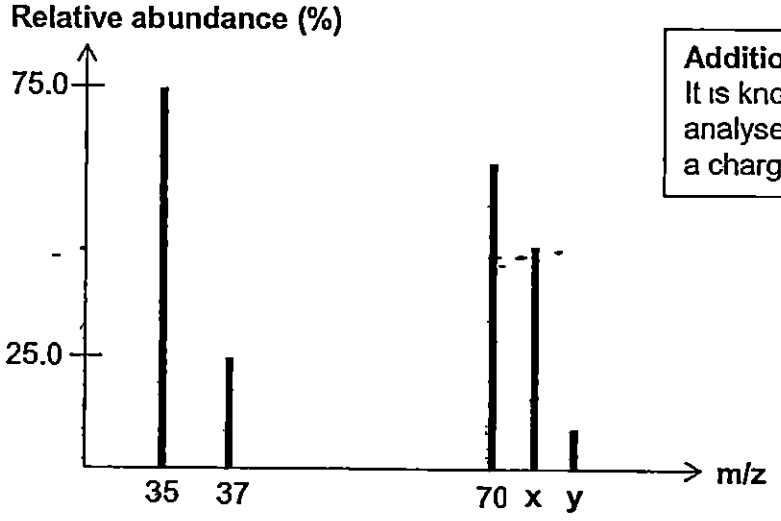


Figure 2: Mass spectrum of a pure sample of ***chlorine***

Figure 3 below shows the mass spectrum of a pure sample of **an unknown hydrocarbon:**

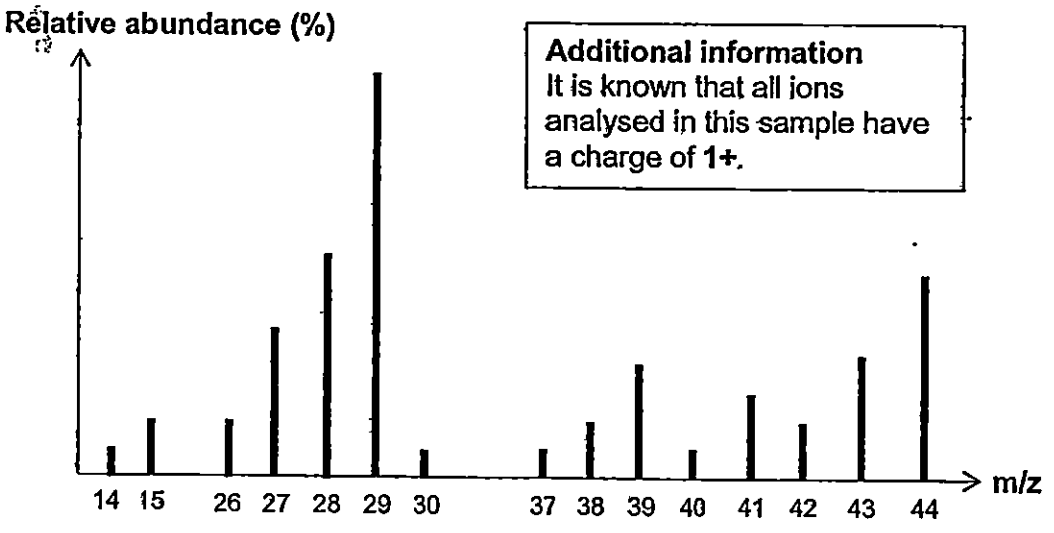


Figure 3: Mass spectrum of a pure sample of ***an unknown hydrocarbon***

Figure 1

(a) (i) Explain how the data in **Figure 1** shows that there are two isotopes of lithium. [2]

....

....

....

(ii) Show that the average relative atomic mass of lithium is 6.96 rounded off to 3 significant figures. Show your working clearly. [1]

Figure 2

(b) (i) State the values of **x** and **y**. .... [2]

(ii) There are only two known isotopes of chlorine, C*l*-35 and C*l*-37. Use the data in **Figure 2** to suggest why there are 3 additional peaks of **70, x** and **y** on the mass spectrum of chlorine [2]

. ...

. ...

.. ..

Figure 3

(c) (i) A student comments that the unknown hydrocarbon is propane [2]
Explain how the data in **Figure 3** shows that this is true.

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

(ii) Suggest the formula of the ion which has a **m/z** value of 14. [1]

.....

(iii) Another mass spectrometry analysis was carried out on a sample of butane. Suggest how the results of the mass spectrum of butane would differ from that of propane. [2]

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

[Total marks: 12]

B7 The table below provides some information on four organic compounds:

Compound	Molecular formula	Decolourises brown aqueous bromine?	Turns moist blue litmus paper red?
A	C_2F_4	Yes	No
B	$C_3H_6O_2$	No	Yes
C	$C_3H_6O_2$	Yes	No
D	$HO_2C-C_2H_4-CO_2H$	No	Yes

(a) (i) Compound **A** can be polymerised to make polytetrafluoroethylene, also known as **PTFE.** **[1]**
Draw the structure of **PTFE.**

(ii) There are high and low grades of **PTFE.** **[1]**
Molecules of high-grade **PTFE** typically have a relative molecular mass of 1.2×10^6.
Calculate how many repeat units there are in a typical molecule of high-grade **PTFE.** Show your working clearly.

(iii) Low-grade **PTFE** molecules typically have a relative molecular mass of 1.4×10^4. **[1]**
Explain why low-grade **PTFE** has a lower melting point than high-grade **PTFE.**

.....

.....

(iv) Describe and explain a pollution problem caused by getting rid of substances made of **PTFE.** **[2]**

.....

.....

(b) Compound **B** can react with another organic compound to form ethyl propanoate.

(i) Draw the structure of the organic compound which can react with **B** to form ethyl propanoate. [1]

(ii) Draw the structure of ethyl propanoate. [1]

(c) Compound **C** can be polymerised with Compound **D**. [1]
During this polymerisation process, small molecules of water are eliminated.
Draw the structure of the polymer formed when **C** is polymerised with **D**, showing 2 repeat units.

[Total marks: 8]

EITHER

B8 This question concerns the chemistry of carbon and silicon, elements from Group IV of the Periodic Table.
The table below provides some information on two different forms of carbon (allotropes) and silicon:

Substance	Melting point / °C	Electrical conductivity	Uses
Carbon allotrope **A**	Above 3000	Poor	Cutting tools, drill bits
Carbon allotrope **B**	Above 3000	Good	Lubricant
Silicon	1414	Good	Semiconductors in electronics

Table 1: Some information on carbon and silicon

(a) Carbon tends to form covalent compounds. **[3]**
By drawing the dot-and-cross diagram of a carbon compound of your choice, describe how a covalent bond is formed. You only need to show valence electrons.

.....

.....

.....

(b) Explain, in terms of bonding, why carbon allotrope **A** can be used as a drill bit while carbon allotrope B can be used as a lubricant. **[2]**

.....

.....

.....

.....

(c) Carbon is commonly used as a reducing agent. For example, it can reduce zinc oxide to form zinc. [1]
Explain, using oxidation states, how carbon is acting as a reducing agent in the reduction of zinc oxide.

....

... ...

(d) Silicon has the structure has shown below: [2]

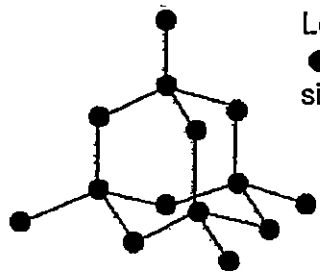


Figure 4: Structure of silicon

This structure of silicon in **Figure 4** above alone is <u>unable</u> to account for one of its physical properties stated in **Table 1.**
State this physical property and explain why.

... .

....

....

(e) Silicon reacts with oxygen to form silicon dioxide. [2]
Describe one **similarity** and one **difference** between the **structures** of silicon and silicon dioxide.

....

....

....

[Total marks: 10]

OR

B8 This question concerns the chemistry of some elements in Group II of the Periodic Table.

(a) Magnesium is in Group II of the Periodic Table. It tends to form ionic compounds. **[3]**
By drawing the dot-and-cross diagram of a magnesium compound of your choice, describe how an ionic bond is formed. You only need to show valence electrons.

(b) Magnesium reacts with oxygen to form magnesium oxide.

(i) In terms of bonding, "strong electrostatic forces of attraction" exist in both solid magnesium and solid magnesium oxide, but different kinds of particles are involved. **[2]**
State these particles.

(ii) Both solid magnesium and molten magnesium oxide conduct electricity differently. **[1]**
Explain how solid magnesium conducts electricity differently from molten magnesium oxide.

(c) Both magnesium and calcium metals are reducing agents. [1]
Some chemical reactions show that calcium is a stronger reducing agent than magnesium.
Write a single, chemical equation to represent one such reaction.

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(d) The table below provides some information on some salts of Group II elements: [3]

Name of salt	Solubility (maximum grams dissolved in 100 cm^3 of water at r.t.p)
Magnesium sulfate	35.1
Calcium sulfate	0 21
Barium sulfate	2.45×10^{-4}
Radium sulfate	?

From the information give in the table above, suggest how you would prepare a pure, dry sample of radium sulfate. Name the starting reagents in your answer.

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[Total marks: 10]

- End of Section B -

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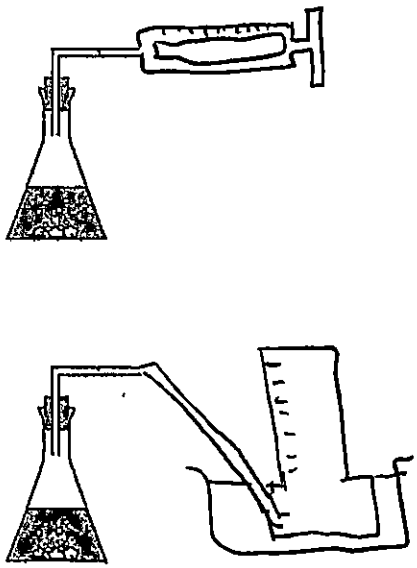
2015 Prelim Answers

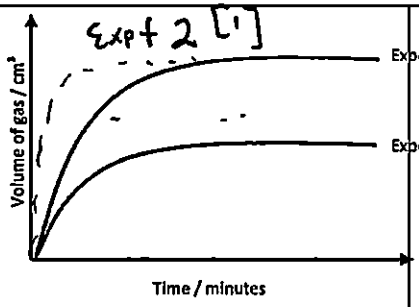
Paper 1

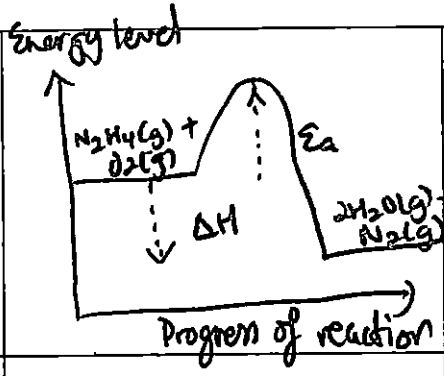
1 C	2 D	3 C	4 A	5 C	6 B	7 C	8 A	9 A	10 C
11 C	12 C	13 D	14 D	15 B	16 B	17 A	18 B	19 A	20 A
21 D	22 B	23 C	24 B	25 C	26 C	27 D	28 A	29 C	30 C
31 A	32 B	33 D	34 D	35 D	36 C	37 B	38 B	39 C	40 A

Paper 2 Section A

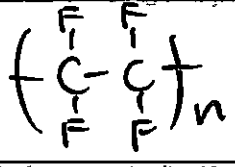
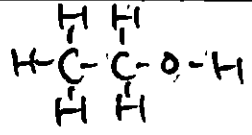
	Marking scheme	Remarks
A1ai	B	
ii	E	
b	Carbon monoxide binds irreversibly with haemoglobin [1] to form carboxyhaemoblobin which prevents transportation of oxygen to the whole body, causing respiratory difficulty [1]	Reject breathing difficulty
C i	Any noble gas	
ii	Noble gases is unreactive/full valence shell/octet or duplet structure [1]	
A2ai	Cathode: $2H^+(aq) + 2e^- \rightarrow H_2(g)$ Anode $2Cl^-(aq) \rightarrow Cl_2(g) + 2e^-$	-1 mark if no state symbols
ii	Effervescence of a colourless gas produced at cathode. [1] Hydrogen is less reactive than sodium in the reactivity series, therefore, H^+ ions is preferentially discharged [1] Effervescence of a greenish yellow gas produced at anode. [1] Cl^- ions are preferentially discharged because it is a concentrated solution [1]	Reject chlorine ions/chloride atoms. Reject hydrogen is preferentially discharged
(b)(i)	No. of mol of Cl_2 $= \frac{6.0}{24} = 0.25$ mol [1] No. of mol of $e^- = 0.50$ mol [1] $Cu^{2+} + 2e^- \rightarrow Cu$ Mass of $Cu = \frac{0.50}{2} \times 64$ $= 16.0$ g [1]	ECF from A2ai ECF from within question.

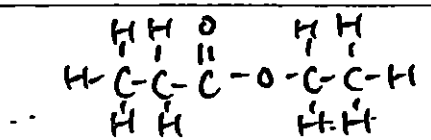
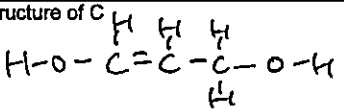
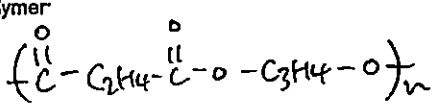
	$Ag^+ + e^- \rightarrow Ag$ Mass of Ag = 0.50 × 108 = 54.0g [1]	
ii	Solution will turn from **blue to colourless** [1] **Copper ions** are **preferentially discharged** from the solution [1]	
(c)	**Silver anode** will **dissolve** compared to seeing **effervescence** seen at the anode [1] Silver anode is a **reactive electrode** compared to **inert carbon electrode** [1]	Comparison must be made
A3a		Markings must be shown
(b)	$2HCl(aq) + Zn(s) \rightarrow ZnCl_2(aq) + H_2(g)$	-1 mark for no state symbol No marks for wrongly balanced equation

(c)		
(d)	Y = 30.0 cm^3 Z = 0.25 mol/dm^3 Or Y = 60 0 cm^3 Z = 0 125 mol/dm^3	
(e)	Increase in temperature, **Increases the kinetic energy of the particles [1]**, **more particles have energy greater or equal to the activation energy [1]**, **higher frequency of effective collision**,[1] increase speed of reaction	
A4a	A,C,D,B	
b	Metal A. No visible observation [1] Metal D: Metal D dissolves/brown solution becomes colourless/Grey solid produced (Any 2 for 2 marks)	
(c)(i)	Coke, Haematite and Limestone	
(ii)	$Fe_2O_3(s) + 3CO(g) \rightarrow 3CO_2(g) + 2Fe(l)$	-1 mark if no state symbols
(d)(i)	Oxygen and water	Reject air
(ii)	Sacrificial Protection A **more reactive metal** like magnesium or zinc can be **placed beside iron [1]** It will **corrode in place of iron [1]**	
A5a	**Bond energy absorbed to break the bonds of N_2H_4 and O_2** [1] is **lesser** [1] than the **energy released for the bond formation** of **H_2O and N_2** [1]	

(b)		1m - Shape of the graph 2m – For enthalpy change, activation energy and correct reactants and products. (-1 m if one or two is missing) Arrow wrong = wrong
(c)	Energy absorbed = 163 + 390(4) + 158(2) = 2039 kJ [1] Energy released = 565(4) + 945 = 3205 kJ [1] ΔH = 2039 − 3205 = −1166 kJ/mol [1]	
(d)(i)	A strong acid is an acid that <u>dissociates completely in water to produce H^+ ions</u>	
(ii)	The statement is false. Hydrogen fluoride is made up of <u>non-metals</u> [1] therefore it is a <u>covalent compound</u> [1]	

Paper 2 Section B

	Marking scheme	Remarks
B6ai)	Isotopes have the same number of protons but different number of neutrons In Figure 1, there are 2 ions detected which have different m/z values of 6 and 7 [1] This indicates that these 2 ions have different numbers of neutrons [1]	ACCEPT "particles" in place of ions REJECT different "mass numbers"
aii)	3 75/100 x 6 + 96 25/100 x 7 = 6.96 (3sf)	No marks if no working is shown
bi)	x = 72 [1], y = 74 [1]	
bii)	Chlorine exists as diatomic molecules [1] There are 3 possible combinations 2 atoms of *Cl*-35 1 atom of *Cl*-35 and 1 atom of *Cl*-37 2 atoms of *Cl*-37 [1]	OWTTE
ci)	The largest m/z value is 44, which belongs to the ion formed by the largest molecule This molecule would be that of the unknown hydrocarbon as it is unbroken [1] Propane has a relative molecular mass of 44 [1]	OWTTE
cii)	CH_2^+	
ciii)	The highest m/z value recorded would be 58 [1] There would be more peaks [1]	
B7ai)		ACCEPT 2 or more repeat units
aii)	M_r of one repeat unit = 12 x 2 + 19 x 4 = 100 No of repeat units = $(1\,2 \times 10^6) / 100 = 12000$	
aiii)	Low-grade PTFE molecules are smaller, and hence there are fewer electrons. There are weaker intermolecular forces in low-grade PTFE which require less heat to overcome [1]	
aiv)	Substances made of PTFE are non-biodegradable [1]. If they are disposed by burning, toxic gases are released [1] OR if they are disposed by burying, valuable land space has to be used as landfills [1]	
bi)		

bii)		
c)	Structure of C  Polymer 	ACCEPT 2 or more repeat units
EITHER 8a)	Any appropriate compound 1 mark for correct number of electrons on carbon atom 1 mark for correct number of electrons on the other atom(s) Explanation. the carbon atom and X atom share a pair of electrons to attain a noble gas electronic configuration [1]	0 marks for ionic compound
b)	In allotrope A, every carbon atom is bonded to 4 other carbon atoms by strong covalent bonds This makes the whole structure very hard. In allotrope B, every carbon atom is bonded to 3 other carbon atoms in hexagonal layers. Little force is needed to overcome these weak intermolecular forces of attraction between layers, making B slippery.	To discuss mark allocation
c)	Carbon causes the oxidation state of zinc to decrease from +2 in ZnO to 0 in Zn, hence reducing zinc oxide	
d)	Good electrical conductivity [1] Every carbon atom is bonded to 4 other carbon atoms, all valence electrons are used in bonding and there appears to be no mobile delocalised electrons or ions	
e)	Similarity. both silicon and silicon dioxide have giant covalent tetrahedral [1] structures Difference: the structure of silicon only involves silicon atoms while there are silicon and oxygen atoms present in silicon dioxide [1].	

OR B8		
a)	Any appropriate compound 1 mark for correct number of electrons and charge on magnesium ion 1 mark for correct number of electrons and charge on the other ion(s) Explanation the magnesium atom transfers 2 valence electrons to X atom. Both ions attain noble gas electronic configurations [1]	
bi)	In solid magnesium, strong electrostatic forces of attraction exist between positive and negative ions [1] In solid magnesium oxide, strong electrostatic forces of attraction exist between positive ions and "sea" of mobile, delocalised electrons [1]	
bii)	Solid magnesium conducts electricity because of the "sea" of mobile, delocalised electrons Molten magnesium oxide conducts electricity because of mobile ions	
c)	Any appropriate reaction, e g displacement reaction involving calcium and magnesium	
d)	Add any soluble radium salt, e g aqueous radium nitrate to any soluble sulfate salt, e.g. aqueous sodium sulfate [1] Filter the mixture and keep the residue [1] Wash residue with distilled water and press dry between sheets of filter paper [1]	