Class:	Register No:	Name:

CRESCENT GIRLS' SCHOOL
SECONDARY FOUR
PRELIMINARY EXAMINATION 2014

CHEMISTRY **5073/01**
1 SEPT 2014

Paper 1 Multiple Choice **1 hour**

READ THESE INSTRUCTIONS FIRST

Do not open this booklet until you are told to do so.

Write in soft pencil.

Do not use staples, paper clips, highlighters, glue or correction fluids.

Write your name, index number and class on the answer sheet in the spaces provided.

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

Choose the **one** you consider correct and record your choice in **soft pencil** on the answer sheet.

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

Any rough working should be done in this booklet

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

This paper consists of 15 printed pages, including the cover page.

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

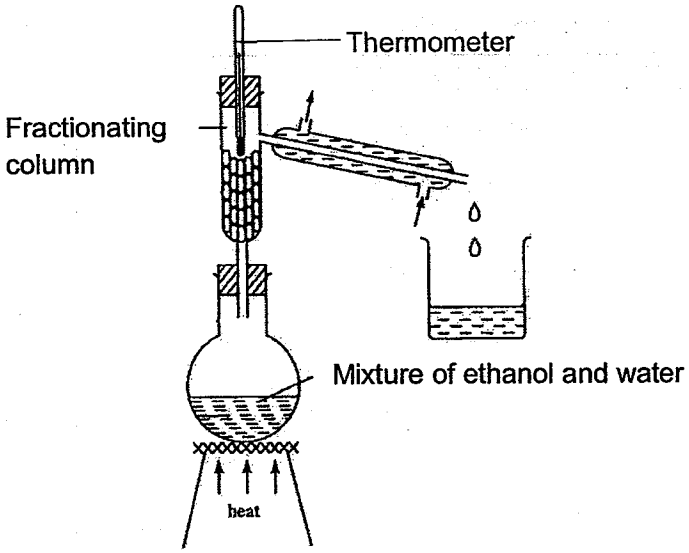
Key: a / X / b

a = relative atomic mass

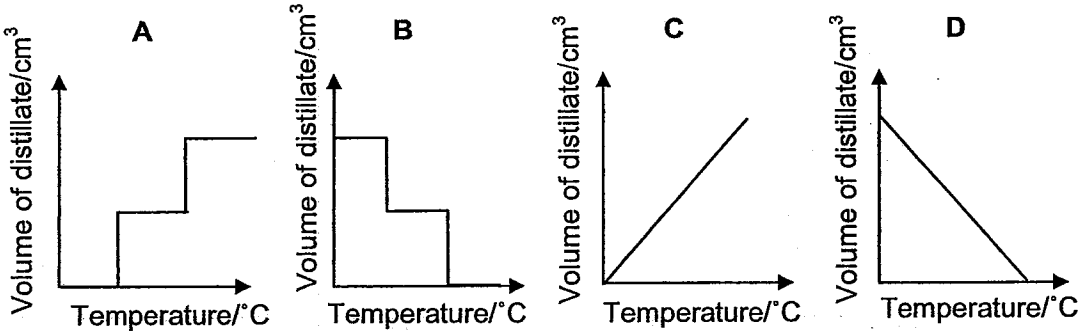
X = atomic symbol

b = proton (atomic) number

1. A student sets up the following apparatus to separate ethanol (boiling point 78 °C) and water (boiling point 100 °C).



Which graph correctly shows the relationship between total volume of distillate plotted against temperature?



2. Which statement is correct about two gases with the same relative molecular mass?

A They have the same melting and boiling points

B They have the same mass.

C They have the same rate of diffusion at room temperature and pressure.

D They have the same solubility in water at room temperature and pressure.

3. Element **X** has n protons and forms ions with a charge of 2-.
Element **Y** has (n+3) protons.

Which of the following correctly shows the structure and formula of a compound formed between elements **X** and **Y**?

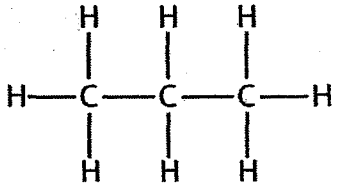
A an ionic compound YX_2

B a covalent compound YX_2

C an ionic compound Y_2X

D a covalent compound Y_2X

4. Propane has the structure as shown below.



How many electrons in a molecule of propane is/are not involved in bonding?

A 0 **C** 2

B 4 **D** 6

5. Which statement is correct about the melting point of caesium chloride, CsC*l*?

A It has a low melting point as its molecules are held together by weak van der waals' forces.

B It has a high melting point as the ions are held together by strong electrostatic attractions.

C It has a low melting point as the atoms are held together by weak covalent bonds.

D It has a high melting point as the atoms are held togeter by strong covalent bonds.

6. When a 2.31 g sample of oxide of nitrogen was analysed, it was found to contain 0.68 g of nitrogen.

What is the empirical formula of the oxide of nitrogen?

A NO **C** NO_2

B N_2O **D** N_2O_4

7. 35.0 cm^3 of 0.500 mol/dm^3 dilute hydrochloric acid was added to 0.70 g of a sample of sodium carbonate contaminated with sodium chloride. The excess acid required 15.0 cm^3 of 0.400 mol/dm^3 sodium hydroxide solution for neutralisation.

Find the percentage purity of the sodium carbonate in the sample.

A 43.5 %
B 45.4 %
C 87.1 %
D 90.9 %

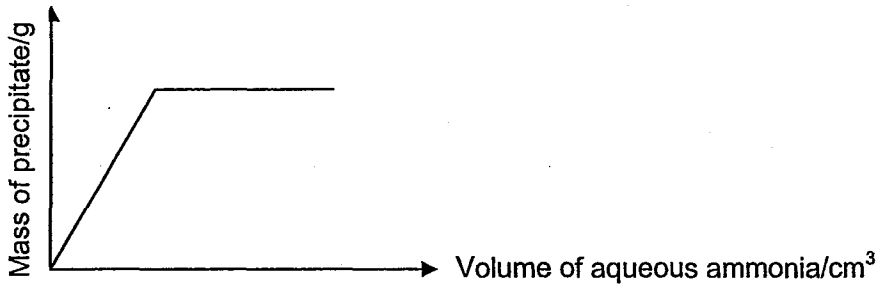
8. What volume of air is required to ensure the complete combustion of 150 cm^3 of carbon monoxide at room temperature and pressure?

A 75 cm^3
B 375 cm^3
C 250 cm^3
D 500 cm^3

9. Which solution will produce gases when reacted with both sulfuric acid and warm aqueous sodium hydroxide?

A $(NH_4)_2CO_3$
B NaCl
C NH_4NO_3
D $Fe(NO_3)_2$

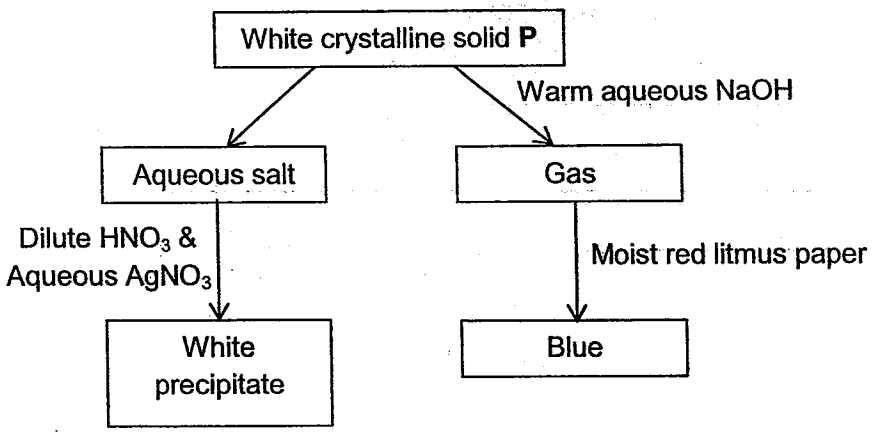
10. An aqueous solution of a salt was placed in a test tube and aqueous ammonia was gradually added from a burette. The mass of the precipitate was obtained when various volumes of aqueous ammonia were added and a graph was obtained as shown.



Which salt would show this behaviour?

A copper(II) nitrate
B zinc chloride
C iron(II) sulfate
D sodium nitrate

11. The diagram below shows the reaction of a white crystalline solid **P**.



Which is the identity of the white crystalline solid P?

A aluminium sulfate
B ammonium chloride
C ammonium nitrate
D magnesium chloride

12. Which of the following **cannot** be a reducing agent?

A HNO_3
B NH_3
C H_2
D KI

13. In which experiment does the oxidation state of iodine remain unchanged?

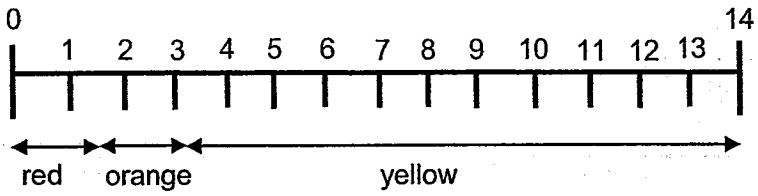
A Chlorine gas is bubbled into aqueous magnesium iodide.
B Acidified potassium manganate(VII) is added into aqueous potassium iodide.
C Bromine water is added to aqueous sodium iodide.
D Aqueous silver nitrate is added into aqueous sodium iodide.

14. 1.0 mol/dm^3 of 25.0 cm^3 aqueous hydrochloric acid requires 25.0 cm^3 of 1.0 mol/dm^3 of aqueous sodium hydroxide for complete neutralisation.

Which acid of the same concentration will require a different volume for complete neutralisation given that the same volume and concentration of sodium hydroxide is used?

A Ethanoic acid
B Nitric acid
C Propanoic acid
D Sulfuric acid

15. The colours of an indicator **X** in solutions of different pH are shown below:



Which pair of solutions can be differentiated by using Indicator **X**?

A aqueous solutions of ammonia and ethanoic acid at the same concentration

B aqueous solutions of sodium chloride and ethanoic acid at the same concentration

C aqueous solutions of sodium hydroxide and carbonic acid at the same concentration

D aqueous solutions of hydrogen chloride and carbonic acid at the same concentration

16. How can lead(II) sulfate best be prepared from lead(II) oxide?

A by adding dilute sulfuric acid

B by adding dilute hydrochloric acid followed aqueous sodium sulfate

C by adding dilute nitric acid followed by aqueous sodium sulfate

D by heating lead(II) oxide followed by adding sulfuric acid

17. In which reaction is sulfuric acid **not** acting as an acid?

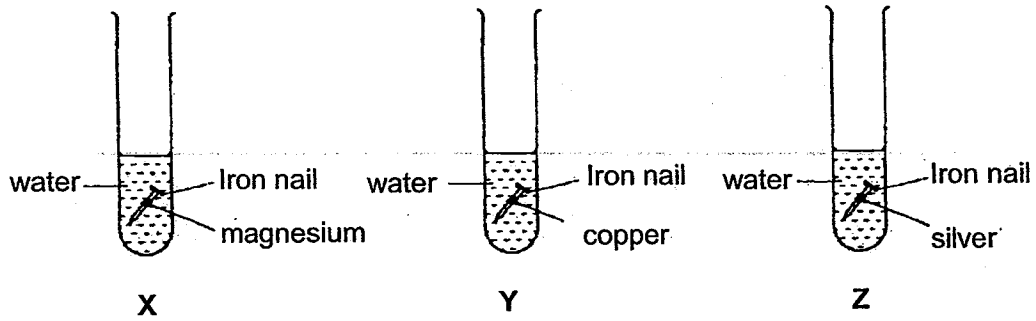
A formation of sodium sulfate by adding sodium carbonate

B formation of magnesium sulfate by adding magnesium

C formation of barium sulfate by adding aqueous barium hydroxide

D formation of barium sulfate by adding aqueous barium nitrate

18. Three experiments are set up to investigate the sacrificial protection of iron.



In which test tube(s) will the iron nail rust?

A **X** only

B **X** and **Y** only

C **X** and **Z** only

D **Y** and **Z** only

19. Small pieces of different metals were added to metal ions in water. Use the information below to answer **Question 19** and **20.**

Solution	**Metal added**				
	X	**Iron**	**Copper**	**Zinc**	**Y**
Copper(II) chloride	Copper displaced	Copper displaced	_____	Copper displaced	Copper displaced
Nitrate of metal X	_____	Metal **X** displaced	No reaction	Metal **X** displaced	Metal **X** displaced
Iron(II) chloride	No reaction	_____	No reaction	Iron displaced	Iron displaced
Chloride of metal Y	No reaction	No reaction	No reaction	No reaction	_____
Zinc chloride	No reaction	No reaction	No reaction	_____	Zinc displaced

Which of the following correctly shows the different metals arranged in the order of increasing reactivity?

A copper, **X**, iron, zinc, **Y**

B copper, iron, **X**, zinc, **Y**

C **X**, copper, iron, zinc, **Y**

D **X**, iron, copper, **Y**, zinc

20. Which method should be used to extract metal **Y** from its ore?

A by heating the ore with ammonia

B by heating the ore

C by electrolysis of its molten ore

D by heating the ore with carbon

21. A sample of air along the Pan Island Expressway (PIE) is collected and its composition is examined.

Which of the following is **least** likely to be one of the components in the sample of air?

A Carbon monoxide

B Nitrogen monoxide

C Nitrogen dioxide

D Sulfur dioxide

22. Which property generally decreases when going across a period of the Periodic Table from Group I to Group VII?

A the reducing power of an element

B the number of electrons in the valence shell

C the acidity of the oxides of the elements

D the tendency of the elements to form negative ions

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

$$Z^- (aq) + Y_2 (aq) \rightarrow \text{no reaction}$$
$$X^- (aq) + Z_2 (aq) \rightarrow \text{no reaction}$$
$$2Y^- (aq) + X_2 (aq) \rightarrow 2X^- (aq) + Y_2 (aq)$$

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

A X, Y, Z

B X, Z, Y

C Z, Y, X

D Z, X, Y

24. Which statement is true about the Haber Process?

A Nitrogen is obtained from the cracking of petroleum.

B Increasing the pressure to above 200 atmospheres will speed up the reaction but cause the yield to be low.

C Increasing the temperature to above 450 °C will speed up the reaction but cause the yield to be low.

D Unreacted gases produced are released into the atmosphere.

25. The enthalpy change when one mole of hydrogen ions is neutralised is known as the enthapy of neutralisation.

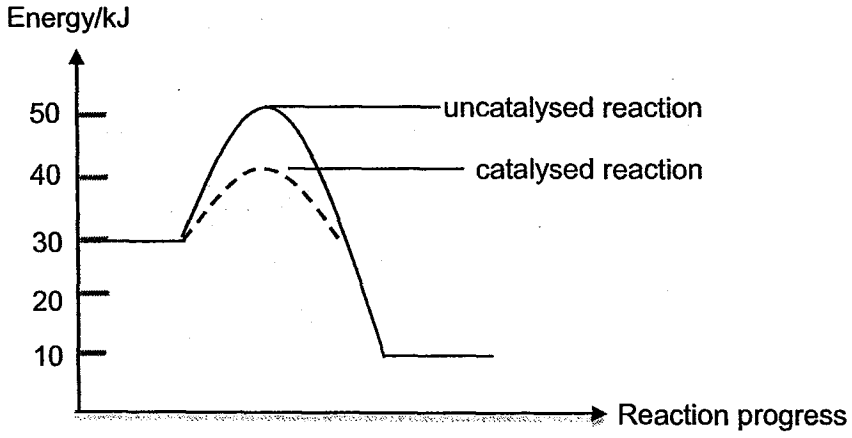
$$H^+ (aq) + OH^- (aq) \rightarrow H_2O (l) \qquad \Delta H = -57 \text{ kJ/mol}$$

How much energy is released when one mole of sulfuric acid is completely neutralised?

A 28.5 kJ **C** 114 kJ

B 57 kJ **D** 228 kJ

26. The energy diagram for a particular reaction under catalysed and uncatalysed conditions is shown below.



What is the activation energy of the **backward catalysed** reaction?

A + 10 kJ **C** + 30 kJ

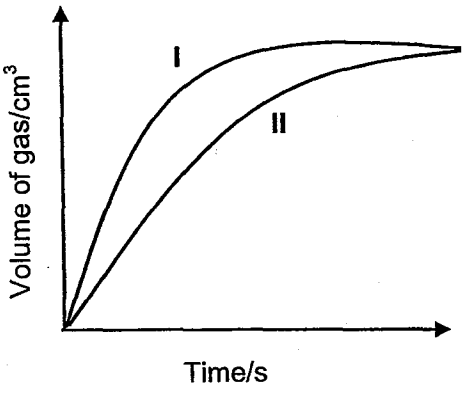
B + 20 kJ **D** + 40 kJ

27. In two separate experiments, magnesium carbonate was reacted with an excess of dilute acid. The following shows the different conditions used in each experiment, with all other conditions being identical in both experiments.

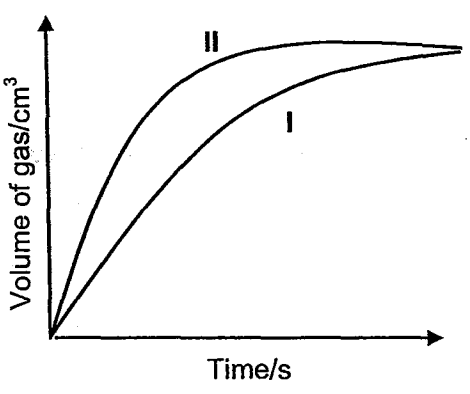
Experiment **I** : 0.05 dm^3 of 1.0 mol/dm^3 of hydrochloric acid
Experiment **II** : 0.05 dm^3 of 1.0 mol/dm^3 of sulfuric acid

Which graph correctly represents the results of the two experiments?

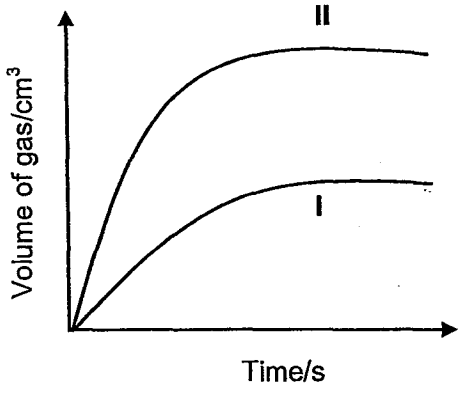
A



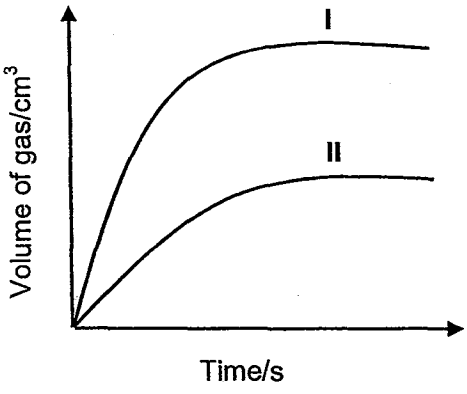
C



B



D



28. Which statement best explains why the speed of a chemical reaction slows down as the reaction nears completion?

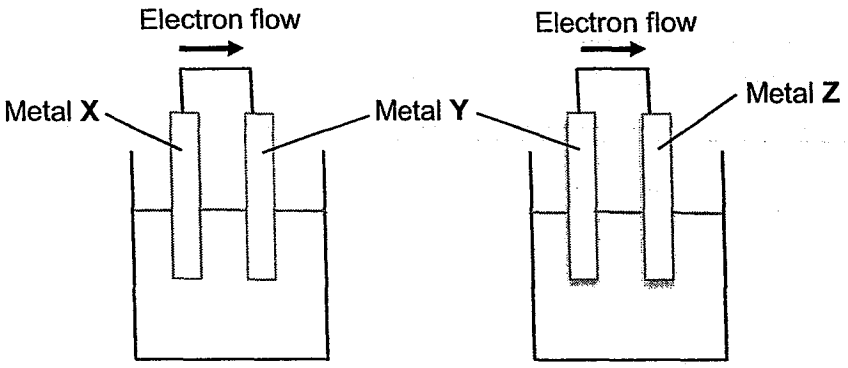
A The concentration of the reactant particles decreases.

B Particles lose their kinetic energy as the reaction proceeds.

C Most of the energy produced during the reaction has been used up.

D The temperature of the reaction falls as heat is lost to the surroundings.

29. Two cells were set up as shown in the diagram. The arrow shows the direction of electron flow in the circuit.



Which set of metals would give the electron flows in the direction shown?

	Metal **X**	Metal **Y**	Metal **Z**
A	Ag	Cu	Zn
B	Cu	Zn	Ag
C	Zn	Ag	Cu
D	Zn	Cu	Ag

30. A compound was being electrolysed using graphite electrodes and the half ionic equations below show the reactions at the electrodes.

$$\text{Cathode: } 2X^{+}(aq) + 2e^{-} \rightarrow X_2(g)$$
$$\text{Anode: } 2Y^{-}(aq) \rightarrow Y_2(g) + 2e^{-}$$

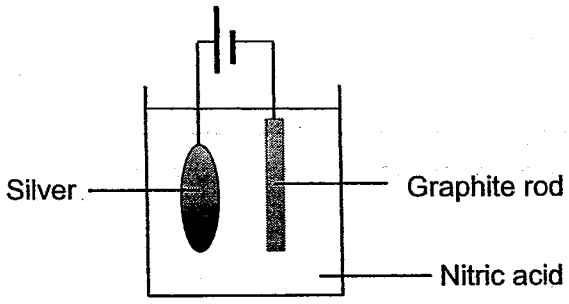
What can be the possible identity of the compound?

A aqueous potassium chloride
B aqueous sulfuric acid
C concentrated magnesium chloride
D molten calcium chloride

31. Which statement is true about the hydrogen-oxygen fuel cell?

A Hydrogen gas is oxidised at the negative electrode to form water.
B Hydrogen gas is reduced at the negative electrode to form water.
C Oxygen gas is oxidised at the negative electrode to form hydroxide ions.
D Oxygen gas is reduced at the negative electrode to form hydroxide ions.

32. An electrolytic cell is set up as shown.



Which of the following will be observed?

A The solution turns blue.

B The graphite rod will be coated with silver.

C Effervescence will be seen at the silver rod.

D Effervescence will be seen at the graphite rod.

33. Useful fractions are obtained by the fractional distillation of petroleum.

Which fraction is correctly matched with its uses?

	Fraction	Use
A	Petrol	Aircraft fuel
B	Bitumen	Car fuel
C	Kerosene	For making roads
D	Liquid Petroleum Gas	For cooking purposes

34. The molecular formula of oleic acid is $C_{18}H_{32}O_2$.

How many C=C bonds are present in one mole of oleic acid?

A 1 **C** 3

B 2 **D** 4

35. The equation for the reaction of a hydrocarbon C_xH_y is shown below.

$$C_xH_y + Br_2 \rightarrow C_xH_{y-1}Br + HBr$$

Which statement is true?

A This reaction is called addition of bromine.

B The brown aqueous bromine will decolourise rapidly.

C This reaction requires UV light.

D C_4H_8 can be a possible identity for the hydrocarbon.

36. Which statement about the homologous series of alcohols is **NOT** true?

A They can be represented by a general formula.

B They have the same empirical formula.

C Their melting points generally increase down the homologous series.

D They can be prepared by the hydration of their corresponding alkenes.

37. An alcohol **X** can react with acid **Y** to form an ester with the formula $C_6H_{12}O_2$.

Alcohol **X** can be oxidised to acid **Y** by heating with aqueous acidified potassium manganate(VII).

What is the structural formula of the ester?

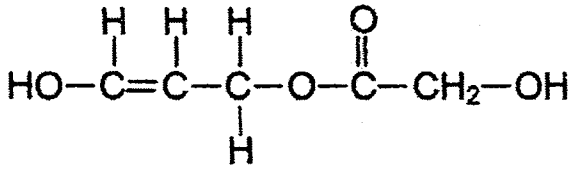
A $C_2H_5COOC_3H_7$

B $HCOOC_2H_5$

C $C_3H_7COOC_3H_7$

D $CH_3COOC_4H_9$

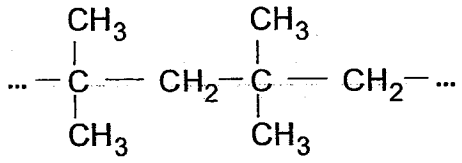
38. An organic compound has the following structure.



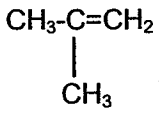
Which of the following correctly shows the reactions of the compound?

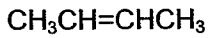
	With aqueous Na_2CO_3	**With aqueous Br_2**	**With acidfied potassium manganate(VII)**
A	Effervescence observed	Turns colourless	Turns colourless
B	Effervescence observed	No visible reaction	Remains purple
C	No visible reaction	Turns colourless	Turns colourless
D	No visible reaction	No visible reaction	Remains purple

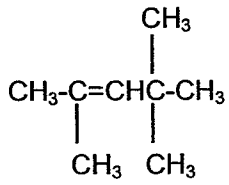
39. Drugs can be administered in patches made from 'pressure-sensitive adhesives' that stick to the skin but are easy to remove. One such pressure-sensitive adhesive has the following structure.

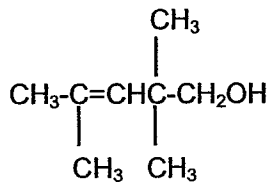


Which monomer could be used to make this polymer?

A 

B 

C 

D 

40. Which physical property does not change during the polymerisation of ethene to form polyethene?

A boiling point

B density

C mass

D relative molecular mass

END OF PAPER ☺

2014 Chemistry Preliminary Examination

Paper 1 Answers & Worked Solutions

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

Class:	Register No:	Name:

CRESCENT GIRLS' SCHOOL
SECONDARY FOUR
PRELIMINARY EXAMINATION 2014

CHEMISTRY

Paper 2

5073/02
19 August 2014
1 hr 45 mins

READ THESE INSTRUCTIONS FIRST
Write your name, index number and class in the spaces provided at the top of this page and on any separate answer paper used.
Write in blue or black pen in the spaces provided on the Question Paper.
You may use a pencil for any diagrams, graphs, or rough working.
You may use a calculator.
All final answers for calculations are to be rounded off to **3 significant figures**.
Do not use staples, paper clips, highlighters, and glue or correction fluid.

A copy of the Periodic Table is printed on page 16.
Section A (50 Marks)
Answer **all** questions.
Write your answers in the spaces provided on the Question Paper.

Section B (30 Marks)
Answer all **THREE** questions from this section.
The last question is in the form of EITHER/OR and only ONE of the alternatives should be attempted.

Begin each question on a **fresh piece of paper.**
Fasten your answers to Section B together.

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

Submit Section A & B separately.

For Examiner's Use	
Section A	
B8	
B9	
B10 EITHER/OR	
Total	80

Section A (50 Marks)

Answer all questions in this section in the spaces provided.

A1 The equations **A**, **B**, **C**, **D** and **E** show some reactions involving compounds of **M**.

A $\mathbf{M}CO_3(s) \rightarrow \mathbf{M}O(s) + CO_2(g)$

B $2\mathbf{M}O(s) + C(s) \rightarrow 2\mathbf{M}(s) + CO_2(g)$

C $\mathbf{M}O(s) + H_2SO_4(aq) \rightarrow \mathbf{M}SO_4(aq) + H_2O(l)$

D $\mathbf{M}SO_4(aq) + 2NaOH(aq) \rightarrow \mathbf{M}(OH)_2(s) + Na_2SO_4(aq)$

E $\mathbf{M}(OH)_2(s) + 2HCl(aq) \rightarrow \mathbf{M}Cl_2(aq) + 2H_2O(l)$

Use the letters **A**, **B**, **C**, **D** and **E** to answer the following questions.

(a) Which equation shows a change in the oxidation state of **M**?

_____ [1]

(b) Two of the reactions are exothermic reactions. Give the letters for the equations of these reactions.

_____ [1]

(c) When reaction **D** is carried out, a blue precipitate which is insoluble in excess aqueous sodium hydroxide is observed.

State the expected observation when aqueous ammonia is added dropwise in excess into a portion of aqueous $\mathbf{M}SO_4$.

_____

_____ [2]

[Total: 4]

A2 The melting points of the oxides of the third period elements are given below.

Compound	Na_2O	MgO	Al_2O_3	SiO_2	P_2O_3	SO_2	Cl_2O
Melting Point/ °C	1275*	2800	2045	1700	24	-73	-20

sublimation occurs

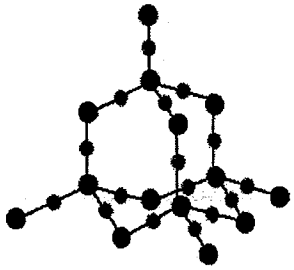
(a) Dichlorine monoxide, Cl_2O, has a low melting point of -20 °C.

Draw a 'dot-and cross' diagram to show the bonding in dichlorine monoxide.

You only need to show the outer shell electrons.

[2]

(b) Silicon dioxide has a structure as shown below.



Explain, in terms of bonding and structure, why the melting point of silicon dioxide is higher than that of dichlorine monoxide.

_____

_____

_____

_____ [3]

(c) A scientist discovered a new element, **Y**, which can also be placed in Period 3. Oxide of **Y** has a melting point of -95 °C.

Using your understanding of bonding and structure, indicate with a (✓) whether the statements are true or false.

	True	False
Oxide of **Y** can conduct electricity when molten.		
Oxide of **Y** is a crystalline solid at room temperature.		
Oxide of **Y** can be dissolved in an organic solvent.		
Oxide of **Y** can be used as a refractory material that lines the inner surface of blast furnace.		

[2]

[Total:7]

A3 The table below shows results from a laboratory investigation on the rate of decomposition of 50 cm^3 of aqueous hydrogen peroxide into water and oxygen using 0.5 g of powdered manganese(IV) oxide as catalyst.

Experiment	Concentration of aqueous hydrogen peroxide (mol/dm^3)	Initial temperature (°C)	Time to collect 20 cm^3 of oxygen (s)
A	0.1	25	200
B	0.2	25	100
C	0.3	25	65
D	0.4	25	50

(a) **(i)** State the trend in the results shown above.

_____

_____ [1]

(ii) Use ideas about collisions between particles to explain the trend stated in **(a)(i)**.

_____

_____

_____ [2]

(b) Predict the time taken to collect 20 cm^3 of oxygen when 0.6 mol/dm^3 of hydrogen peroxide is used. Use the results in the table to explain your answer.

_____

_____

_____ [2]

(c) A student wants to investigate what the result will be if **no** catalyst is added into 0.1 mol/dm^3 of aqueous hydrogen peroxide.

(i) State whether the expected result will show a shorter or longer time compared to when a catalyst is used.

_____ [1]

(ii) Use collision theory to explain the expected result when no catalyst is added into the aqueous hydrogen peroxide.

_____

_____

_____ [2]

(d) Another student wants to investigate if surface area of catalyst will affect the result.

Describe clearly the experimental procedures and expected results for the investigation. Explain the expected results.

_____

_____

_____

_____

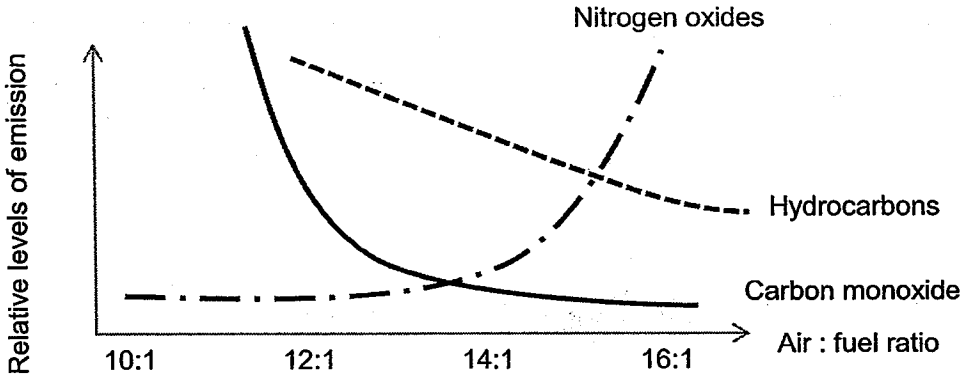
_____

_____ [3]

[Total: 10 marks]

A4 Most vehicles are operated using either petrol engine or hydrogen fuel cell.

For vehicles which are run by petrol engine, air : fuel ratio in the engine plays an important role to determine the relative levels of emission of different air pollutants as shown in the diagram given below.



(a) Use the information from the diagram to show that lesser pollutants are released when petrol is burnt in excess oxygen.

_____

_____ [1]

(b) Suggest why the level of nitrogen oxides increases when the air : fuel ratio is greater than 14:1.

_____

_____

_____ [2]

(c) The diagrams below show the substances that enter and leave vehicles that use petrol engines and fuel cells.

In petrol engine	Petrol and air → Combustion chamber → Catalytic converter → **X**, N_2, CO_2
In fuel cell	H_2 and O_2 → Fuel Cell → **X**

(i) Identify the unknown substance, **X**.

_____ [1]

(ii) Write a balanced chemical equation to show one reaction that occurs in the catalytic converter to produce two of the waste gases shown in the flowchart.

_____ [1]

(iii) The release of carbon dioxide by the petrol engine vehicles to the air causes global warming. Explain how fuel cell can also contribute to global warming.

_____

_____ [1]

(d) Brazil uses ethanol as fuel to run their vehicles. The ethanol is obtained from fermentation of sugarcane juice.

Explain how ethanol fuel helps to maintain the level of carbon dioxide in air.

_____

_____

_____ [2]

[Total: 8 marks]

A5 Ammonia is made in the Haber Process by the reaction involving nitrogen and hydrogen as shown in the equation below.

$$N_2 + 3H_2 \rightleftharpoons 2NH_3 \qquad \Delta H = -92 \text{ kJ/mol}$$

The table below shows some bond energies.

Bond	Bond Energy (kJ/mol)
$3H_2 \rightarrow 6H$	+1308
$2N + 6H \rightarrow 2NH_3$	-2346

(a) Use the information given above to answer the following questions.

During the Haber Process, two types of bond breaking occur.
One type of bond breaking can be illustrated by the following equation,

$$N_2 \rightarrow 2N$$

Write the equation that represents another bond breaking and bond formation process that occur.

Bond breaking: _____

Bond formation: _____ [2]

(b) Hence, using the information provided and your answer to **(a)**, calculate the bond energy of $N_2 \rightarrow 2N$.

[2]

(c) In the Haber Process, a mixture of ammonia gas, nitrogen and hydrogen enters a condenser. Only ammonia gas condenses to form liquid ammonia. The other gases do not.

State whether the boiling point of ammonia is higher or lower than that of nitrogen and hydrogen.

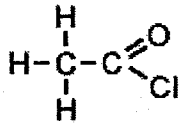
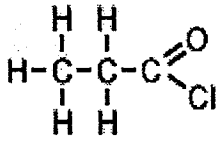
[1]

(d) Explain by using oxidation state, why the making of ammonia by Haber Process is a redox reaction.

[2]

[Total: 7 marks]

A6 Some members of the homologous series of acyl chlorides are given below.

Name of acyl chloride	**Full structural formula of acyl chloride**
Ethanoyl chloride	
Propanoyl chloride	
Butanoyl chloride	

(a) Complete the table above by drawing the full structural formula of butanoyl chloride. [1]

(b) State the general formula for acyl chlorides.

_____ [1]

(c) Ethanoyl chloride can also react with methanol to form an ester and another product.

(i) Write a balanced chemical equation for the reaction by drawing full structural formulas for the reactants and products formed.

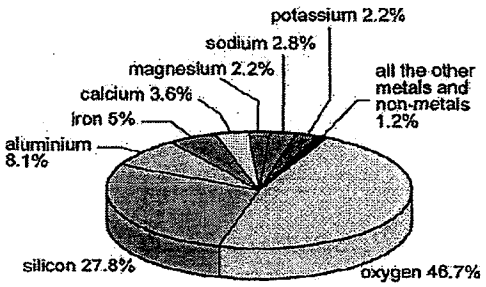
[2]

(ii) Name the ester formed.

_____ [1]

[Total: 5 marks]

A7 The pie chart below shows the percentage abundance of elements in the Earth's crust.



(a) There are many oxides present in the Earth's crust. Explain how the pie chart above shows that the statement is true.

_____ [1]

(b) Suggest a reason why there is a very low percentage of non-metals in the Earth's crust.

_____ [1]

(c) Iron exists in the crust as oxides. A sample of 116 g of iron oxide is found to contain 84 g of iron.

Determine the empirical formula of this oxide.

[3]

(d) There is a high demand for both aluminium and iron in the industry and the percentage of abundance of aluminium is higher than that of iron.

Iron is obtained from the reduction of iron oxide by carbon.

(i) State clearly the method used to extract aluminium from its oxide.

_____ [1]

(ii) Price of aluminium per kilogram is greater than that of iron for the same mass. Explain why this is so.

_____

_____ [1]

(e) A piece of block is made up of an alloy of aluminium and iron. The block is then coated with a thin layer of aluminium around it to prevent rusting.

Explain how prevention of rusting is possible by coating a layer of aluminium around iron block.

_____

_____ [1]

[Total: 8 marks]

Section B

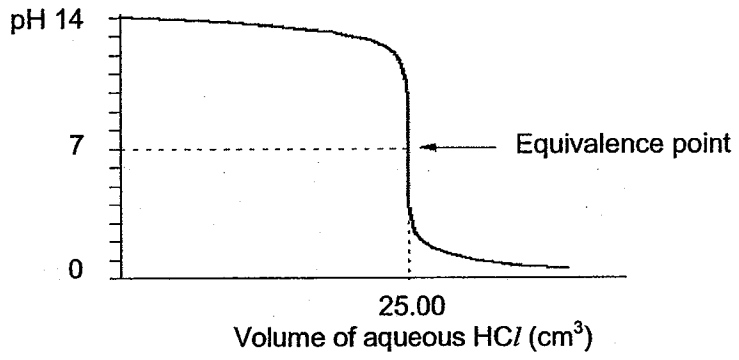
Answer all **three** questions in this section.
The last question is in the form of an either/or and only **one** of the alternatives should be attempted.
Write your answers on the writing paper provided.

B8 A pH datalogger measures pH changes during some titration experiments.

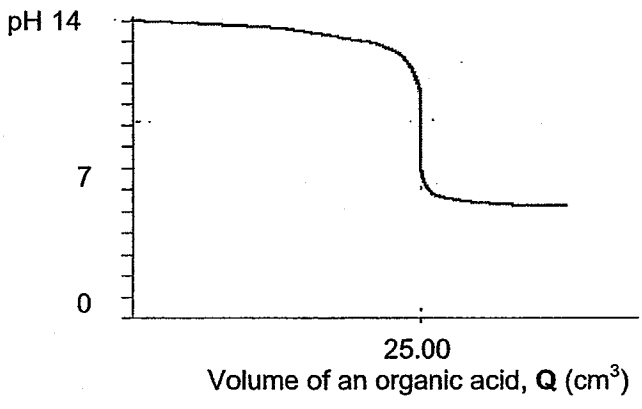
In **Experiment 1**, dilute hydrochloric acid was added from a burette to 20.0 cm^3 of 0.2 mol/dm^3 aqueous sodium hydroxide. The equivalence point of the reaction is at pH=7.

Equivalence point of a titration is reached when the reactants have just reacted or neutralised each other according to the stoichiometric ratio given by the balanced equation of the reaction.

Graph 1: Experiment 1



Graph 2: Experiment 2



Experiment 2 is carried out by titrating a weak organic acid, **Q**, of concentration 0.2 mol/dm^3 with a solution of sodium hydroxide of the same concentration as that used in **Experiment 1**.

(a) Use the information given to calculate the concentration of hydrochloric acid used in **Experiment 1**. [2]

(b) State the equivalence point for **Experiment 2**. [1]

(c) It is given that the weak organic acid, **Q**, is ethanol and that it dissolves in water according to the chemical equation given below.

$$CH_3CH_2OH\ (aq) \rightleftharpoons CH_3CH_2O^-\ (aq) + H^+\ (aq)$$

Explain why ethanol is considered to be a weak organic acid.

Use the information provided in graph 2 to support this. [2]

(d) Write a balanced chemical equation for the reaction between ethanol and magnesium. [2]

(e) A list of indicators with the pH range at which it changes colour is given.

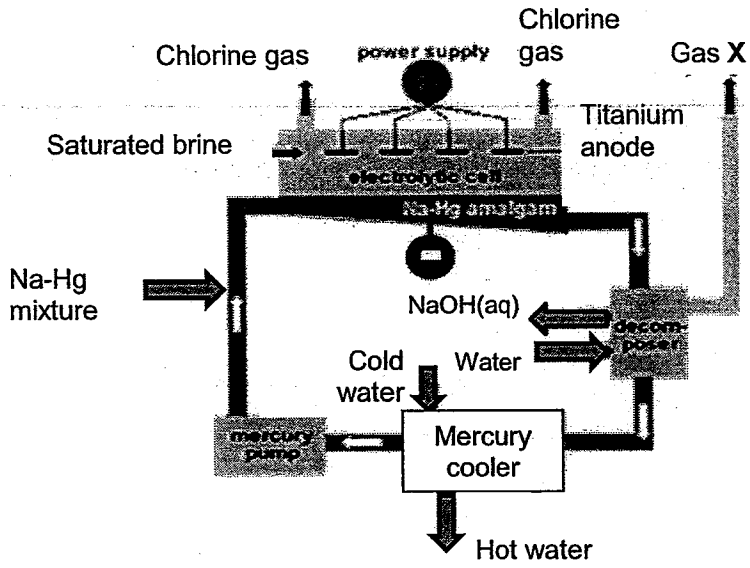
Indicator	Colour Change	pH range at which colour change occurs
Bromthymol blue	Yellow - blue	6.0 - 7.6
Litmus	Red - blue	5.0 - 8.0
Methyl orange	Red - orange	3.1 - 4.4
Phenolpthalein	Colourless - red	8.2 - 9.8
Thymol blue	Red - yellow	1.2 - 2.8

(i) Identify two suitable indicators that should be used to distinguish the equivalence point obtained for **Experiment 1 and 2**.
Reference to the type of experiments should be given in your answers. [2]

(ii) Explain your reasoning for the indicators that you have chosen. [1]

[Total: 10 marks]

B9 Castner-Kellner cell can be used to perform electrolysis of brine. Brine is saturated sodium chloride solution.



In the Castner-Kellner cell, the cathode is the mercury that flows along the bottom of the cell.

Chlorine gas is produced at the anode whereas solid sodium is produced at the cathode.

Sodium dissolves in the liquid mercury to form Na-Hg amalgam. The amalgam flows into the decomposer. In the decomposer, the amalgam reacts with water to form sodium hydroxide and gas **X**. Mercury is released here.

(a) Write a half ionic equation with state symbols to show the formation of chlorine gas. [1]

(b) Describe a simple test to show that the gas produced is chlorine. [2]

(c) Calculate the mass of solid sodium formed when 7200 dm^3 of chlorine gas forms at the anode. [2]

(d) Identify gas **X** and write a balanced chemical equation to show the reaction that occurs in the decomposer. [2]

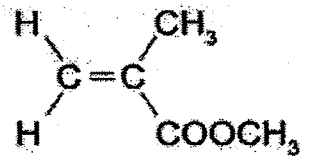
(e) Explain why there is a need to pump the mercury back through the cell. [1]

[Total: 8 marks]

B10
Either

(a) Plastic packaging provides excellent protection for many products. Traditional plastics are manufactured from oil, coal and natural gas and are cheap to manufacture.

An example of plastic that is commonly used is Perspex. Perspex is a polymer that is made up of the joining of large number of methyl-2-methylpropenoate.
The molecular structure of the methyl-2-methylpropenoate is shown below.



Methyl-2-methylpropenoate

(i) State one advantage and one disadvantage of using plastics such as Perspex. [2]

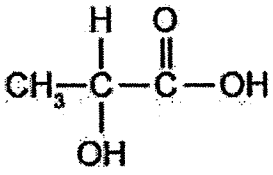
(ii) Draw the structure of Perspex, showing two repeat units. [1]

(iii) A manufacturer controls the average relative molecular mass of Perspex in the range of 24 000 to 30 000.

What is the range of the average number of repeat units in the Perspex? Show your working. [3]

(b) In recent years, there have been efforts made to produce plastics from natural plant polymers. To manufacture these plastics, starch that is harvested from corn or wheat will then be transformed into lactic acid by micro-organisms. Lactic acid will join together to form a polymer known as polyactide.

The molecular structure of lactic acid is shown below.



Lactic acid

(i) List TWO advantages of using plastics manufactured from natural plant polymers. [2]

(ii) Draw the structure of polyactide, showing two repeat units. [1]

(iii) Name one natural polymer that has the same linkage as polyactide. [1]

(c) State two differences between the formation of Perspex and polyactide. [2]

[Total: 12 marks]

B10 Or Group I and Group VII elements show trends in their melting points and boiling points.

	Element	Melting point /°C	Boiling point/°C
Group I	Lithium	180	1330
	Sodium	97.8	890
	Potassium	64	774
Group VII	Chlorine	-101	-35
	Bromine	-7	59
	Iodine	114	184

(a) **(i)** State the trends observed in the melting points and boiling points of Group I elements. [1]

(ii) In terms of bonding and structure, explain the trend stated in **(a) (i)** [2]

Explain why all group 1 elements are solid at room temperature. [1]

(b) When group I metals tarnish in air, different types of oxide are formed.

Element	Oxides formed	Formula
Lithium	Lithium oxide	Li_2O
Sodium	Sodium oxide	Na_2O
	Sodium peroxide	Na_2O_2
Potassium	Potassium superoxide	KO_2
Rubidium	Rubidium superoxide	RbO_2

State the formulae of the

(i) peroxide ion and

(ii) superoxide ion [2]

(c) A scientist discovered a new Group VII element, **Z**, which is a solid at room temperature with a melting point of 135 °C.

(i) Where would you place element **Z** in the Periodic Table? Using the information from the table, explain your answer. [3]

(ii) Describe a simple test that you can carry out by using aqueous Z_2, to determine the relative reactivity of element **Z** compared to iodine. [3]

[Total: 12 marks]

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
– Fr francium 87	– Ra radium 88	– Ac actinium 89 †	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

*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 / X / b

a = relative atomic mass

X = atomic symbol

b = proton (atomic) number

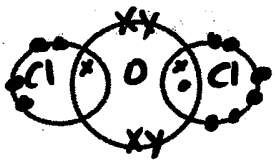
CRESCENT GIRLS' SCHOOL
SECONDARY FOUR
CHEMISTRY PRELIMINARY EXAMINATION 2014
MARK SCHEME

A1 **(a)** B ;

(b) C and E ;
One correct [0]

(c) **Blue precipitate** forms. ;
The blue precipitate **dissolves** to form **dark blue solution** when excess aqueous ammonia is added. ;

A2 **(a)**



Correct no. of electrons shared;

Correct no. of valence electrons in the shells;

(b) Silicon dioxide has a **giant covalent structure** with **strong covalent bonds** between the atoms. ;

Dichlorine monoxide has a **simple molecular structure** with **weak intermolecular force of attraction.** ;

A lot of energy is required to break the strong covalent bonds in silicon dioxide, hence silicon dioxide has a higher melting point than dichlorine monoxide. ;
OR OR
Less energy is required to overcome the weak intermolecular force of attraction in dichlorine monoxide. ;

(c)

True	False
	✓
	✓
✓	
	✓

All correct;;

2-3 correct;

1-correct [0]

A3 **(a)** (i) As the **concentration of aqueous hydrogen peroxide increases**, the **time taken** to collect 20 cm^3 of oxygen **decreases.** ;

(ii) As concentration of hydrogen peroxide increases, ;
increase in number of particles per unit volume. ;
Thus **increase frequency of effective collisions between the reacting particles** will increase speed of reaction.

(b) 32.5s. ;

When **concentration of aqueous hydrogen peroxide is doubled, time taken to collect 20 cm^3 of oxygen is halved.** Thus, when 0.6 mol/dm^3 of hydrogen is used, time taken is half of that when 0.3 mol/dm^3 of solution is used. ;

(c) Time taken will be longer. ;

- When no catalyst is used, the **activation energy is high.**
- **Less number of particles with energy greater or equals than activation energy to react.**
- Thus, **Increase frequency of effective** collisions.

3 points mentioned;;
1-2 points mentioned;

(d)

1) Measure **0.5 g of lumps of manganese(IV) oxide** and add **into 50 cm^3 of 0.1 mol/dm^3 of aqueous hydrogen peroxide solution**
2) **Record the time taken to collect 20 cm^3** of oxygen.
3) The **time taken will be longer than 200s** or when powdered catalyst is used.
4) Lumps of manganese(IV) oxide has **smaller surface area and thus lower frequency of effective collisions** between the reacting particles. Speed of reaction is slower.

4 points mentioned;;

3-2 points;

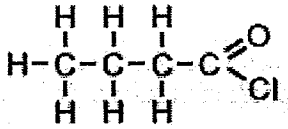
1point Mentioned [0]

A4 **(a)** Amount of oxygen is in excess as the **air: fuel ratio increases**. This results in the **relative level emission of carbon monoxide and hydrocarbons to decrease.** ;

(b) **High in air: fuel** results in **complete combustion** which will then result in large amount of energy released. ;

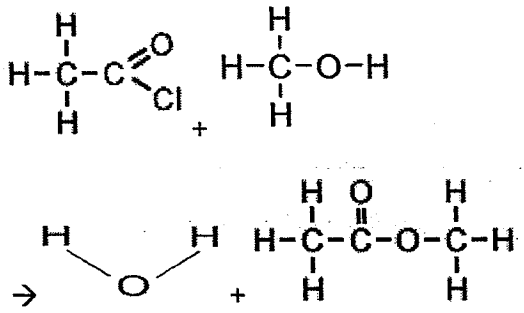
More energy is given out to break the strong triple covalent bonds in N_2 ;
OR
More energy results in **more nitrogen reacts with the oxygen to form oxides of nitrogen** ;

(ci) **X** is water

	(cii)	$2NO + 2CO \rightarrow N_2 + 2CO_2$ Or other relevant chemical reactions that produce nitrogen, carbon dioxide and water.	;
	(ciii)	The **process** to obtain hydrogen such as 1) **Hydrolysis of water** or 2) **Water is a greenhouse gas that contributes to global warming.** 3) From **catalytic cracking of petroleum at high temperature**	
		Releases carbon dioxide when fossil fuel is burnt to provide energy.	One complete answer with mention of source and name of pollutant;
	(d)	Ethanol **burns to release carbon dioxide**, the **carbon dioxide released will be removed from air by photosynthesis carried out by sugarcane plants (which are planted for sugar-highlight in class).** There is **no net gain or loss of carbon dioxide** in air.	3 points mentioned;; 1-2 points mentioned;
A5	**(a)**	Bond breaking: $3H_2 \rightarrow 6H$	;
		Bond formation: $2N + 6H \rightarrow 2NH_3$	;
	(b)	Let x be the bond energy for $N_2 \rightarrow 2N$	
		$x + 1308 - 2346 = -92$	;
		$x = 946$ **kJ/mol**	; Penalise for no unit
	(c)	Boiling point of ammonia is **higher.**	
	(d)	Nitrogen is reduced to ammonia as the **oxidation state of nitrogen decreases from 0 in N_2 to -3 in NH_3**	;
		Hydrogen is oxidised to ammonia as the **oxidation state of hydrogen increases from 0 in N_2 to +1 in NH_3** Oxidation and reduction occur simultaneously.	;
A6	**(a)**		Correct drawing of ester linkage;
	(b)	$C_nH_{2n+1}COCl$	;

(c)

(i)



Correct structure methanol and water;
Correct structure for ester;

(ii) Methyl ethanoate ;

A7 (a) There is a high percentage of **metals in the crust which can oxidise in air** and exist as oxide of metals. ;

(b) Non-metals and their oxides mainly exist as **liquid or gas.** ;

(c)

	Fe	O
Mass(g)	84	116-84 =32
No. of moles	84/56 =1.5	32/16 =2 ;
Ratio	3	4 ;

Empirical formula = Fe_3O_4 ;

(d)
(i) Electrolysis of molten aluminium oxide. ;
(ii) Extraction of aluminium is done by electrolysis which requires a **larger amount of electrical energy** and heat energy to decompose the oxide to form aluminium. ;

(e) The layer of aluminium will oxidise to form **aluminium oxide** which is **impervious to air and water.** ;

Thus, prevent the rusting of iron in the block.
OR

Aluminium is **more reactive than iron** and thus, it oxidises readily to form **aluminium oxide that is impervious to air and water.**
OR
Aluminium is **more reactive than iron** and thus, **aluminium will be preferentially oxidised.** Iron will not be oxidised and hence, will not undergo rusting.

B8 (a) No. of moles of NaOH= 0. 2x (20/1000) = 0.004 mol ;

No. of moles of HCl = 0.004 mol

Concentration of HCl = 0.004/(25/1000) = 0.160 mol/dm^3 ;

(b) pH=9. ;

(c) Ethanol **dissociates partially in water** to form **hydrogen ions.**

(Evidence) In graph 2, when **excess ethanol** is added, the **pH of the resulting solution is 6.**

(d) $Mg + 2CH_3CH_2OH \rightarrow (CH_3CH_2O)_2Mg + H_2$ Correct formulae for all; Equation is balanced;

(e) ;

(i) Experiment 1: bromthymol blue and Experiment 2: phenolpthalein ;;

(ii) The indicators chosen have their **colour changes occur close to the end-point** of the chemical reactions. Thus, provide a more accurate result. ;

B9 **(a)** $2Cl^-(aq) \rightarrow Cl_2(g) + 2e^-$;

(b) Test the gas with **moist blue litmus.** ;
If it turns **red and then bleaches**, the gas is chlorine. ;

(c) $2Cl^-(aq) \rightarrow Cl_2(g) + 2e^-$

$Na^+(aq) + e^- \rightarrow Na(s)$

Ratio of no. of moles chlorine: electrons: sodium= 1:2:2

No. of moles of chlorine gas = 7200/24=300 mol ;
No. of moles of electrons = 300 x 2 = 600 mol
Mass of Na= 600 x 23 = 13 800 g ;

(d) Gas **X** is hydrogen. ;

$2Na + 2H_2O \rightarrow 2NaOH + H_2$;

(e) To conserve the finite resource of mercury. ;

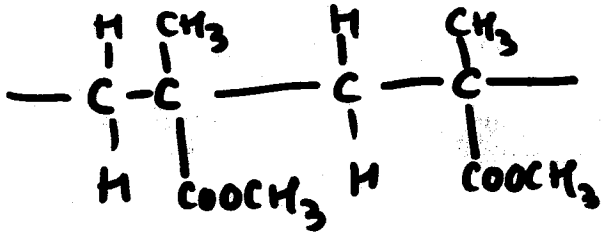
B10
Either

(a) **(i)** Advantage: It is durable. ; Reject cheap

Disadvantage: ;

1) It will cause shortage of land available to hold items that are non-biodegradable.
2) It produces toxic gases when burnt

(ii) Perspex



Two repeat units are correctly shown;

(iii) Mr of Perspex = 5x12 + 8 + 2 x16 = 100 ;

Minimum no. of repeat units = 24 000/100 = 240 ;

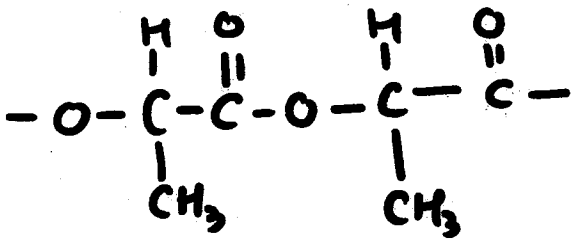
Maximum no. of repeat units = 30 000/100 = 300

Average range is 240 to 300. ;

(b)

(i) 1) Plastics made from plants are non-biodegradable. ;
2) Plants are renewable source. ;

(ii) polyactide



Two repeat units are correctly drawn with ester linkage shown;

(iii) Fats ;

(c)

1) Only Perspex is formed during its formation. Polyactide is formed together with another product.

2) No mass loss during the formation of Perspex whereas there is mass loss during formation of polyactide.

		3) There are loss of small molecules in the formation of polyactide but no loss of small molecules in the formation of Perspex.	
		4) Perspex is formed by addition polymerisation whereas polyactide is formed by condensation polymerisation.	Any 2 correct answers;;
	(e)	Mr of Perspex = 5x12 + 8 + 2 x16 = 100	;
		Minimum no. of repeat units = 24 000/100 = 240	;
		Maximum no. of repeat units = 30 000/100 = 300	
		Average range is 240 to 300.	;
B10 Or	**(a)**	(i) Down Group I, the melting point and boiling decreases.	;
	(a)	(ii)	3 correct points mentioned;; 1-2 correct points mentioned;
		1. Group I elements are metals with **metallic structure.**	
		2. As the Group 1 atomic radius increases down the group, the **electrostatic force of attraction between the metals ions and sea of delocalised electrons gets weaker./ metallic bonds get weaker**	
		3. **Less energy** is required to break the metallic bonds.	
		(iii)Their melting points are above room temperature.	;
	(b)	(i) O_2^{2-}	;
		(ii) O_2^-	;
	(c)	(i) Below iodine.	;
		Element **Z** has melting point greater than iodine.	;
		Since the melting point of Group VII increases down the group, element **Z** should be placed below iodine.	;
		(ii) Equal volume of aqueous $\mathbf{Z_2}$ is added to a certain volume of aqueous **potassium iodide.**	;
		If the **colourless potassium iodide turns reddish brown,** it indicates that $\mathbf{Z_2}$ is **more reactive** than iodine.	Colour change is described clearly;
		If the colourless potassium iodide remains unchanged for certain period of time, element Z is less reactive than iodine.	Correct deduction;