Class.	Register No	Name.

CRESCENT GIRLS' SCHOOL
SECONDARY FOUR
PRELIMINARY EXAMINATION 2015

CHEMISTRY 5073/01
31 August 2015
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**

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	188 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

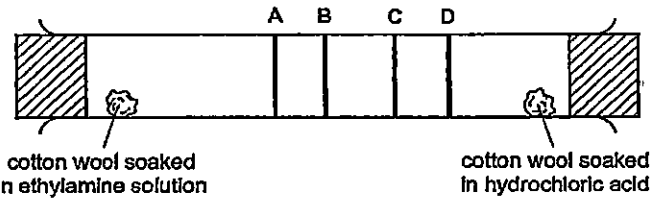
†90-103 Actinoid series

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

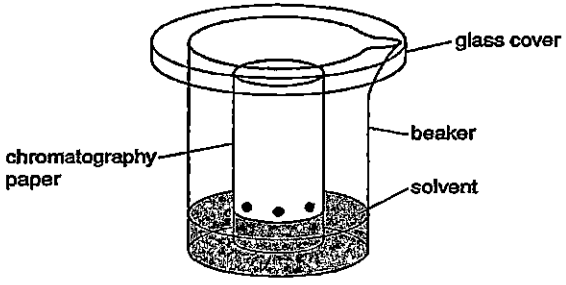
Key: a / X / b — a = relative atomic mass; X = atomic symbol; b = proton (atomic) number

1 Ethylamine gas, $C_2H_5NH_2$, and hydrogen chloride gas, HCl, react together to form a white solid, ethylamine hydrochloride.

At which position in the tube would a ring of solid white ethylamine hydrochloride form?



2 Amino acids are colourless and can be separated and identified by chromatography as shown



What additional apparatus and/or chemical is/are required to calculate the R_f value of the amino acids present in a mixture?

A a ruler

B a locating agent

C a ruler and a locating agent

D neither a ruler nor a locating agent

3 In which pair do neither of the gases change the colour of moist blue litmus paper?

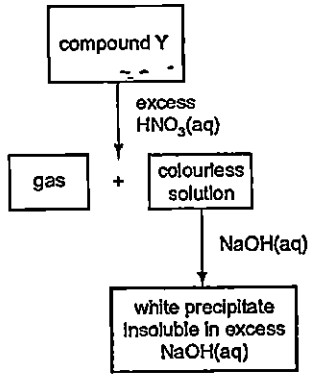
A ammonia and hydrogen

B ammonia and hydrogen chloride

C carbon dioxide and chlorine

D carbon dioxide and sulfur dioxide

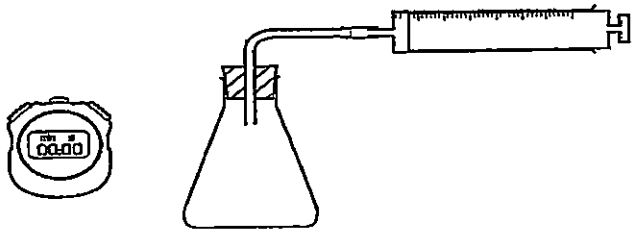
4 The scheme shows a sequence of reactions starting from compound Y



What could compound Y be?

A aluminium hydrogencarbonate
B calcium carbonate
C copper(II) carbonate
D zinc carbonate

5 The apparatus shown can be used to find the rate of some chemical reactions



The rate of which reaction can be followed using this apparatus?

A Mg + HCl
B $AgNO_3$ + KI
C NaOH + HCl
D NaOH + $CuSO_4$

6 Naturally-occuring bromine has a relative atomic mass of 80 and consists entirely of two isotopes of relative atomic masses 79 and 81

What can be deduced about naturally-occuring bromine from this information only?

A Bromine is radioactive

B Bromine has different oxidation states

C Bromine isotopes have different number of protons

D Bromine contains the two isotopes in equal proportions.

7 An ion X^{2-} has **m** nucleons and **n** electrons

What does the nucleus of an atom **X** contain?

	number of protons	number of neutrons
A	n – 2	m – n
B	n – 2	m – (n – 2)
C	n + 2	m – (n – 2)
D	n + 2	m – (n + 2)

8 Both magnesium oxide, MgO, and aluminium oxide, Al_2O_3, are solids at room temperature of 25 °C

The table below shows their melting and boiling points

	melting point (°C)	boiling point (°C)
MgO	2852	3600
Al_2O_3	2072	2880

Over which temperature range will both pure compounds conduct electricity?

A 25 °C to 2852 °C

B 2072 °C to 2852 °C

C 2852 °C to 2880 °C

D 2880 °C to 3600 °C

9 The structure of metals consists of positive ions in a 'sea of electrons'.

Which statement correctly describes what happens to the particles in the metallic heating element of an electric kettle when the kettle is switched on?

A Electrons move in both directions in the element.

B Electrons move in one direction only in the element.

C Positive ions move in one direction only in the element.

D Electrons move in one direction and positive ions move in the opposite direction in the element.

10 In the lattice structure of ionic compounds, coordination number is the number of nearest neighbour ions of opposite charge For instance, in sodium chloride, each Na^+ ion is surrounded by 6 Cl^- ions and each Cl^- ion is surrounded by 6 Na^+ ions Therefore, coordination number of Na^+ and Cl^- ions is 6.

The table below shows the ions present and the coordination number of the ions in some ionic compounds

compound	ions present		coordination number of		formula
	cation	anion	cation	anion	
sodium chloride	Na^+	Cl^-	6	6	$NaCl$
titanium(IV) oxide	Ti^{4+}	O^{2-}	6	3	TiO_2
P	Q	R	4	8	?

What is the formula of compound P?

A QR_2 B Q_2R

C QR_4 D Q_4R

11 Silicon carbide, SiC, has a structure similar to diamond. Boron nitride, BN, has a structure similar to graphite Bronze is an alloy of copper and tin

Which statements about SiC, BN and bronze are correct?

1 All are bonded covalently.
2 All have high melting and boiling point.
3 All except bronze are soluble in organic solvent.
4 All except silicon carbide conduct electricity when solid

A 1 and 2 B 2 and 3

C 2 and 4 D 3 and 4

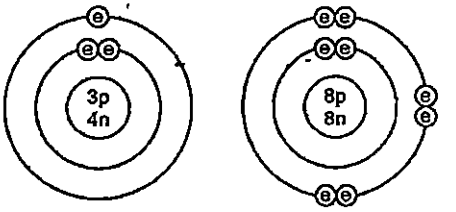
12 One volume of gaseous element X_2 reacts with an equal volume of gaseous hydrogen to form two volume of a gaseous hydride

What is the formula for the hydride of X?

A HX B HX_2

C H_2X_2 D H_2X

13 The diagram shows the stuctures of the atoms of elements Y and Z.



Y Z

Elements Y and Z react to form a compound

What is the mass of one mole of this compound?

A 11 g B 12 g

C 23 g D 30 g

14 An equal number of moles of two chemical compounds, R and S, are given

The chemical formulae of these two substances, R and S, are shown below

R $NaAlSi_3O_8$

S $CaAl_2Si_2O_8$

Which statements are incorrect?

1 R and S contain the same number of moles of oxygen

2 Both R and S have the same percentage by mass of oxygen.

3 The percentage by mass of aluminium in S is twice the percentage by mass of aluminium in R

A 1 and 2 B 1 and 3

C 2 and 3 D 1, 2 and 3

15 Four students prepared hydrated copper(II) sulfate by adding an excess of dilute sulfuric acid to copper(II) oxide Each student used a different mass of copper(II) oxide

$$\underset{Mr = 80}{CuO} \xrightarrow{\text{dilute sulfuric acid}} \underset{Mr = 250}{CuSO_4\,5H_2O}$$

After the copper(II) sulfate had crystallised, the students dried and weighed the crystals

It is known that 1 mole of copper(II) oxide produces 1 mole of hydrated copper(II) sulfate from the reaction

Which student produced the highest percentage yield of hydrated copper(II) sulfate?

	mass of copper(II) oxide used / g	mass of crystal produced / g
A	4 0	11 5
B	8 0	23 5
C	12 0	35 0
D	16 0	46 5

16 20 cm^3 of propyne, C_3H_4, is reacted with 500 cm^3 of oxygen.

The equation for the reaction is shown below.

$$C_3H_4 + 4O_2 \rightarrow 3CO_2 + 2H_2O$$

What is the total volume of gas remaining at the end of the reaction?

(all volumes are measured at room temperature and pressure)

A 60 cm^3 B 100 cm^3

C 480 cm^3 D 520 cm^3

17 Which processes are endothermic?

1 $Cl_2 \rightarrow 2Cl$

2 burning a fossil fuel

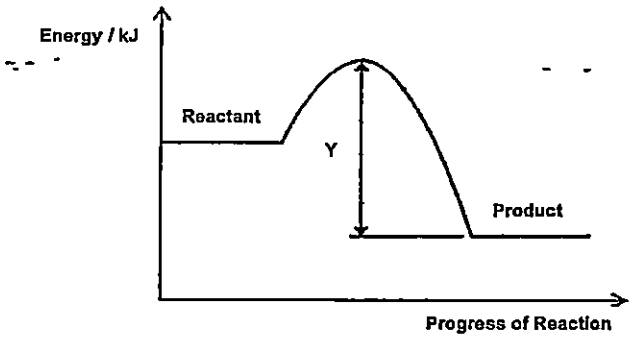
3 obtaining lime (CaO) from limestone ($CaCO_3$)

4 reacting hydrogen with oxygen

A 1 and 2 B 1 and 3

C 2 and 4 D 3 and 4

18 The change in energy during a reaction is represented in the following energy profile diagram



What does Y represent?

A the enthalpy change for the forward reaction

B the activation energy of the forward reaction

C the activation energy for the reverse reaction

D the energy released to form the bonds in the products for the reverse reaction

19 Solutions of hydrochloric acid, HCl and ethanoic acid, CH_3COOH, of the same concentration react completely with 5 0 g of calcium carbonate, $CaCO_3$, in separate containers

Which statement is correct?

A CH_3COOH reacts slower because it has a lower pH than HCl

B A smaller volume of CO_2 is produced with CH_3COOH than with HCl

C A greater volume of CO_2 is produced with CH_3COOH than with HCl

D The same volume of CO_2 is produced with both CH_3COOH and HCl

20 In which reaction does a single nitrogen atom have the greatest change in oxidation number?

A $2NO + O_2 \rightarrow 2NO_2$

B $4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O$

C $4NH_3 + 6NO \rightarrow 5N_2 + 6H_2O$

D $3NO_2 + H_2O \rightarrow 2HNO_3 + NO$

21 Three electrolytic cells are set up Each cell uses inert electrodes

The electrolytes used for each cell are shown in the table below

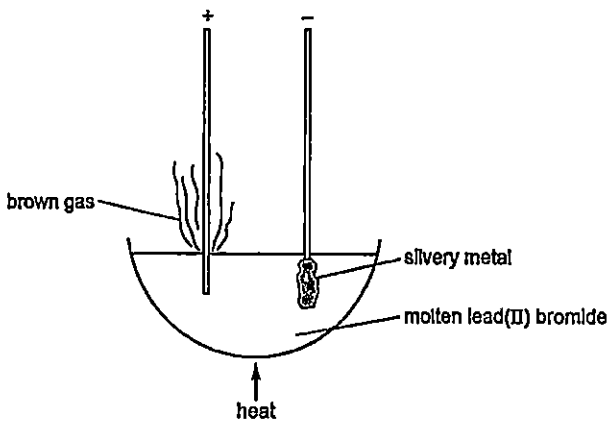
cell 1	concentrated silver chloride solution
cell 2	molten sodium iodide
cell 3	dilute nitric acid solution

In which of these cells is a gas formed at **both** electrodes?

A 1 and 2 B 1 and 3

C 2 only D 3 only

22 The diagram shows the electrolysis of molten lead(II) bromide using inert electrodes



What happens during this electrolysis?

A Ions change to atoms

B Atoms change to Ions

C Covalent bonds are broken

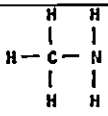
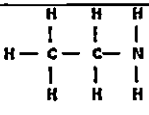
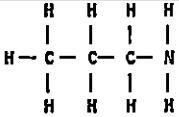
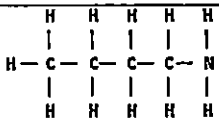
D New compounds are formed

23 The dissociation constant (K_b) for a base indicates the extent to which it dissocates into ions in water The higher the dissociation constant (K_b), the higher the strength of the base

Generally, compounds from amine homologous series form weak bases when dissolved in water For instance, when methylamine is added to water, it ionises partially into methylammonium ion and hydroxide ion as shown in the equation below

$$CH_3NH_2\ (aq) + H_2O\ (l) \rightleftharpoons CH_3NH_3^+\ (aq) + OH^-\ (aq)$$

The dissociation constant (K_b) and full structural formula for the first four members of the amine homologous series are given in the table below

amine	full structural formula	dissociation constant (K_b)
methylamine		4.6×10^{-4}
ethylamine		4.5×10^{-4}
propylamine		3.5×10^{-4}
butylamine		4.0×10^{-4}

Based on the data above, which statement is correct?

A Aqueous methylamine turns Universal Indicator from green to yellow

B Increasing the length of carbon chain increases the strength of the base

C There are more undissociated molecules in a solution of butylamine than that in ethylamine of same concentration.

D Given that the K_b of ammonia = 1.8×10^{-5}, there is a higher concentration of OH^- ions in ammonia solution than that in propylamine of the same concetration

24 Three oxides are added separately to aqueous barium hydroxide

1 lead(II) oxide

2 nitrogen monoxide

3 silicon dioxide

Which oxide(s) react(s) with aqueous barium hydroxide?

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

25 A colourless solution contains three different ions, Ag^+, Ba^{2+} and an unknown anion, Y

What is Y?

A	Cl^-	B	CO_3^{2-}
C	NO_3^-	D	SO_4^{2-}

26 Which two statements indicate metal M may have a proton number between 21 to 30?

1 It conducts electricity

2 It forms two coloured sulfates

3 It forms two basic oxides with formulae MO and M_2O_3.

4 It reacts with steam to form a metal oxide with formula M_3O_4

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

27 Which property would all the hydrogen compounds of the Group VII elements possess?

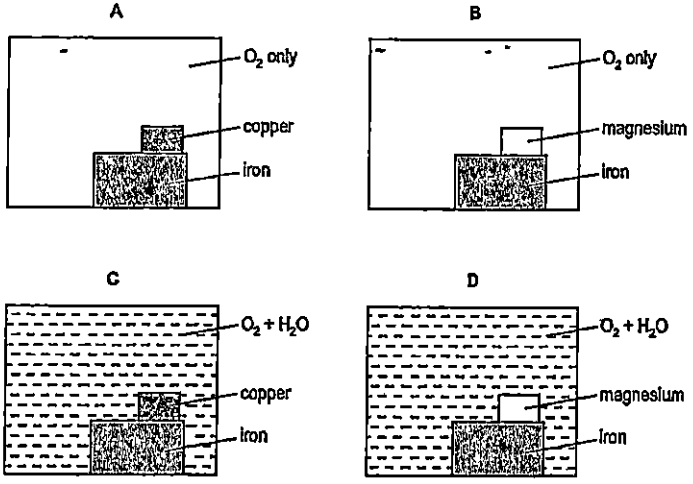
A They are covalent.

B They are solids at room temperature

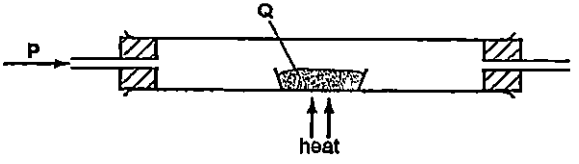
C They conduct electricity when molten

D They form alkaline aqueous solutions

28 Which diagram correctly illustrates how iron is prevented from rusting by sacrificial protection?



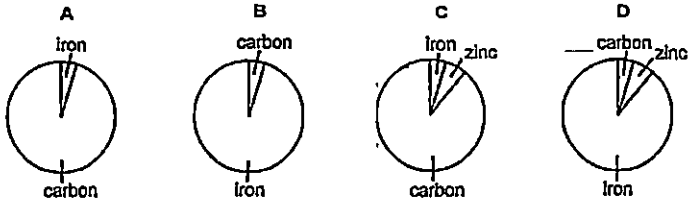
29 In the apparatus shown, gas P is passed over solid Q No visible reaction occurs



Identify gas P and solid Q.

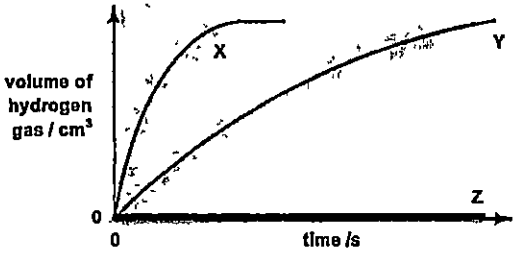
	P	Q
A	hydrogen	zinc oxide
B	hydrogen	iron(II) oxide
C	oxygen	sulfur
D	oxygen	carbon

30 Which chart could represent the composition of a galvanised roof?



31 Three different metals, X, Y and Z, are each added to an excess of dilute hydrochloric acid

The graph shows how rapidly hydrogen gas is given off



Identify metal X, Y and Z.

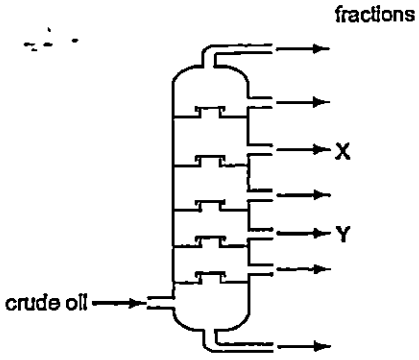
	X	Y	Z
A	Fe	Cu	Ca
B	Ca	Fe	Cu
C	Mg	Pb	Ag
D	Mg	Ag	Pb

32 Which pollutant gas is produced by the decomposition of vegetation?

A CH_4 B CO

C NO D SO_2

33 Crude oil is fractionally distilled in a fractionating column The positions at which fractions X and Y are collected are shown



Which statement is correct?

A X has a higher boiling point than Y.
B X has a longer chain molecules than Y
C The temperature increases up the column
D X condenses at a lower temperature than Y.

34 Which organic compound requires the least oxygen for the complete combustion of one mole of the compound?

A C_3H_8 B C_4H_8
C C_3H_7OH D C_3H_7COOH

35 Which bonds is/are **not** present in methanoic acid?

1 C–C
2 C=C
3 C–O

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

36 With the presence of UV light, 1 mole of propane reacts with 3 moles of chlorine in a substitution reaction

What is the formula of the organic product in this reaction?

A $C_3H_2Cl_6$ B $C_3H_3Cl_5$

C $C_3H_4Cl_4$ D $C_3H_5Cl_3$

37 Arachidonic acid is one of the most abundant polyunsaturated fatty acids in the brain.

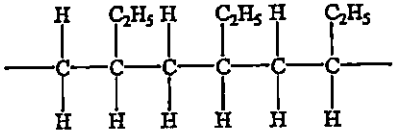
It has a molecular formula of $C_{19}H_{31}COOH$

How many C=C double bonds are present in 1 molecule of arachidonic acid

A 1 B 2

C 3 D 4

38 The diagram shows a section of a polymer



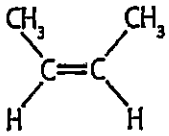
Which statement about this polymer is correct?

A It is a condensation polymer.

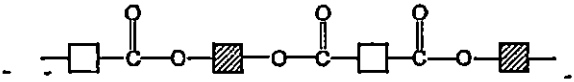
B It decolourises aqueous bromine

C Both the polymer and its monomers have the same empirical formula.

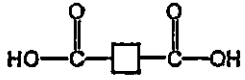
D The structural formula of its monomer is

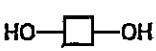
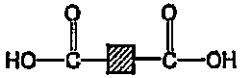


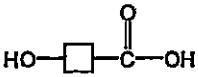
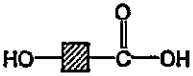
39 The diagram shows the partial structure of Terylene

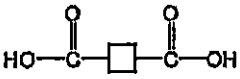
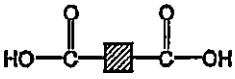


From which pair of monomers is it made?

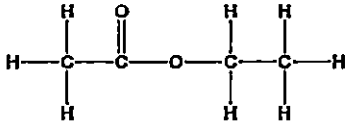
A  + 

B  + 

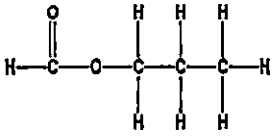
C  + 

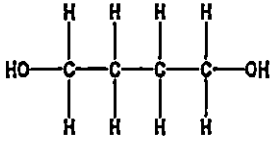
D  + 

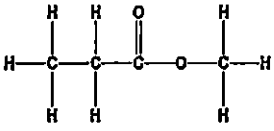
40 The diagram shows the structure of ethyl ethanoate

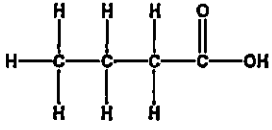


Which structure is not an isomer of ethyl ethanoate?

A 

B 

C 

D 

Crescent Girls' School
Secondary Four
Preliminary Examinations 2015
Chemistry Paper 1 – Worked Solutions

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

CLASS:	REGISTER NO.:	NAME:

CRESCENT GIRLS' SCHOOL
SECONDARY FOUR
PRELIMINARY EXAMINATION 2015

CHEMISTRY

Paper 2

5073/2
20th August 2015
1 hour 45 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

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 pencil for any diagrams or graphs.
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.

Section A (50 Marks)
Answer **ALL** questions in the spaces provided.

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

The number of marks is given in brackets [ ] at the end of each question or part question.
A copy of the Periodic Table is printed on page 17.

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

For Examiner's Use	
Section A	
B6	
B7	
B8 EITHER/OR	
Total	80

This paper consists of 17 printed pages, including the cover page.

Section A

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

A1 The following information is given for the oxides of some elements in Period 3.
The elements are labelled as **W**, **X**, **Y** and **Z**.

Element	Formula of oxide	Melting point/°C	Boiling point/°C	Behaviour of oxide with water	Reaction of oxide with hydrochloric acid
W	WO_2	-72	-10	Dissolves in water to form a solution that turns blue litmus paper red	No reaction
X	XO	2852	3600	Insoluble in water	Reacts with acid
Y	Y_2O	1132	1950	Dissolves in water to form a solution that turns red litmus paper blue	Reacts with acid
Z	Z_2O_3	2072	2977	Insoluble in water	Reacts with acid

Use the information from the table to answer the following questions.

(a) Which element has the highest tendency to gain electrons? Explain your answer. **[2]**

_____

_____

(b) **(i)** Draw a 'dot and cross' diagram to show the bonding in Y_2O. **[2]**
Show the valence electrons only.

A1 (b) (ii) Predict the electrical conductivity of Y_2O in the solid state. Explain your answer. [2]

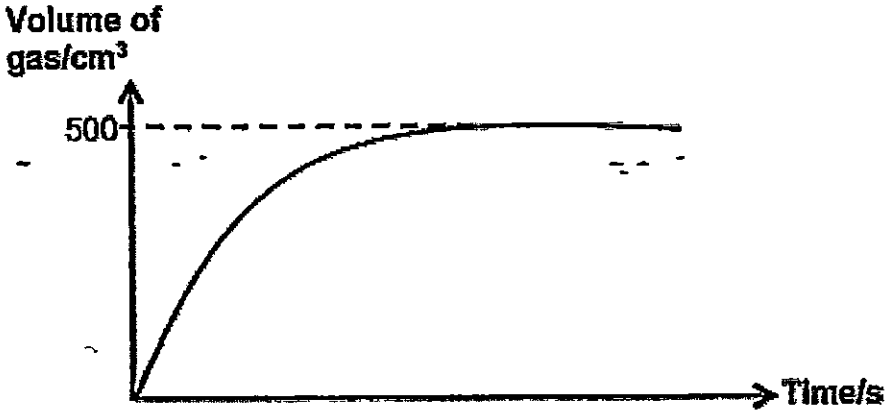
(c) Arrange the elements **W, X, Y, Z** in order of increasing proton numbers [2]

[Total: 8 marks]

A2 (a) During a chemistry experiment, a student added 1.00 g of calcium metal to 25.0 cm^3 of 1.50 mol/dm^3 of nitric acid. The gas evolved from the reaction was collected and measured over fixed intervals until the reaction is completed. [3]

Calculate the total volume of gas expected to be collected at the end of the reaction.

A2 (b) At the end of the experiment, a graph of volume of gas collected against time was plotted and shown below.



Suggest a reason for the difference between the actual volume of gas obtained and the theoretical volume calculated in (a). [1]

(c) The student intends to repeat the experiment using sulfuric acid. Other than mass, suggest one other important factor regarding the metal reagent that needs to be kept constant in order to ensure that a fair second experiment was conducted. [2]

Explain your answer.

(d) Given that the volume and concentration of acid and mass of calcium metal used for the second experiment is kept the same as the first experiment, sketch the expected graph on the same axes and label the graph as (d). [2]

(e) Explain the shape of your graph in (d). [3]

[Total: 11 marks]

A3 The Ostwald Process is a chemical process for manufacturing nitric acid, HNO_3. It is done via two stages.

The chemical equation below illustrates the redox reaction that occurs in Stage One.

Stage One: $4NH_3\ (g) + 5O_2\ (g) \rightarrow 4NO\ (g) + 6H_2O\ (g)$ $\Delta H = -905.2$ kJ

(a) Draw an energy "profile" diagram for the reaction above, indicating the enthalpy change and activation energy clearly. [3]

(b) In terms of oxidation states, explain why the reaction in Stage One is a redox reaction. [2]

Stage Two consists of two steps.

Step 1: $2\ NO\ (g) + O_2\ (g) \rightarrow 2\ NO_2\ (g)$

In **Step 2**, NO_2 produced in **Step 1** is absorbed by water readily to form dilute nitric acid as well as nitrogen monoxide, which is recycled to be used in **Step 1**.

(c) (i) Write a balanced chemical equation to show the reaction in **Step 2**. [1]

(ii) Name a physical process that can be carried out to increase the concentration of the dilute nitric acid that is obtained at the end of Stage 2. [1]

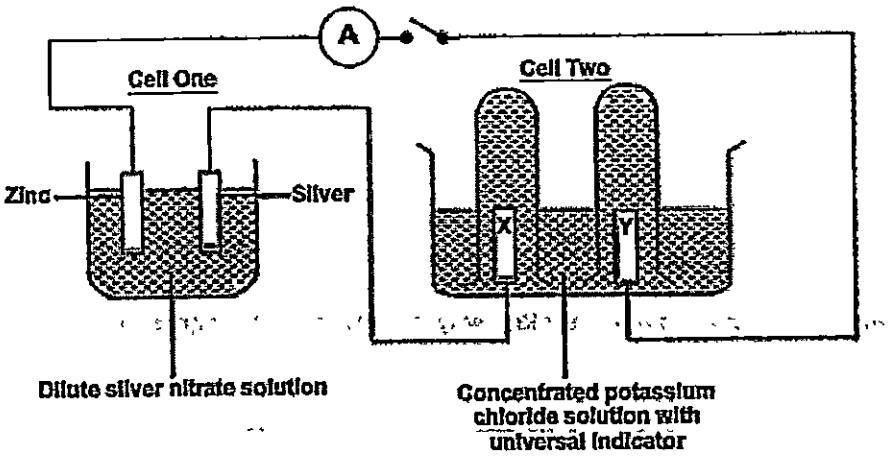
A3 (c) (iii) Explain why it is important that the product in **Step 1** of Stage Two does not escape into the atmosphere. [2]

_____

_____

Total: [9 marks]

A4 The diagram below shows an experimental set-up of two electrochemical cells



Both electrodes **X** and **Y** are made of graphite.

(a) Identify the **positive terminals** of both electrochemical cells and write the equations to illustrate the reactions happening at the electrodes. Include state symbols. [3]

	Positive Terminal	Half-equation
Cell One		
Cell Two		

(b) (i) What is the expected ratio of the volume of the gases obtained at electrodes **X** and **Y**? [2]

Explain your answer with appropriate equation(s). Include state symbols.

_____

_____

_____

A4 (b) (ii) Suggest a possible reason why the ratio of the volume of the gases may not be the same as what was expected in (b)(i) [1]

_____

_____

(c) What is the colour observed in the electrolyte of **Cell Two** when the circuit has been switched on for a period of time? [2]

Explain your answer.

_____

_____

_____

[Total: 8 marks]

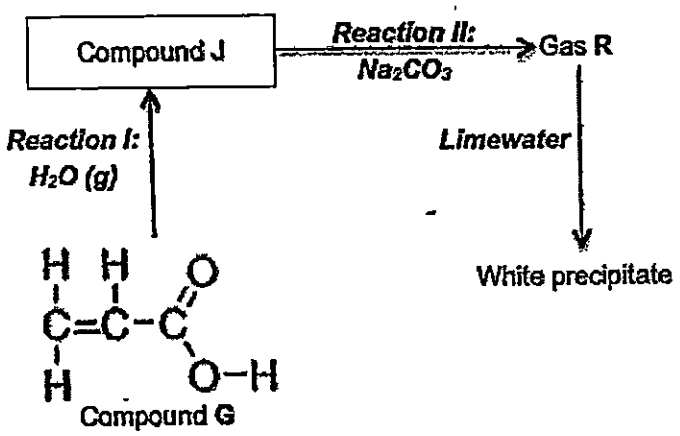
A5 (a) (i) An organic compound **J** contains 40.0% of carbon, 53.3% of oxygen and 6.7% of hydrogen. [3]

Calculate the empirical formula of the compound.

(ii) The relative molecular mass of the compound is 90. [2]

What is the molecular formula of the compound J?

A5 (b) The diagram below shows some information related to compound J.



(i) **Reaction I** is known as a ***hydration*** reaction. State the conditions required for the reaction to take place. [1]

_____

(ii) Identify Gas **R** and the functional group present in compound **J** that allows **Reaction II** to occur. [2]

_____

_____

(iii) Compound **J** has an isomer. [2]

Using the information in **(a)** and the diagram above, deduce and draw the **full** structural formulae of compound **J** and its isomer

Compound J	**Isomer of Compound J**

A5 (c) (i) One of the isomers of compound **J** can undergo ***condensation polymerisation***. [1]

Define the term '***condensation polymerisation***'.

(ii) Draw the structure of the polymer formed when compound **J** undergoes condensation polymerisation. Show at least **two** repeating units. [1]

(d) (i) What type of polymerisation can compound **G** undergo? [1]

(ii) Draw the structure of the polymer of compound **G**. Show at least **two** repeating units. [1]

[Total:14 marks]

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 Read the information below about titanium and answer the questions.

Titanium is a metal that is higher than carbon in the reactivity series. However, it is not extracted by electrolysis. It is extracted from rutile, which contains 50% titanium(IV) oxide Although titanium is the 10th most common occurring element in the Earth's crust, it is a very expensive metal.

The flowchart below shows the extraction of titanium.

Step 1: Titanium(IV) oxide (TiO_2) is reacted with chlorine and coke at 1000 °C to produce titanium(IV) chloride ($TiCl_4$) and carbon monoxide Titanium(IV) chloride is cooled and collected.

↓

Step 2: Titanium(IV) chloride from **Step 1** is reacted with magnesium at a temperature of 1100°C in a sealed reactor for 3 days to obtain titanium. The sealed reactor contains an atmosphere of argon.

↓

Step 3: The reactor is allowed to cool.
The reactor is opened and the titanium is separated from the other product, magnesium chloride.

(a) Titanium(IV) chloride that is produced in **Step 1** exists as a colourless liquid at room temperature and pressure and boils at 136°C.

(i) Based on the information given, deduce the structure and bonding present in titanium(IV) chloride. Explain your answer. **[2]**

(a) (ii) What is unusual about the bonding present in titanium(IV) chloride? Briefly explain your answer. **[1]**

B6 (a) (iii) Hence, suggest a possible reason why electrolysis of titanium(IV) chloride is not used as a method to extract titanium. [2]

(b) (i) Write a balanced chemical equation to show the reaction that took place in **Step 1** to convert titanium(IV) oxide to titanium(IV) chloride. [1]

(ii) State an health effect of the product(s) produced in this reaction. [1]

(c) (i) Write a balanced chemical equation to show the reaction that took place in **Step 2.** [1]

(ii) Name the type of reaction that has occurred. [1]

(iii) Suggest a reason why an argon atmosphere is necessary in this process [1]

(iv) Based on the information given above, deduce why titanium is expensive despite its abundance in the Earth's crust. [2]

[Total: 12 marks]

B7 (a) You are given two 1 0 mol/dm^3 of strong acids **A** and **B**, which have different basicity. One is monobasic while the other is dibasic

(i) Give an example of a monobasic acid and dibasic acid. [1]

Monobasic acid	
Dibasic acid	

(ii) Using your answer in (a)(i) as example, state and explain the difference in electrical conductivity, if any, between monobasic and dibasic acids [2]

(iii) Using your answer in (a)(i) as example, briefly describe and explain an experiment to distinguish two given samples of a monobasic and dibasic acid using a solution of 1.0 mol/dm^3 of aqueous NaOH. [3]

(b) Aqueous solutions of chlorine and iodine are added separately to two test tubes each containing a solution of iron(II) ions. Aqueous sodium hydroxide is then added to each test tube The results are given in the table below.

	Addition of aqueous Cl_2	**Addition of I_2**
Aqueous iron(II) ions	Green solution turns yellow	Green solution remains green
After addition of 3 drops of aqueous NaOH	Reddish brown precipitate is formed	Dirty green precipitate is formed

(i) Name the reddish brown precipitate formed. [1]

B7 (b) (ii) State what is observed when excess aqueous NaOH is added to the brown precipitate. [1]

(iii) Based on the table of results above, compare the oxidising powers of chlorine and iodine. [2]

Include appropriate ionic equation(s), with state symbols, in your explanation.

[Total: 10 marks]

EITHER

B8 Crude oil is a raw material which is processed in an oil refinery. Two of the processes involved in the refinery process are fractional distillation and cracking.

The table below shows the percentage by mass of different fractions in crude oil and the demand for each fraction expressed as a percentage.

Fraction	Number of carbon atoms per molecule	Percentage in crude oil (%)	Percentage needed by the oil refinery to supply demand (%)
Petroleum gases	1 – 4	4	11
Petrol	5 – 9	11	22
Kerosene	10 – 14	12	20
Diesel oil	14 – 20	18	15
Naptha & bitumen	Over 20	23	4

(a) State the physical property that is used to separate crude oil by fractional distillation [1]

(b) (i) Define the term 'cracking'. [1]

EITHER

B8 **(b)** **(ii)** Using the information from the table, explain how cracking helps an oil refinery match the supply of petrol with the demand of petrol. **[2]**

_____

_____

_____

(c) The hydrocarbon $C_{15}H_{32}$ can be cracked to form 2 moles of ethene, 2 moles of propene and one other hydrocarbon. **[1]**

Write a balanced chemical equation for this reaction.

_____

(d) Ethene can be reacted with hydrogen to give a saturated compound **M**.

(i) Draw the structural formula of saturated compound **M** formed. **[1]**

_____

(ii) Describe a chemical test that can be used to distinguish between ethene and compound **M**. **[2]**

_____

_____

[Total: 8 marks]

OR

B8 (a) The table shows some information about a homologous series of carbon compounds called alkynes

Name	Condensed formula	Molecular formula	Enthalpy change of combustion (kJ/ mol)
Ethyne	$HC \equiv CH$	C_2H_2	- 1390
Propyne	$HC \equiv C-CH_3$	C_3H_4	- 1466
Butyne	$HC \equiv CH_2CH_3$	C_4H_6	- 1952
Pentyne	$HC \equiv C-CH_2CH_2CH_3$	C_5H_8	- 2438

(a) Using the information given, deduce the general formula of alkynes [1]

(b) How will the boiling points of alkynes vary down the homologous series? Explain your answer. [2]

(c) What general trend can be observed in the enthalpy changes of combustion of alkynes? Explain your answer. [2]

OR

B8 **(d)** Researchers have been investigating the use of propyne for replacing hydrogen as a liquid fuel for space craft intended for low Earth orbit. Its major advantage is that, unlike hydrogen, propyne can be used as a liquid fuel without the need for storage at extremely low temperatures.

(i) Given that the enthalpy change of combustion of hydrogen is −118 kJ/g, which fuel, hydrogen or propyne, gives a greater energy output per gram of fuel used? Show your workings clearly. **[2]**

(ii) Suggest a reason why it is necessary for the space craft to store and use a fuel in its liquid state instead of its gaseous form. **[1]**

_____

_____

[Total: 8 marks]

☺ End of Paper ☺

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

CRESCENT GIRLS' SCHOOL
SECONDARY FOUR
2015 PRELIMINARY EXAMINATION
CHEMISTRY PAPER 2 – ANSWER SCHEME

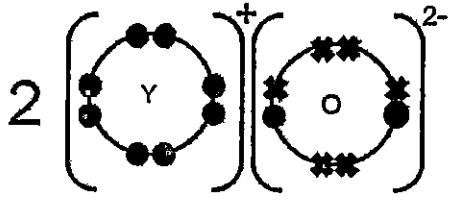
A1 (a) Element W

W forms an <u>acidic oxide</u> and W is a <u>non-metal</u> which tends to gain electrons

OR

WO_2 has a <u>low melting point and boiling point</u> indicating it is a <u>simple covalent compound</u> which is usually formed by non-metals

(b) (i)



(ii) <u>Poor/non-conductor</u> of electricity
In solid state, the <u>ions are held in fixed positions</u>
<u>No mobile ions</u> or <u>mobile electrons</u> to conduct electricity

(c) Y, X, Z, W

A2 (a) $Ca + 2HNO_3 \rightarrow Ca(NO_3)_2 + H_2$

No. of moles of acid = $\frac{25.0}{1000} \times 1.5$ = 0 0375 moles

No of moles of Ca = $\frac{1.0}{40}$ = 0 025 moles

0 025 moles of Ca requires 0 05 moles of acid

Hence acid is the limiting reagent.

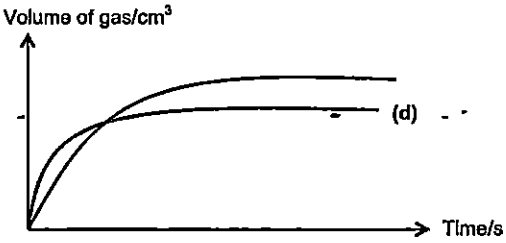
Number of moles of H_2 = $\frac{0.0375}{2}$ = 0 01875 moles

Volume of H_2 = 0 01875 x 24= 0 45 dm^3 or 450 cm^3

(b) Calcium is a <u>reactive metal</u> and hence it can <u>react with water</u> as well to form aqueous calcium hydroxide and hydrogen gas

(c) <u>Particle size/ surface area</u> of M must be the same as the surface area affects the speed of reaction
<u>The larger the surface area, the larger the area of contact between reactant particles</u> and hence faster the reaction

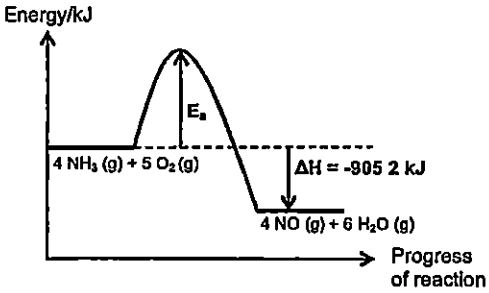
(d)



(e) The reaction will be faster initially as sulfuric acid is a **dibasic acid** and hence the **concentration of H+ ions will be twice/higher** than nitric acid, leading to **higher frequency of effective collisions**

However, calcium reacts with sulfuric acid to form an **insoluble coating of calcium sulfate** around calcium and hence the volume of gas formed will not be maximum

A3 (a)



(b) The oxidation state of N of NH_3 increases from -3 to +2 in NO
The oxidation state of O in O_2 decreases from 0 to -2 in NO

(c) (i) $3NO_2 + H_2O \rightarrow 2HNO_3 + NO$
(ii) Distillation

(iii) NO_2 is an acidic oxide and dissolves in water readily to form **acid rain** which **corrodes metal structures and limestone buildings/ damages crops due to low pH of soil**

A4 (a)

	Positive Terminal	Half-equation
Cell One	Silver ✓	$Ag^+(aq) + e \rightarrow Ag(s)$ ✓
Cell Two	X✓	$2Cl^-(aq) \rightarrow Cl_2(g) + 2e$ ✓

(b) (i) Equation 1: $2Cl^-(aq) \rightarrow Cl_2(g) + 2e$

Equation 2 $2H^+(aq) + 2e \rightarrow H_2(g)$

OR

$2Cl^-(aq) + 2H^+(aq) \rightarrow H_2(g) + Cl_2(g)$

From the equations, $1Cl_2 \equiv 2e$; $1H_2 \equiv 2e$. Hence, when 1 mole of Cl_2 is formed, 2 mole of electrons is lost and accepted by H^+ ions to form one mole of H_2 Hence, the **expected ratio of H_2 to Cl_2 formed is 1:1**

(ii) This is because chlorine is **more soluble in water** than hydrogen/ **chlorine is very soluble in water** while **hydrogen gas is insoluble in water** The volume of Cl_2 collected may be lower than expected, resulting in a different ratio

(c) **Violet/Purple** solution obtained because when

H^+ and Cl^- ions are discharged, the

OH- ions left behind are at a high concentration/ the OH ions form a strong alkali with K^+ ions

OR

The solution turned **colourless** dye to the **bleaching by the Cl_2 gas** dissolved in the solution

A5 (a) (i)

Element	C	H	O
% by mass	40 0	6 7	53 3
No. of moles	$\frac{40.0}{12} = 3.333$	$\frac{6\ 7}{1} = 6.7$	$\frac{53.3}{16} = 3.331$
Ratio	1	2	1

The empirical formula is CH_2O

(ii) Molar mass of CH_2O = 12 + 2 + 16 = 30 g/mol

$n(CH_2O) = 90$

$n = 3$

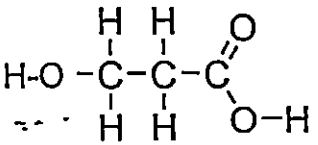
Molecular formula – $C_3H_6O_3$

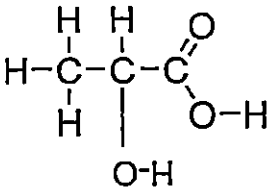
(b) (i) 300 °C, 60 atm; Phosphoric acid (H_3PO_4)

(ii) CO_2 gas

Carboxyl / -COOH functional group

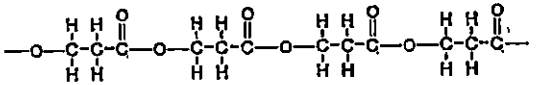
(III)





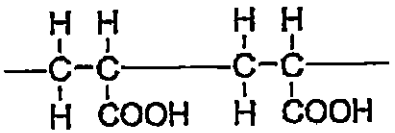
(c) (I) Condensation polymerisation occurs when monomers combine to form a polymer with the removal of small molecules such as water

(II)



(d) (I) Addition polymerisaton

(II)



Section B

B6 (a) (i) As titanium(IV) chloride exists as a liquid at room temperature and pressure and boils at 136°C, it has a low melting and boiling point. Hence, it should exist as a simple covalent compound, with weak intermolecular forces between its molecules

(ii) No Titanium is a metal and hence usually forms ionic compound with chlorine (a non-metal) but titanium(IV) chloride is a covalent compound

(iii) Since titanium(IV) chloride is a covalent compound, thus it cannot conduct electricity at any state since it
does not have any mobile ions or free moving electrons

(b) (i) $TiO_2 + 2Cl_2 + 2C \rightarrow TiCl_4 + 2CO$

(ii) CO is a poisonous gas as it combines with haemoglobin to form a compound which prevents oxygen gas from being transported to the rest of the body/ causes respiratory difficulties

(c) (i) $TiCl_4 + 2Mg \rightarrow Ti + 2MgCl_2$

(ii) Metal displacement/ redox reaction

(iii) To provide an inert atmosphere to
prevent magnesium from reacting with air since it is a reactive metal

(iv) The extraction of titanium requires the use of magnesium which is a reactive metal and requires electrolysis to be extracted

Alternative answer accepted:
The process requires the use of argon which is obtained from fractional distillation of liquid air and large amount of fossil fuels is required in order to maintain the high temperature required.

B7 (a) (i) Monobasic – Hydrochloric acid/Nitric acid
Dibasic – Sulfuric acid

(ii) The electrical conductivity of the *(dibasic acid)* will be higher than the *(monobasic acid)* because

1 mole of *(monobasic acid)* dissociates to give 2 moles of mobile ions *($1H^+$ and $1X^-$)* while
1 mole of dibasic acid dissociates to give 3 moles of mobile ions *($2H^+$ and Y^{2-})*

Hence, there is higher number of mobile ions present in the dibasic acid when it dissociates

(iii) Titrate and

measure the volume of NaOH required to completely neutralise 25.0 cm^3 (fixed volume) of acid A and B

Since both acids have the same concentration,
the volume of the NaOH required for complete neutralization of dibasic acid will be twice than that of the monobasic acid as the
mole ratio between NaOH : HCl = 1:1 while mole ratio of NaOH : H_2SO_4 = 2:1

(b) (i) Iron(III) hydroxide

(ii) The precipitate is insoluble in excess aqueous NaOH

(iii) Aqueous chlorine was able to oxidise Fe^{2+} solution to Fe^{3+} solution while iodine was unable to do so
Chlorine is a stronger oxidising agent than iodine
$Cl_2(aq) + 2Fe^{2+}(aq) \rightarrow 2Fe^{3+}(aq) + 2Cl^-(aq)$

B8 EITHER

(a) Differences in boiling point

(b) (i) Process of breaking down longer hydrocarbons into smaller hydrocarbons.

(ii) Cracking helps to break down bigger hydrocarbon fractions like naptha and bitumen which are
lower in demand (4%) but
exists in higher proportion in crude oil (11%) into smaller fractions like petrol and kerosene which are
higher in demand (23%) but
exists in lower proportion in crude oil (4%)

(c) $C_{15}H_{32} \rightarrow 2C_2H_4 + 2C_3H_6 + C_5H_{12}$

(d) (i) CH_3CH_3

(ii) When aqueous bromine is added separately to both compound M and ethene in the absence of light,
ethene will decolourise brown aqueous bromine while compound M will not.

B8 OR

(a) C_nH_{2n-2}

(b) The boiling points increase down the homologous series
As the molecules get bigger,
the van der waals' forces of attraction between molecules get stronger/ intermolecular forces get stronger
Larger amount of energy required to overcome them and hence boiling points increase.

(c) The enthalpy change of combustion becomes more negative/ increases as the carbon chain increases down the homologous series

As the carbon chain increases, greater amount of energy is released to form the greater no of moles of products (CO_2 and H_2O) formed

(d) (i) 1 mol of propyne releases 1466 kJ of energy
1 mol of propyne -> 40 g

I e 40 g of propyne releases 1466 kJ of energy
amount of energy released by 1 g of propyne = $\frac{1466}{40} = 36\ 7\ kJ$
Hence, hydrogen has a greater energy output

(ii) As particles in the liquid state are closely packed together, more molecules of the fuel can be stored in the same volume of space when transported in liquid state as compared to gaseous state

OR

Fuel in the gaseous form is more explosive than when it is in its liquid form as gaseous particles contains more kinetic energy than liquid particles