ZHONGHUA SECONDARY SCHOOL
Preliminary Examination 2015

CANDIDATE NAME		( )
CLASS		

CHEMISTRY **5073/01**

Paper 1 Multiple Choice **14 September, 2015**

Secondary 4 Express **1 hr**

Set by: Ms Ong Lay Hong

Vetted by: Mrs Maybne Ang and Mr Ong Kai Kun

READ THESE INSTRUCTIONS FIRST

Write in soft pencil

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

Write your name, index number and class on the OTAS 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 separate OTAS Answer Sheet.

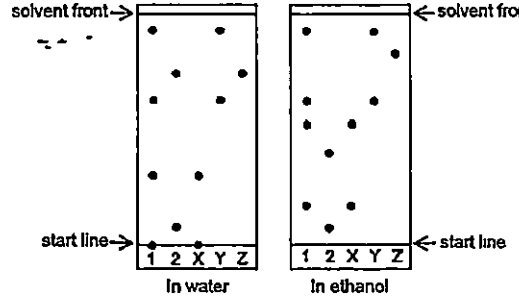
Read the instructions on the Answer Sheet very carefully.

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

Any rough working should be done in this booklet.

A copy of the Periodic Table is printed on page 15

1 Food dyes, 1 and 2 are known to contain one or more of three substances X, Y and Z. Two chromatograms are developed, one used water as the solvent, and the other used ethanol. The results are shown in the diagram below



Which of the following statement(s) is/are correct?

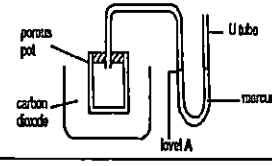
I There is a component in Sample 1 that is insoluble in water but soluble in ethanol
II The component in Z is more soluble in water than in ethanol
III Substance Z is likely to be pure

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

2 In a porous pot experiment, the porous pot was placed in a beaker of carbon dioxide. The porous pot was joined to a U tube filled with mercury as shown.

Which of the gases, I to IV when used to fill the porous pot would cause level A to move up?

I	chlorine
II	hydrogen
III	ammonia
IV	nitrogen



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

3 Lead(II) sulfate is soluble in hot water, but not in cold water Lead(II) sulfate boils off at 2670 °C while sodium sulfate boils at 1430 °C

Which method is most suitable for obtaining a pure, dry sample of lead(II) sulfate from a hot solution of lead(II) sulfate and sodium sulfate?

A Cool the mixture, filter and collect the residue

B Cool the mixture, filter and evaporate the filtrate.

C Heat the mixture gently and collect the substance which boils off

D Heat the mixture gently and collect the substance which is left in the boiling flask.

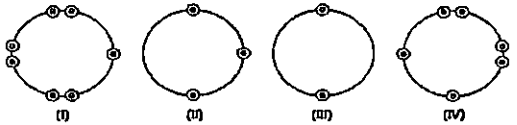
4 A giant molecule is made up of a large amount of carbon, mainly isotopes ^{12}C and ^{13}C It was found that the average relative atomic mass of carbon in the molecule is 12 2

What is the ratio by mass of ^{12}C to ^{13}C?

A 4 1 B 1 . 4

C 3 . 4 D 3 · 1

5 The diagram below show the electron arrangement in the outer shells of four elements, labelled (I) to (IV)



Which two elements will form an ionic compound with formula of the type YZ_2?

A I and III B III and IV

C II and III D II and IV

6 Carbon monoxide is an air pollutant which is included in our PSI Index and is generated by incomplete combustion of carbon containing fuels.
Which is the electronic structure, showing the outermost electrons of carbon monoxide?

A 

B 

C 

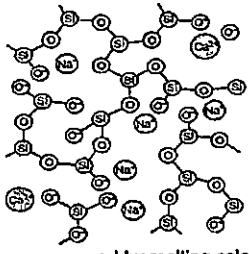
D 

7 Silicon carbide has a similar structure to diamond
Which one of the following are advantages of using a silicon carbide ceramic compound instead of steel?

I Silicon carbide has a higher melting point.
II Silicon carbide is more resistant to oxidation
III Silicon carbide is less likely to deform under compression

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

8 A flame cauldron is specially designed and created for every Olympic games One of the materials commonly used is soda-lime glass as it can withstand high temperatures of over 2000°C when the cauldron is lit during each opening ceremony The structure of soda-lime glass is shown below



Soda-lime glass is prepared by melting calcium carbonate, sodium carbonate and silicon dioxide in a furnace

What bond(s) is/are present in soda-lime glass?

A covalent only
B covalent and ionic only
C ionic and metallic only
D metallic and covalent only

9 Chlorine gas is a severe irritant to the eyes and respiratory system The maximum safe toleration level of chlorine gas in air is 0 005 mg dm^{-3}
How many molecules of chlorine gas are present in 1 dm^3 of air at this toleration level? (*Note 1g =1000 mg*)

A 0 005/ 6 x10^{23} x 71
B 0 005/71 x 6 x10^{23}
C 0 005/1000 x 1 / 71 x 6 x 10^{23}
D 0 005/1000 x 71 x 6 x 10^{23}

10 A mixture of 10 cm^3 of oxygen and 50 cm^3 of hydrogen is sparked continuously
What is the maximum theoretical decrease in volume at room temperature pressure?

A 10 cm^3
B 15 cm^3
C 20 cm^3
D 30 cm^3

11 In a pathology laboratory, a sample of urine containing 0 120 g of urea, NH_2CONH_2 (Mr = 60) was treated with an excess of nitrous acid The urea reacted according to the following equation

$$NH_2CONH_2 + 2HNO_2 \rightarrow CO_2 + 2N_2 + 3H_2O$$

The gas produced was passed through aqueous sodium hydroxide and the final volume measured
What was this final volume of gas left behind at room temperature and pressure?

A 9 6 cm^3 B 14 4 cm^3 C 48 0 cm^3 D 96 0 cm^3

12 A cheap carbon monoxide detector for a gas heater consists of a patch containing palladium chloride crystals When carbon monoxide is present, the crystals turn from orange to black as the following reaction takes place.

$$CO(g) + PdCl_2(s) + H_2O(l) \rightarrow CO_2(g) + Pd(s) + 2HCl(aq)$$

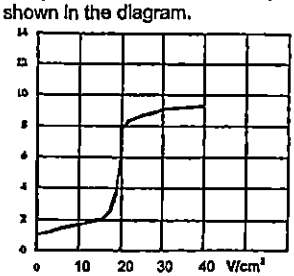
Which is the element whose oxidation number decreases in this reaction?

A carbon B chloride
C hydrogen D palladium

13 Which of the following is an example of a redox reaction?

A $Na_2CO_3 + 2HCl \rightarrow 2NaCl + H_2O + CO_2$
B $Mg + 2HCl \rightarrow MgCl_2 + H_2$
C $ZnCl_2 + 2NaOH \rightarrow Zn(OH)_2 + 2NaCl$
D $CaO + SiO_2 \rightarrow CaSiO_3$

14 In an acid – base titration, a 0 10 mol/dm^3 solution of a base is added to 20 cm^3 of a 0.10 mol/dm^3 solution of an acid
The pH value of the solution is plotted against the volume of base, *V*, added as shown in the diagram.



This diagram could represent a titration between

A CH_3COOH (aq) and NH_3 (aq) B CH_3COOH(aq) and KOH (aq)
C HCl(aq) and KOH (aq) D HCl(aq) and NH_3(aq)

15 The table below refers to four metals and some of their compounds

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

Which one of the following is the order of *thermal stability* of their carbonate towards heating?

more stable towards heating → less stable towards heating

A	H	G	J	I
B	H	J	G	I
C	I	J	G	H
D	I	H	G	J

16 The equation shows the reaction between a halogen and aqueous bromide ions.

$$X_2 + 2Br^-(aq) \rightarrow 2X^-(aq) + Br_2(aq)$$

Which of the following sets is true for the above reaction?

	Identity of X_2	colour change observed	explanation
A	chlorine	reddish brown to colourless	X_2 is an oxidising agent.
B	chlorine	colourless to reddish brown	Br^- is oxidized.
C	iodine	brown to colourless	X_2 is reduced
D	chlorine	colourless to brown	Br^- is a reducing agent.

17 Solid **X** has the following properties

I It is soluble in water
II When warmed with sodium hydroxide solution, a gas is given off.
III It gives off a gas when added to dilute sulfuric acid

Which of the following is **X**?

A ammonium carbonate B sodium nitrate

C calcium chloride D magnesium sulfate

18 Many properties of an element and its compounds can be predicted from the position of the element in the Periodic Table What property could not be predicted in this way?

A the acidic or basic nature of its oxide

B the formula of its oxide

C the number of isotopes it has

D its metallic or non-metallic properties

19 Which of the following statements are true about the elements in Group I of the Periodic Table?

1 They are reducing agents
2 The ionic radius increases down the group
3 Their reactivities decrease on descending down the group

A 1, 2 and 3 B 1 and 2 only

C 2 and 3 only D 1 only

20 In an experiment 4 0 cm^3 of 1.0 mol/dm^3 of copper(II) sulfate solution are mixed with 8.0 cm^3 of 1 0 mol/dm^3 potassium carbonate solution

What does the reaction vessel now contain?

A a green precipitate and a blue solution

B a colourless solution only

C a white precipitate and a colourless solution

D a green precipitate and a colourless solution

21 Approximately 40% of all iron and steel is produced by recycling
Which statements are correct reasons for recycling iron?

1. Iron, when obtained by a recycling process produces less carbon dioxide than the blast furnace process
2. Scrap steel contains a higher percentage of iron than iron ore
3. Scrap metal, if not recycled, would cause environmental problems due to disposal by landfill

A 1, 2 and 3 B 1 and 2 only

C 1 and 3 only D 2 and 3 only

22 Which reaction is not a step in the production of iron from haematite in the blast furnace?

A Carbon burning in air to produce carbon dioxide

B Carbon reacting with carbon dioxide to produce carbon monoxide

C Iron (III) oxide reacting with carbon monoxide to form iron

D Iron reacting with limestone to produce slag

23 The reaction in the Haber process is represented as

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \qquad \Delta H = -92\ kJ$$

Which of the following statements about the Haber process is incorrect?

A 92 kJ of heat is given off when 2 mol of ammonia are formed

B Iron catalyst has the same effect on both forward and backward reaction

C The process is carried out at a high pressure of 250 atmospheres

D When 2 mol of N_2 and 6 mol of H_2 are used, 4 mol of NH_3 are collected

24 In the conversion of compound **P** into compound **R**, it was found that the reaction proceeded by way of compound **Q**. The following graph shows the energy profile diagram for the reactions.

What can be deduced from the diagram?

Progress of reaction

step 1: P → Q
step 2 Q → R

A Both steps are endothermic

B The overall reaction to convert **P** to **R** is exothermic

C Step 2 involves breaking of stronger bonds than step 1 because **Q** is at higher energy level.

D Step 1 is harder to take place than step 2 because more energy is needed for bond breaking

25 Dilute hydrochloric acid reacts with an aqueous solution of sodium thiosulfate, $Na_2S_2O_3$, according to the chemical equation below

$$Na_2S_2O_3(aq) + 2HCl(aq) \rightarrow 2NaCl(aq) + H_2O(l) + S(s) + SO_2(g)$$

10 0 cm^3 portions of 2 00 mol/dm^3 dilute hydrochloric acid were added to four separate conical flasks. Each flask contains 90 0 cm^3 sodium thiosulfate solution which was prepared by dilution with different volumes of water as shown in the table.

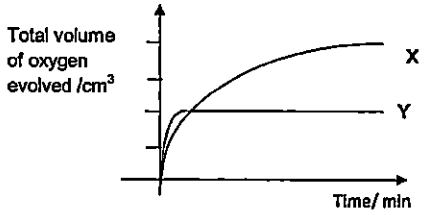
conical flask	sodium thiosulfate solution		volume of water added/cm^3
	initial concentration/ mol/dm^3	volume/cm^3	
W	1 00	80 0	10 0
X	1 50	60 0	30 0
Y	2 50	30 0	60 0
Z	3 00	20 0	70 0

In which one of the above conical flasks would the reaction proceed at the fastest rate?

A W B X

C Y D Z

26 The result of an experiment involving the decomposition of 20 0 cm^3 of hydrogen peroxide of 1.5 mol/dm^3 is represented by graph X below



Which one of the following produces graph Y?

	volume of hydrogen peroxide used (cm^3)	concentration of hydrogen peroxide used (mol/dm^3)
A	10 0	1 5
B	5 0	2 5
C	20 0	0 75
D	7.5	2 0

27 To reduce atmospheric pollution, the following waste gases from a coal burning power station are passed through wet powdered calcium carbonate

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

carbon monoxide	carbon dioxide
nitrogen monoxide	nitrogen dioxide
sulfur dioxide	phosphorus(V) oxide

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

28 In the past, CFC (chlorofluorocarbon eg CF_3CH_2Cl) compounds were used as aerosol propellants
Which element in the compound can cause a depletion of ozone?

A carbon **B** fluorine **C** chlorine **D** hydrogen

29 Element X is extracted by the electrolysis of a molten compound of elements X and Y The electrode reactions are shown below

cathode · $X^{2+} + 2e^- \rightarrow X$

anode $2Y^{2-} \rightarrow Y_2 + 4e$

Which of the following could be the compound?

A aluminium oxide
B calcium chloride
C magnesium oxide
D potassium chloride

30 Three electrolytic cells are set up with inert electrodes
The electrolytes used are listed below

cell **1** concentrated aqueous rubidium chloride
cell **2** dilute nitric acid
cell **3** molten zinc bromide

In which of these cell(s) is/are gases formed at both electrodes?

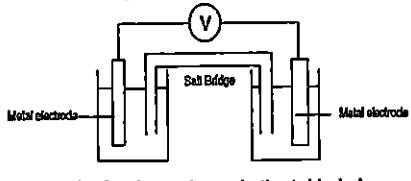
A 2 only
B 3 only
C 1 and 2 only
D 1 and 3 only

31 In the electrolysis of molten aluminium oxide, 4 moles of aluminium ions (Al^{3+}) were discharged at the cathode

Which one of the following would be discharged by the same amount of electricity?

A 4 moles copper (II) ions (Cu^{2+}) in the electrolysis of aqueous copper (II) sulfate
B 6 moles of lead ions (Pb^{2+}) in the electrolysis of molten lead (II) bromide
C 6 moles of silver ions (Ag^{+}) in the electrolysis of aqueous silver nitrate
D 12 moles of zinc ions (Zn^{2+}) in the electrolysis of molten zinc sulfate

32 Four metals tin, ***x***, ***y*** and ***z*** were connected in pairs and the voltages were recorded



The results obtained are shown in the table below

negative terminal	positive terminal	Voltage (V)

tin	*y*	1 10
x	tin	0 90
z	tin	2 50

What is the order of reactivity the four metals with the most reactive first?

A *x*, tin, *y*, *z*
B *y*, tin, *x*, *z*
C *z*, tin, *y*, *x*
D *z*, *x*, tin, *y*

33 The compound C_8H_{10} is a member of a hydrocarbon homologous series
Which of the following can be the first possible member of this series?

A C_2H_6
B C_2H_4
C C_2H_3
D C_2H_2

34 Metal X reacts rapidly with hydrochloric acid It can be used for the sacrificial protection of underwater pipes

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

Metal Z reacts rapidly with water to form hydrogen

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

	electrolysis of molten ore	heating with carbon
A	X and Y	Z
B	X and Z	Y
C	Y	X and Z
D	Z	X and Y

35 Which ester contains five carbon atoms in one molecule of the ester?

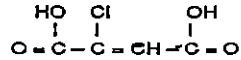
A butyl propanoate

B ethyl ethanoate

C ethyl propanoate

D propyl methanoate

36 The diagram shows the structural formula of chloromaleic acid



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

Chloromaleic acid

A will turn acidified potassium dichromate (VI) from orange to green

B decolourises aqueous bromine rapidly

C can undergo addition polymerisation

D will react with zinc carbonate to produce a gas

37 Which statement about fractional distillation of petroleum is correct?

A At each level in the column, only one compound is collected

B The higher up the column, the greater the temperature

C The molecules collected at the bottom of the column are the most flammable

D The molecules reaching the top of the column have the smallest relative molecular mass

38 The formulae of four covalent molecules are shown

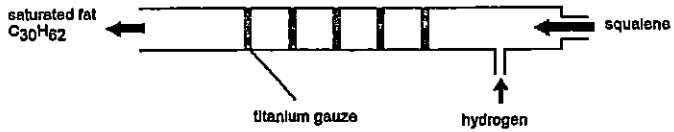
1 CO_2
2 H_2O
3 C_2H_5OH
4 C_2H_5COOH

In which pair of molecules does oxygen atom form at least one double bond in both molecules?

A 1 and 2 B 1 and 4

C 2 and 3 D 3 and 4

39 The diagram below shows how pure titanium can be used to catalyse the reduction of unsaturated oils to saturated fats Squalene is naturally occurring unsaturated oil present in sharks

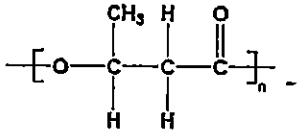


A 0 100 mol sample of squalene reacted with 14 4 dm^3 of hydrogen at room temperature and pressure to form a saturated hydrocarbon $C_{30}H_{62}$
What is the molecular formula of squalene?

A $C_{30}H_{50}$ B $C_{30}H_{52}$

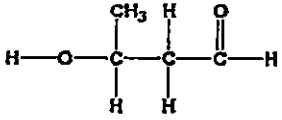
C $C_{30}H_{54}$ D $C_{30}H_{58}$

40 Polyhydroxyalkanoates are biodegradable plastics The structure of one type of these plastics is shown below

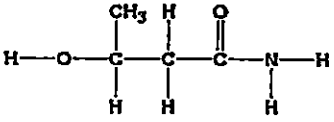


Which of the following molecules could be its monomer?

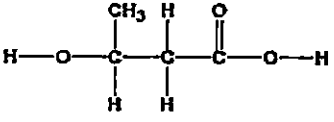
A



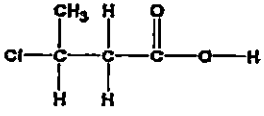
B



C



D



— 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	98 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 †															

*68-71 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

The volume of one mole of any gas is 24 dm^3 at room temperature and

ZHONGHUA SECONDARY SCHOOL
Preliminary Examination 2015

CANDIDATE NAME			( )
CLASS	4	E	

CHEMISTRY **5073/02**

Paper 2 Theory **31 August, 2015**

Secondary 4 Express **1 hour 45 minutes**

Set by: **Mrs Elizabeth Lim**

Vetted by: **Ms Ong Lay Hong and Mr Ong Kai Kun**

READ THESE INSTRUCTIONS FIRST

Write your name, index number and class in the spaces at the top of this page and on all separate answer paper used.

Write in dark blue or black pen.

You may use a pencil for any diagrams, graphs or rough working.

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

Section A

Answer **all** questions.

Write your answers in the spaces provided on the question paper.

Section B

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

Answer all questions in the spaces provided.

You are advised to spend no longer than one hour on **Section A** and no longer than 45 minutes on **Section B**.

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

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

All essential working must be shown clearly.

A copy of the Periodic Table is printed on page 21.

For Examiner's Use	
Section A	
B 7	
B 8	
B 9	
Total	

Section A

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

A1 Table 1.1 shows information about six substances

Table 1.1

substances	state at room temperature	pH in water
A	gas	1
B	gas	4
C	gas	11
D	gas	No reaction
E	liquid	7
F	solid	14
G	solid	No reaction

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

(a) Which substance, whose solution when added to the solid G, produces an effervescence?

..... [1]

(b) Which substance, whose solution, when added to aluminum nitrate solution produces a precipitate soluble in excess?

..... [1]

(c) Which substance can be found in fizzy drinks?

..... [1]

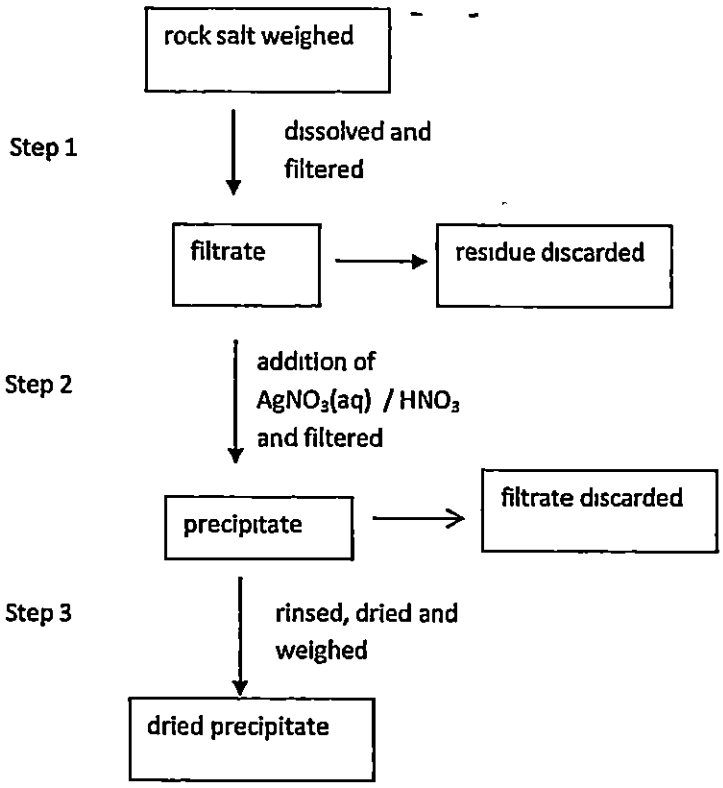
(d) Which two substances when reacted together produced a fertilizer that is used in the agriculture industry?

..... [1]

(e) Which substance is formed when there is incomplete combustion of fuel?

..... [1]

A2 Rock salt (NaCl) is an ionic compound that occurs naturally as white crystals. It is extracted from the mineral form halite or evaporation of seawater. The flowchart outlines the steps used to determine the percentage of sodium chloride present in a sample of rock salt of mass 2.5 g.



(a) Give the ionic equation for the formation of the precipitate formed in Step 2.

..... [1]

(b) Explain what precautions must be taken in steps 2 and 3 to ensure accuracy of results.

.....

.....

.....

.....

..... [2]

(c) At the end of the experiment the mass of the precipitate was found to be 5.74 g. Calculate the percentage of sodium chloride in the rock salt sample.

[3]

(d) Suggest another test to show that the rock salt is impure.

_____

_____

_____ [2]

A3 A student performed three experiments using the metals iron, manganese and chromium.
In the first experiment he added the metals separately into dilute sulfuric acid.
In the second experiment he heated the metals in air and in the last experiment he put strips of the metals in metal salt solutions.

Table 3.1 below shows the results of the first two experiments.

Table 3 1

metal	reaction with sulfuric acid	reaction with air
iron	metal dissolves slowly with effervescence, a pale green solution is formed	burns in air to form dark brown iron (III) oxide
manganese	metal dissolves quickly with effervescence, a pale pink solution, manganese (II) sulfate, is formed	burns in air with an intense white light forming a red solid, manganese(II,III) oxide, Mn_3O_4
chromium	metal dissolves readily with effervescence, a violet solution, chromium (III) sulfate, is formed	burns in air to form green chromium(III) oxide, Cr_2O_3

5

(a) From the information above, state two properties of iron, manganese and chromium that show them to be transition metals.

_____

_____

_____ [2]

(b) Write a balanced equation for the reaction of manganese with dilute sulfuric acid

_____ [1]

(c) Figure 3.1 below shows strips of manganese and chromium in iron(II) sulfate and manganese(II) sulfate solutions.

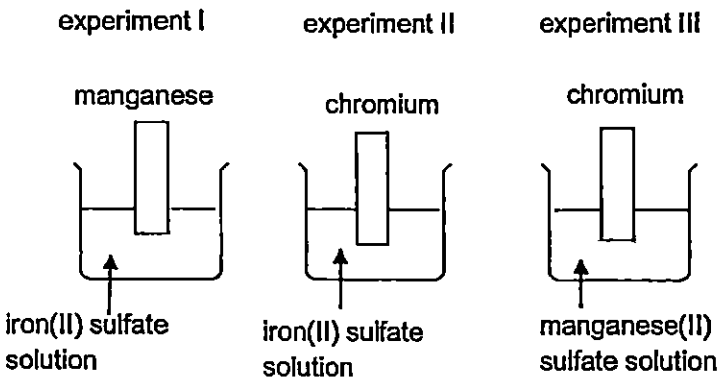


Fig 3.1

State the observations you would expect in Table 3 2 below.

Table 3.2

experiment I	experiment II	experiment III

[3]

(d) Decomposition temperature of a substance is the temperature at which the substance chemically decomposed. Carbonate of iron, manganese and chromium decompose to give the metal oxide and carbon dioxide.

$$MCO_3 \longrightarrow MO + CO_2$$

(i) Explain which of the three carbonates has a higher decomposition temperature?

[2]

(ii) When 2 3 g of a metal carbonate is decomposed completely by heating, 480 cm^3 of carbon dioxide is produced at room temperature and pressure. Calculate the relative formula mass of the metal carbonate and hence identify the metal.

[3]

A4 Figure 4.1 represents the electrolysis of aqueous silver nitrate using graphite electrodes.

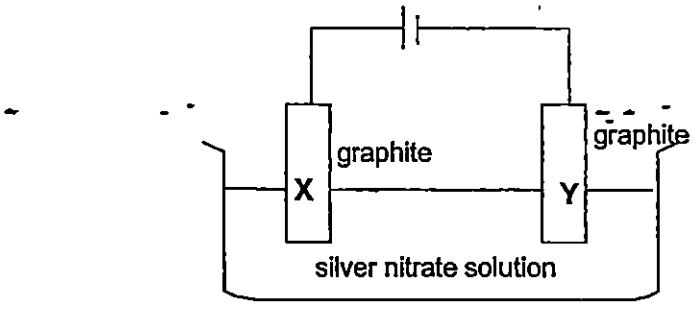


Fig 4.1

(a) **(i)** What would you observe at each electrode and write the ionic half equation for the reaction that occurred at each electrode

electrode **X**

observation: ....

ionic equation: ..... [2]

electrode **Y**

observation. ....

ionic equation: .... [2]

(ii) Explain what happened to the electrolyte after some time.

_____

_____

_____

_____ [2]

(b) Rust and corrosion are costing the industry billions of dollars a year. In fact, rust has almost become part of our everyday life - with many industries resigned to accepting rust as being inevitable and costly.

(i) Write the ionic half equation when iron rust.

[1]

_____

8

(ii) Figure 4.2 illustrates one method of protecting an underground steel pipe.

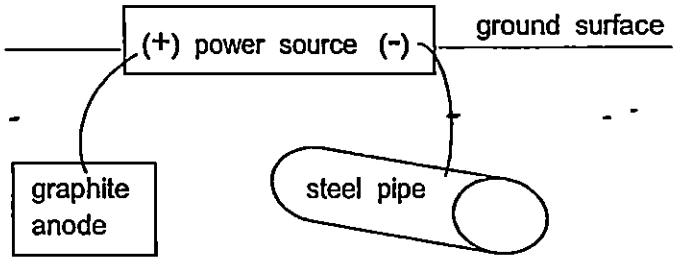


Fig 4 2

1. Indicate on the diagram the flow of electrons. [1]

2. Explain how this method works.

.....

..... [1]

(iii) Suggest an alternative way the underground pipe can be protected
With the help of ionic half equation, explain your answer.

.....

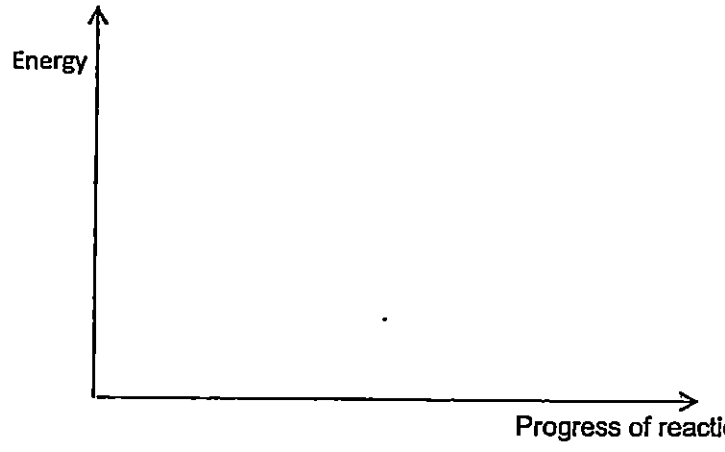
.....

..... [2]

A5 Fossil fuels are a major source of energy. To generate electricity, heat produced by the burning of liquefied petroleum gas (LPG) is used to convert water to steam which then drives a turbine that generates electricity. LPG contains mainly propane. The equation for the combustion of propane is shown below.

$$C_3H_8\,(g) + 5O_2\,(g) \longrightarrow 3CO_2\,(g) + 4H_2O\,(g) \quad \Delta H = -2220\ kJ/mol$$

(a) Draw an energy profile diagram for the combustion of propane.
Your diagram should show and label
- reactants and products,
- the activation energy for the reaction,
- the enthalpy change of the reaction.



[2]

(b) Sketch on the energy profile diagram you have drawn in **(a)** for the burning of liquid propane. [1]

(c) A propane – oxygen fuel cell uses oxygen and propane to produce electricity. The followings are the two half equations for the reactions.

Equation 1: $C_3H_8(g) + 6H_2O\,(l) \longrightarrow 3CO_2(g) + 20H^+(aq) + 20e^-$

Equation 2: $5O_2(g) + 20H^+(aq) + 20e^- \longrightarrow 10\,H_2O(l)$

(i) Which reaction takes place at the anode and which at the cathode?

anode: .....

cathode: ..... [1]

(ii) What is the overall equation for the propane – oxygen fuel cell?

[1]

.....

(iii) Suggest with reasons which is a more efficient way of producing electricity, propane – oxygen fuel cell or the burning of LPG to drive the turbine in the generator

.....

..... [1]

(d) Liquefied petroleum gas (LPG) and paraffin (kerosene) are used as household fuel. Paraffin is safer than LPG. Suggest a reason why.

_____

_____ [1]

A6 (a) Group IV elements show a trend from non-metallic to metallic behaviour with increasing atomic number. This is shown by the acid base properties of carbon dioxide, silicon dioxide and lead(II) oxide.

group IV elements	formula of oxide	acidic / basic / amphoteric
C	CO_2	
Si	SiO_2	
Pb	PbO	

(i) Complete the table by filling in the empty boxes. [1]

(ii) Support your answer with equations where possible to explain the acidic, basic or amphoteric behaviour of CO_2, SiO_2 and PbO.

.....

.....

.....

.....

.....

.....

.....

..... [4]

(b) PbO and PbO_2 differ strikingly in their properties. Both oxides react with acid as given in the equations below.

equation 1: $PbO + 2HCl \longrightarrow PbCl_2 + 2H_2O$

equation 2: $PbO_2 + 4HCl \longrightarrow PbCl_2 + Cl_2 + 2H_2O$

What is the role of lead oxide in each of the reaction with hydrochloric acid? Explain your answer.

PbO:

_____

_____

_____ [1]

PbO_2:

.....

.....

.....

..... [2]

Section B

Answer **three** questions from this section.

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

B7 (a) The ionization energy of an atom describes the minimum amount of energy required to remove an electron (to infinity) from an atom.
The data below shows a plot of ionisation energy against the number of the electron removed for sodium.

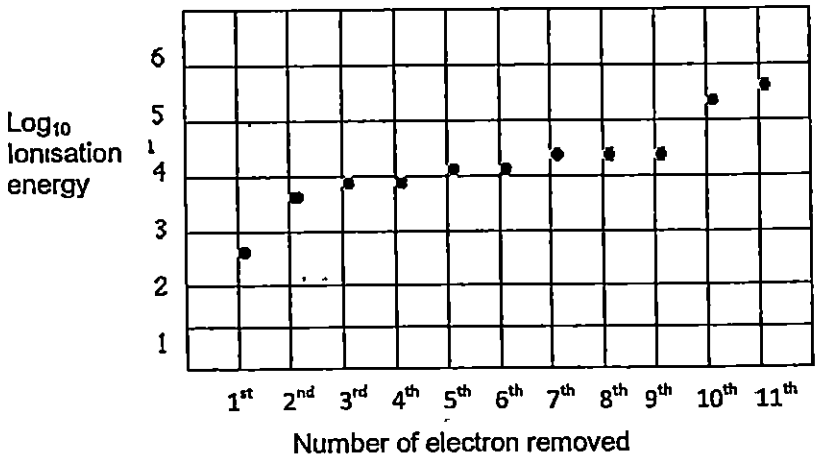


Fig 7.1

Use the information above to explain the trend in ionisation energy for sodium with reference to its electronic structure.

[3]

(b) Table 7.1 shows the first ionization energy (energy required to remove the first electron from the atom) of elements in Period 3.

Table 7.1

element	Na	Mg	Al	Si	P	S	Cl	Ar
first ionisation energy / kJ /mol	496	738	577	786	1060	1000	1256	1520
formula of the hydride of the element	NaH	MgH_2	AlH_3			H_2S	HCl	

(i) Complete the table by filling in the formulae of the hydrides. [1]

(ii) Explain why there is a great difference in the first ionization energy of sodium and argon.

_____

_____

_____

_____ [2]

(iii) Draw a 'dot and cross' diagram to show the bonding in sodium hydride. You need to show all the electrons. [2]

(iv) Suggest one similarity and one difference in physical property between sodium hydride and hydrogen chloride.

similarity: .....

.....

difference: ..... [2]

.....

B8 A student carried out an experiment to investigate the relationship between the mass of zinc used in a reaction and the volume hydrogen gas liberated.
In the experiment he added pieces of zinc to 50 cm^3 of hydrochloric acid and recorded the volume of the gas collected. Table 3.1 shows the student's results.

Table 3.1

mass of zinc /g	volume of hydrogen collected / cm^3
0.1	33
0 2	66
0.3	99
0.4	132
0.5	165
0.6	198
0.7	225
0 8	225

The reaction of zinc and hydrochloric acid is

$$Zn + 2HCl \longrightarrow ZnCl_2 + H_2$$

(a) **(i)** Calculate the volume of hydrogen liberated when 0.5 g of zinc was used.

[2]

(ii) Using information from Table 3.1 suggest why the answer in a **(i)** is different from the one obtained in the experiment.

.....

..... [1]

(b) Suggest why the volume of the hydrogen collected is different for 0.1 g to 0.6 g of zinc but remains the same for 0.7 g and 0.8 g.

.....

.....

.....

.....

..... [2]

(c) Using information from the Table 3.1 calculate the concentration of the acid used in this experiment.

[3]

(d) The experiment was repeated using hydrochloric acid which was warmed to 60°C. Using the collision theory explain why a shorter time was observed to collect the hydrogen gas.

.....

.....

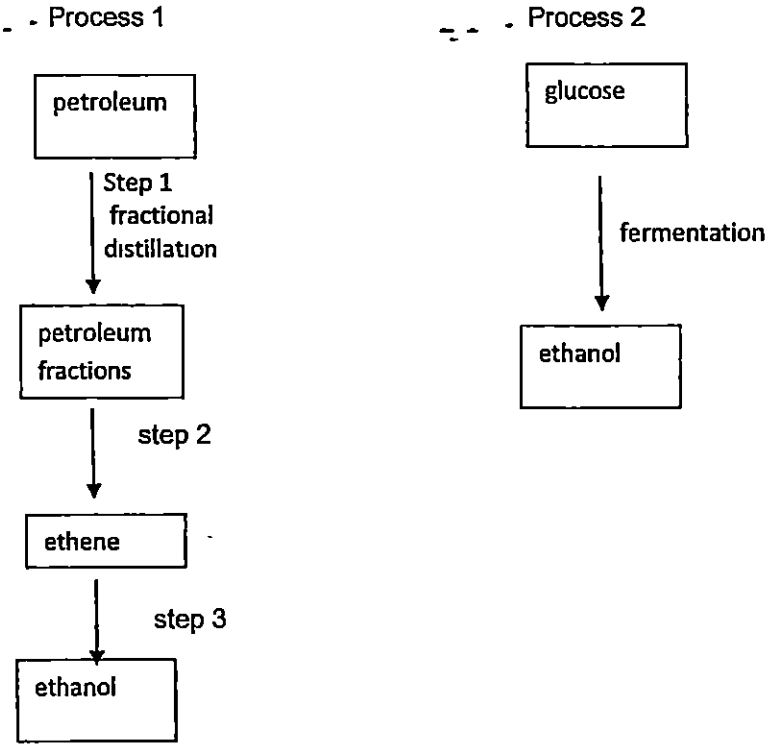
.....

.....

..... [2]

Either

B9 **(a)** Ethanol can be manufactured by two processes. The flowcharts outline the sequence of steps for producing ethanol



(i) Name the process in step 2

_____ [1]

(ii) State the conditions for step 3.

_____ [1]

(iii) Briefly explain which process 1 or 2 is sustainable in the production of ethanol in the industry

_____

_____ [1]

(iv) Suggest two reasons to show that Process 2 is more environmentally friendly than Process 1.

_____

_____

_____ [2]

(b) (i) Ethyl ethanoate, a sweet smelling compound, has many uses It can be used in perfumes or as flavouring.
Outline with the help of condensed or full structural formula equations, how a sample of ethyl ethanoate can be prepared in the laboratory. You can only use ethanol as the starting material. Other inorganic reagents where appropriate can be used in the preparation.

[4]

(ii) Draw the full structural formula of an isomer of ethyl ethanoate which belongs to the same homologous series.

[1]

Or

B9 Today, a significant number of personal care products such as scrubs and toothpastes are known to contain thousands of minuscule balls of plastic called microplastics, or more specifically, microbeads. Over the years, microbeads have replaced traditional, alternatives such as ground nut shells, and salt crystals.

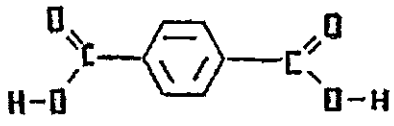
The microbeads used in personal care products are almost always smaller than 1 mm, the width of a pencil tip. They are mainly made **of polyethene (PE)**, but can be also be made of **polypropene (PP), polyethylene terephthalate (PET), polymethyl methacrylate (PMMA)** and **nylon.**

Microbeads are washed down the drain after use and flow through sewer systems around the world before making their way into rivers and canals and ultimately, straight into the seas and oceans. Now, fish have a gut full of them. Researchers around the world have detected them in marine mussels and shore crabs. Their synthetic molecules bind to chemicals to become "a pathway for pollutants to enter the food chain".

(a) Draw the full structural formula of **polypropene** showing **two** repeat units.

[1]

(b) Polyethylene terephthalate (PET) is made from two monomers, **terephthalic acid** and **ethane-1,2-diol (HO CH_2CH_2OH).**
The structural formula of **terephthalic acid** is:



Draw the repeat unit of PET.

[1]

(c) **Methyl methacrylate (MMA)** is an organic compound with the formula $CH_2=C(CH_3)COOCH_3$ This colourless liquid, **(MMA),** is the methyl ester of **methacrylic acid.**
MMA is a monomer produced on a large scale for the production of **polymethyl methacrylate (PMMA).**

(i) Draw the full structural formula of **methacrylic acid.** [1]

(ii) Draw the structure of **polymethyl methacrylate (PMMA)** showing **two** repeat units.

[1]

(iii) The common name for **polymethyl methacrylate (PMMA)** is perspex and has the appearance of glass. It is used in aeroplane windows.
Suggest one advantage of perspex over the use of glass.

_____

_____ [1]

(d) **(i)** Microbeads are cheap. Give one reason why they might become expensive in the future.

_____

_____ [1]

(ii) Suggest a reason why the traditional use of ground nut shells is better than the use of microbeads.

_____

_____ [1]

(e) Polypropene can be disposed of by combustion.

(i) Using its empirical formula construct an equaton for the complete combustion of polypropene.

_____ [1]

(ii) Calculate the volume of carbon dioxide produced when 1 tonne of polypropene is burned

[2]

☺☺☺ END ☺☺☺

Group																	
I	II										III	IV	V	VI	VII	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	46 Sc scandium 21	48 Ti titanium 22	51 V vanadium 23	52 Cr chromium 24	55 Mn manganese 25	56 Fe iron 26	59 Co cobalt 27	59 Ni nickel 28	64 Cu copper 29	65 Zn zinc 30	70 Ga gallium 31	73 Ge germanium 32	75 As arsenic 33	79 Se selenium 34	80 Br bromine 35	84 Kr krypton 36
85 Rb rubidium 37	88 Sr strontium 38	89 Y yttrium 39	91 Zr zirconium 40	93 Nb niobium 41	96 Mo molybdenum 42	– Tc technetium 43	101 Ru ruthenium 44	103 Rh rhodium 45	106 Pd palladium 46	108 Ag silver 47	112 Cd cadmium 48	115 In indium 49	119 Sn tin 50	122 Sb antimony 51	128 Te tellurium 52	127 I iodine 53	131 Xe xenon 54
133 Cs caesium 55	137 Ba barium 56	139 La lanthanum 57 *	178 Hf hafnium 72	181 Ta tantalum 73	184 W tungsten 74	186 Re rhenium 75	190 Os osmium 76	192 Ir iridium 77	195 Pt platinum 78	197 Au gold 79	201 Hg mercury 80	204 Tl thallium 81	207 Pb lead 82	209 Bi bismuth 83	– Po polonium 84	– At astatine 85	– Rn radon 86
– Fr francium 87	– Ra radium 88	– Ac actinium 89 †															

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

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

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

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.)

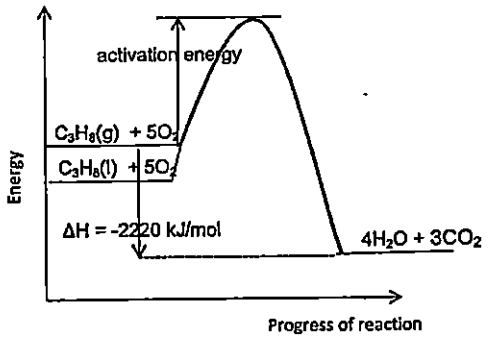
Zhonghua Secondary School

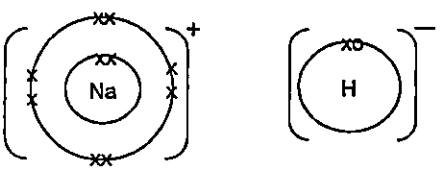
2015 Prelim Chemistry

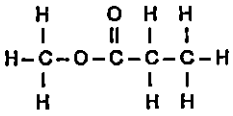
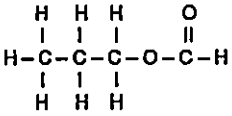
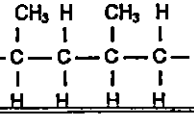
1	C	21	A
2	D	22	D
3	A	23	D
4	A	24	D
5	A	25	B
6	D	26	D
7	A	27	B
8	B	28	C
9	C	29	C
10	D	30	C
11	D	31	B
12	D	32	D
13	B	33	D
14	D	34	B
15	C	35	C
16	B	36	A
17	A	37	D
18	C	38	B
19	B	39	A
20	D	40	C

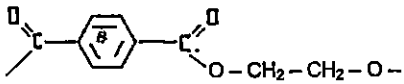
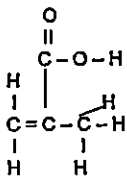
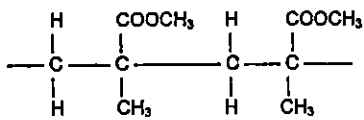
2015 Preliminary 2 Chemistry
Marking Scheme

A1	(a)	A or B	[1]
	(b)	F	[1]
	(c)	B	[1]
	(d)	A / B and C	[1]
	(e)	D	[1]
A2	(a)	$Ag^+(aq) + Cl^-(aq) \longrightarrow AgCl(s)$	[1]
	(b)	In step 2 there must be excess of silver nitrate solution and nitric acid to ensure all chloride ions are precipitated In step 3 the precipitate must be dried and weighed a number of time until a constant weight is obtained to ensure all water has evaporated from silver chloride	[1] [1]
	(c)	Moles of AgCl $= \frac{5.74}{143.5} = 0.04$ Mass of NaCl $= 0.04 \times 58.5 = 2.34\ g$ % of NaCl $= \frac{2.34}{2.5} \times 100 = 93.6$	[1] [1] [1]
	(d)	Carry out chromatography on the rock sample If there is one spot it is pure More than one spot it is impure Or Check the melting point of the rock sample If it melts at a fixed temperature it is pure If it melts over a range of temperature it is impure	[2]
A3	(a)	They form coloured compounds They have variable oxidation states	[1] [1]
	(b)	$Mn + H_2SO_4 \longrightarrow MnSO_4 + H_2$	[1]
	(c)	Experiment I: pale green solution turns pale pink, a grey deposit is formed Experiment II: pale green solution turns violet, a grey deposit is formed Experiment III: no reaction	[3]
	(d)	(i) $MnCO_3$ has the highest decomposition temperature Mn is the most reactive metal among the three metals, its compounds are the most stable and need more energy to decompose	[1] [1]
		(ii) Moles of $CO_2 = \frac{480}{24000} = 0.02$	[1]

		Relative Formula mass = $\frac{2\,3}{0\,02}$ = 115	[1]
		Relative atomic mass of M = 55 The metal is manganese	[1]
A4	(a)	(i) Electrode X. effervescence $4OH^-(aq) \longrightarrow 2H_2O(l) + O_2(g) + 4e$ Electrode Y. a silvery grey deposit $Ag^+(aq) + e \longrightarrow Ag(s)$ (ii) $AgNO_3$ solution slowly turns into acidic HNO_3 solution as OH^- ions are being discharged from the solution leaving behind H^+ ions.	[1] [1] [1] [1] [1] [1]
	(b)	(i) $Fe \longrightarrow Fe^{3+} + 3e$ (ii) 1 The electrons from the power source (-) travels to the steel pipe 2. Excess electrons on the steel pipe prevents the oxidation of iron (iii) Attached a block of Mg to the steel pipe Mg being more reactive than iron will corrode instead of iron $Mg \longrightarrow Mg^{2+} + 2e$	[1] [1] [1] [1] [1]
A5	(a)	 Correct diagram with labelling [2] (b) Correct position of liquid propane [1]	[2] [1]
	(c)	(i) Anode Equation 1 Cathode Equation 2 (ii) $C_3H_8(g) + 5O_2(g) \longrightarrow 3CO_2(g) + 4H_2O(g)$ (iii) Fuel cell is a more efficient way Using the generator a lot of heat is lost to the surroundings when fuel is burnt to generate steam to turn the turbine	[1] [1] [1]
	(d)	Paraffin is safer to use as it is a liquid and has a higher boiling point and is not as flammable as LPG	[1]
A6	(a)	(i) CO_2 - acidic, SiO_2 - acidic, PbO - amphoteric	[1]

		(ii) CO_2 is acidic dissolves in water to form H_2CO_3 SiO_2 is acidic. It reacts with CaO (a base) to form a salt,calcium silicate $SiO_2 + CaO \longrightarrow CaSiO_3$ PbO is amphoteric It reacts with acid to form a salt and water $PbO + 2HCl \longrightarrow PbCl_2 + H_2O$ PbO reacts with NaOH to from a salt, sodium plumbate, and water	[1] [1] [1] [1]
	(b)	Equation1 PbO is acting as a base It reacts with acid to form salt and water Equation 2 PbO_2 is an oxidising agent. PbO_2 oxidises Cl in HCl to Cl_2 There is an increase in oxidation state od chlorine from -1 to 0	[1] [1] [1]
B7	(a)	The first ionisation energy is removing one electron from the third shell which is furthest away from the nucleus hence lowest energy required. There is only a slight increase from the 2nd to 9th ionisation energy as this involves the removal of 8 electrons from the same second shell 10th and 11th ionisation energy are the highest as it involves removal from the first shell closest to the nucleus.	[1] [1] [1]
	(b)	(i) First ionisation energy of Na and Ar both involves removal of one electron from the third shell However the comletely-filled shell of Ar has extra stability It is more difficult to remove electron from this stable configuration and hence the ionisation energy is very high (ii) Formula of the hydride of the element: SiH_4 | PH_3 | — If all correct [1]	[1] [1] [1]
		(iii)  sodium hydride	[2]
		(iv) Similarity NaH and HCl are both soluble in water Difference NaH has high melting point and boiling point. HCl has low melting and boiling point	[1] [1]
B8	(a)	(i) Moles of 0 5 g of zinc $= \frac{0\,5}{65}$ $= 0\,007692$ Moles of H_2 $= 0\,007692$ Volume of H_2 $= 0\,007692 \times 24000$ $= 184\,6\ cm^3$	[1] [1]

		(ii) The zinc samples are impure	[1]
	(b)	In the experiments when 0 1 g to 0 6 g of zinc were used , zinc is the limiting reagent. In excess of 0 7 g of zinc, HCl is the limiting reagent	[1] [1]
	(c)	Moles of H_2 = $\frac{225}{24000}$ = 0 009375 Moles of HCl = 0 009167 x 2 = 0 01875 Concentration of HCl = $\frac{1000}{50}$ x 0 01875 = 0 375 mol/dm^3	[1] [1] [1]
	(d)	At a higher temperature the particles gain energy and move faster There are more particles that possess the minimum activation energy hence increase in effective collisions, increase in rate of reaction	[1] [1]
Either B9	(a)	(i) cracking (ii) heat, 60 atmospheric pressure and phosphoric (V) acid (iii) Process 2 is more viable as the source of glucose which comes from plants is renewable whereas petroleum in Process 1 is non-renewable (iv) Process 1 involves processes that require energy and at the same time produce a lot of waste products like CO_2 In Process 2 the carbon footprint is zero as the CO_2 produced during fermentation is absorbed by plants during photosynthesis	[1] [1] [1] [1] [1]
	(b)	(i) Ethanol is oxidized to ethanoic acid using acidified $K_2Cr_2O_7$ or $KMnO_4$ and heat $CH_3CH_2OH + O_2 \longrightarrow CH_3COOH + H_2O$ Ethanol is then heated with ethnoic acid in the presence of concentrated H_2SO_4 to produce ethyl ethanoate $CH_3COOH + CH_3CH_2OH \longrightarrow CH_3COOCH_2CH_3 + H_2O$ (ii)  Or 	[1] [1] [1] [1] [1]
OR B9	(a)		[1]

	(b)		[1]
	(c)	(i) 	[1]
		(ii) 	[1]
		(iii) Perspex does not break as easily as glass / Perspex when shattered does not injure as seriously as glass	[1]
	(d)	(i) The raw material of microbeads is crude oil and in future, oil will be very expensive as it is running low	[1]
		(ii) Ground nut shells occur naturally hence it is biodegradable and environmental friendly.	[1]
	(e)	(i) $2CH_2 + 3O_2 \longrightarrow 2CO_2 + 2H_2O$	[1]
		(ii) 1 tonne $CH_2 = \frac{1}{14} \times 10^6$ moles	
		Moles of $CO_2 = 0\ 07142 \times 10^6$	[1]
		Volume of $CO_2 = 0\ 07142 \times 10^6 \times 24\ dm^3$	
		$= 1\ 71 \times 10^6\ dm^3$	[1]
		OR $2C_3H_6 + 9O_2 \longrightarrow 6CO_2 + 6H_2O$	
		1 tonne $C_3H_6 = \frac{1}{42} \times 10^6$ moles	
		$= 0\ 023809 \times 10^6$	
		Moles of $CO_2 = 0\ 023809 \times 10^6 \times 3$	
		Volume of $CO_2 = 0\ 07142 \times 10^6 \times 24\ dm^3$	
		$= 1\ 71 \times 10^6\ dm^3$	