SWISS COTTAGE SECONDARY SCHOOL
SECONDARY FOUR EXPRESS
PRELIMINARY EXAMINATIONS

Name _____ ( ) Class 4E

CHEMISTRY **5073/01**

Monday 24 August 2015

Additional Materials. Multiple Choice Answer Sheet **1 hour**

READ THESE INSTRUCTIONS FIRST

Write in soft pencil
Do not use staples, paper clips, highlighters, glue or correction fluid
Write your name, class and index number on the Answer Sheet in the spaces provided unless this has been done for you

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 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 18
The use of an approved scientific calculator is expected, where appropriate

This document consists of 18 printed pages

Setter Mr Goh Weibin
Vetters ~~Mr Hoon Yongwei & Mdm Tan Pui San~~ [Turn over

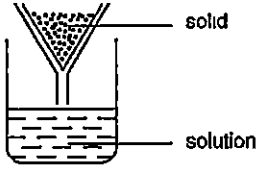
1 A crystal of iodine produces a coloured vapour when gently heated

Which pair of statements correctly describes this process?

	type of bond broken	formula of coloured species
A	intermolecular	I
B	intermolecular	I_2
C	intramolecular	I
D	intramolecular	I_2

2 A mixture of copper, magnesium and zinc is added to an excess of dilute sulfuric acid

The resulting mixture is then filtered



What is the colour of the filtrate?

A blue

B colourless

C grey

D pink

3 Which of these pairs of aqueous ions both react with dilute sulfuric acid to give a visible result?

A Ba^{2+} and Cl^-

B Ba^{2+} and CO_3^{2-}

C NH_4^+ and Cl^-

D NH_4^+ and CO_3^{2-}

4 Which atom has twice as many neutrons as protons?

A $^{1}_{1}H$ B $^{2}_{1}H$ C $^{3}_{1}H$ D $^{4}_{1}H$

5 The ^{68}Ge isotope is medically useful because it undergoes a natural radioactive process to give a gallium isotope, ^{68}Ga, which can be used to detect tumours. This transformation of ^{68}Ge occurs when an electron enters the nucleus, changing a proton into a neutron.

Which statement about the composition of an atom of the ^{68}Ga isotope is correct?

A It has 3 shells

B It has 5 electrons in its outer shell

C It has 37 neutrons

D Its proton number is 32

6 Hard water contains calcium ions and hydrogencarbonate ions arising from dissolved calcium hydrogencarbonate, $Ca(HCO_3)_2$.

How many electrons are present in the hydrogencarbonate ion?

A 30 B 31 C 32 D 33

7 Boron is a non-metallic element which is placed above aluminium in Group III of the Periodic Table. It forms a compound with nitrogen known as boron nitride which has a structure similar to graphite.

Which of the following conclusions can be drawn from this information?

1 The empirical formula of boron nitride is BN.

2 The boron and nitrogen atoms are likely to be arranged alternately in a hexagonal pattern.

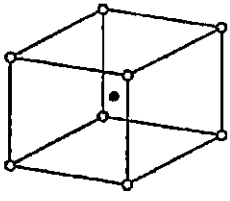
3 Boron nitride has a layer structure with intermolecular forces of attraction between the layers.

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

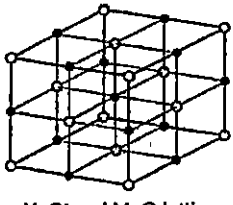
8 The table gives the radii, in pm, of some ions [1 pm = 10^{-12} m]

ion	radii
Na^+	102
Mg^{2+}	72
Cs^+	167
Cl^-	181
O^{2-}	140

Caesium chloride, CsCl, has a different lattice structure from both sodium chloride, NaCl, and magnesium oxide, MgO



CsCl lattice



NaCl and MgO lattice

Which factor appears to determine the type of lattice for these three compounds?

A the charge on the cation

B the ratio of the ionic charges

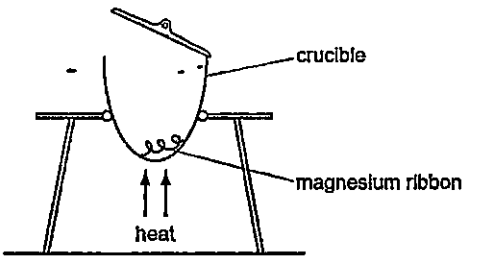
C the ratio of the ionic radii

D the sum of the ionic charges

9 Which relative molecular mass, Mr, is not correct for the molecule given?

	molecule	M_r
A	ammonia	17
B	carbon dioxide	44
C	methane	16
D	oxygen	16

10 The diagram shows an experiment to find the formula of magnesium oxide



Which piece of apparatus would be needed in addition to those shown?

A a balance

B a measuring cylinder

C a stopwatch

D a thermometer

11 Nickel makes up 20 % of the total mass of a coin The coin has a mass of 10 0 g.

How many nickel atoms are there in the coin?

A $2\,03 \times 10^{22}$ **B** 4.29×10^{22} **C** $2\,14 \times 10^{23}$ **D** $1\,20 \times 10^{24}$

12 On collision, airbags in cars can inflate rapidly due to the production of nitrogen

The nitrogen is formed according to the following equations.

$$2NaN_3 \rightarrow 2Na + 3N_2$$

$$10Na + 2KNO_3 \rightarrow K_2O + 5Na_2O + N_2$$

How many moles of nitrogen gas are produced from 1 mol of sodium azide, NaN_3?

A 1 5 **B** 1.6 **C** 3 2 **D** 4.0

13 Which oxide, when mixed with water, will produce the solution with the lowest pH?

A CO B Na_2O C P_4O_{10} D SiO_2

14 A sample of soil has a nitrogenous fertiliser in the form of an ammonium salt added to it The ammonium salt dissolved in the water in the soil

When tested a week later, the water in the soil contained 15 3 % of dissolved nitrogen and had a pH of 4 6

Calcium hydroxide was added to the soil and then the water in the soil was tested the next day, both for nitrogen content and pH

What would be the most likely result of the final test?

	% of nitrogen	pH
A	11 4	4 6
B	12.7	6.9
C	15 3	4 6
D	15 3	6 9

15 The table gives the concentrations and pH values of the aqueous solutions of two compounds X and Y Either compound could be an acid or base

	X	Y
concentration	2 mol/dm^3	2 mol/dm^3
pH	6	10

Student P concluded that X is a weak base

Student Q concluded that the extent of dissociation is lower in X(aq) than in Y(aq)

Which of the students are correct?

A both P and Q

b neither P and Q

C P only

D Q only

16 A student puts 10 cm^3 of 0·100 mol/dm^3 nitric acid into one test-tube and 10 cm^3 of 0·100 mol/dm^3 ethanoic acid into another test-tube. He then adds 1·0 g (an excess) of magnesium ribbon to each test-tube and takes suitable measurements. Both acids have the same starting temperature.

Neither reaction is complete after 2 minutes, but both are complete after 20 minutes.

Which statements are correct?

1 After 2 minutes, the nitric acid is at a higher temperature than the ethanoic acid

2 After 2 minutes, the nitric acid has produced more gas than the ethanoic acid

3 After 20 minutes, the nitric acid has produced more gas than the ethanoic acid

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

17 Rat poison needs to be insoluble in rain water but soluble at the low pH of stomach contents.

What is a suitable barium compound to use for rat poison?

A barium carbonate

B barium hydroxide

C barium nitrate

D barium sulfate

18 In which equation is the underlined substance acting as a reducing agent?

A $3\underline{CO} + Fe_2O_3 \rightarrow 2Fe + 3CO_2$

B $\underline{CO_2} + C \rightarrow 2CO$

C $\underline{CuO} + H_2 \rightarrow Cu + H_2O$

D $\underline{CaO} + H_2O \rightarrow Ca(OH)_2$

19 Sulfur dioxide, SO_2, is added to wines to prevent oxidation of ethanol by air To determine the amount of SO_2, a sample of wine is titrated with iodine, I_2 In this reaction, one mole of SO_2 is oxidised by one mole of I_2

What is the change in oxidation number of sulfur in this reaction?

A $+2 \rightarrow +4$ B $+4 \rightarrow +6$ C $+6 \rightarrow +4$ D $+4 \rightarrow +2$

20 A metal has the following properties

- It does not react with cold water
- It reacts with dilute hydrochloric acid
- It cannot be extracted from it oxide using carbon

Between which two metals in the reactivity series should it be placed?

A calcium and magnesium

B iron and copper

C magnesium and zinc

D zinc and iron

21 Which of the following carbonates shows the least change in mass after strong heating?

A calcium carbonate

B copper(II) carbonate

C sodium carbonate

D silver carbonate

22 Some calcium carbonate and hydrochloric acid start to react

Water is then added to the reaction mixture

What happens to the speed of the reaction?

A It decreases

B It increases

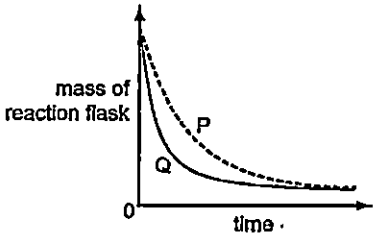
C It stays the same.

D It stops

23 A student investigates the rate of reaction between marble chips and hydrochloric acid

The loss in mass of the reaction flask is measured.

The graph shows the results of two experiments, P and Q



Which change explains the difference between P and Q?

A A catalyst is added in P.

B A higher temperature is used in P

C A higher pressure is used in Q

D Powdered marble chips are used in Q

24 The following report appeared in a newspaper

> Drums of bromine broke open after a vehicle crash on the motorway Traffic was diverted as purple gaseous bromine drifted over the road (it is denser than air), causing irritation to drivers' eyes Fireman sprayed water over the scene of the accident, dissolving the bromine and washing it away

What is **wrong** with the report?

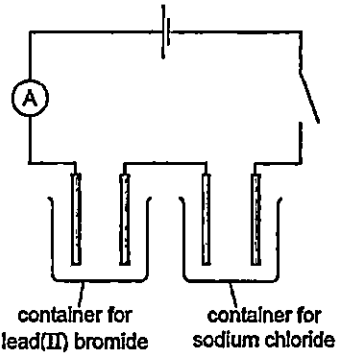
A Bromine does not dissolve in water

B Bromine does not vapourise readily

C Bromine is less dense than air.

D Bromine is not purple

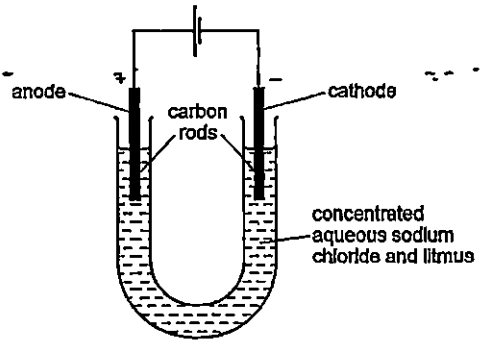
25 The diagram shows the circuit for electrolysing lead(II) bromide and sodium chloride to liberate the metal.



In which form are these salts electrolysed for liberating the metal?

	lead(II) bromide	sodium chloride
A	concentrated solution	concentrated solution
B	concentrated solution	molten
C	molten	concentrated solution
D	molten	molten

26 The diagram shows the electrolysis of concentrated aqueous sodium chloride



What is the colour of the litmus at each electrode after five minutes?

	colour at anode	colour at cathode
A	blue	green
B	red	green
C	colourless	green
D	colourless	blue

27 The ability of an atom in a covalent bond to attract electrons to itself is called its electronegativity

The greater the difference between the electronegativities of the two atoms in the bond, the more polar is the bond.

Which pair will form the **most** polar covalent bond between the atoms?

A chlorine and bromine

B chlorine and iodine

C fluorine and chlorine

D fluorine and iodine

28 Which substance does **not** produce a poisonous gas when burnt in a limited amount of air?

A hydrogen **B** methane **C** propene **D** sulfur

29 Which gas is present in the exhaust fumes of a car engine in a much greater amount than any other gas?

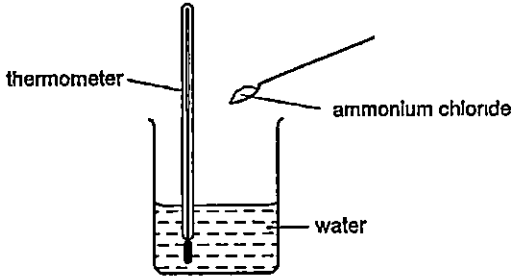
A carbon dioxide

B carbon monoxide

C nitrogen

D water vapour

30 When solid ammonium chloride is added to water, a solution is formed



Which row correctly shows the temperature change and the type of reaction taking place?

	temperature change	type of reaction
A	decreases	endothermic
B	decreases	exothermic
C	increases	endothermic
D	increases	exothermic

31 Some bond energy values are listed below.

bond	bond energy / kJmol^{-1}
C–H	410
C–*Cl*	340
Cl–*Cl*	244
Br–Br	193

These bond energy values relate to the following four reactions

P $Br_2 \rightarrow 2Br$

Q $2Cl \rightarrow Cl_2$

R $CH_3 + Cl \rightarrow CH_3Cl$

S $CH_4 \rightarrow CH_3 + H$

What is the order of enthalpy changes of these reactions from most negative to most positive?

A P → Q → R → S

B Q → R → S → P

C R → Q → P → S

D S → P → Q → R

32 Ethanol is a fuel used in cars It can be made from petroleum.

$$C_4H_{10} \rightarrow C_2H_4 + C_2H_6$$

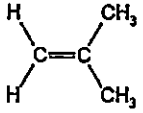
$$C_2H_4 + H_2O \rightarrow C_2H_5OH$$

$$C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O$$

Compounds of how many homologous series appear in these equations?

A 1 B 2 C 3 D 4

33 The compound 2-methylpropene, C_4H_8, is a monomer used in the production of synthetic rubber



In addition to 2-methylpropene there are x other isomers of C_4H_8 which contain a double bond.

What is the value of x?

A 1 B 2 C 3 D 4

34 One of the reactions taking place in a catalytic converter in a car exhaust system is between nitrogen oxide and octane (unburned petrol). The products of this reaction are non-toxic

Which is the correct equation for the reaction?

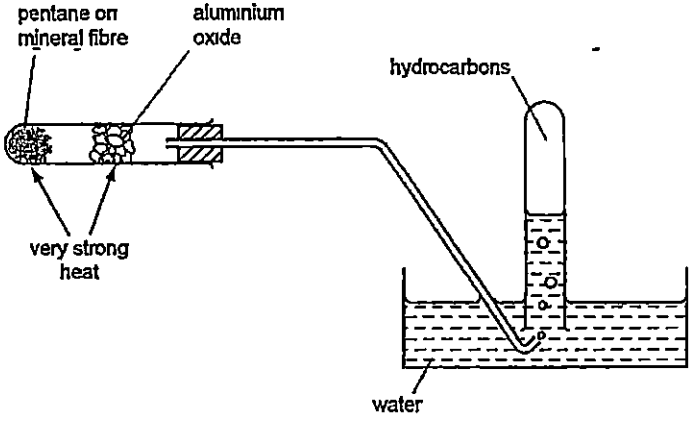
A $C_8H_{16} + 16NO \rightarrow 8CO + 8N_2 + 8H_2O$

B $C_8H_{16} + 24NO \rightarrow 8CO_2 + 12N_2 + 8H_2O$

C $C_8H_{16} + 17NO \rightarrow 8CO + 8\frac{1}{2}N_2 + 9H_2O$

D $C_8H_{16} + 25NO \rightarrow 8CO_2 + 12\frac{1}{2}N_2 + 9H_2O$

35 Which hydrocarbon would **not** be collected in the inverted tube by heating pentane, $CH_3(CH_2)_3CH_3$, in the apparatus shown?



A CH_4

B CH_3CH_3

C $CH_3CH_2CH{=}CH_2$

D $CH_3(CH_2)_8CH_3$

36 A pure hydrocarbon is used in bottled gas for cooking and heating.

Exactly 50 cm^3 of oxygen is needed for complete combustion of 10 cm^3 of the hydrocarbon.

30 cm^3 of carbon dioxide is produced

All gaseous volumes were measured at room temperature and pressure.

What is the formula of the hydrocarbon?

A C_2H_6 B C_3H_6 C C_3H_8 D C_4H_{10}

37 The solubility of the carboxylic acids in water decreases as the size of the carboxylic acid molecules increases

Which carboxylic acid is the least soluble in water?

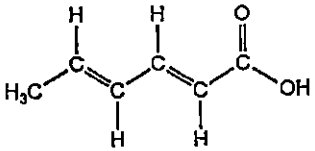
A butanoic acid

B ethanoic acid

C methanoic acid

D propanoic acid

38 Sorbic acid is used as a food preservative because it kills fungi and moulds.



sorbic acid

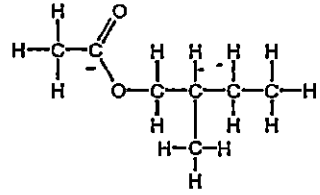
Sorbic acid will react with

- hydrogen in the presence of a nickel catalyst,
- bromine in an organic solvent

How many moles of hydrogen and of bromine will be incorporated into one mole of sorbic acid by these reactions?

	moles of hydrogen	moles of bromine
A	2	2
B	2	2 ½
C	3	2
D	3	2 ½

39 Bees use 2-methylbutyl ethanoate as an 'alarm' pheromone to alert other bees



2-methylbutyl ethanoate

Which starting materials would be required to synthesise 2-methylbutyl ethanoate?

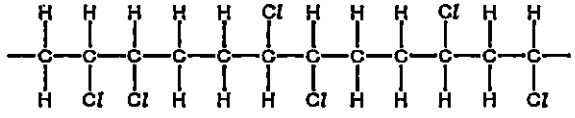
A CH_3CH_2OH and $CH_3CH_2CH(CH_3)CO_2H$

B CH_3CO_2H and $CH_3CH_2CH(CH_3)CH_2OH$

C CH_3CH_2OH and $CH_3CH_2CH(CH_3)CH_2CO_2H$

D CH_3CO_2H and $CH_3CH_2CH(CH_3)CH_2CO_2H$

40 A molecule of a polymer contained the sequence shown



Which monomer could produce this polymer by addition polymerisation?

A $CHCl{=}CHCl$

B $CH_2{=}CHCl$

C $CH_3CCl{=}CHCl$

D $CH_3CCl{=}CH_2$

DATA SHEET
The Periodic Table of the Elements

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 Sulphur 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	226 Ra Radium 88	227 Ac Actinium 89 †															

*58-71 Lanthanoid 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
†90-103 Actinoid series	232 Th Thorium 90	231 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 dm³ at room temperature and pressure (r.t.p.)

SWISS COTTAGE SECONDARY SCHOOL
SECONDARY FOUR EXPRESS
PRELIMINARY EXAMINATIONS

Name: _____( ) Class: Sec 4E _____

CHEMISTRY
Paper 2

5073/02
Thursday 20 Aug 2015
1 hour 45 min

Additional materials: Nil

READ THESE INSTRUCTIONS FIRST

Write in blue or black ink. You may use a calculator.

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

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

The number of marks is given in brackets [ ] at the end of each question or part of the question.
Omission of essential working will result in loss of marks.
A copy of the Periodic Table is printed on page **20**.

This question paper consists of **20** printed pages.

Setter: Mr Hoon Yeng Wei
Vetter: Mr Goh Weibin and Mdm Tan Pui San

[Turn over

*We Nurture Students to **Think, Care** and **Lead** with **P.R.I.D.E.***

Section A (50 Marks)

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

A1 The diagram shows the structures of various compounds.

substance	melting point / °C	boiling point / °C	electrical conductivity as a solid	electrical conductivity as a liquid
A	839	1484	good	good
B	-188	-42	poor	poor
C	776	1497	poor	good
D	-117	78	poor	poor
E	1607	2227	poor	poor
F	-5	102	poor	good

Use the letters **A** to **F** to answer the following questions.
Each compound may be used once, more than once or not at all.

(a) Which substance could be a metal?

.....[1]

(b) State all the substances that are liquid at room temperature?

.....[1]

(c) Which substance could have a macromolecular structure similar to that of silicon(IV) oxide?

.....[1]

(d) Which substance could be propane?

.....[1]

(e) Which substance could be sodium chloride?

.....[1]

A2 The table shows some properties of the Group I metals.

metal	density in g / dm^3	melting point / °C	boiling point / °C
lithium	0.53	181	1342
sodium	0.97	98	883
potassium	0.86	63	
rubidium	1.53	39	686
caesium	1.88	29	669

(a) **(i)** Describe the general trend in the density of the Group I metals.

.....[1]

(ii) Predict the boiling point of potassium.

.....[1]

(iii) What is the physical state of caesium at 35 °C? Explain your answer.

.....

.....[1]

(b) **(i)** Describe the trend in reactivity of the Group I metals with water.

.....[1]

(ii) Construct the equation for the reaction of rubidium with water.

.....[1]

(iii) The reaction of rubidium with water is exothermic.
What is meant by the term *exothermic*?

.....[1]

(c) Sodium and calcium form ionic hydrides containing the hydride ion, H^-.
Sodium and calcium hydrides react with water to form the hydroxide and hydrogen.

$$NaH + H_2O \rightarrow NaOH + H_2$$

$$CaH_2 + 2H_2O \rightarrow Ca(OH)_2 + 2H_2$$

Deduce the general ionic equation for these reactions.

.....[1]

(d) Sodium is a soft metal with little catalytic activity.
Nickel is a hard metal which is often used as a catalyst.

(i) Describe two **other** differences in the physical properties of sodium and nickel.

1 .....

.....

2 .....

.....

[2]

(ii) State one industrial use of nickel as a catalyst.

.....[1]

(iii) Explain why an alloy of nickel and copper is less malleable than copper alone.

.....

.....

.....

.....

..... [2]

5

A3 The melting point of sodium chloride is 801 °C.
The melting point of chlorine is –101 °C.

(a) Explain, in terms of structure and bonding, the difference between the melting points of these two substances.

.....

.....

.....

.....

.....

.....

.....[3]

(b) Explain why molten sodium chloride conducts electricity but solid sodium chloride does not.

.....

.....

.....

.....

.....

.....

.....[2]

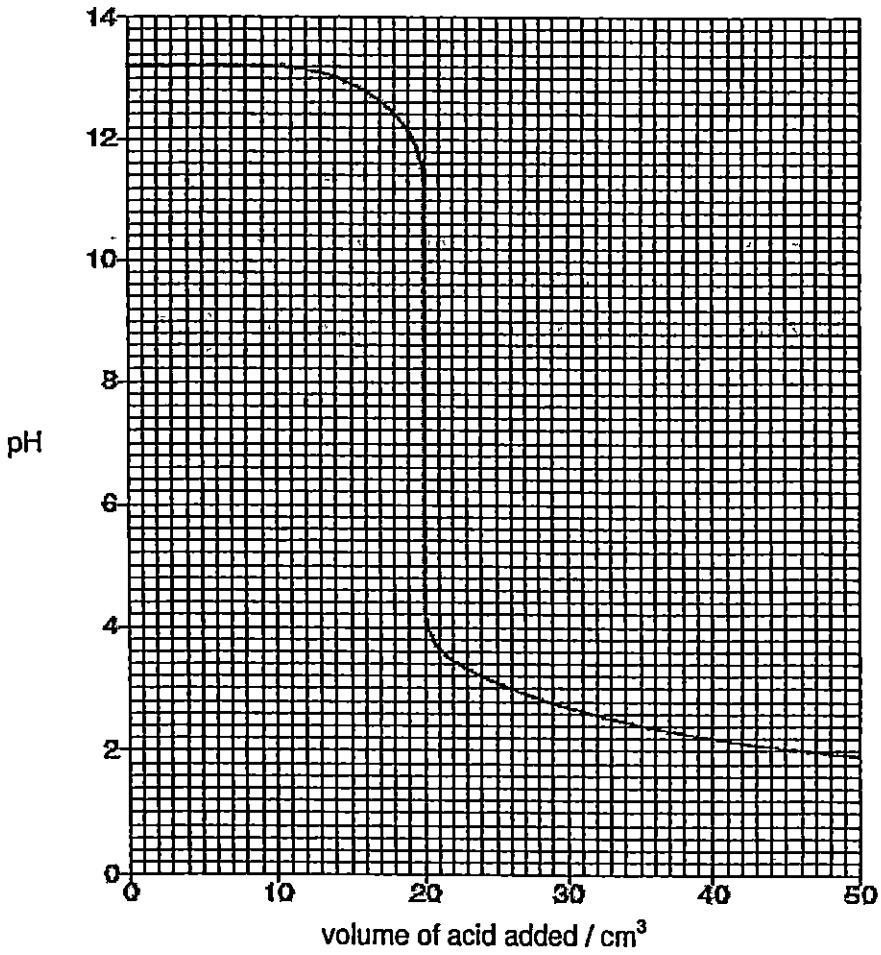
A4 Sulfuric acid reacts with the alkali sodium hydroxide.

$$H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$$

(a) Write the ionic equation for this reaction.

.....[1]

(b) The graph below shows how the pH changes when aqueous sulfuric acid is added slowly to 45.0 cm^3 of 0.150 mol / dm^3 sodium hydroxide until the acid is in excess.



(i) What volume of acid has been added when the pH is 7?

.....[1]

(ii) Use your answer to part (i) to calculate the concentration, in mol / dm^3, of the sulfuric acid.

[3]

(c) The experiment was repeated using ethanoic acid of the same concentration as the sulfuric acid The same volume and concentration of aqueous sodium hydroxide was used.

(i) The volume of ethanoic acid required to neutralise the aqueous sodium hydroxide was twice as great compared with the volume of sulfuric acid.

Explain why.

.....

.....[2]

(ii) Suggest the value of the pH after excess ethanoic acid has been added.

.....

.....[1]

(d) Sulfuric acid is one of the acids present in acid rain.

(i) Suggest how sulfuric acid is formed in the atmosphere.

.....

.....

.....[2]

(ii) State one effect of acid rain on human health.

.....

..... [1]

A5 Chromium is a transition element.

(a) (i) State two differences in the physical properties of chromium and sodium.

.....

.....

.....

.....[2]

(ii) State two differences in the chemical properties of chromium and sodium.

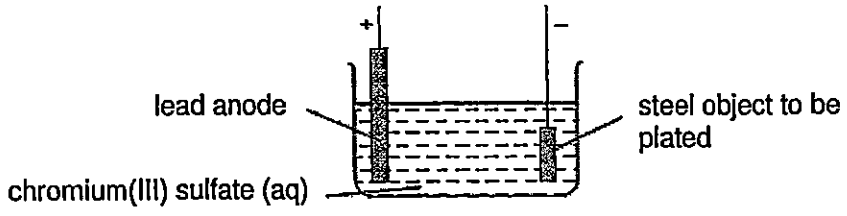
.....

.....

.....

.....[2]

(b) Chromium is used in minute amounts in producing stainless steel. Chromium is also used to electroplate steel objects. The diagram shows how this could be done.



(i) Suggest **two** reasons why steel objects are plated with chromium.

.....

.....[2]

(ii) Write the ionic half-equation for the reaction at the negative electrode.

.....[1]

(iii) During the electroplating process, a colourless gas is formed at the positive electrode. Suggest the name for this gas and describe the test for it.

.....

.....

.....

.....[2]

(iv) During electroplating, it is necessary to add more chromium(III) sulfate but during copper plating using a copper anode, it is not necessary to add more copper(II) sulfate. Explain this difference.

.....

.....

.....

.....

.....

.....[2]

A7 Iodine reacts with chlorine to form dark brown iodine monochloride.

$$I_2 + Cl_2 \rightarrow 2ICl$$

(a) Calculate the overall energy change for the reaction between iodine and chlorine using the bond energy values shown.

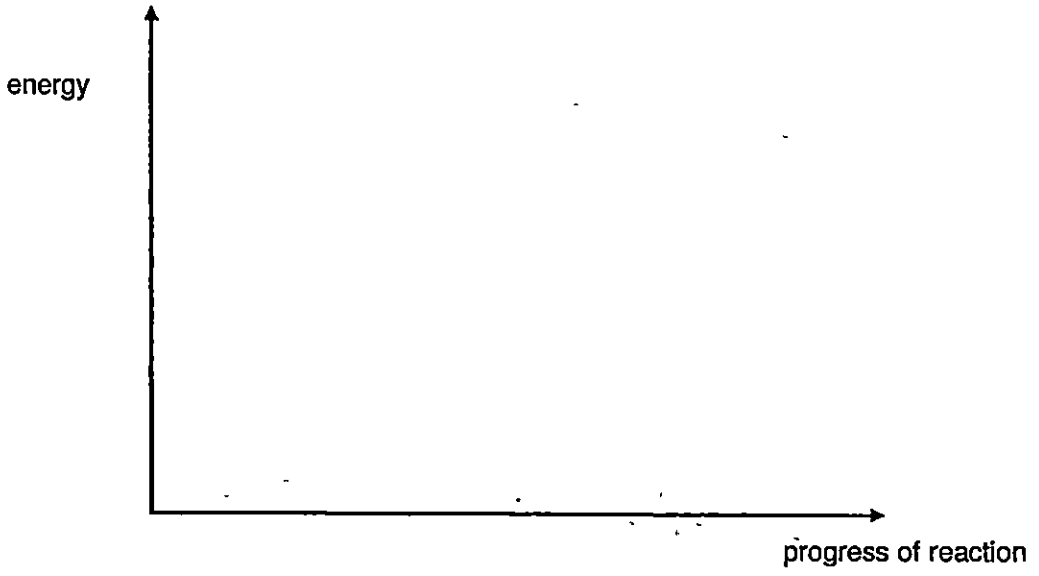
bond	energy / kJ per mol
I - I	151
Cl - Cl	242
I - Cl	208

Show your working.

[3]

11

(b) Draw a labelled energy level diagram for the reaction between iodine and chlorine using the information in **(a)**. Label '**activation energy** and '**ΔH**'.



[3]

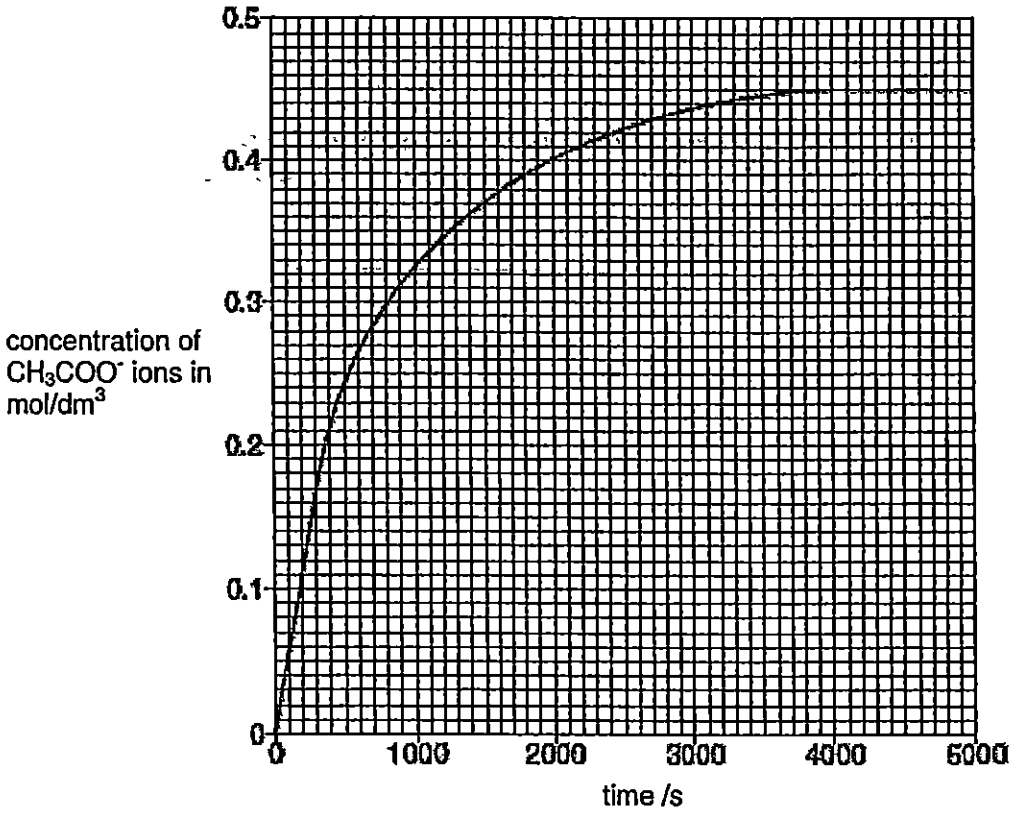
Name:_____( ) Class:____

Section B

Answer all **three** questions from this section.
The last question is in the form either/or and only **one** of the alternatives should be attempted.
The total mark for this section is 30

B8 The ester, ethyl ethanoate, reacts with hydroxide ions to form ethanoate ions and ethanol.

The graph shows how the concentration of ethanoate ions, CH_3COO^-, changes as the reaction proceeds at 25 °C.



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

.....[1]

13

(b) Describe and explain, using the kinetic particle theory, the change in the rate of reaction with time in the above graph.

.....

.....

.....

.....

.....[3]

(c) Use the information in the graph to deduce the mass of ethanoate ions in 200 cm^3 of solution when the reaction is complete.

[2]

(d) Use the information in the graph to calculate the average rate of reaction, in mol / dm^3 / s, during the first 300 seconds.

[1]

(e) Describe how, and explain why, the rate of reaction changes with increase in concentration of hydroxide ions.

.....

.....

.....

.....[2]

(f) Sketch on graph, the curve you would expect if the reaction is done at 40 °C. Label this curve H.

[1]

B9 There are two types of polymerisation, addition and condensation.

(a) Explain the difference between these two types of polymerisation.

.....

.....

.....

..... [1]

(b) Some plastics, formed by polymerisation, are non-biodegradable.
Describe two pollution problems that are caused by non-biodegradable plastics.

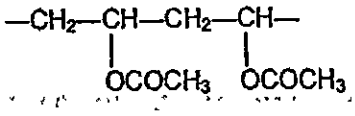
.....

.....

.....

.....[2]

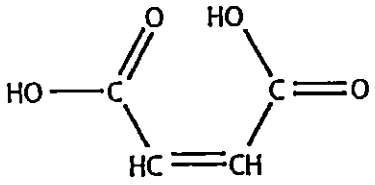
(c) The polymer known as PVA is used in paints and adhesives. Its structural formula is shown below.



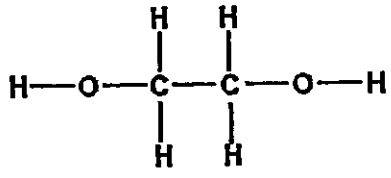
Deduce the structural formula of its monomer.

[1]

(d) The structural formulae of butenediol acid and ethane-1,2-diol are shown.



butenediol acid



ethane-1,2-diol

15

Describe the visible observations when butenediol acid or ethane-1,2-diol reacts with

(i) aqueous bromine

.....

.....[1]

(ii) aqueous sodium carbonate

.....

.....[1]

(iii) acidified potassium(VII) manganate

.....

.....[1]

(e) Butenediol acid and ethane-1,2-diol can undergo condensation polymerisation under the right conditions to form a polymer **W**.

Draw the structural formula of a repeat unit of the polymer **W** and circle the group that links the monomers together.

[2]

(f) Butenediol acid can undergo self-polymerisation under the right conditions to form a polymer **X**.

Draw the structural formula of two repeat units of the polymer **X**.

[1]

Either

B10

'Tin cans' are often used as containers for food. In fact, a 'tin can' is made from a steel alloy with a thin coating of tin on it

To recover the tin from used cans, they crushed and then warmed with chlorine. The tin forms tin(IV) chloride, boiling point 114 °C, which distils from the mixture.

On stronger heating, the tin(IV) chloride decomposes into molten tin and chlorine, which is re-used.

(a) Suggest why the steel alloy is coated with tin for use in food containers.

.....

.....[1]

(b) Draw the 'dot-and-cross' diagram to show the bonding in tin(IV) chloride. Show outer electrons only.

[2]

(c) Is the bonding in this compound ionic or covalent? Give an explanation for your answer.

.....

.....[2]

(d) Construct the balanced chemical equation for the decomposition of tin(IV) chloride. Explain why this decomposition is an example of a redox.

.....

.....

.....[2]

17

(e) Calculate the mass volume of chlorine gas produced from the decomposition of 30 g of tin(IV) chloride.

[3]

Or

B10

A 6.30 g sample of hydrated ethanedioic acid, $H_2C_2O_4.xH_2O$, was dissolved in water and the solution made up to 250 cm^3.

A 25.0 cm^3 sample of this solution was acidified and titrated with 0.100 mol / dm^3 potassium manganate(VII) solution. 20.0 cm^3 of this potassium manganate(VII) solution was required to react fully with the ethanedioate ions, $C_2O_4^{2-}$, present in the sample.

(a) The MnO_4^- ions in the potassium manganate(VII) *oxidise* the ethanedioate ions.

(i) How does the oxidation state of Mn change during the reaction?

.....

....[1]

(ii) Complete and balance the ionic equation for the reaction between the manganate(VII) ions and the ethanedioate ions.

$2MnO_4^-(aq) + 5C_2O_4^{2-}(aq) + ...H^+(aq) \rightarrow .....Mn^{2+}(aq) + 10CO_2(aq) + ...H_2O(l)$

[1]

(b) **(i)** Calculate the number of moles of manganate(VII) used in the titration.

[1]

(ii) Calculate the relative formula mass of $H_2C_2O_4.xH_2O$.

[3]

(ii) The relative formula mass of anhydrous ethanedioic acid, $H_2C_2O_4$, is 90. Calculate the value of x in $H_2C_2O_4.xH_2O$.

[1]

(c) (i) Suggest and draw the full structural formula of anhydrous ethanedioic acid, $H_2C_2O_4$.

[1]

(ii) Draw the 'dot-and-cross' diagram to show the bonding in anhydrous ethanedioic acid, $H_2C_2O_4$.

[2]

~ End of paper ~

DATA SHEET
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 Sulphur 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	226 Ra Radium 88	227 Ac Actinium 89 †															

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

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

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.).

Swiss Cottage Secondary
2015 4E Prelim Examinations
Mark Scheme

Section A

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

Paper 2 Section A

Qn		Mark Scheme	M	Markers Comments
A1	a	A	1m	
	b	D and F	1m	
	c	E	1m	
	d	B	1m	
	e	C	1m	

A2	a i	Density generally increases down the group	1m	
	a ii	760 °C (Allow between 710 – 860 °C)	1m	
	a iii	The physical state is liquid and melting point is below 35 °C and boiling point is above 35 °C.	1m for both correct	
	b i	Metals in Group I are generally more reactive down the group	1m	
	b ii	$2Rb + 2H_2O \rightarrow 2RbOH + H_2$	1m	
	b iii	Exothermic is a reaction which releases heat / releases energy to the surroundings	1m	
	c	$H^- + H_2O \rightarrow OH^- + H_2$	1m	
	d i	Any two of the following • sodium has low density but nickel has high density • sodium has low melting and boiling point but nickel has high melting and boiling point	1m each [2m]	
	d ii	Any two from the following • sodium is more reactive than nickel, • nickel has more than one oxidation state, sodium has one, • nickel forms coloured compounds, sodium compounds are white; • sodium reacts with cold water, nickel does not, • nickel has catalytic properties, sodium does not	1 m for each point [2]	

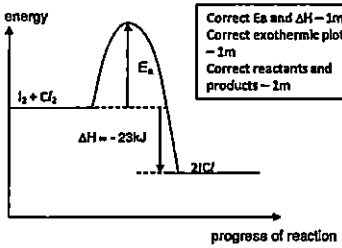
2

	d iii	Use in the manufacture of margarine / hydrogenation of alkenes	1m	
	d iv	Different sized nickel atoms are added to disrupt the orderly arrangement of copper atoms [1] Thus the layers of copper atoms cannot slide past one another as easily as before addition of nickel making it less malleable [1]	1m each [2m]	
A3	a	Cl_2 is a covalent substance/ molecule with a simple molecular structure [0.5] There is weak intermolecular force of attraction between molecules [0 5] Thus little heat energy is required to overcome these weak forces of attraction [0 5] Thus, Cl_2 has a low melting and boiling point. On the other hand, NaCl is an ionic compound with a giant ionic structure. [0.5] There is strong electrostatic force of attraction between oppositely charge ions [0 5] Thus high heat energy is required to overcome these strong forces of attraction.[0.5] Thus, NaCl has a high melting and boiling point.	0.5m for each point [3]	
	b	Molten sodium chloride does conduct electricity as it has mobile ions to act as charge carriers. [1] On the other hand, the ions in solid sodium chloride are held in fixed positions thus are not mobile to act as charge carriers. [1]	1 m for each point [2]	

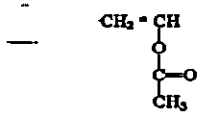
A4	a	$H^+ + OH^- \rightarrow H_2O$	1m	
	b I	20 cm^3 or 0 02 dm^3	1m	
	b II	No of moles of NaOH = 0 15 × 0.045 = 0 00675 mol [1] Comparing mole ratio, H_2SO_4/ NaOH = 1 / 2 No of moles of H_2SO_4 = 1 / 2 x 0 00675 = 0 003375 mol [1] concentration = 0 003375 ÷ 0 02 = 0 169 mol/dm^3 [1]	1 m for each point [3]	
	c I	The volume of ethanoic acid used will be doubled / 40 cm^3. [1] 1 mole of ethanoic acid dissociates in water to produce 1 mol of H^+ whereas 1 mole of H_2SO_4 produces 2 per mol of H^+. [1] Thus for the same concentration, the volume required for ethanoic acid to neutralise sulphuric acid is twice as much	1 m for each point [2] Reject definition of 'strong' and 'weak' acid	
	c II	Any pH value between 3 and 6 9 inclusive	1 m	

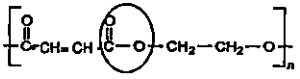
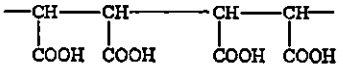
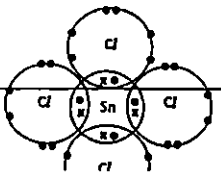
	d I	Sulfur dioxide from volcanic activity / combustion of fossil fuels[1] reacts with water in the atmosphere to produce sulfurous acid which is slowly oxidised to form sulfuric acid. [1]	1 m for each point [2]	
	d II	Any one of the following • corrode buildings • irritates skin • irritates eyes • leaching of nutrients • harm to marine life	1 m	
A5	a	$Cr^{3+}(aq) + 3e^- \rightarrow Cr(s)$	1 m for equation 1 m for correct state symbols [2]	
	b	$4OH^- \Rightarrow 2H_2O + O_2 + 4e$ [1] Oxygen gas is produced Place a glowing splint [1] near the electrode, the glowing should relight / rekindle [1]	1 m for each point [3]	
	c	Chromium(III) sulfate is added to replace the chromium(III) ions that were used to plate steel [1] However, during copper plating using a copper anode, the copper(II) ions are replaced from the oxidation of the copper anode [1]	1 m for each point [2]	

A6	a	Energy absorbed in bond breaking = 1(I - I) + 1 (Cl - Cl) = +151 + 242 = 393 kJ [1m] Energy released in bond making = 2 (I - Cl) = 2(-208) = 416 kJ [1m] Energy change = + 393+ (-416) = - 23 kJ [1m][3]	Minus 1 for each of the following no units/sign (only for final step) allow ECF in final step	
	b	The reaction is exothermic. The heat energy absorbed for bond breaking in 1 mole of iodine and 1 mole of chlorine[1] is less than the heat energy released in the bond forming of 2 moles of iodine monochloride [1]	1m for each point [2]	

	c	 Correct Ea and ΔH – 1m Correct exothermic plot – 1m Correct reactants and products – 1m	Minus 1 mark for each of the following • Arrow points in opposite direction/double head arrow/arrow too long or too short. If exothermic plot given, ECF for Ea and ΔH, and reactants and products [3]	
B 7	a	$CH_3COOC_2H_5 + OH^- \rightarrow CH_3COO^- + C_2H_5OH$ A $CH_3COOC_2H_5 + NaOH \rightarrow CH_3COONa + C_2H_5OH$ A $CH_3COOC_2H_5 + H_2O \rightarrow CH_3COOH + C_2H_5OH$	[1]	•
	b	1 The rate of reaction decreases with time / reaction slows down [1] 2 As concentration/number of mole of ethyl ethanoate and hydroxide ions or reactant per unit volume decreases [1], 3 frequency of effective collision decreases. [1]	[3] No mark if candidates discussed with respect to temperature and SA, even if point 2 and 3 were mentioned	•

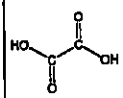
	c	Concentration of ethanoate = 0 45 mol / dm^3 No of moles of ethanoate ions = 0 45 x 200/100 = 0 09 mol [1] mass = 0 09 × 59 = 5.31 g [1]	[2] No mark for missing unit	•
	d	Average rate = 0 16/0 17 ÷ 300 = 5.33/5 67 × 10^{-4} mol/dm^3 s^{-1}[1]	[1] No mark for missing/incorrect unit or incorrect sig fig	
	e	1 The concentration of ethanoate ions will double/increase [1] 2 as the ethanol is oxidized by atmospheric oxygen to form ethanoic acid which will dissociate to form ethanoate ions [1]	[2]	•
	f	Steeper initial gradient only [1]	[1]	
B8	a	(any one) 1 Addition polymerization is where there is only one product involves unsaturated monomers with carbon – carbon double bonds Condensation polymerization involves monomers with functional group such as carboxyl group, hydroxyl group and amino group 2 Addition polymerization produces addition polymers which are made up of repeating units bonded together by carbon to carbon single covalent bond Condensation polymerization produces condensation polymers which are made up of	[1]	•

		repeating units bonded together by ester or amide linkages 3 In addition polymerization, monomers are joined together to form an addition polymer without the removal of small molecules Condensation polymerization monomers are joined together to form a condensation polymer with the removal of small molecules.		
	b	(any two) 1 Burning of plastics releases poisonous gases. 2 It causes land pollution as they take up space in landfills 3 Marine animals may mistake plastic bags for food and choke on them 4 Plastics may clog up rivers and drains, which might become breeding grounds for mosquitoes	[2]	
	c		[1]	
	dI	With butenediol acid, reddish brown aqueous bromine is decolourised but remains reddish brown with ethane-1,2-diol	[1]	
	dII	With butenediol acid, bubbles of colourless odourless gas will be observed but no visible change with ethane-1,2-diol.	[1]	
	dIII	With ethane-1,2-diol, purple acidified $KMnO_4$ is	[1]	

		decolourised but remains purple with butenediol acid.		
	ei		1m for correct circle 1m for correct structure [2]	
	eii		[1]	
B 1 0	a	The tin acts as a protective layer and prevents the iron in steel from rusting/coming into contacts with oxygen and moisture in the air	[1]	
	b	The bonding is covalent [1] This is because $SnCl_4$ has a relatively low boiling point. [1]	[2]	
	c		1m for correct bonding 1m for all correct valence electrons	

10

			[2] No deduction of marks for wrong size.	
	d	$SnCl_4 \rightarrow Sn + 2Cl_2$ [1] The oxidation states of tin in $SnCl_4$ has decreased from +4 to 0 in tin and $SnCl_4$ is reduced Chlorine in $SnCl_4$ has increased from -1 to 0 in Cl_2 and $SnCl_4$ is oxidised [1] Thus the reaction is a redox reaction.	[2]	•
	e	No of moles of $SnCl_4$ = 30 / 261 = 0 11494 mol [1] Compare mole ratio, Cl_2 / $SnCl_4$ = 2 / 1 No of moles of sulfur = 2 x 0 11494 } [1] = 0.22988 mol Volume of chlorine gas produced = 0 22988 x 24 = 5.52 dm^3 (3sf) [1]	[3]	•
B 9	al	$2MnO_4^-(aq) + 5C_2O_4^{2-}(aq) + 16H^+(aq) \rightarrow 2Mn^{2+}(aq) + 10CO_2(aq) + 8H_2O(l)$	[1]	

	aII	The oxidation state of Mn in MnO_4^- decrease from +7 to +2 in Mn^{2+}	[1]	
	bI	No of moles of MnO_4^- = 0 02 × 0 100 = 2×10^{-3} mol	[1]	
	bII	Comparing mole ratio, $C_2O_4^{2-}$ / MnO_4^- = 5 / 2 No of moles of $C_2O_4^{2-}$ = 5 / 2 x 2 ×10^{-3} (1m) = 5× 10^{-3} mol No of moles of $C_2O_4^{2-}$ in 6.3 g = 5 × 10^{-3} x 250/25 = 0 05 mol [1m] Relative molecular mass of $H_2C_2O_4.xH_2O$ = 6.3 / 0 05 = 126 [1m]	[3]	
	bIII	Value of x = (126 – 90) / 18 = 2	[1]	
	cI		[1]	
	cII	*Students need to refer to c(I) and draw the representative 'dot and cross' diagram	1m for correct bonding	

			1m for all correct valence electrons [2] No deduction of marks for wrong size.	