ZHONGHUA SECONDARY SCHOOL

PRELIMINARY EXAMINATION 2020

SECONDARY 4E

Candidate's Name	Class	Register Number

CHEMISTRY 6092 /02

14 September 2020
1 hour 45 minutes

Additional Materials: NIL

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.

Write your answers 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 20.

For Examiner's Use	
Section A	/50
B9	/10
B10	/10
B11	/10
Total	/80

Setter: Mrs Maybrie Ang & Ms Julia Yeo
Vetter: Ms Ong Lay Hong

This document consists of **20** printed pages, including this cover page.

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 a list of substances.

Table 1.1

sodium	graphite	lead(II) hydroxide	calcium carbonate
lead(II)chloride	chlorine	iron(II) chloride	sulfur dioxide

Use the list of substances to answer the following questions. Each substance can be used once, more than once, or not at all.

Which substance

(a) can be decomposed by heat to give a gaseous product at room temperature and pressure?

……..... [1]

(b) dissolves in both acids and alkalis?

……..... [1]

(c) consists of particles that have the highest kinetic energy at room temperature and pressure?

……..... [1]

(d) is formed during electrolysis of concentrated aqueous sodium chloride.

……..... [1]

(e) has a giant covalent structure.

……..... [1]

[Total:5]

A2 Fig 2.1 shows an article from a textbook about elderberries.

Elderberries are widely used in wine making. Extract of elderberries is a useful pH indicator and it can be separated by chromatography.

As an indicator, the colour of the extract changes to pink at a pH of 2 – 3 and to blue at a pH of 11 – 12.

elderberries

Fig 2.1

(a) The chromatogram, Fig 2.2, was obtained when water was added to a drop of elderberries extract at the centre of a filter paper.

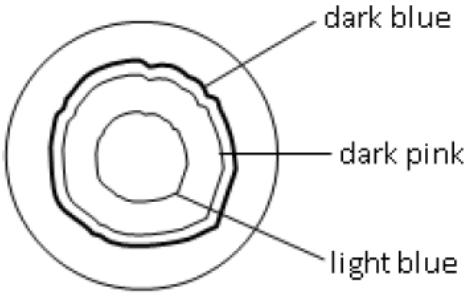


Fig 2.2

(i) Predict the colour of the elderberries extract at pH 7.

……..... [1]

(ii) An alternative set-up for the above experiment was shown in Fig 2.3 below.

dye	R_f value	distance travelled (cm)
light blue	0.2	
dark pink	0.4	1.00
dark blue	0.5	

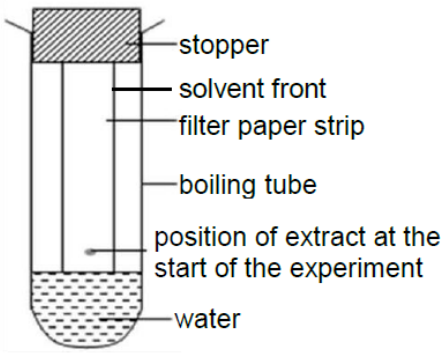


Fig 2.3

[1]

Given that the distance travelled by the dark pink dye is 1.00 cm, complete the table above by stating the distance travelled by the light blue and dark blue dyes.

(b) Fig 2.4 below shows how pH values changed during a titration when an acid was added from a burette into an alkali. A few drops of elderberries extract were added at the start of titration to monitor the pH of the solution.

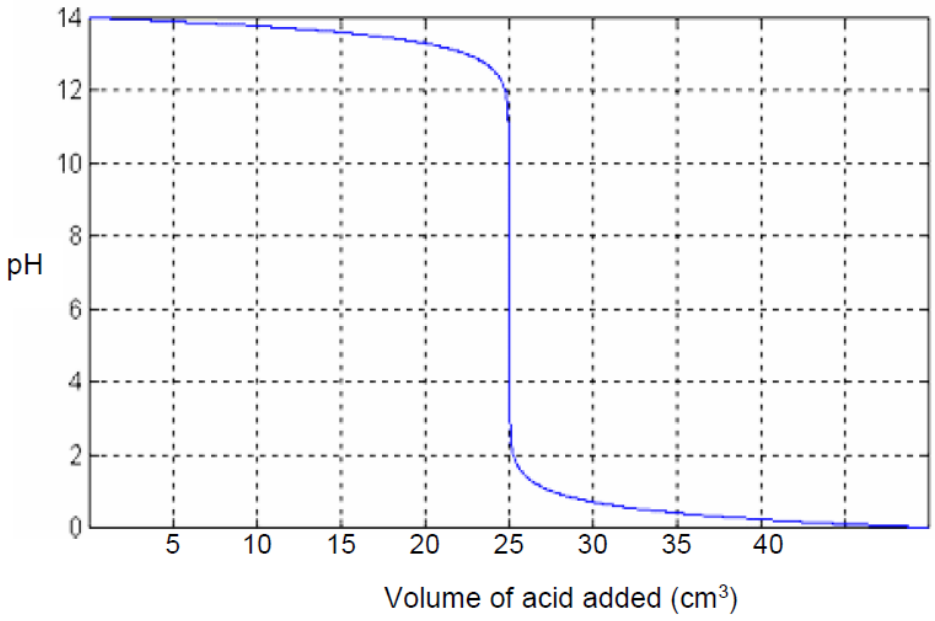


Fig 2.4

(i) State and explain what could be one possible chemical formula of the alkali used.

……

…… [2]

(ii) State the colour of the elderberries extract when the volume of acid added was

20 cm^3 ……

30 cm^3 …… [2]

[Total:6]

A3 An unknown colourless solution, **X**, was spotted in the laboratory. Several tests were carried out as shown in Fig 3.1.

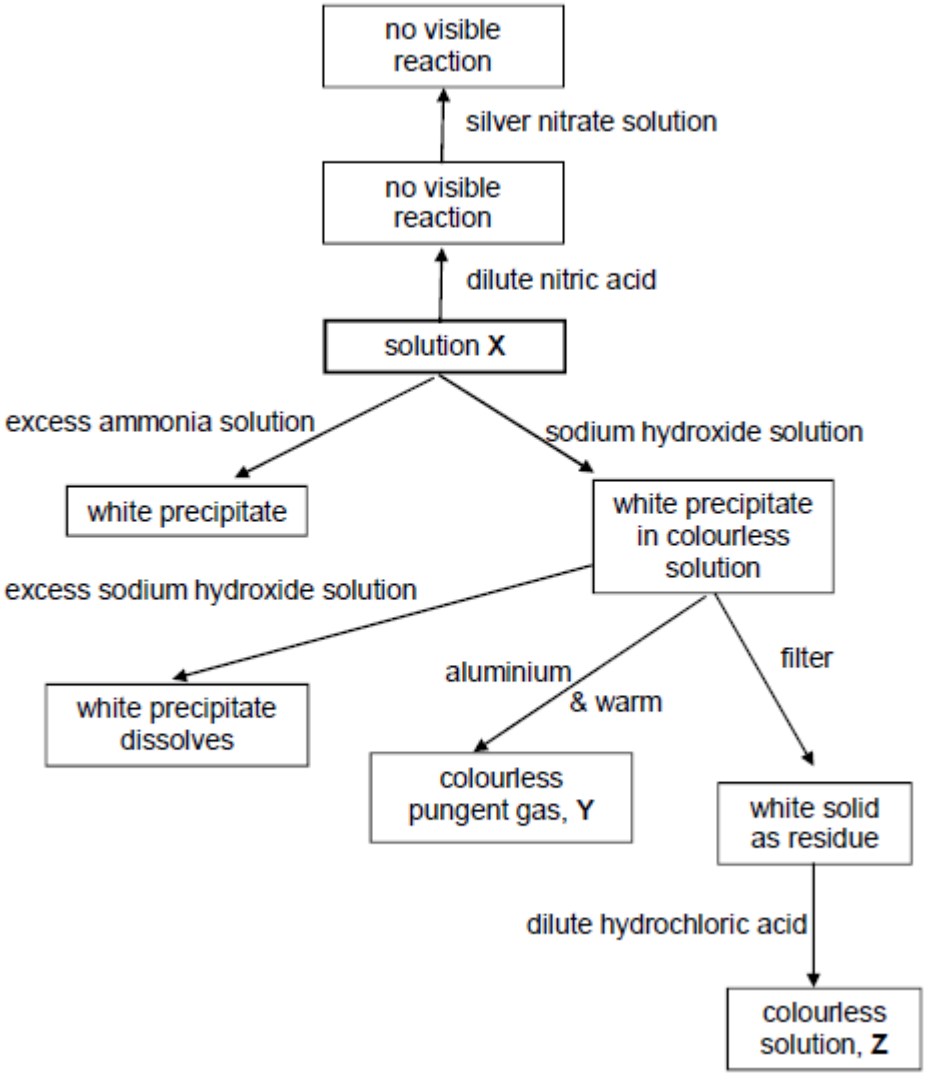


Fig 3.1

(a) Identify gas **Y** and describe a test to confirm the identity.

……

…… [2]

(b) Identify solution **Z** and write balanced equation with states symbols for the formation of solution **Z**.

……

…… [2]

(c) Prior to the addition of silver nitrate solution, dilute nitric acid was added to unknown solution **X**. Explain the purpose of adding dilute nitric acid and how does the observation made lead to the conclusion.

……

……

…… [2]

[Total:6]

A4 Fig 4.1 is a label found on a bottle of cleaning agent. It can be used to remove tarnish from steel pipes. Read the information on the label and answer the questions that follow.

TOTALSHINE

- Removes rust stains quickly and effectively.
- Removes tarnishes and restores original shine of surfaces without damaging them.

Directions:
1. Pour directly on surface or apply on cloth or sponge to use.
2. Leave it for 2 – 5 minutes and rinse with water.

CAUTION:
Not recommended for application on surfaces of marble.
Active ingredient: Phosphoric acid (H_3PO_4), a weak acid

Fig 4.1

(a) TOTALSHINE contains phosphoric acid. With the help of an ionic equation, explain why phosphoric acid is a tribasic acid and a weak acid?

……

……

…… [2]

(b) Explain why a steel pipe will tarnish after some time.

…… [1]

(c) Write a balanced chemical equation for the reaction that occurs when TOTALSHINE is applied to rust, Fe_2O_3.

…… [1]

(d) Why is it important to rinse the object with water after TOTALSHINE has been applied?

……..... [1]

(e) Why TOTALSHINE should not be used to clean a dirty marble table top?

……..

……. [1]

[Total:6]

A5 The bond dissociation energies of some hydrogen halides are shown in Fig 5.1. Bond dissociation energy is the energy that must be provided to the molecule in order to break the bond.

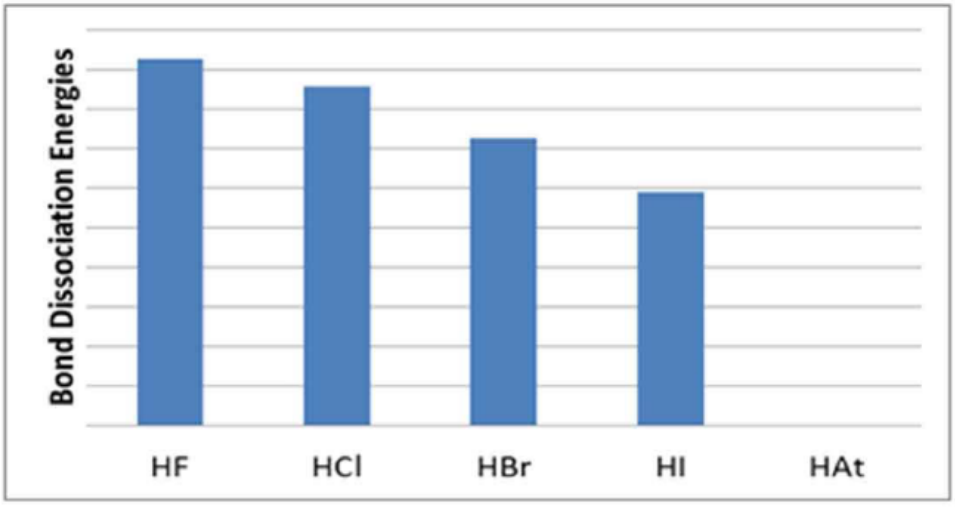


Fig 5.1

(a) Describe the trend shown in the above chart.

……..... [1]

(b) Predict the bond dissociation energy of hydrogen astatide, HAt, by drawing the rectangular bar in the chart above. [1]

(c) **(i)** Suggest which one of the hydrogen halides forms the strongest acid.

……..... [1]

(ii) Explain your answer to **(c)(i)**.

……

……. [1]

(d) Hydrogen bromide can be produced by reacting hydrogen and bromine according to the following reaction.

$$H_2\,(g) + Br_2\,(g) \rightarrow 2HBr\,(g)$$

The bond energies of some bonds are shown in Table 5.1 below.

Table 5.1

bond	H-H	H-Br	Br-Br
bond energy (kJ/mol)	432	363	193

Calculate the enthalpy change of this reaction and state whether it is exothermic or endothermic.

[2]

[Total:6]

A6 Fig 6.1 shows the results of experiments involving the reaction of calcium and excess water, carried out under different conditions.

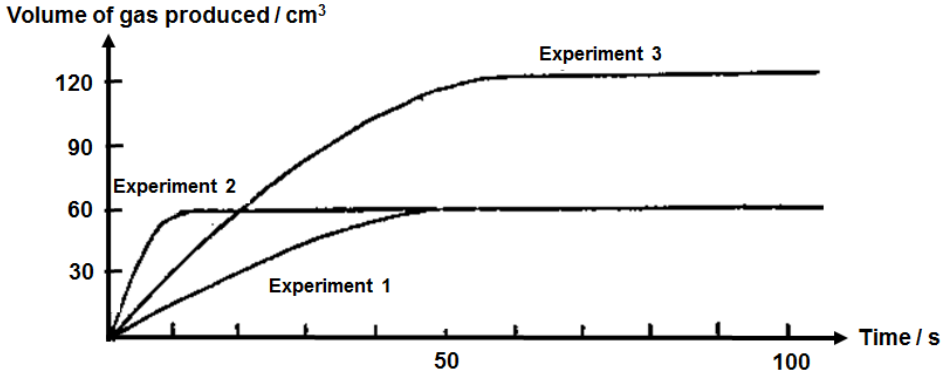


Fig 6.1

(a) Explain why

(i) the first part of each curve has a steep gradient.

……..... [1]

(ii) the last part of each curve is a horizontal line.

……..... [1]

(b) **(i)** Name two factors that can result in the difference in the experimental results of experiments 1 and 2.

……..... [1]

…….....

(ii) Use the ideas about collisions between particle to explain one of the factors identified in **b(i).**

…….....

…….....

……..... [2]

(c) Another experiment was carried out and the results are shown as experiment 3 in the Fig 6.1. Explain what is the likely experimental condition in experiment 3 as compared to experiment 1?

…….....

……..

……..... [2]

[Total:7]

A7 Pure titanium is extracted from its ore, rutile which has a chemical formula of TiO_2. Rutile is first reacted with chlorine gas at 1000^oC to produce titanium(IV) chloride and oxygen gas. The titanium(IV) chloride formed is then cooled and collected.

(a) **(i)** Construct the chemical equation for the reaction described above.

……..... [1]

(ii) Which is the oxidising agent in the reaction above? Explain your answer using oxidation states.

.....

……..... [2]

(b) Titanium (IV) chloride is then reacted with magnesium at 1100^{o}C in a sealed reactor which is filled with argon gas. Titanium is then obtained at the end.

(i) Name the type of reaction described above. Explain why the reaction can take place.

……

…… [2]

(ii) Other than magnesium, name another metal and explain why it can be used in the above reaction.

…… [1]

(iii) Why is it necessary for the reactor be filled with argon gas?

…… [1]

[Total:7]

A8 Fig 8.1 shows an experimental set-up to coat an object with copper using electroplating.

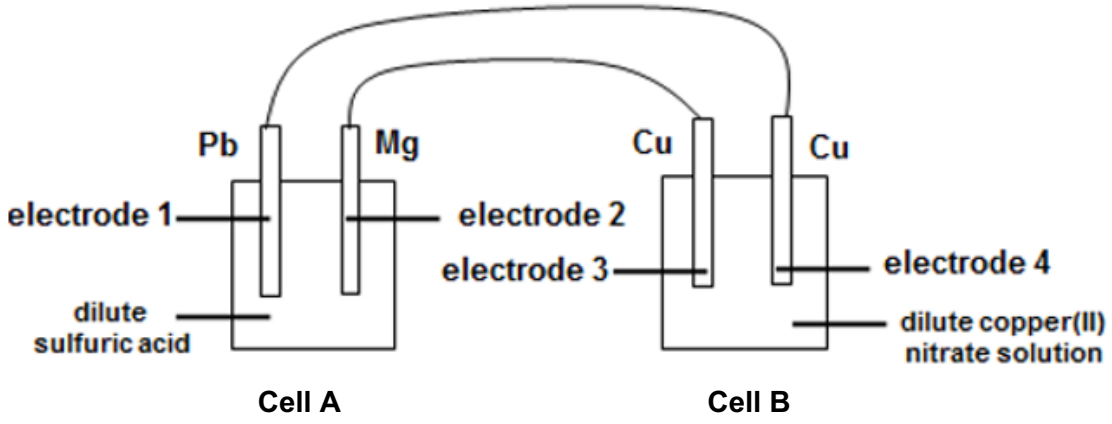


Fig 8.1

(a) On Fig 8.1, indicate the direction of electron flow. Explain your answer.

……

…… [2]

(b) A student would like to coat one of his metal toy object with copper. At which electrode (1, 2, 3, or 4) should the object be placed in order for it to be coated with copper?

…… [1]

(c) Write the half-equations with state symbols for the reactions occurring at electrodes 1 and 2.

electrode 1:

…….....

electrode 2:

……..... [2]

(d) Use half equations to explain whether there will be a change in colour intensity of the blue copper (II) nitrate solution in cell B throughout the experiment.

…….....

…….....

……..

……..... [2]

[Total:7]

Section B

Answer **all** three questions in this section.

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

B9 There are a range of atmospheric pollution problems currently threatening the Earth's general environment. The increased use of fossil fuels has a negative effect on the health of the environment in terms of air and water pollution.

Of all the fossil fuels, coal is the least expensive for its energy content. However, burning coal in electric power plants is a major source of carbon dioxide emissions. It also releases substantial amounts of methane. The U.S. Environmental Protection Agency's Clean Power Plan, as well as the low cost of natural gas, is leading older coal plants to close and reducing interest in new coal plants. Alternative sources of energy used as fuels are thus constantly sought after to meet the increasing demands of human activities.

Fig 9.1 below shows the changes in the type of fuel used between 1990 and 2002.

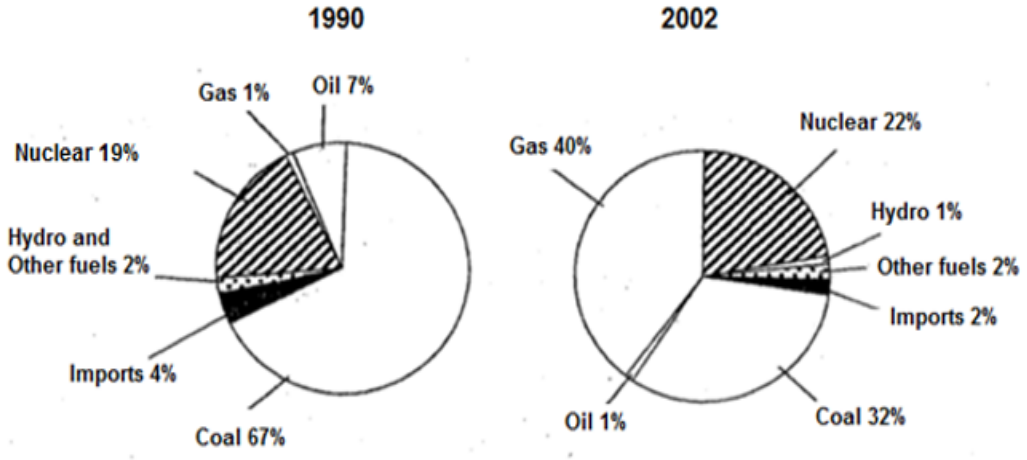


Fig 9.1

Air pollution is caused by solid particles and poisonous gases in the air. These substances are called air pollutants, which include carbon monoxide and unburnt hydrocarbons.

Fig 9.2 shows the relationship between the air : fuel ratio and the production of air pollutants by the vehicle engines.

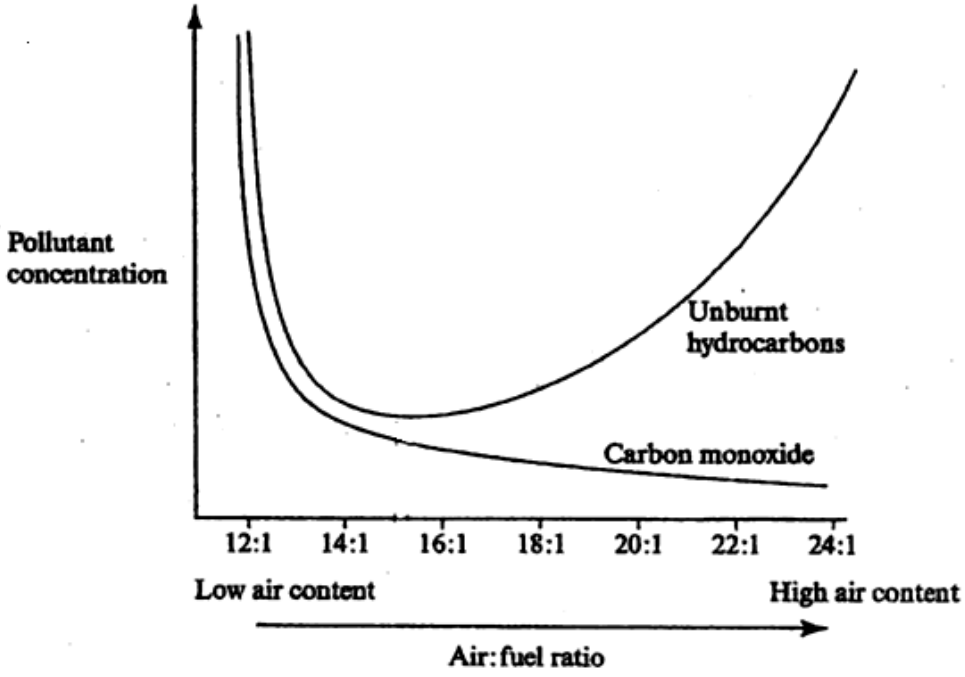


Fig 9.2

(a) Using information provided in Fig 9.1, give two main changes in the type of fuel used over 12 years from 1990 to 2002. Suggest an explanation for these changes and the effect on the environment.

……

……

……

……

……

……

……

…… [3]

(b) Using the information from Fig 9.2, describe and explain the trend for the carbon monoxide curve.

……

……

……

……

……

……

…….. [3]

(c) Estimate the optimum air : fuel ratio to minimise pollution by carbon monoxide and unburnt hydrocarbons.

…….. [1]

(d) **(i)** Suggest another air pollutant not mentioned in the graphs which is also produced by the vehicle engines.

……..... [1]

(ii) Name the device fitted in cars which is used to remove both the emissions of carbon monoxide and the pollutant you named in **(d)(i)** from the car engine. Write a balanced equation for this reaction.

……

……

……..... [2]

[Total:10]

B10 A student carries out a series of experiments. In each experiment, he electrolyses aqueous copper (II) sulfate solution using the apparatus shown in Fig 10.1.

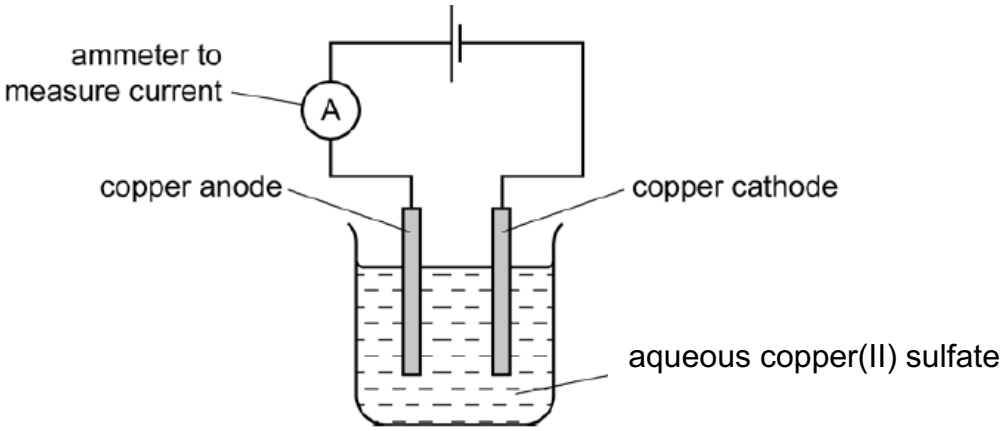


Fig 10.1

He uses the same concentration of aqueous copper (II) sulfate each time, but changes the current he passes through the solution. He runs each electrolysis for 10 minutes. The student weighs the negative electrode before and after each experiment and works out the mass of copper deposited.

Table 10.1 shows the results of his experiments.

Table 10.1

experiment	time / mins	current / A	mass of copper deposited / g
1	10	1.0	0.21
2	10	2.0	0.40
3	10	3.0	0.58
4	10	4.0	0.81

(a) **(i)** Use data from the Table 10.1 to describe the relationship between the current and the mass of copper deposited.

[1]

……..

(ii) Explain the trend observed in **(a)(i).**

…… [1]

(iii) Explain why the student ran the electrolysis for 10 min for all the experiments.

..... [1]

(b) The student carries out another experiment. He passes an electric current of 6.0 A through a solution of copper(II) sulfate for 5 minutes.
Use the information above to predict the mass of copper that would be formed in the experiment. Explain how you derived at your answer by showing your calculation.

[2]

(c) At the end of the electrolysis, the student removes a sample of the electrolyte and puts it in a test tube. He then adds aqueous ammonia dropwise to the sample until there is no further change.
Describe and explain what the student sees.

……

……

…… [2]

(d) The student carries out another electrolysis using aqueous silver nitrate and silver electrodes. His results are shown in Table 10.2.

Table 10.2

electrolyte	time / mins	current / Amps	mass of silver deposited / g
aqueous silver nitrate	10	4.0	2.7

(i) Write an ionic half equation with state symbols for the reaction that happens at the cathode.

…… [1]

(ii) Carry out calculations to compare the difference in the number of moles of copper and the number of moles of silver that are formed when a current of 4.0 A is used for 10 minutes.
Suggest an explanation for the difference in the number of moles of each metal formed.

[2]

[Total:10]

Either B11 This question describes how some substances that can be obtained from 2 different methods.

(a) Method 1 describes the extraction of zinc from its ore in the blast furnace

The temperature inside the blast furnace in which zinc is extracted is around 1000 °C.

Table 11.1 gives some information about substances in the blast furnace in which zinc is extracted.

Table 11.1

substance	melting point/ ^{o}C	boiling point/ ^{o}C
carbon	sublimes at 4330 ^{o}C	
silicon(IV) oxide	1610	2230
zinc	420	907

Use the data in the Table 11.1 to explain why the molten zinc obtained does not contain high levels of impurities such as silicon(IV) oxide and carbon.

……..

……..

…….....

……..

…….. [2]

(b) Method 2 describes the preparation of silver dichromate (VI) salt.
Silver dichromate (VI), $Ag_2Cr_2O_7$, is a red insoluble salt.
Silver dichromate (VI) can be made by reacting ammonium dichromate [$(NH_4)_2Cr_2O_7$] solution as one of the reactants.

(i) Suggest the other reactant and describe how it can be used to obtain pure dry solid silver dichromate.

…….....

……..

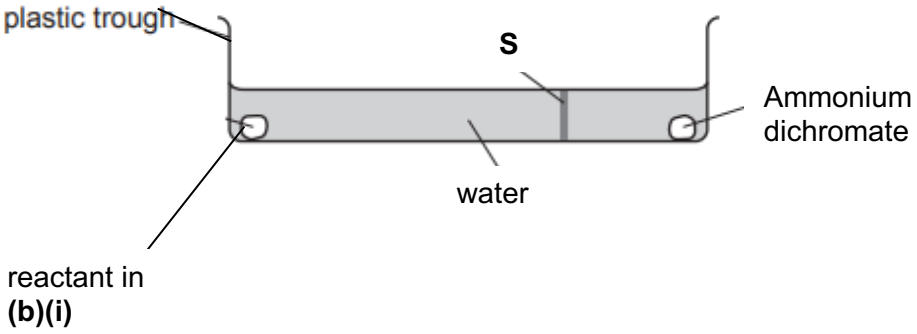
……..

……

……..... [3]

(ii) Ammonium dichromate and the reactant in **(b)(i)** were poured into opposite ends of a trough. Upon reaction, a red solid appeared along the line marked **S** in Fig 11.1 after five minutes.

Fig 11.1



Explain the position of the red solid on the line marked **S**.

…….....

……..... [2]

(iii) The experiment was repeated at a higher temperature.
What effect, if any, would this have on the time taken for the red solid to appear? Explain your answer.

…….

……..... [2]

(iv) Predict the change in colour of silver dichromate (VI) when it reacts with a reducing agent.

……..... [1]

[Total:10]

Or B11 A laboratory assistant has six elements that are consecutively arranged in the Periodic Table. He randomly assigns each element a letter, **T, V, W, X, Y** and **Z.** The letters do not represent the atomic symbols and the order of the elements.

He carried out some experiments on the elements and found the following properties.

- $\mathbf{V}_2$ reacts with $\mathbf{X_2}$ to form a compound $\mathbf{VX_3}$.
- **Y** forms a carbonate that decomposes to carbon dioxide and an oxide on heating.
- **W** reacts with $\mathbf{T_2}$ to form $\mathbf{W_2T}$. $\mathbf{W_2T}$ dissolves in water to form a solution that turns purple with addition of Universal Indicator.
- **Z** is a gaseous element. It is used in advertising strip lights.

(a) Name the following elements

(i) T …… **(ii) W** ……

(iii) Z …….. [3]

(b) Write a balance equation for the between

(i) Y and Cl_2

……..... [1]

(ii) $\mathbf{X}_2$ and NaCl.

..... [1]

(c) **(i)** State the industrial conditions required to produce $\mathbf{VH_3}$. (H is hydrogen).

……..... [1]

(ii) Explain in terms of collision between reacting particles why one of the conditions named in **c(i)** is used.

……

……..

…….. [2]

(d) Explain in terms of structure and bonding why $\mathbf{VX_3}$ and $\mathbf{W_2T}$ have very different electrical conductivity.

……

……..... [2]

[Total:10]

The Periodic Table of Elements

Group																	
I	II											III	IV	V	VI	VII	0
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9		Key proton (atomic) number atomic symbol name relative atomic mass									5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium -	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57 – 71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89 – 103 actinoids	104 Rf Rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

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