NAME		REG. NO.		CLASS	

SERANGOON GARDEN SECONDARY SCHOOL
PRELIMINARY EXAMINATION 2020

SUBJECT: CHEMISTRY; 6092/1
LEVEL: SECONDARY 4 EXPRESS
DATE: 25 AUGUST 2020 (TUESDAY)
TIME: 1055 - 1155 HOURS
DURATION: 1 HOUR

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.
Write your name, class register number and class on the Answer Sheet in the spaces provided unless this has been done for you.
DO **NOT** WRITE IN ANY BARCODES.

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 paper.
A copy of the Periodic Table is printed on page 18.
The use of an approved scientific calculator is expected, where appropriate.

_____ _____
Name/Signature of Parent/Guardian Date

FOR MARKER'S USE

40

This question paper consists of 17 printed pages and 1 blank page.

Setter: Mr Michael Chia **Vetter: Ms Lim Wan Qi**

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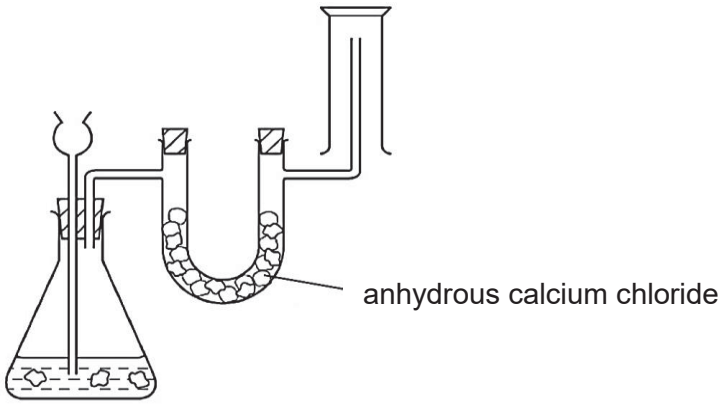
For each question, there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

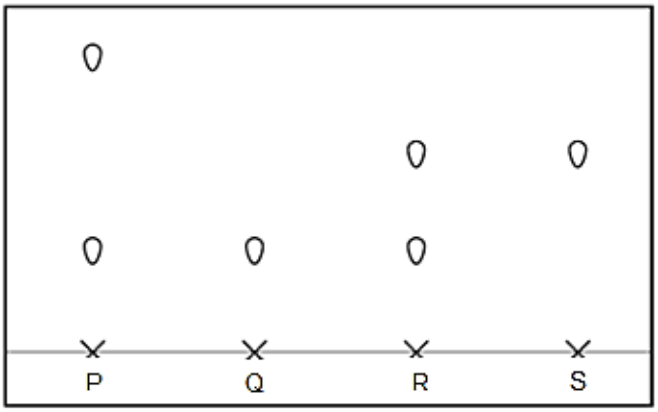
1 The diagram below shows an experimental set up for the preparation and collection of a dry gas.



What could the gas be?

A carbon monoxide
B carbon dioxide
C hydrogen
D sulfur dioxide

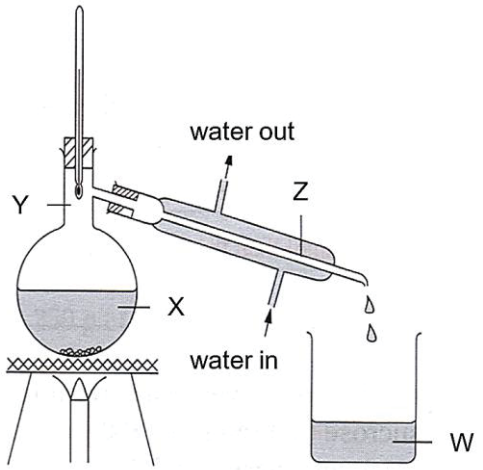
2 The diagram below shows the paper chromatogram for 4 substances, P, Q, R and S.



Based on the chromatogram, which of the above substances are pure?

A P and Q
B P and R
C Q and R
D Q and S

3 The diagram shows the apparatus used to obtain water from aqueous iron(II) sulfate which is pale green in colour.



Which of the following statements about the separation process is true?

A Liquid X becomes darker in colour.

B A green precipitate is formed in liquid W.

C Liquid W changes from colourless to green.

D The temperature at Y steadily rises as liquid W is being collected.

4 A sample of hydrogen contains a mixture of two isotopes; $^{2}_{1}H$ and $^{3}_{1}H$. Which of the following relative molecular mass is not a possible value when this sample of hydrogen reacts with sulfur to form hydrogen sulfide, H_2S?

A 34

B 36

C 37

D 38

5 Polonium is an element in Group VI of the Periodic Table. One of its isotopes, Po-210, is a rare radioactive metal discovered by Marie Curie in the late 19th century. Po-210 can be produced artificially by bombarding Bismuth-209 with neutrons.

$$^{209}_{83}Bi + 1 \text{ neutron} \rightarrow {}^{210}_{83}Bi$$
$$^{210}_{83}Bi \rightarrow {}^{210}_{84}Po + \beta \text{ (beta particle)}$$

Which statement about the above reaction is correct?

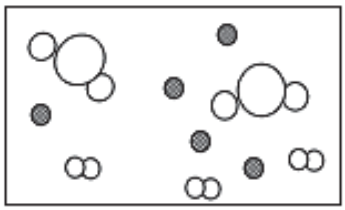
A $^{209}_{83}Bi$ atom has the same number of neutrons as $^{210}_{84}Po$ atom.

B $^{210}_{83}Bi$ atom has the same number of protons as $^{210}_{84}Po$ atom.

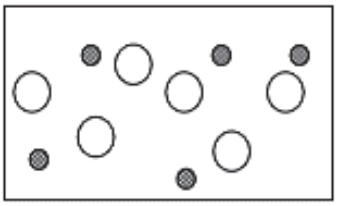
C $^{209}_{83}Bi$ atom has fewer electrons than $^{210}_{83}Bi$ atom.

D $^{210}_{83}Bi$ atom has fewer neutrons than $^{210}_{84}Po$ atom.

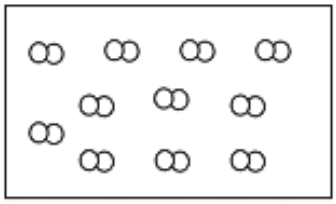
6 The composition of the particles in four different substances, are shown in the diagrams below.



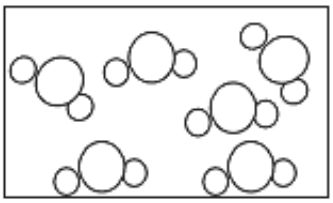
I



II



III



IV

Which of the following shows the correct composition of the particles in the four substances?

	molecules of an element	molecules of a compound	mixture of elements	mixture of elements and compounds
A	I	II	III	IV
B	II	IV	III	I
C	III	IV	II	I
D	IV	III	I	II

7 Which of the following particles contain 10 electrons, 11 protons and 12 neutrons?

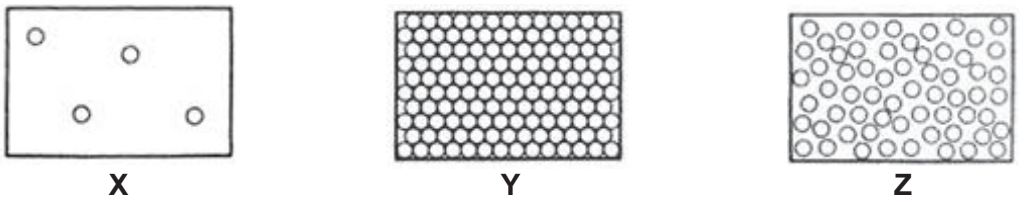
A $^{24}_{12}Mg^{2+}$

B $^{23}_{11}Na$

C $^{23}_{11}Na^{+}$

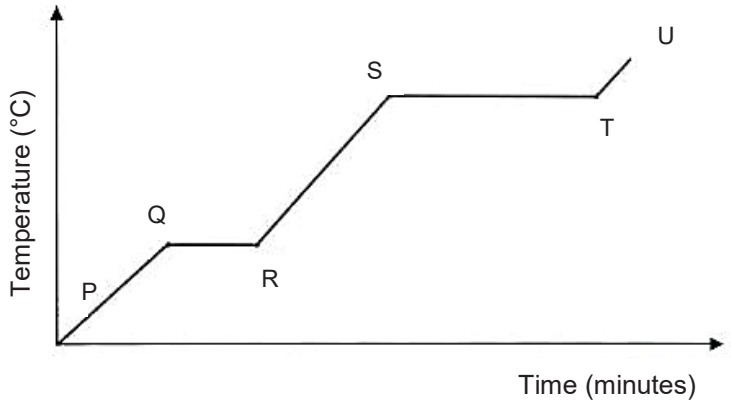
D $^{21}_{10}Ne$

8 The diagrams below show how the particles of a substance are packed at different temperatures.



X **Y** **Z**

Which region in the graph would contain particles with the arrangement of particles as shown in diagrams **Y** and **Z**?



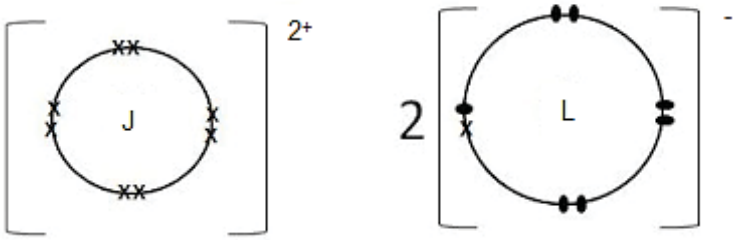
A Region PQ

B Region QR

C Region RS

D Region ST

9 The diagram below shows the 'dot and cross' diagram of the compound formed between elements **J** and **L**.



Which of the following statements is/are correct?

I **L** is an element in Group I of the Periodic Table.

II Element **J** donates 2 electrons to element **L**.

III Elements **L** and **J** are bonded by ionic bonds.

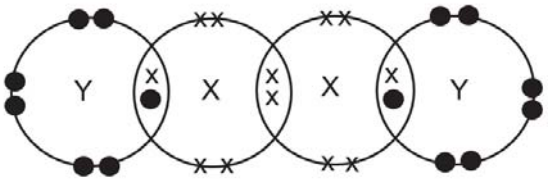
A III only

B I and II only

C II and III only

D I, II and III

10 The diagram shows the bonding between two unknown elements **X** and **Y**.



Which of the following statements is true?

A Element **X** is in Group IV of the Periodic Table.
B Element **X** has 6 electrons in its outermost shell.
C Element **Y** has 6 electrons in its outermost shell.
D Element **Y** is in Group I of the Periodic Table.

11 A student obtained the following information about substance **W**:

- can be separated into its constituent elements through electrolysis of its molten compound
- melting point higher than 500 °C
- soluble in water
- insoluble in organic solvent

What substance is **W** likely to be?

A lithium chloride
B poly(ethene)
C magnesium
D silicon dioxide

12 The table below gives the proton and nucleon numbers of atoms **P**, **Q**, **R** and **S**.

atom	proton number	nucleon number
P	6	14
Q	7	14
R	16	32
S	20	40

Which of the following statements is true?

A Atom **P** and atom **Q** are isotopes of the same element.
B Atom **P** and atom **R** will combine to form a covalent compound.
C Atom **Q** and atom **S** will form an ionic compound with the formula $\mathbf{S_2Q_3}$.
D Atom **S** can form a diatomic molecule.

13 Copper powder was added to excess silver nitrate solution. The chemical equation for the reaction that occurred is shown below:

$Cu(s) + 2AgNO_3(aq) \rightarrow 2Ag(s) + Cu(NO_3)_2(aq)$

After the reaction was completed, the mixture was filtered.

Which of the following gives the correct description of the residue and the filtrate obtained?

	residue	filtrate
A	blue solid	colourless solution
B	grey solid	blue solution
C	reddish-brown solid	colourless solution
D	reddish-brown solid	blue solution

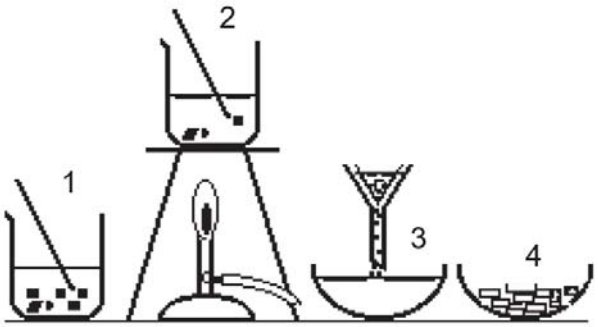
14 A student wanted to retain Ba^{2+} ions and remove I^- ions from a bottle containing aqueous barium iodide solution and wrote the following procedure.

Add ___1___ to aqueous barium iodide until no more ___2___ precipitate forms.

Which of the following completes the blanks in the procedure?

	1	2
A	aqueous lead(II) nitrate	white
B	aqueous lead(II) nitrate	yellow
C	dilute sulfuric acid	white
D	dilute sulfuric acid	yellow

15 Which of the following reagents can be used to prepare a salt that would involve the steps shown by the diagram below?



A calcium sulfate with dilute hydrochloric acid to prepare calcium chloride

B lead(II) carbonate with dilute nitric acid to prepare lead(II) nitrate

C potassium oxide with dilute hydrochloric acid to prepare potassium chloride

D sodium carbonate with dilute sulfuric acid to prepare sodium sulfate

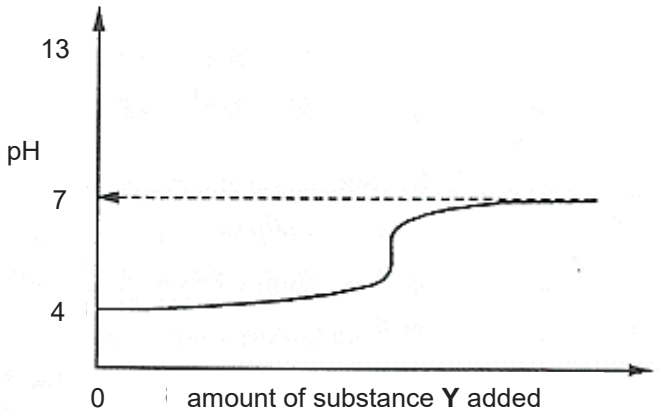
16 Which substance has the highest percentage by mass of nitrogen?

A $CO(NH_2)_2$
B KNO_3
C NH_4Cl
D $(NH_4)_3PO_4$

17 A 25.0 cm^3 sample of dilute sulfuric acid contains 0.025 moles of the acid. What is the concentration of the hydrogen ions in the solution?

A 0.250 mol/dm^3
B 0.500 mol/dm^3
C 1.00 mol/dm^3
D 2.00 mol/dm^3

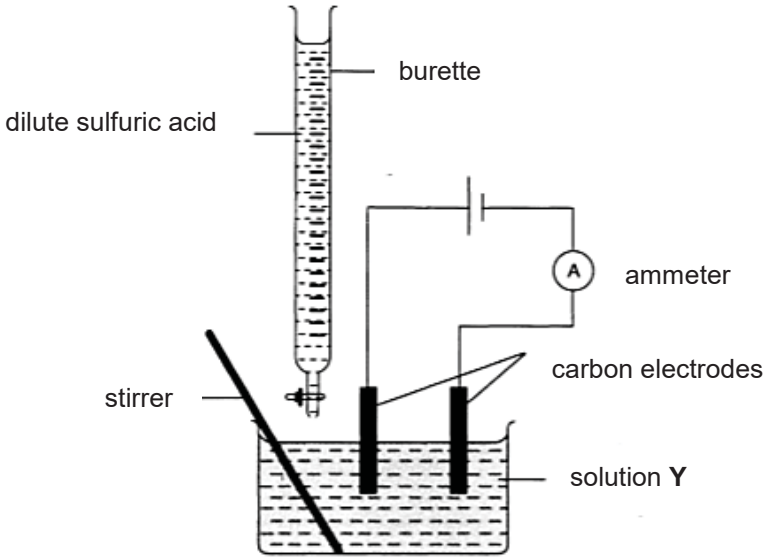
18 Substance **Y** was added slowly, with stirring to aqueous solution **Z**. The changes in pH of the mixture are shown in the graph.



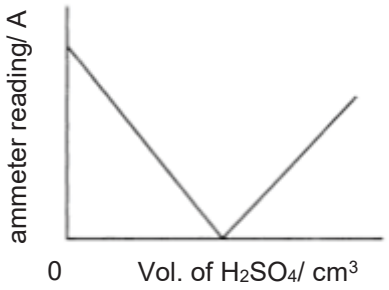
Which of the following are possible identities for substance **Y** and substance **Z**?

	substance **Z**	substance **Y**
A	ethanoic acid	calcium oxide
B	ethanoic acid	lead(II) oxide
C	hydrochloric acid	copper(II) oxide
D	hydrochloric acid	sodium oxide

19 Dilute sulfuric acid was added to solution **Y**, as shown in the diagram below. After each addition, the mixture was stirred and the ammeter reading was recorded.



The following graph was obtained based on all the readings recorded.



Which of the following is likely to be solution **Y**?

A barium hydroxide
B potassium oxide
C iron(II) chloride
D zinc nitrate

20 Solid **X** is a good conductor of electricity. It also reacts with oxygen to form compound **Y** that turns moist red litmus paper blue. Which of the following is likely to be solid **X**?

A graphite
B calcium
C chlorine
D sulfur

21 Which of the following equations suggests that the metal oxide, MO, has amphoteric properties?

A $MO(s) + C(s) \rightarrow M(s) + CO(g)$

B $MO(s) + H_2O(l) \rightarrow M^{2+}(aq) + 2OH^-(aq)$

C $MO(s) + 2OH^-(aq) \rightarrow MO_2^{2-}(aq) + H_2O(l)$

D $MO(s) + 2NH_4Cl(s) \rightarrow MCl_2(s) + H_2O(l) + 2NH_3(g)$

22 A student recorded that pale green iron(II) sulfate solution turned brown when reacted with hydrogen peroxide solution.

Which of the following best explains the observation recorded by the student?

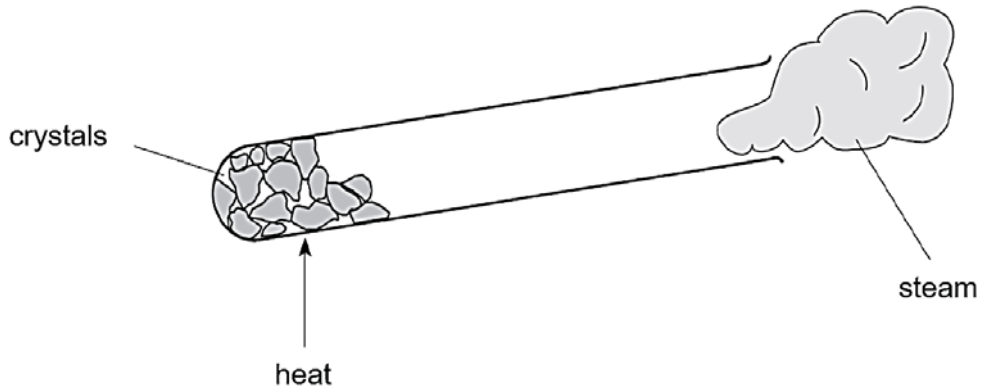
A Hydrogen peroxide was the reducing agent in the reaction.

B Iron(II) sulfate reacted to form iron(III) hydroxide, a brown precipitate.

C The brown solution was due to the oxidation of Fe^{2+} ions to Fe^{3+} ions.

D The Fe^{2+} ions reacted with oxygen and underwent rusting.

23 The diagram below shows crystal of copper(II) sulfate, $CuSO_4.5H_2O$, being heated.



The copper(II) sulfate crystals were noted to have changed colour during the heating.

Which two terms best describe the changes observed in the above diagram?

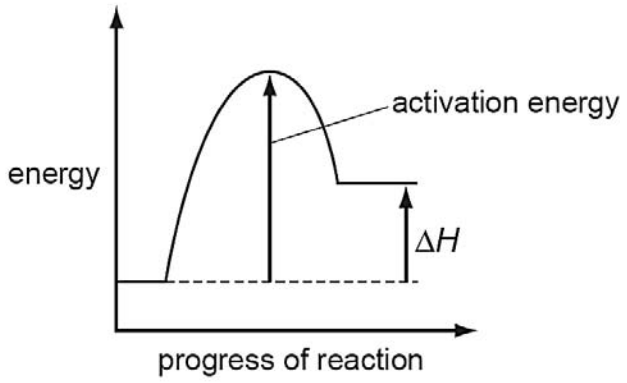
A endothermic and dehydration

B endothermic and hydration

C exothermic and dehydration

D exothermic and hydration

24 The energy profile diagram for the forward reaction of a chemical reaction is shown below.



Which row correctly shows the enthalpy change, the activation energy and the type of enthalpy change for the reverse reaction?

	sign of enthalpy change	sign of activation energy	type of enthalpy change
A	negative	negative	exothermic
B	negative	positive	exothermic
C	positive	negative	endothermic
D	positive	positive	endothermic

For questions 25 and 26, refer to the information below.

Ammonia has many important uses and is manufactured industrially by the Haber process. The equation for the reaction is shown below:

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

25 Which statements correctly describe the Haber process?

I It is a direct combination of elements.
II It is a reversible reaction.
III It is a redox reaction

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

26 Ammonia gas is produced industrially by the Haber process. Which of the following statements is **not true** with regard to the Haber process?

A A catalyst is added to increase the rate of reaction.
B High pressure is applied to increase the yield of ammonia.
C High temperature is applied to increase the yield of ammonia.
D Nitrogen is obtained from the air.

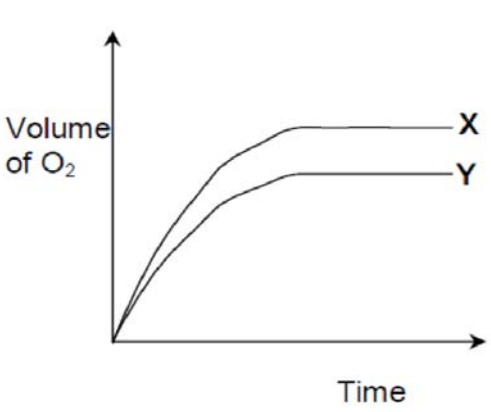
27 Aqueous hydrogen peroxide decomposes according to the following equation.

$$2H_2O_2 \rightarrow 2H_2O + O_2$$

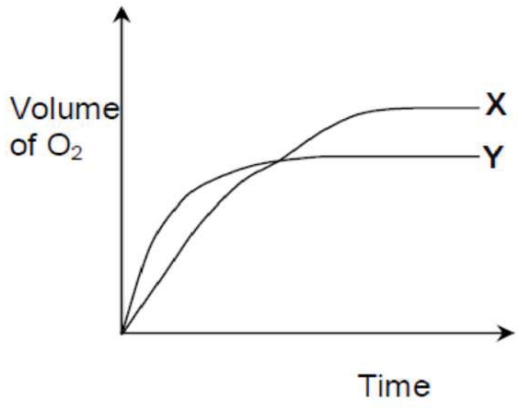
Two experiments were carried out to measure the rate of production of oxygen from aqueous hydrogen peroxide. The results are given below.

Experiment	Solution used
X	100 cm^3 of 2 mol/dm^3 H_2O_2
Y	mixture of 100 cm^3 of 2 mol/dm^3 H_2O_2 and 50 cm^3 of 1 mol/dm^3 H_2O_2

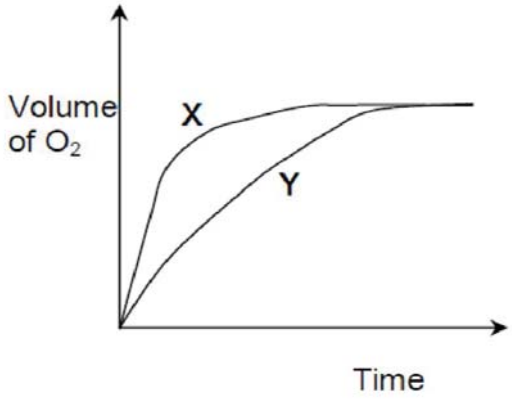
Which graph best shows the results of the two experiments?



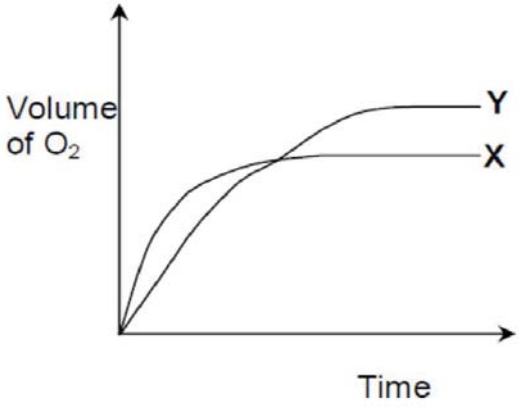
A



B

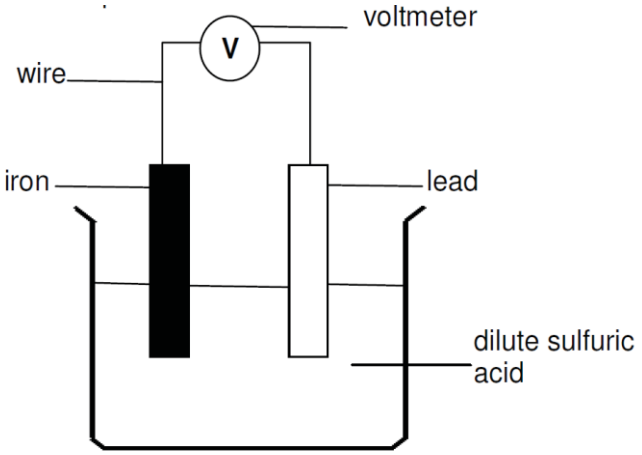


C



D

28 The diagram below shows a simple cell.



Which half-equations best represent the reactions occurring at the positive and the negative electrode?

	negative electrode	positive electrode
A	$Fe \rightarrow Fe^{2+} + 2e^-$	$Pb^{2+} + 2e^- \rightarrow Pb$
B	$Fe \rightarrow Fe^{2+} + 2e^-$	$2H^+ + 2e^- \rightarrow H_2$
C	$2H^+ + 2e^- \rightarrow H_2$	$Fe \rightarrow Fe^{2+} + 2e^-$
D	$Pb^{2+} + 2e^- \rightarrow Pb$	$2H^+ + 2e^- \rightarrow H_2$

29 Which of the following is expected of a metal that is positioned between aluminium and lead in the reactivity series?

A It forms a hydroxide that dissolves in water.
B It forms an oxide that decomposes to form the metal on heating.
C It liberates hydrogen from dilute hydrochloric acid.
D It reacts with aluminium oxide when heated.

30 Which of the following has no change in the concentration of the solution during electrolysis?

A copper(II) sulfate solution between copper electrodes
B copper(II) sulfate solution between platinum electrodes
C dilute sodium chloride solution between platinum electrodes
D concentrated sodium chloride solution between carbon electrodes

31 The table shows the properties of some metal oxides, W, X, Y and Z.

oxide	colour of oxide	change on heating
W	black	remains black
X	red	oxygen gas evolved and silvery liquid remains
Y	white	solid turns yellow when hot by turns white again when cold
Z	brown	oxygen evolves and solid turns yellow

Which of the oxides in the table above remain(s) chemically unchanged when heated?

A W only
B Y only
C X and Z only
D W and Y only

32 The table below shows some properties of four elements. Which element is likely to be copper?

	element	density (g/cm^3)	melting point (°C)	electrical conductivity
A	P	0.97	97.8	poor
B	Q	2.34	2300	poor
C	R	13.6	-38.9	good
D	S	8.96	1083	good

33 Which statement about the four gases carbon dioxide (CO_2), hydrogen (H_2), oxygen (O_2) and ozone (O_3) is correct?

A One mole of each gas has the same volume at room temperature and pressure.
B Ozone has the fastest rate of diffusion at room temperature and pressure.
C They are all denser than air.
D They are all elements.

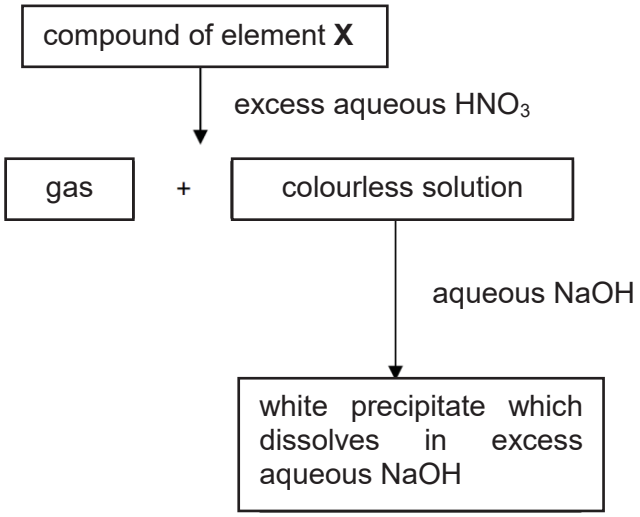
34 It was found that cars which were parked near a coal-fired power station often corroded more quickly. Which gas, when present in above average levels in the air, is a possible explanation for this?

A carbon dioxide
B nitrogen monoxide
C sulfur dioxide
D water vapour

35 Which of the following statements best explains why the elements sodium and chlorine are in the same period in the Periodic Table?

A Sodium and chlorine are both reactive elements.
B The atomic numbers of sodium and chlorine differ by less than eight.
C The atoms of both elements have eight electrons in their second shell.
D The atoms of both elements have only three shells containing electrons.

36 The scheme below shows some reactions of a compound of element **X**.



Which of the following substances is likely to be a compound of element **X**?

A aluminium carbonate
B calcium(II) carbonate
C copper(II) sulfate
D lead(II) sulfate

37 An aqueous sample of **T** shows these observations with the following reagents.

Reagent	Observation
Aqueous ammonia	Reddish brown precipitate
Lead(II) nitrate	White precipitate
Barium nitrate	White precipitate

Which of the following is likely to be compound **T**?

A iron(II) sulfate
B iron(III) sulfate
C iron(III) chloride
D potassium chloride

38 Which statement about alkali metals is true?

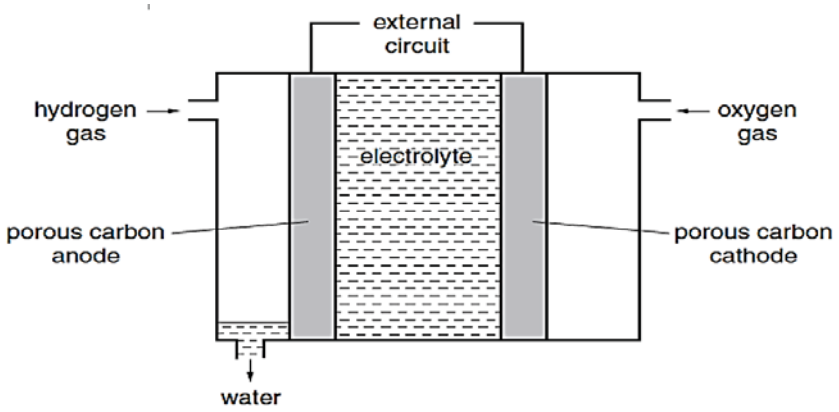
A Their melting points decrease on going down Group I.
B Their reactivity decrease on going down Group I.
C They form covalent bonds with Group VII.
D They form oxides on reacting with water.

39 Elements **X** and **Y** are in Group VII of the Periodic Table.
X is a liquid at room temperature**. Y** is a solid at room temperature. Which statement(s) is/are correct?

1 Atoms of Y have more protons than atoms of **X**.
2 Molecules of **Y** have more atoms than molecules of **X**.
3 **Y** displaces **X** from aqueous solutions of $\mathbf{X}^-$ ions.

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

40 A hydrogen-oxygen fuel cell is built using sodium hydroxide solution as the electrolyte. What would be the change in pH of the solution around each electrode when current flows?



Reaction at anode: $H_2(g) + 2OH^-(aq) \rightarrow 2H_2O(l) + 2e^-$
Reaction at cathode: $O_2(g) + 2H_2O(l) + 4e^- \rightarrow 4OH^-(aq)$

	anode	cathode
A	increase	decrease
B	increase	increase
C	decrease	increase
D	decrease	decrease

END OF PAPER

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.).

NAME		REG. NO.		CLASS	

SERANGOON GARDEN SECONDARY SCHOOL
PRELIMINARY EXAMINATION 2020

SUBJECT: CHEMISTRY; 6092/2
LEVEL: SECONDARY 4 EXPRESS
DATE: 21 AUGUST 2020 (FRIDAY)
TIME: 1045 – 1230 HOURS
DURATION: 1 HOUR 45 MINUTES

READ THESE INSTRUCTIONS FIRST

Write your name, class register number and class on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

Section A [50 marks]
Answer **all** questions in the spaces provided.

Section B [30 marks]
Answer all **three** questions, the last question is in the form either/or.
Answer all questions in the spaces provided.

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.
A copy of the Periodic Table is printed on page 22.

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

_____ _____
Name/Signature of Parent/Guardian Date

FOR MARKER'S USE
80

This question paper consists of 21 printed pages and 1 blank page.

Setter: Mr Michael Chia **Vetter: Ms Lim Wan Qi**

[Turn Over

BLANK PAGE

Section A

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

A1 Choose from the following elements to answer the questions below.

hydrogen	sodium	zinc
chlorine	iodine	calcium
magnesium	nickel	platinum

Each element can be used once, more than once or not at all.

Which element

(a) is used as a catalyst in the catalytic converter of cars?

…… [1]

(b) reacts with dilute acids readily but not cold water?

…… [1]

(c) forms an ion, that in solution, reacts with aqueous sodium hydroxide to give a white precipitate that is insoluble in excess sodium hydroxide?

…… [1]

(d) is **most** suitable as a sacrificial material used to prevent the rusting of underground water pipes made of iron?

…… [1]

(e) is able to decolourise aqueous iron(III) chloride when added in excess?

…… [1]

(f) reacts with water to form an acidic solution?

…… [1]

(g) forms a hydroxide that reacts with sodium hydroxide to give a colourless solution?

…… [1]

[Total marks: 7]

A2 Carbon is a group IV element and it forms many inorganic and organic compounds. In these compounds, carbon shows a range of oxidation numbers.

Name	Formulae	Oxidation number of carbon
methane	CH_4	-4
ethane	C_2H_6	-3
methanol	CH_3OH	
ethanol	C_2H_5OH	-2
glucose	$C_6H_{12}O_6$	
carbon dioxide	CO_2	+4

(a) Complete the table above by filling in the oxidation numbers of carbon in the respective compounds. [1]

(b) Suggest the formula of a compound in which carbon has an oxidation number of +2.

…… [1]

(c) Plants undergo a process known as photosynthesis. Choose from the table above, two substances that are involved in photosynthesis, and write the balanced chemical equation for photosynthesis.

…… [2]

(d) Explain if carbon is likely to exhibit an oxidation number of +5 in its compounds.

……

…… [1]

(e) Using your knowledge on oxidation states, explain if the change of ethanol to form ethanoic acid (CH_3COOH) is an oxidation reaction.

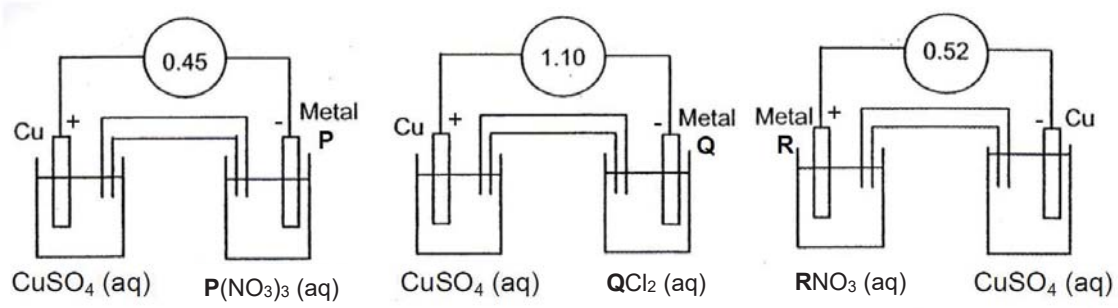
……

……

…… [2]

[Total marks: 7]

A3 Three electrochemical cells are set up as shown below. The electromotive force (e.m.f.) in volts is shown on each voltmeter.



(a) Arrange the four metals (Cu, **P**, **Q** and **R**) in order of decreasing reactivity.

…… [1]

(b) A piece of magnesium ribbon is added separately to each of the salt solutions of metals **P**, **Q** and **R**. The observations made are as shown in the table below.

Test	Observations
Magnesium ribbon in **P**$(NO_3)_3$(aq)	A silver solid is formed. The green solution is decolourised.
Magnesium ribbon in **Q**Cl_2(aq)	A silver-grey solid is formed. The solution remained colourless.
Magnesium ribbon in **R**NO_3(aq)	A silver solid is formed. The solution remained colourless.

(i) Write an ionic equation for the reaction between magnesium and **P**$(NO_3)_3$.

…… [1]

(ii) Give two observations that can be made if metal **P** is placed in aqueous copper (II) sulfate.

……

……

…… [2]

(iii) Suggest the most economical method to extract metal **P** from its ore.

…… [1]

(iv) In the industry, metal **P** is mixed with carbon and iron to form steel alloys. Suggest why the use of alloys of iron is preferred over pure iron.

……

……

……

…… [3]

(v) Metal **Q** can be used to protect iron or steel objects from rusting through a process known as galvanising. Explain why metal **Q** is a more suitable choice than copper to prevent iron from rusting.

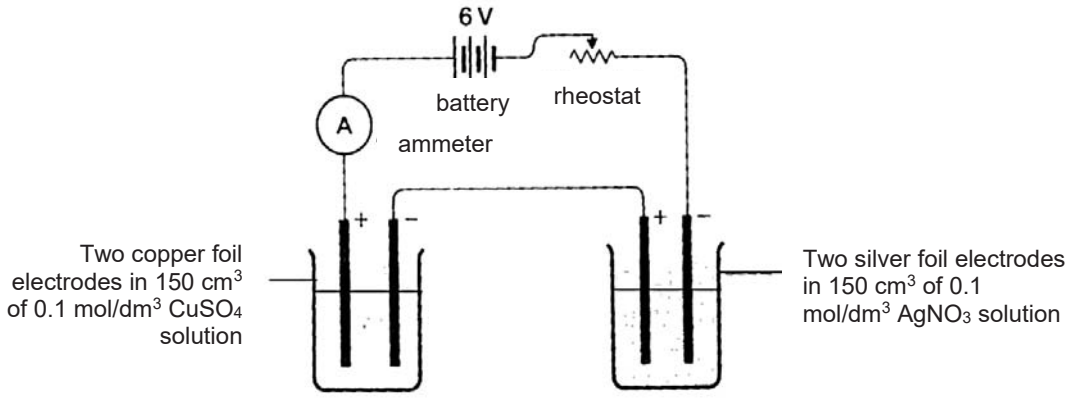
……

……

…… [2]

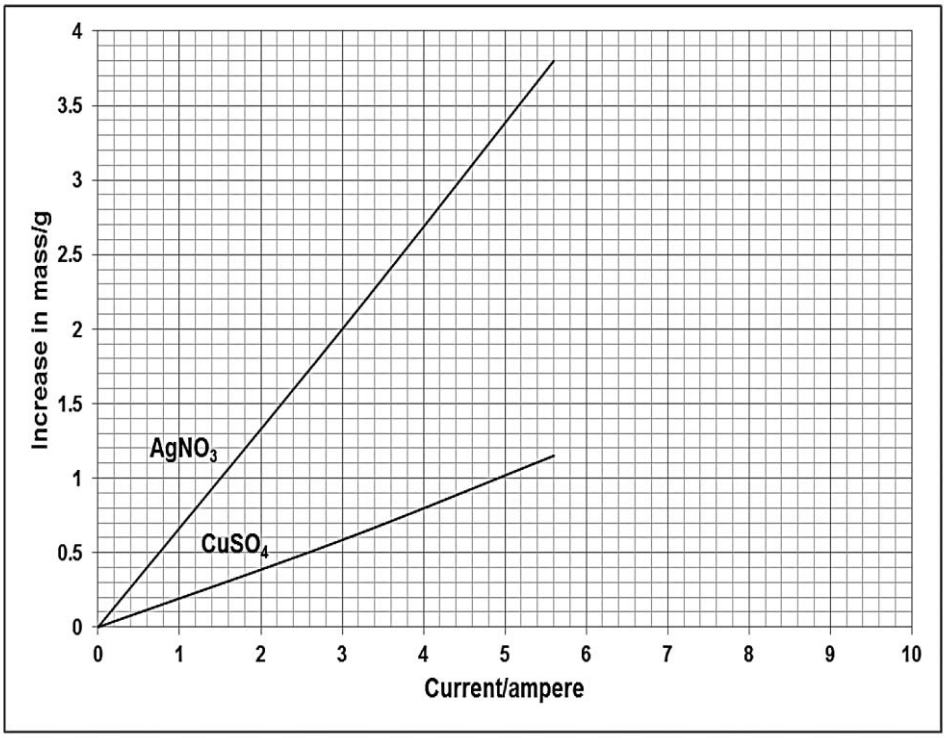
[Total marks: 10]

A4 A student carries out a series of experiments. He electrolyzes aqueous copper(II) sulfate and aqueous silver nitrate using the apparatus shown.



He repeats the experiment a few times using the same concentration of copper(II) sulfate and silver nitrate, but changes the current that passes through the solution. He runs each experiment for 10 min. At the end of 10 min, the student weighs the mass of the negative electrodes and works out the increase in mass of the electrodes.

The graph below shows the results of his investigations.



(a) Describe the relationship between the current and the increase in mass of the negative electrode as shown by the graph.

……

…… [1]

(b) Use the graph to predict the increase in mass of the negative electrode in copper(II) sulfate solution if the experiment is carried out using an electric current of 9.0 A for 5 min.

……..…… [1]

(c) During the electrolysis, copper and silver are deposited at the negative electrodes. Write equations to show the deposition of copper and silver at the electrodes.

……..……

……..…… [2]

(d) Determine 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.

[2]

(e) Comment on the difference between the masses of copper and silver formed when the same conditions are used for the electrolysis. Explain the difference.

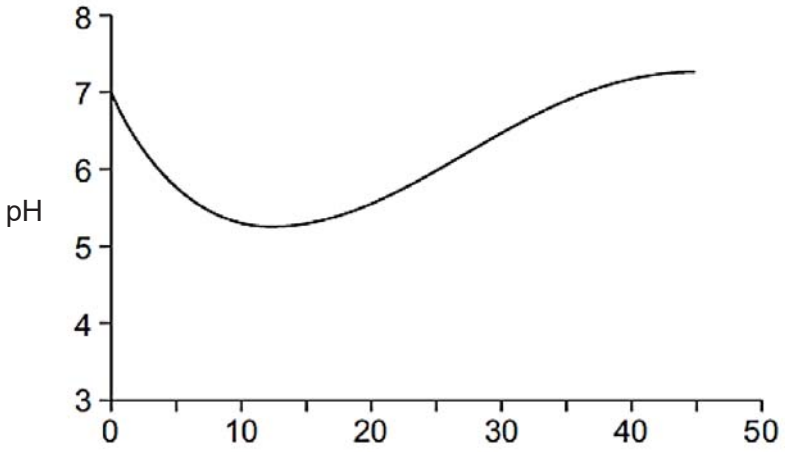
……..……

……..……

……..…… [2]

[Total marks: 8]

A5 The diagram shows the changes in pH in a student's mouth after she has eaten a sweet.



(a) Chewing an acidic sweet stimulates the formation of saliva. Saliva is slightly alkaline. Use this information to describe and explain the shape of the graph.

……

……

……

…… [3]

(b) Many sweets contain citric acid. Citric acid can be extracted from lemon juice using the following steps:

stage 1: add calcium carbonate to excess hot lemon juice
stage 2: filter off the precipitate which is formed (calcium citrate)
stage 3: wash the calcium citrate precipitate with water
stage 4: add sulfuric acid to the calcium citrate to make a solution of citric acid
stage 5: crystallise the citric acid

(i) When calcium carbonate is added to lemon juice, fizzing is observed. Explain why there is fizzing.

…… [1]

(ii) Suggest why the calcium citrate precipitate is washed with water.

…… [1]

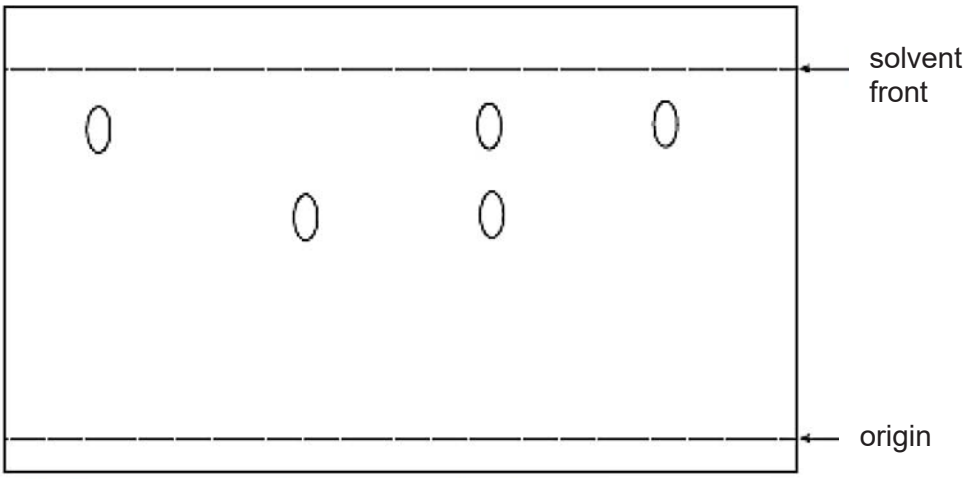
(iii) Describe how 'stage 5' should be carried out.

……

……

…… [2]

(c) Wines contain malic and lactic acids. This is because of a process known as malo-lactic fermentation. During this process, malic acid is converted into lactic acid. The extent of malo-lactic fermentation in 2 samples of wine was analysed using thin layer chromatography. A sample of each wine was spotted onto the chromatography plate. Reference samples of lactic acid and malic acid were also spotted onto the plate. The chromatogram obtained is shown below:



(i) Explain why malic acid moved a shorter distance than lactic acid.

……

…… [1]

(ii) Which sample of wine is older? Explain your answer.

……

……

…… [2]

[Total marks: 10]

A6 Singapore is a densely populated city with strict standards on air quality as well as preventive air pollution control measures. The following table shows the ambient air quality targets set by the National Environment Agency (NEA). (1 μg = 10^{-6}g)

pollutant	sulfur dioxide	nitrogen dioxide	ozone	carbon monoxide
target (μg/m^3)	15	40	100	30000

(a) Explain why carbon monoxide is considered as an air pollutant.

……

…… [1]

(b) State a source of nitrogen dioxide.

……

…… [1]

(c) A researcher working with the NEA takes a 200 dm^3 sample of gaseous emissions from a factory. The composition of this sample of air is shown in the table below.

gas	sulfur dioxide	nitrogen dioxide	nitrogen	oxygen	carbon dioxide
volume (cm^3)	0.0022	0.0031	157000	42900	99.9

Explain, with calculations, whether the emissions of sulfur dioxide and nitrogen dioxide meet the targets set by NEA. [1 m^3 = 1000 dm^3]

[5]

(d) Another factory was found to emit 60 μg/m^3 of sulfur dioxide. Suggest a reason why the factory produces such a high amount of sulfur dioxide.

……

…… [1]

[Total marks: 8]

Section B

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

B7 Ionization energy (IE) is the energy required to remove an electron from a gaseous atom or ion.

$$M(g) \rightarrow M^{+}(g) + e^{-}$$

It is possible to remove more electrons from most elements, so this quantity is more precisely known as the first ionization energy, the energy to go from neutral atoms to cations with a 1+ charge. The second ionization energy is the energy that is required to remove a second electron from the cation with a 1+ charge, to form cations with a 2+ charge.

$$M^{+}(g) \rightarrow M^{2+}(g) + e^{-}$$

The third ionization energy is the energy required to form cations with a 3+ charge:

$$M^{2+}(g) \rightarrow M^{3+}(g) + e^{-}$$

A graph of the logarithm of the ionisation energy of a sodium atom against the number of electrons removed is shown in Fig. 7.1 below.

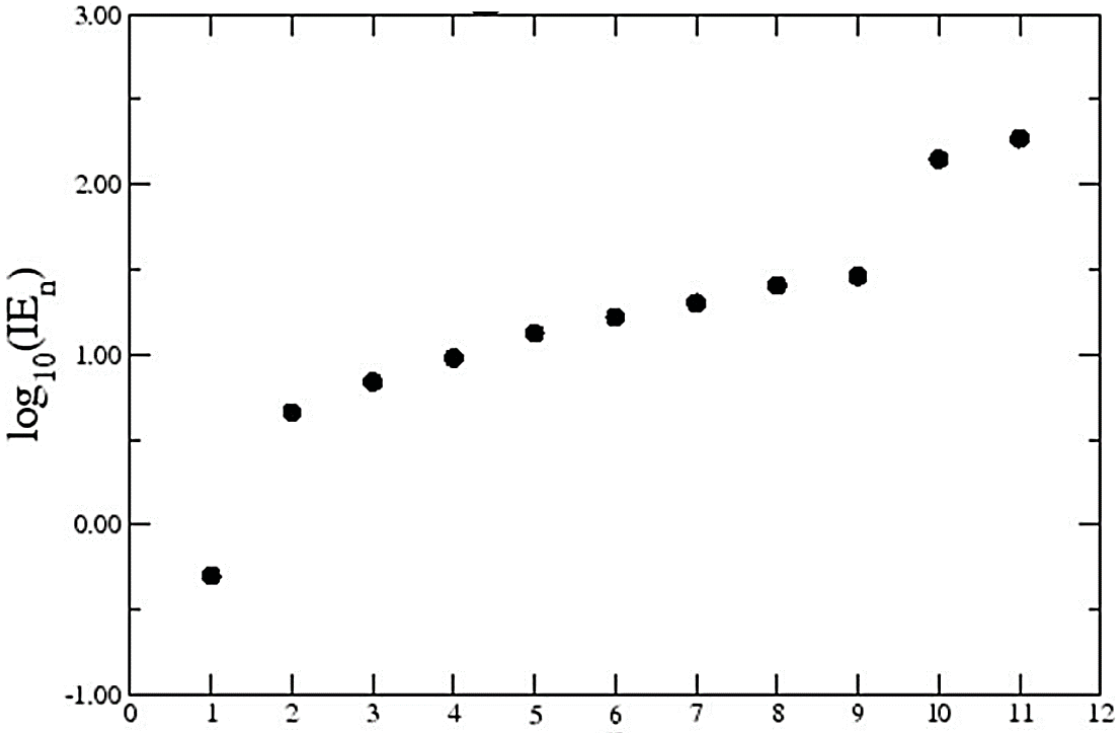


Fig. 7.1

The ionization energy may be an indicator of the reactivity of an element. Table 7.1 shows the ionization energies of the elements across Period 3 of the Periodic Table.

Table 7.1

element	Na	Mg	Al	Si	P	S	Cl	Ar
first ionisation energy	496	738	578	789	1012	1000	1251	1521

(a) With reference to the electronic structure of sodium, explain the trend in the ionization energy shown in Fig. 7.1.

……

……

……

…… [3]

(b) Explain the difference in first ionization energies for sodium and argon.

……

……

……

…… [2]

The term hydride is commonly named after binary compounds that hydrogen forms with other elements of the Periodic Table. Hydrides can be classified as covalent or ionic hydrides, depending on which element hydrogen bonds to.

(c) Draw a 'dot and cross' diagram to show the bonding in silane, the hydride formed by the reaction between silicon and hydrogen. Show only the outermost electrons.

[2]

(d) Suggest one similarity and one difference in physical properties between sodium hydride and hydrogen chloride.

similarity

……..

……..

difference

……..

…….. [2]

(e) The hydride formed by phosphorus is phosphine. Suggest with reasons, whether phosphine will have a higher or lower melting point than hydrogen chloride.

……

……

……

…… [1]

[Total marks: 10]

B8 A student carries out some tests on an unknown solution **P** which is known to contain 2 metallic cations and 1 anion. She recorded her observations and deductions in the table shown below.

Expt no	Procedure	Observations	Deductions
1a	To a solution of **P**, add sodium hydroxide solution.	White ppt formed.	Pb^{2+}, Zn^{2+}, Ca^{2+} or Fe^{2+} could be present.
1b	Add excess sodium hydroxide solution into the test-tube in expt 1a.	Ppt decreased by approximately half. The remaining ppt is insoluble in excess sodium hydroxide.	Ca^{2+} is present.
2	Add aluminium foil to the mixture in expt 1b. Warm the mixture.	Gas evolved turns moist red litmus paper blue.	Cl^- is present.
3a	To new sample of solution **P**, add aqueous ammonia.	White ppt formed.	Al^{3+}, Pb^{2+} or Zn^{2+} could be present.
3b	Add excess aqueous ammonia solution into the test-tube.	White ppt insoluble in excess aqueous ammonia.	Al^{3+} or Pb^{2+} could be present.

(a) The student made 3 mistakes in her deductions. In Table 8.1, state the experiment number in which the mistakes were made. **Briefly** explain your answer.

Table 8.1

	Expt no	Explanation
Mistake 1		
Mistake 2		
Mistake 3		

(b) Describe a simple test to differentiate between aluminium ions (Al^{3+}) and lead(II) ions (Pb^{2+}).

……

……

……

…… [2]

(c) Chlorine undergoes a reaction when it dissolves in water. The equation for the reaction is:

$$Cl_2 + H_2O \rightarrow HCl + HOCl$$

The bond energies of the reaction are given in the table below

Bond	Bond Energy (kJ/mol)	Bond	Bond Energy (kJ/mol)
Cl – Cl	239	H – Cl	427
Cl – O	203	H – O	467

(i) Calculate the enthalpy change of the reaction.

[3]

(ii) Draw the energy profile diagram for the reaction. Label:

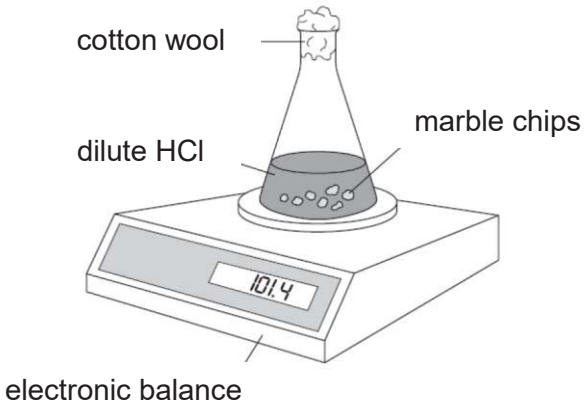
- the reactants and products
- the activation energy
- the enthalpy change of the reaction

[2]

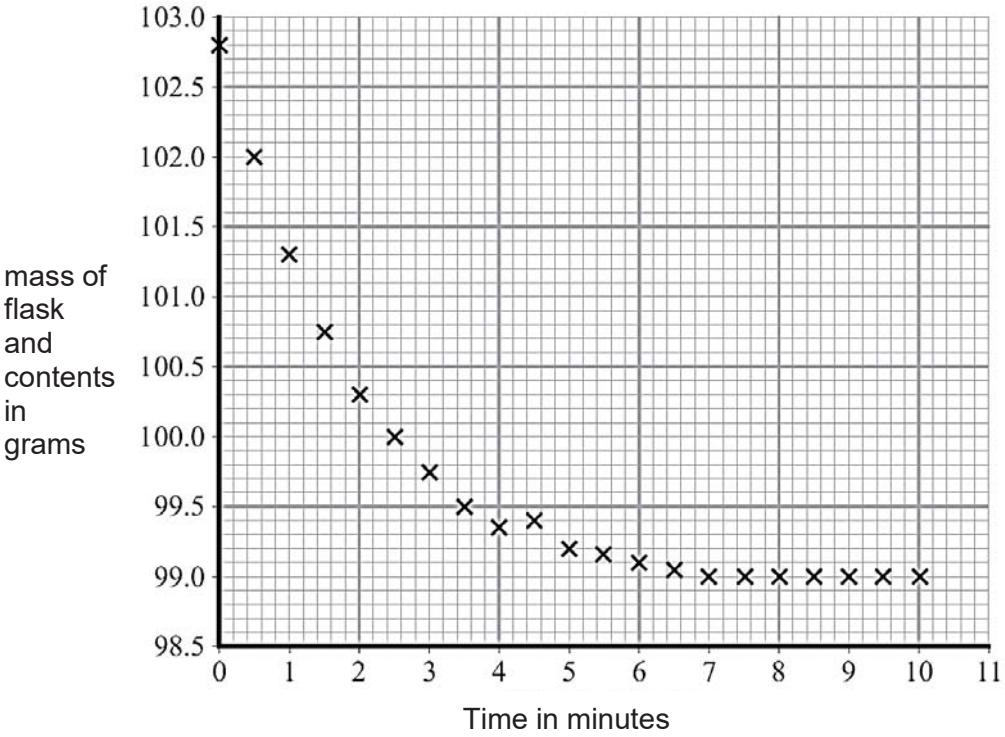
[Total marks: 10]

B9 EITHER

The rate of reaction between hydrochloric acid and excess marble chips (calcium carbonate) was investigated at a temperature of 40 °C using the apparatus shown in the diagram below.



The mass of the flask and contents was measured every half minute for ten minutes. The data obtained was plotted on a graph shown in the grid below.



(a) State the time taken for the reaction to complete.

…….. [1]

(b) Explain why the mass of the flask and contents decreased with time.

……..

…….. [1]

(c) A student repeated the experiment but forgot to place the cotton wool at the neck of the conical flask. State how his results would be different and explain your answer.

……..

……..

…….. [2]

(d) Given that 40 cm^3 of hydrochloric acid were used in the reaction, calculate the concentration of this acid in mol/dm^3.

[3]

(e) Another student repeated the first experiment at a temperature of 50 °C. All other variables were kept the same.

(i) On the same grid on page 18, draw the graph she can expect to obtain for this experiment. Label this graph T. [1]

(ii) Explain, in terms of the collision theory, how an increase in temperature affects the rate of reaction.

……

……

……

…… [2]

[Total marks: 10]

B9 OR

A student carried out three experiments to investigate the rate of reaction of excess magnesium carbonate with dilute acids.

Experiment	Acid
1	100 cm^3 of 0.10 mol/dm^3 sulfuric acid
2	50 cm^3 of 0.20 mol/dm^3 sulfuric acid
3	100 cm^3 of 0.10 mol/dm^3 ethanoic acid

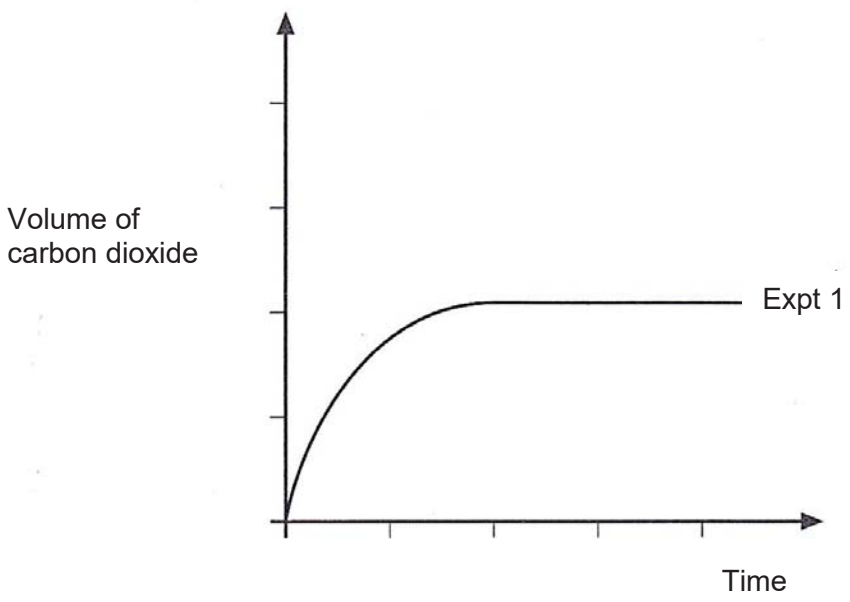
(a) Suggest a method the student could use to follow the progress of the reaction.

……..

……..

…….. [2]

The curve obtained for Experiment 1 is shown on the graph below.



(b) Draw curves on the graph to show the results obtained for Experiment 2 and Experiment 3. Label each curve clearly. [2]

(c) Explain the shape of the curve in Experiment 3.

……..

……..

……..

…….. [3]

(d) Another student repeated Experiment 1 at a temperature of 50 °C. All other variables were kept the same. State the effect of this temperature increase. Explain your answer using collision theory.

……..

……..

……..

…….. [3]

[Total marks: 10]

END OF PAPER

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											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
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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 –		

Key

proton (atomic) number
atomic symbol
name
relative atomic mass

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.).