

Visit
FREETESTPAPER.com
for more papers



Website: freetestpaper.com



[Facebook.com/freetestpaper](https://www.facebook.com/freetestpaper)



[Twitter.com/freetestpaper](https://www.twitter.com/freetestpaper)



PASIR RIS CREST SECONDARY SCHOOL
End-Of-Year Examination
Secondary THREE Express

CANDIDATE
NAME

--

CLASS

	/	
--	---	--

INDEX
NUMBER

--	--

Chemistry

Paper 1

5073/01

10 October 2016

45 minutes

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write your name, class and register number in the spaces above.
Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Calculators are allowed.

There are **thirty** 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.

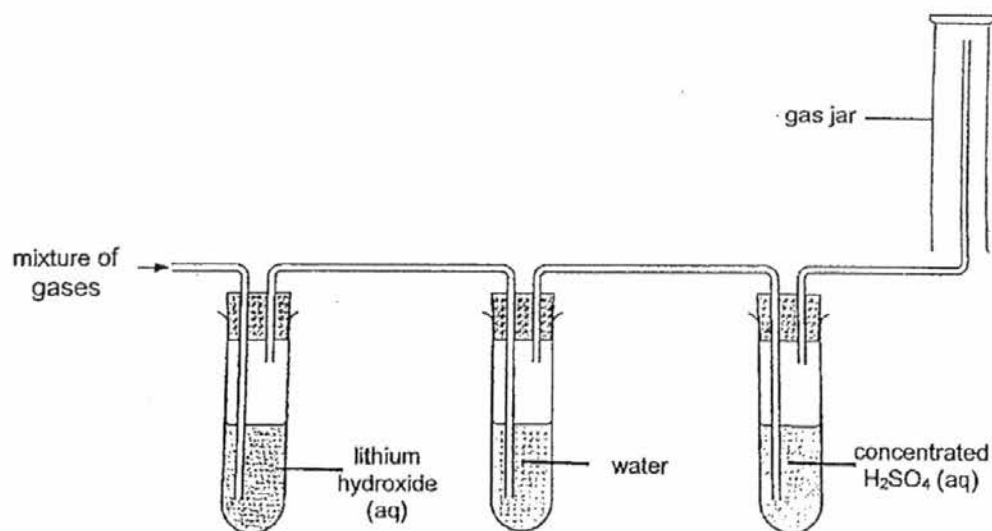
Read the instructions on the Answer Sheet very carefully.

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 11.

For Examiner's Use
30
Parent's Signature

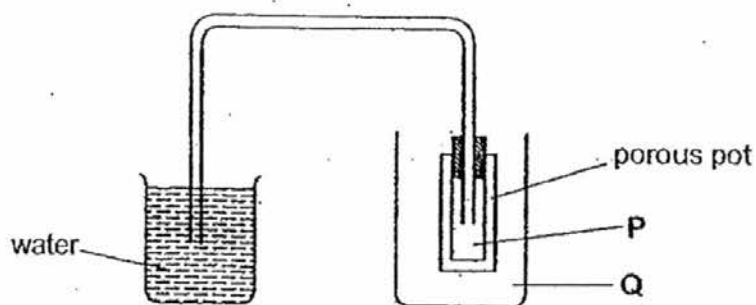
This document consists of 11 printed pages.

- 1 A mixture of ammonia, hydrogen, chlorine and hydrogen chloride gas is passed through the arrangement as shown below.



Which of the following gas will be collected in the gas jar at the end of the experiment?

- A ammonia
 - B chlorine
 - C hydrogen
 - D hydrogen chloride
- 2 An experiment was set up to investigate the rate of diffusion of two gases P and Q.

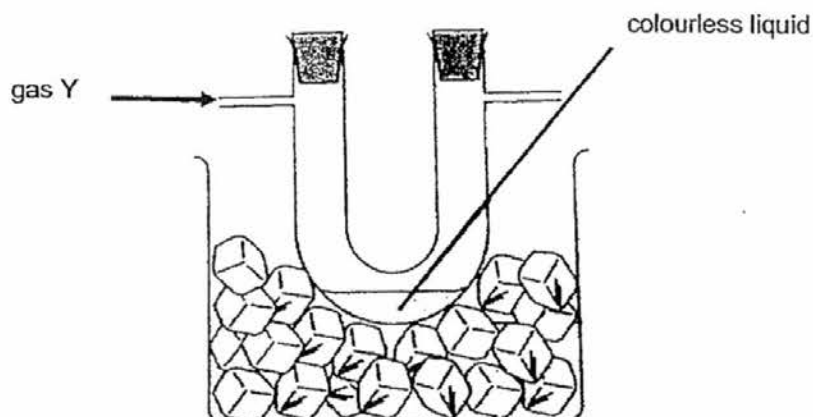


After some time, bubbling was observed in the beaker of water.
Which of the following conclusion is correct?

- A P diffuses out of the tube faster than Q diffuses into the porous pot.
- B P has higher relative molecular mass than Q.
- C P is an unreactive gas and Q is a reactive gas.
- D P is monatomic and Q is diatomic.

[Turn over

- 3 Gas Y was made from a reaction and collected by passing through a U-tube immersed in an ice mixture. The gas condensed into a colourless liquid.



Which could be the melting and boiling point of Y?

	melting point / °C	boiling point / °C
A	180	211
B	-78	-39
C	-129	20
D	-81	-84

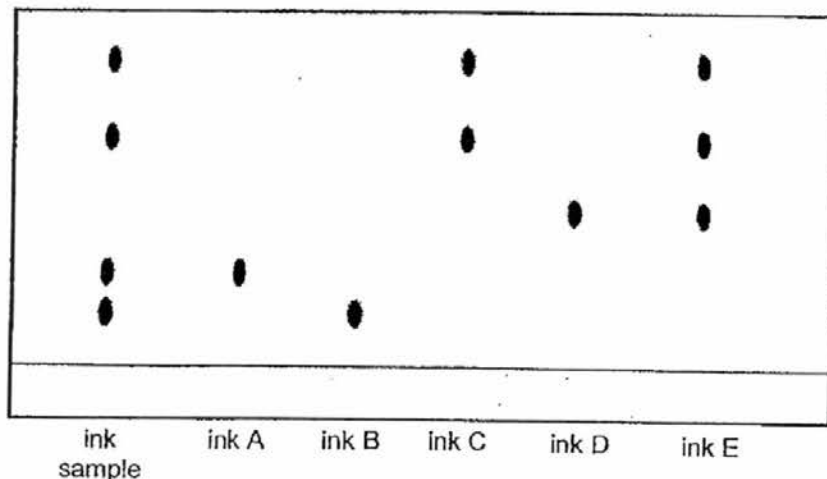
- 4 The table below gives some information about the properties of three chemicals.

chemical	water	effect of heat
ammonium chloride	soluble	decomposes
naphthalene	insoluble	sublimes
lead(II) sulfate	insoluble	no effect

Arrange the following steps in the most appropriate sequence to separate a mixture of ammonium chloride, lead(II) sulfate and naphthalene into its components.

- I. Heat the residue
 - II. Filter the mixture
 - III. Heat then cool the filtrate
 - IV. Add water to the mixture and stir
- A I, II, III, IV
 B II, IV, III, I
 C IV, III, I, II
 D IV, II, III, I

- 5 The chromatogram below is to identify the components in an ink sample.



Which of the following statement is correct?

- A Ink A and C are present in the ink sample.
 B Ink E is one of the components in the ink sample.
 C The ink sample contains a mixture of four different inks.
 D The ink sample is a pure substance.
- 6 An element forms a positive ion with the electronic configuration of 2.8.8. What is the proton number of the element?
- A 16
 B 17
 C 18
 D 19
- 7 An element Q reacts with fluorine to form a compound QF_3 . QF_3 can conduct electricity in molten state. What is the chemical formula of Q sulfate?
- A QSO_4
 B Q_2SO_4
 C $Q_2(SO_4)_3$
 D $Q_3(SO_4)_2$

[Turn over

8 Which of the following explain why graphite is a good lubricant?

- A It contains free moving electrons.
- B It contains carbon atoms that are bonded by weak intermolecular forces of attraction.
- C It contains layers of carbon atoms bonded by weak intermolecular forces of attraction.
- D It contains layers of carbon atoms bonded by weak covalent bond.

9 Four substances have the following electrical properties.

substance	property
W	does not conduct under any condition
X	conducts only in aqueous solution
Y	conducts in both molten and solid state
Z	conducts in both molten and aqueous state

What are these four substances?

	W	X	Y	Z
A	hydrogen fluoride	carbon	lithium chloride	magnesium
B	carbon	hydrogen fluoride	magnesium	lithium chloride
C	lithium chloride	magnesium	hydrogen fluoride	carbon
D	carbon	lithium chloride	magnesium	hydrogen fluoride

10 Which molecule has the largest number of electrons involved in covalent bonds?

- A C_2H_4
- B CO_2
- C N_2
- D NH_3

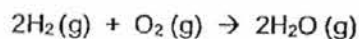
11 What is the maximum mass of magnesium, Mg, which can be extracted from 14 g of magnesium oxide, MgO, by electrolysis?

- A 4.2 g
- B 8.4 g
- C 16.8 g
- D 24 g

- 12 The compound called cynogen is used as rocket propellant. 0.65 g of cynogen occupies 300 cm³ at room temperature and pressure. The empirical formula of cynogen is given as CN. What is the molecular formula of cynogen?

A CN
B C₂N₂
C C₃N₃
D C₄N₄

- 13 Hydrogen burns in oxygen to produce steam as shown in the equation below.



Which of the following statement is correct?

- A 36 g of water is obtained from 2 g of hydrogen burns completely.
B 4 g of hydrogen gas burns in 16 g of oxygen.
C 16 g of oxygen would produce 18 g of steam.
D 1 mol of steam is produced from a complete reaction of 1 mol of oxygen.
- 14 400 dm³ of diluted magnesium sulfate solution has a concentration of 70 g/dm³. After heating the solution for twenty minutes, the concentration of magnesium sulfate solution becomes 560 g/dm³. What is the volume of magnesium sulfate solution left after heating?
- A 30 dm³
B 50 dm³
C 100 dm³
D 200 dm³
- 15 Which of the following gives the largest number of ions when stirred in water?
- A 1 mol of ammonium sulfate
B 1 mol of barium sulfate
C 1 mol of lithium nitrate
D 1 mol of iron(II) hydroxide

[Turn over

- 16 An aqueous solution has pH value of 13.
What information does this fact give about the ions present in the solution?

	concentration of H^+ ions	concentration of OH^- ions
A	low	high
B	none	high
C	high	none
D	high	low

- 17 Calcium carbonate is commonly used in coal-burning power stations to remove some of the air pollutants. Which of the following **cannot** be removed by the use of calcium carbonate?

- A carbon monoxide
- B nitrogen dioxide
- C phosphorus(V) oxide
- D sulfur dioxide

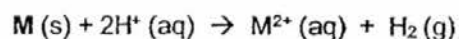
- 18 Which of the following mixture would react with sulfuric acid to form two different gases?

- A silver and magnesium carbonate
- B silver carbonate and magnesium
- C silver carbonate and magnesium oxide
- D silver oxide and magnesium

- 19 The pH of a dilute solution of hydrochloric acid is approximately 2. When 10 g of solid sodium chloride is added to it, what will the pH be?

- A 2
- B 5
- C 7
- D 9

- 20 Which of the following reactions could be represented by the ionic equation below in which **M** is the symbol for a metallic element?



- A copper + dilute nitric acid
B iron + hydrochloric acid
C lead + sulfuric acid
D zinc + steam
- 21 Which of the pairs would react most violently together?
- A caesium and chlorine
B caesium and fluorine
C sodium and chlorine
D sodium and fluorine
- 22 Which of the following statements about the elements in the Periodic Table is correct?
- A Elements in Group III do not react with halogens.
B Elements in Group IV form only acidic oxide with oxygen.
C Elements in Group VII always exist as diatomic molecules.
D The reactivity of elements increases down the group.
- 23 Element R and S are in Group VII of the Periodic Table. R is a liquid and S is a solid at room temperature. Which of the statements are correct?
- I. Atoms of S have more protons than atoms of R.
II. The colour of element S darker than of element R.
III. S displaces R from aqueous solutions of R^- ions.
- A I only
B I and II
C II and III
D I, II and III

[Turn over

- 24 Which of the following is **not** a trend down Group I of the Periodic Table?
- A changes in atomic size
 - B changes in melting points
 - C changes in reactivity
 - D changes in number of valence electrons
- 25 Steel is an alloy of iron and carbon. Which of the following statements is correct?
- A Iron and carbon reacts together to form steel.
 - B Steel has higher melting point than pure iron.
 - C Steel can be represented by a chemical formula
 - D The iron in steel will react with dilute hydrochloric acid.
- 26 Which of the following properties about calcium, lithium and aluminium is correct?
- A Their carbonate has very low thermal stability.
 - B They can only be extracted from their oxide by electrolysis.
 - C They formed basic oxide.
 - D They react vigorously with cold water.
- 27 Metals P, Q, R and S are found to have the following properties.
- I Only oxides of P and R can be reduced by heating with carbon.
 - II P and Q react with acid but not with cold water. R does not react with both acid and water.
 - III Carbonate of S does not decompose under heat.
- Which of the following shows the order of increasing reactivity of the four metals?
- A P, Q, R and S
 - B R, P, Q and S
 - C R, P, S and Q
 - D S, Q, P and R

202

[Turn over]

- 28 During the manufacture of iron from haematite, which of the gases are present in the blast furnace?
- A carbon monoxide only
 - B carbon dioxide and carbon monoxide only
 - C carbon dioxide and nitrogen only
 - D carbon dioxide, carbon monoxide and nitrogen only
- 29 One raw material used in the extraction of iron in the blast furnace is calcium carbonate. Which statement best explains the use of calcium carbonate?
- A To produce slag as a by-product.
 - B To reduce haematite to iron.
 - C To remove the basic impurities in the ore.
 - D To speed up the rate of reaction.
- 30 Why is brass harder than pure copper?
- A The zinc atoms form strong ionic bonds with the copper atoms.
 - B The zinc atoms prevent the sea of electrons from moving freely in the lattice.
 - C There is a greater attraction force due to larger number of atoms in brass.
 - D The zinc atoms prevent layers of copper atoms from sliding over easily.

End of paper

[Turn over

I		II		Group										VII		0		
				1 H Hydrogen 1														
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	2
23 Na Sodium 11	24 Mg Magnesium 12											27 Al Aluminium 13	28 Si Silicon 14	31 P Phosphorus 15	32 S Sulfur 16	35.5 Cl Chlorine 17	40 Ar Argon 18	
39 K Potassium 19	40 Ca Calcium 20	45 Sc Scandium 21	48 Ti Titanium 22	51 V Vanadium 23	52 Cr Chromium 24	55 Mn Manganese 25	56 Fe Iron 26	59 Co Cobalt 27	59 Ni Nickel 28	64 Cu Copper 29	65 Zn Zinc 30	70 Ga Gallium 31	73 Ge Germanium 32	75 As Arsenic 33	78 Se Selenium 34	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	101 Ru Ruthenium 44	101 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	127 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54		
133 Cs Cesium 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	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	210 Po Polonium 84	210 At Astatine 85	222 Rn Radon 86		

Key

a	X
---	---

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.).

140	141	144	150	152	157	159	162	165	167	169	173	175
Ce Cerium 58	Pr Praseodymium 59	Nd Neodymium 60	Sm Samarium 62	Eu Europium 63	Gd Gadolinium 64	Tb Terbium 65	Dy Dysprosium 66	Ho Holmium 67	Er Erbium 68	Tm Thulium 69	Yb Ytterbium 70	Lu Lutetium 71
232	238											
Th Thorium 90	Pa Protactinium 91	U Uranium 92	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



PASIR RIS CREST SECONDARY SCHOOL
End of Year Examination
Secondary Three Express

CANDIDATE
NAME

CLASS

	/	
--	---	--

INDEX
NUMBER

--	--

Chemistry

Paper 2

5073/02

10 October 2016

1 hour 30 minutes

Candidates answer on the Question Paper.
No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name, class and index number on all the work you hand in.
Write in dark blue or black pen.
You may use an 2B pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

Answer **all** questions.
If working is needed for any question it must be shown with the answer.
The use of an approved scientific calculator is expected, where appropriate.
If the degree of accuracy is not specified in the question, and if the answer is not exact, give the answer to three significant figures.

A copy of the Periodic Table is printed on page 15.

The number of marks is given in brackets [] at the end of each question or part question.
The total number of marks for this paper is 70.

For Examiner's Use	
Section A	/ 40
Section B	/ 30
TOTAL	/ 70
Parent's signature	

This document consists of 15 printed pages, including the cover page.

2014

[Turn over

SECTION A [40 marks]

- A1** A sample of a naturally occurring element **Z** from Group VII was found to have the following composition.

Element	Abundance / %
⁷⁹ Z	50.69
⁸¹ Z	49.31

- (a) Identify **Z** by calculating the average relative atomic mass of **Z**.

[2]

- (b) An element **Y** is in period 3 of the Periodic Table. **Y** reacts with a sample of **Z** to form a compound **YZ₂**. An aqueous solution of this compound can conduct electricity. Draw a "dot and cross" diagram to show the bonds in **YZ₂**, showing only the valence electrons.

[2]

[Turn over]

- (c) Element Z reacts with hydrogen to form the compound HZ with a boiling point of -66°C while YZ_2 has a boiling point of 1250°C . Compare and explain the difference in their boiling points in terms of structure and bonding.

.....

.....

.....

.....

.....

.....

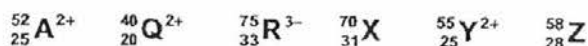
.....

.....

[4]

[Total: 8]

- A2 The symbols of some particles including their nucleon number and proton number are shown below.



- (a) (i) Which of the particles has the greatest number of electrons?

..... [1]

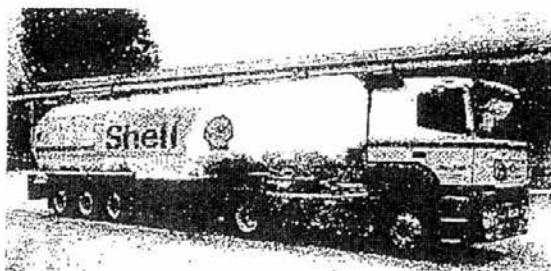
- (ii) Which two of these particles have the same number of neutrons?

..... [1]

- (iii) Which two of these particles are isotopes?

..... [1]

- (b) The figure below shows a tanker used to transport fuel.



- (i) Suggest one reason why fuel is transported in liquid state but not in gaseous state.

.....

.....

.....

[2]

205

Turn over

- (ii) When the fuel is transported in a hot day, its density decreases slightly. Explain why it is so.

.....

[2]

[Total: 7]

A3 A mixture of 200 cm^3 of 0.01 mol/dm^3 of silver nitrate solution and 20 cm^3 of 0.2 mol/dm^3 of aqueous lithium chloride were mixed. The resulting mixture was filtered. The residue was collected and its mass was measured immediately.

- (a) Write an ionic equation of the reaction.

..... [1]

- (b) (i) Assuming that the percentage yield of the reaction is 95.6%, calculate the actual mass of the solid silver chloride formed.

[4]

- (b) (ii) Name all the ions present in the filtrate at the end of the reaction.

..... [1]

[Turn over]

- (c) Suggest how the accuracy of the mass calculated in part (b)(i) can be improved.

..... [1]

[Total: 7]

A4 Sodium is an alkali metal which can react with many compounds to form different products.

- (a) State the differences between sodium and iron metal in terms of

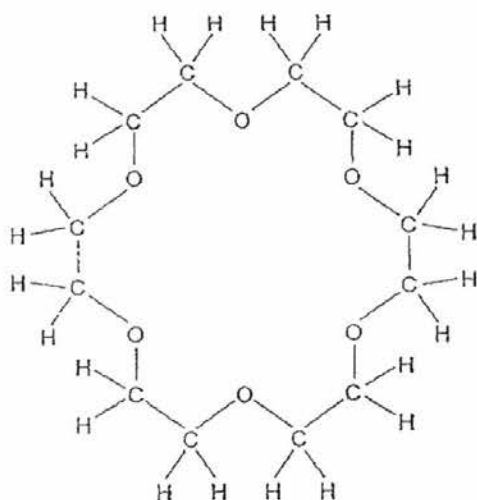
- (i) density:

..... [1]

- (ii) melting point:

..... [1]

- (b) Sodium can react with compound known as crown ethers. The structural formula of a typical crown ether is shown below.



- (i) State the empirical formula for the crown ether shown above.

..... [1]

- (ii) During the reaction, sodium loses an electron. Explain why.

..... [1]

206

[Turn over]

(c) Sodium also reacts with water.

- (i) Describe **two** observations that can be made when a small mass of sodium reacts with water.

.....

.....

.....

.....

[2]

- (ii) Write a balanced chemical equation, including state symbols, for the reaction of sodium with water.

.....

[2]

(d) The table shows the decomposition temperatures of some metal carbonates.

metal carbonate	decomposition temperature / °C
barium carbonate	1360
magnesium carbonate	540
rubidium carbonate	3900
strontium carbonate	1280
sodium carbonate	2680
calcium carbonate	900
copper(II) carbonate	145

- (i) Explain why rubidium carbonate has a very high decomposition temperature.

.....

.....

[1]

- (ii) Based on the data in the table, arrange Group II metal from the most reactive to the least reactive.

.....

[1]

[total: 10]

[Turn over]

- A5 (a) The following experiments were conducted on aqueous solution of acids X and Y, each solution having a concentration of 2.0 mol/dm^3 .

	experiment	acid X	acid Y
1.	Measure time taken for 50 cm^3 of acid to react with 0.5 g of magnesium ribbon.	1.5 minutes	20 minutes
2.	Measure the electrical conductivity of acid i.e. the current which flows under identical conditions.	0.3 A	0.001 A

- (i) Which acid has a higher pH? Using the data in the table, explain your answer.

.....

.....

.....

.....

.....

.....

.....

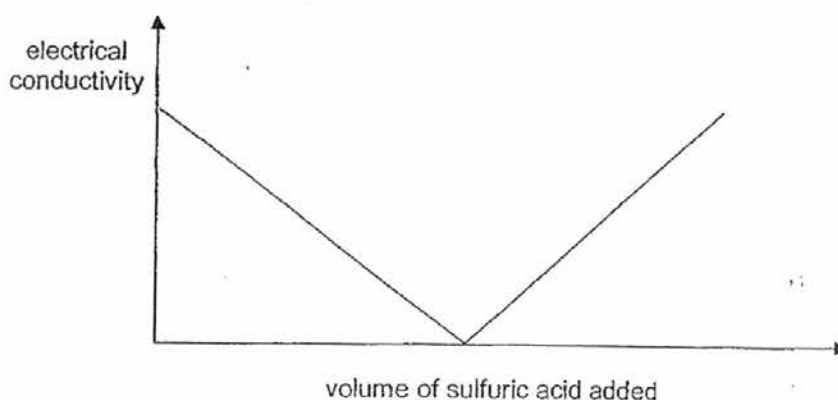
[3]

- (ii) How do we know if the reaction is completed?

.....

[1]

- (b) The graph below show the electrical conductivity of calcium hydroxide solution when sulfuric acid is slowly added to it.



207

Turn over

- (i) Complete the chemical equation for the reaction.



- (ii) Using the equation in (b)(i), explain the trend in the electrical conductivity show in the graph above.

.....

.....

.....

.....

.....

.....

.....

[3]

[Total: 8]

[Turn over

SECTION B [30 marks]

B6 (a) A student prepared a pure crystalline sample of hydrated potassium nitrate by titration method as described below.

1. With a measuring cylinder, measure 25.0 cm^3 of potassium hydroxide solution into a conical flask.
2. Add a few drops of methyl orange indicator into the conical flask.
3. Using a burette, titrate dilute sulfuric acid into the flask with potassium hydroxide.
4. Add dropwise when solution started to change colour.
5. Record the volume of acid used when the colour change is permanent.
6. Repeat steps 1 - 5 using the same recorded volume of acid.
7. Transfer the potassium nitrate solution into an evaporating dish.
8. Evaporate the solution to dryness to obtain hydrated potassium nitrate crystals.
9. Wash the crystals with some distilled water and dry between filter paper.

- (i) There are **four** errors in the passage above.
Rewrite the correct statement by changing or adding words to describe the experimental procedure.

Error 1:

.....

.....

Error 2:

.....

.....

Error 3:

.....

.....

Error 4:

.....

.....

[4]

208

[Turn over

- (ii) Name the type of reaction as shown in the titration.

..... [1]

- (b) Sodium carbonate forms a number of hydrates of general formula $\text{Na}_2\text{CO}_3 \cdot y\text{H}_2\text{O}$.

A 3.04 g sample of one of these hydrates was dissolved in 25.0 cm³ of water to form a solution of 0.980 mol/dm³. In a chemical reaction, this solution was reacted completely by hydrochloric acid using titration.

- (i) Write a balanced equation for the reaction between sodium carbonate and hydrochloric acid.

..... [1]

- (ii) Calculate the relative molecular mass of the hydrated sodium carbonate.

[2]

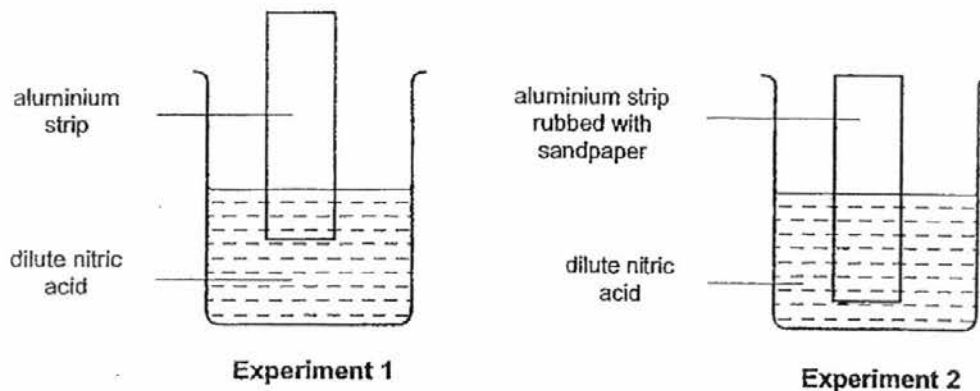
- (iii) The relative molecular mass of a different hydrated sodium carbonate was found to be 250. Determine the value of y in this hydrated sodium carbonate, $\text{Na}_2\text{CO}_3 \cdot y\text{H}_2\text{O}$.

[2]

[Total: 10]

[Turn over]

- B7 (a) The diagram below shows the set-up of the experiments of aluminium in dilute nitric acid.



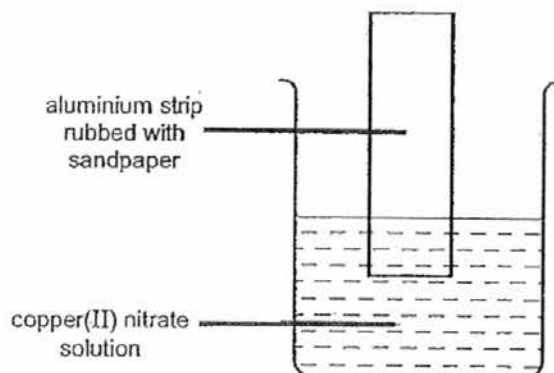
- (i) Describe the observation in both experiments.

.....
 [1]

- (ii) An immediate reaction was observed in Experiment 2, but **not** in Experiment 1. Explain why the two strips behave differently.

.....
 [1]

- (b) A new strip of aluminium is now placed in a beaker containing aqueous copper(II) nitrate as shown in the diagram below.



209

[Turn over

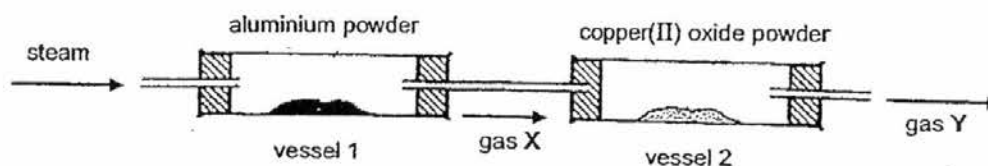
- (i) Describe the observations after some time.

.....
 [2]

- (ii) Explain your observations in (b)(i).

.....
 [1]

- (c) The diagram below shows an experiment of the reaction between steam and aluminium powder.



When steam flow through the aluminium powder in vessel 1, a gas X is produced. Gas X is then allowed to flow through vessel 2 containing copper(II) oxide and a gas Y is produced.

- (i) Suggest the identity of gas X and Y.

X: Y: [2]

- (ii) Describe a method to test for the identity of gas X.

.....
 [1]

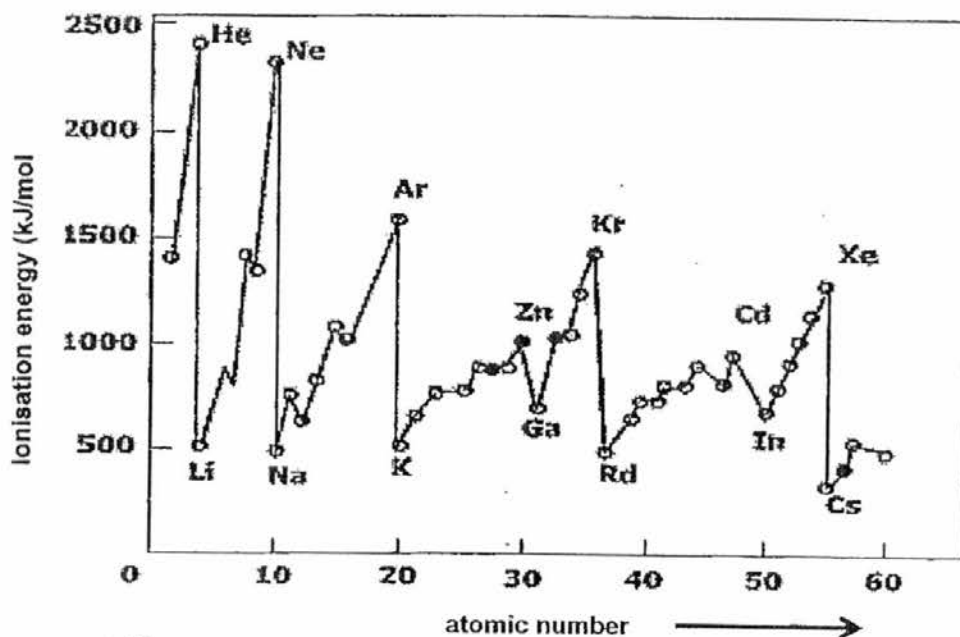
- (iii) Name the solid products that are formed in vessels 1 and 2 after gases have flown through them.

vessel 1: vessel 2: [2]

[Total: 10]

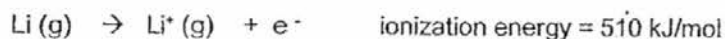
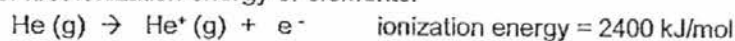
[Turn over

- B8 (a) The graph below shows the first ionization energy of the atoms of elements in the Periodic Table.



The first ionization energy of elements refers to the energy required for 1 mole of gaseous atoms to lose 1 mole of electrons, forming one mole of gaseous ions with a charge of +1.

Examples of first ionization energy of elements.



- (i) Explain why elements in Group 0 have the highest ionization energy compared to other elements in the same period.

.....
 [1]

- (ii) Based on the graph, describe the difference between the ionization energy of the atoms in period 2 as compared to period 3. Suggest an explanation.

.....

 [3]

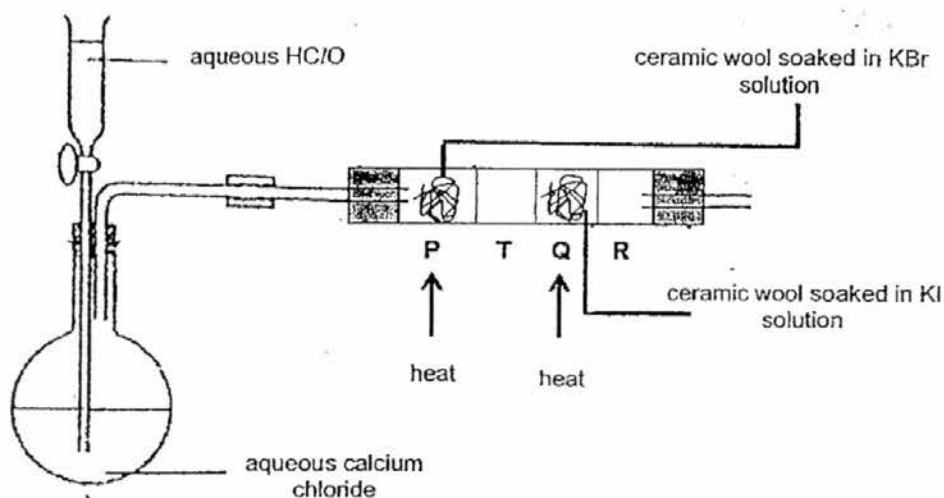
- (iii) A student made the following statement.

"Chlorine-35 and Chlorine-37 have different ionization energy."

Do you agree with the student? Explain your answer.

..... [1]

- (b) Chlorine gas can be made by reacting hypochlorous acid, HClO with calcium chloride using the apparatus below.



- (i) Name the reaction at P. [1]

- (ii) Describe the observations at T and R.

..... [2]

- (iii) Account for the difference in the reaction at P if the ceramic wool is soaked in aqueous potassium fluoride.

..... [2]

[Total: 10]

END OF PAPER

[Turn over

I		II		Group										III		IV		V		VI		VII		0											
7 Li Lithium 3		9 Be Beryllium 4		1 H Hydrogen 1										11 B Boron 5		12 C Carbon 6		14 N Nitrogen 7		16 O Oxygen 8		19 F Fluorine 9		20 Ne Neon 10											
23 Na Sodium 11		24 Mg Magnesium 12												27 Al Aluminium 13		28 Si Silicon 14		31 P Phosphorus 15		32 S Sulfur 16		35.5 Cl Chlorine 17		40 Ar Argon 18											
39 K Potassium 19		40 Ca Calcium 20		45 Sc Scandium 21		48 Ti Titanium 22		51 V Vanadium 23		52 Cr Chromium 24		55 Mn Manganese 25		56 Fe Iron 26		59 Co Cobalt 27		59 Ni Nickel 28		64 Cu Copper 29		65 Zn Zinc 30		70 Ga Gallium 31		73 Ge Germanium 32		75 As Arsenic 33		79 Se Selenium 34		80 Br Bromine 35		84 Kr Krypton 36	
85 Rb Rubidium 37		86 Sr Strontium 38		89 Y Yttrium 39		91 Zr Zirconium 40		93 Nb Niobium 41		96 Mo Molybdenum 42		98 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		210 Po Polonium 84		210 At Astatine 85		222 Rn Radon 86	
Fr Francium 87		Ra Radium 88		227 Ac Actinium 89																															

†90-103 ActInoid series

key

a	X
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.).

Marking Scheme Sec 3E EOY Chemistry 2016

A1	(a)	Average $A_r = (50.67 \times 79) + (49.31 \times 81) = 80.0$ [1] Z is <u>bromine</u>. [1] Comment • answer not left in 3 sf • didn't write the identity of Z	[2]
	(b)	Correct charge [1] Correct electron drawn [1] Award only if ionic compound is drawn. Comment: • generally well done • some drew simple molecular structure	[2]
	(c)	• HZ has a <u>simple molecular structure</u> while YZ_2 has a <u>giant lattice structure</u>. [1] • <u>Little heat energy</u> is needed to <u>overcome the weak intermolecular forces of attraction</u> [1] <u>between molecules</u> in HZ. • <u>A lot of heat energy</u> is needed to <u>overcome the strong electrostatic forces of attraction between oppositely charged ions</u> [1] in YZ_2. * Difference in heat energy [1] Comment: • Answer is not written in the form of comparison • Common error: structure of ionic compound is not written (giant lattice structure) • Common error: break the force • Common error ionic compound ◦ wrong term used "forces between atoms" ◦ Missing "oppositely charged ions" • Common error: weak covalent bond	[4]

A2	(a)	(i)	R^{3-}	[1]
		(ii)	Y^{2+} and Z	[1]
		(iii)	A^{2+} and Y^{2+} Do not award if students do not write the charge of the particles Comment: Did not include the charge of the particles in their answers	[1]
	(b)	(i)	The liquid particles are <u>more closely packed/compact</u> [1] than in gaseous state. Hence there will be <u>more fuel particles transported per unit volume</u> [1]. Comment: - Badly answered - Many wrote "gas will react with the air explosively" - Many just mentioned that gas take up more space/volume than liquid - Did not write "more fuel particles transported per unit volume"	[2]
		(ii)	On a hot day, the fuel <u>particles gain kinetic energy and move further away</u> [1]. <u>Volume of fuel / space occupied increases</u> [1] and hence the <u>density decreases</u> for the same number of fuel particles. OR <u>number of particles per unit volume decreases.</u> Comment: - Missing key term: fuel particles gain kinetic energy and move further away - Common error: particles expand - Common error: fuel expand	[2]
A3	(a)	$Ag^+ + Cl^- \rightarrow AgCl$ Comment: - Badly done; many cannot write ionic equation - Some wrote chemical equation - Silver ion Ag^{2+}		[1]

	(b)		No. of mol of silver nitrate = $0.2 \times 0.01 = 0.002 \text{ mol}$ No. of mol of lithium chloride = $0.02 \times 0.2 = 0.004 \text{ mol}$ [1] Theoretical mole ratio: $\text{Ag}^+ = \text{Cl}^-$ Therefore silver nitrate is the limiting reagent / lithium chloride is in excess. [1] Theoretical mass of silver chloride = $0.002 \times (108 + 35.5) = 0.287 \text{ g}$ [1] Actual mass of silver chloride = $0.956 \times 0.287 = 0.274 \text{ g}$ [1] Allow ECF from LR onwards Comment: • Did not find limiting reagent • Use AgCl_2 • Common error: theoretical mass/ experimental mass $\times 100\%$	[4]
	(c)		Ions: Li^+, NO_3^-, Cl^- [1] Award only all ions are listed correctly Comment: • miss out chloride ions	[1]
	(d)		Wash silver chloride with distilled water Or dry the solid between filter paper. [1] Accept either answer Comment: • badly written • common answer: repeat experiment/ use larger volume of silver nitrate solution/ leave in more significant number	[1]
	A4	(a)	(i) Sodium has a lower density than iron. [1] (ii) Sodium has lower melting point than iron. [1]	
	(b)	(i)	Empirical formula: C_2OH_4 [1] Comment: • not in lowest ratio • incorrect calculation •	
		(ii)	To attain a stable electronic configuration of a noble gas/complete valence electron shells of noble gas. [1] Reject: to become stable/ to become a noble/inert gas Comment: • missing ".... noble gas" • common error: attain a stable structure.	

(c)	(i)	- Heat is given off - Sodium moves rapidly on the surface of water - orange flame observed - effervescence observed - spark observed / catches fire/ <u>may</u> have small explosion (any two observation) Reject: hydrogen gas is produced / explosion/ vigorously / quickly Comment: - common answer: react vigorously/quickly/ explosively	[2]
	(ii)	$2\text{Na (s)} + 2\text{H}_2\text{O (l)} \rightarrow 2\text{NaOH (aq)} + \text{H}_2 \text{ (g)}$ - balanced equation [1] - correct state symbol [1] Comment: - well answered	[2]
(d)	(i)	Rubidium is <u>a very reactive metal</u> thus forms <u>very stable compound/ strong bond with carbonate</u> [1], therefore <u>a lot of heat energy is needed to decompose.</u> Comment: - did not mention that rubidium is a reactive metal - common use of "it" e.g. "it is very reaction" instead of "the rubidium metal is very reactive" - wrote "compound has high thermal stability" instead of "rubidium carbonate is a very stable compound" - common error: rubidium carbonate is very reactive - Common error: rubidium is very stable.	[1]
	(ii)	Barium, strontium, calcium, magnesium Do not award if non group II metal is included in the answer. Do not award if written as metal carbonate. Comment: Students didn't read question carefully, included other group metal in their answer	[1]

A5	(a)	(i)	• <u>Acid Y as it is a weak acid (accept: weaker acid) [1] as it only partially ionised to produce hydrogen ions in water [1]</u> • <u>Acid Y takes a longer time to react with magnesium compared to acid X, indicating that there are lower concentration of hydrogen ions [1]</u> OR • <u>The current flowing through a solution of Y is smaller than that of X, indicating that there lower concentration of hydrogen ions [1] in Y</u> - Allow ECF if data is correctly explain with relation to number of hydrogen ions per unit volume Reject: lesser hydrogen ions Accept: lesser hydrogen ions per unit volume Comment: • Badly done • Misconception: higher pH = stronger acid • Common error: ○ only lift the information without explanation ○ lesser hydrogen ions per-unit-volume-(missing) ○ instead describing as <u>weak / strong</u> acid, student describe as "X is more acidic" ○ assume that strength of acid = rate of H⁺ dissociated	[3]
		(ii)	<u>No effervescence</u> is observed. Comment: • badly done • didn't write as a form of observation • many wrote ○ when Mg is used up ○ when hydrogen gas is no longer produced ○ when salt is formed	[1]
	(b)	(i)	$\text{Ca(OH)}_2 + \text{H}_2\text{SO}_4 \rightarrow \text{CaSO}_4 + 2\text{H}_2\text{O}$ Comment: not in lowest ratio	[1]

		(ii)	The electrical conductivity decreases as sulfuric acid is added because of the <u>formation of solid/insoluble calcium sulfate [1]</u>. However, the electrical conductivity later increases because <u>excess sulfuric acid is added [1]</u>, <u>increasing the number of free moving ions [1]</u> in the solution. Comment: • Badly done • Many do not see that calcium sulfate is insoluble • Common error: ○ Neutral salt cannot conduct electricity ○ Neutralisation caused the electrical conductivity to decrease ○ Only H^+ and OH^- are responsible for electrical conductivity ○ Use "becoming more alkaline" to describe the nature of solution before reaction the neutralisation point	[3]
B6	(a)	(i)	• Step 1: With a measuring cylinder <u>pipette</u>, measure 25.0 cm^3 of potassium hydroxide solution into a conical flask. • Step 3: Using a burette, titrate dilute sulfuric <u>nitric</u> acid into potassium hydroxide. • Step 6: Repeat the titration using the same recorded volume of potassium hydroxide <u>without adding indicator</u> • Step 8: Evaporate the solution to dryness <u>saturation</u> to obtain hydrated potassium nitrate crystals. • Using a burette, titrate dilute sulfuric <u>nitric</u> acid into potassium hydroxide, and <u>swirl the conical flask while titrating</u> Comment: • Generally well done • Many did not spot the error in step 6	[4]
		(iii)	Neutralisation • Comment: Generally well done	[1]

(b)	(i)	$\text{Na}_2\text{CO}_3 + 2\text{HCl} \rightarrow 2\text{NaCl} + \text{CO}_2 + \text{H}_2\text{O}$ Comment: • Generally well done • Some wrote carbon dioxide as H_2CO_3	[1]
	(ii)	Method 1 $\begin{aligned} \text{no. of mole of Na}_2\text{CO}_3 &= 0.98 \times 0.025 \\ &= 0.0245 \text{ [1]} \end{aligned}$ $\begin{aligned} \text{Mr of hydrated sodium carbonate} &= 3.04 / 0.0245 \\ &= 124.3061 \\ &= 124 \text{ (3 s.f.) [1]} \end{aligned}$ Method 2 $\begin{aligned} \text{Concentration} &= 3.04 / 0.025 \\ &= 121.6 \text{ g/dm}^3 \end{aligned}$ $\text{Mr} = 121.6 / 0.98 = 124$ Comment: • Generally well done • Error: calculate the Mr with the assumption of 1 molecule of water	[2]
	(iii)	$\begin{aligned} \text{Mr of hydrated sodium carbonate} &= 250 \\ 23 \times 2 + 12 + 16 \times 3 + 18y &= 250 \text{ [1]} \\ 18y &= 250 - 106 \\ 18y &= 144 \\ y &= 8 \text{ [1]} \end{aligned}$ Award of ECF Comment: • Generally well done • Error: use answer in (b)(i) to calculate with answer as 7 which result in 1 less molecule of water	

B7	(a)	(i)	• <u>bubbles/ effervescence will be observed</u> in both experiments [1] reject: hydrogen gas is observed. Comment: • Generally well done • Common error: no reaction for experiment 1	[1]
		(ii)	There is a <u>layer of aluminium oxide / Al₂O₃</u> in experiment 1 [[1], which will be <u>react with the acid first</u>, before reacting with the aluminium metal. Do not award if student did not state aluminium oxide Comment: • Badly done • Common error: ◦ Sand paper will result in a larger surface area of reaction ◦ Mention "protection layer" only ◦ Some mentioned that there is no reaction in experiment 1	[1]
	(b)	(i)	• <u>Blue solution become paler/ solution changes from blue to colourless</u> [1] • <u>Reddish brown / pink solid or precipitate</u> [1] formed Comment: - Generally well done - Common error: solution turn pinkish brown	[2]
		(ii)	<u>Aluminium is more reactive than copper</u>[1] therefore it will displace copper from its solution. Comment: - Generally well done	[1]
	(c)	(i)	X: hydrogen / H₂ [1] Y: water vapour / H₂O (g) [1] Comment: - Generally well done for X - Common error: Y : ◦ oxygen/ carbon dioxide / steam	[2]

		(ii) Place <u>lighted splint</u> near gas. If <u>flame goes off</u> with a "pop" sound, [1] hydrogen is present. Allow ECF from (c)(i) X: carbon dioxide → bubble gas in limewater, white ppt formed X: chlorine gas → bleaches damp litmus paper. Do not award if student did not mention "flames goes off..." Comment: - Generally well done - Did not state "flame goes off.."	
		(iii) Aluminium oxide [1] copper [1] Comment: Written as • aluminium hydroxide ○ copper (II) ○ copper(II) oxide ○ chemical formula	

B8	(a)	(i)	They have a <u>complete electron shells</u> therefore a <u>lot of energy</u> is needed to remove an electron from the atom. Reject: stable electronic configuration of a noble gas Comment: many students did not explain why is the electronic configuration stable / inert	[1]
		(ii)	<u>Ionization energy of period 2 is higher than period 3.</u> [1] - Atoms in period 3 have <u>an additional electron shell</u> [1] therefore the <u>electrostatic force between the nucleus and valence electrons is weaker</u> [1], thus easier to remove the valence electron. Accept reverse argument Do award: atomic radius is smaller / closer distance between nucleus and electron without stating the difference in the electron shells Comment: - Many did not explain why the reason - Electrostatic forces of attraction is not mentioned in their answer	[3]
		(iii)	<u>No / disagree</u> because both chlorines / isotope contains the <u>same number of electrons</u>[1]. Award only if student disagree with the statement Comment: Students show understanding that isotope have different number of neutron but did not mention the number of electrons remains the same	[1]
	(b)	(i)	Displacement reaction / redox reaction	[1]
		(ii)	At T, reddish brown aqueous bromine observed At R, purplish black iodine solid observed Reject: at R, brown solution observed Comment: - Observation at T is mostly correctly stated - Observation at R mostly state as "brown gas"	[2]

		(iii)	• <u>No reaction</u> occur at P / <u>remain pale greenish-yellow</u>[1] • <u>Chlorine is less reactive</u> [1]than fluorine <u>cannot displace fluorine</u> from KF solution Comment: • Many did not read question carefully, compared to bromine instead of chlorine • State fluo<u>ride</u> instead of fluorine is more reactive than chlorine. • Misconception: more reactive halogen reacts at a faster rfate	[2]
--	--	-------	--	-----

1	C	11	B	21	B
2	B	12	B	22	C
3	C	13	C	23	B
4	D	14	B	24	D
5	A	15	A	25	D
6	D	16	A	26	B
7	C	17	A	27	B

8	C	18	B	28	D
9	B	19	A	29	A
10	A	20	B	30	D