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KUO CHUAN PRESBYTERIAN SECONDARY SCHOOL
2016 END-OF-YEAR EXAMINATION

Secondary 3 Express

NAME

CLASS

REG. NO

CHEMISTRY (SPA)

7 October 2016

2 hours

Additional Materials: Multiple Choice Answer Sheet.

Setter: Mr. Desmond Tan

READ THESE INSTRUCTIONS FIRST

Do not open this booklet until you are told to do so.

Section A

Answer **all** questions.

Write in soft pencil.

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

Write your class, name and index number on the Multiple Choice Answer Sheet in the spaces provided.

There are **thirty** questions in Section A. 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 Multiple Choice Answer Sheet.

Section B

Answer **all** questions.

Write your class, name and index number on the work you hand in.

Write in dark blue pen.

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

Write your answers in the spaces provided in the Question Paper.

Section C

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

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

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

Periodic Table is given on **page 24**.

You are allowed to use calculators.

.....
Parent's signature/
Date

**FOR EXAMINER'S
USE**

Section A	/30
Section B	/40
Section C	/30
Total	/100

This document consists of **24** printed pages

Section A (30 marks)

1 In which change(s) is/are there a decrease in the spacing between particles?

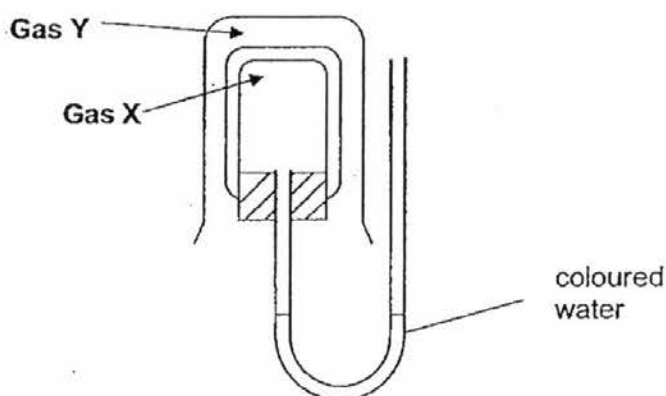
1 condensation 2 freezing 3 sublimation

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

2 Why does the temperature of boiling water remain constant even though heat is supplied at a constant rate?

- A The heat is converted to kinetic energy of the water molecules as they increase in speed.
 B The heat is lost to the surroundings.
 C The heat is used to break the covalent bonds in the water molecules.
 D The heat is used to overcome the intermolecular forces of attraction between water molecules.

3 The apparatus below can be used to show the diffusion of gases.



Which pair of gases X and Y would cause **no** movement of the coloured water?

	X	Y
A	C_2H_4	C_2H_6
B	C_2H_4	N_2
C	CO_2	C_2H_6
D	CO	NO_2

4 Which group of substances contains an element, a mixture, and a compound?

- A air, sea water, oxygen
 B copper, water, magnesium chloride
 C hydrogen, carbon, methane
 D oxygen, air, ammonia

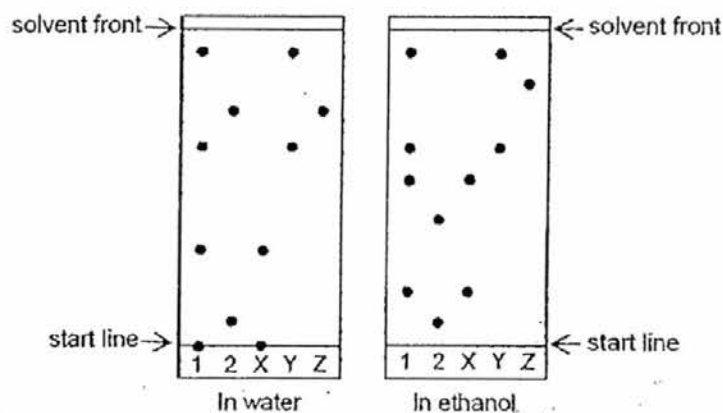
- 7 The table shows the colours and the solubilities in water of four solids.



- | solid | colour | solubility in water |
|-------|--------|---------------------|
| O | blue | insoluble |
| P | blue | soluble |
| Q | white | insoluble |
| R | white | soluble |

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

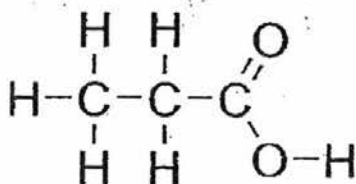
- 8 Food dyes, 1 and 2 are known to contain one or more of three substances X, Y and Z. Two chromatograms are developed; one used water as the solvent, and the other used ethanol. The results are shown in the diagram below.



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

- I There is a component in Sample 1 that is insoluble in water but soluble in ethanol.
 - II The component in Z is more soluble in water than in ethanol.
 - III Substance Z is likely to be pure.
- A I only
 B II only
 C I and III only
 D II and III only
- 9 Element X has 40 nucleons and 19 protons.
 Which of the following represents the **isotope** of X?
- A ${}^{40}_{19}\text{X}$
 B ${}^{39}_{19}\text{X}$
 C ${}^{40}_{18}\text{X}^{+}$
 D ${}^{39}_{18}\text{X}^{+}$
- 10 Which group of elements has the same number of valence electrons?
- A calcium, magnesium, bromine
 B beryllium, barium, strontium
 C potassium, rubidium, calcium
 D sodium, magnesium, aluminium

- 11 Which statement is correct for both diamond and iodine?
- A They conduct electricity.
 - B They consist of small molecules.
 - C They contain covalent bonds.
 - D They have very high melting points.
- 12 Element X has n protons and forms ions with a charge of +2. Element Y has $(n-2)$ protons.
Which of the following correctly describes X and Y?
- A X reacts with Y to form an ionic compound.
 - B X and Y are in the same period of the Periodic Table.
 - C The melting point of element Y is higher than that of element X.
 - D X can conduct electricity in molten and solid state.
- 13 What is the total number of pairs of electrons shared in a molecule of propanoic acid with the following structure?



- A 10
 - B 11
 - C 16
 - D 22
- 14 Which one of the following is a typical property of transition metals?
- A They burn in air.
 - B They form coloured compounds.
 - C They have low melting points.
 - D They react with cold water to give hydrogen.
- 15 Rubidium is an element in Group I of the Periodic Table. Which one of the following statements about rubidium is **incorrect**?
- A Rubidium has a low density.
 - B Rubidium is soft and can be cut with a knife.
 - C Rubidium reacts explosively with water to form an alkaline solution.
 - D Rubidium is the least reactive metal in the group.

- 16 Acetylene (C_2H_2) is used in welding and it was produced by the reaction shown below. Identify X.

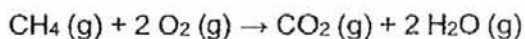


- A CaO
 B Ca_2O
 C CaOH_2
 D $\text{Ca}(\text{OH})_2$
- 17 A large sample of hydrated magnesium sulfate ($\text{MgSO}_4 \cdot x\text{H}_2\text{O}$) is heated gently to give anhydrous magnesium sulfate ($M_r = 120$). The table shows some useful data collected from the experiment.

Mass of hydrated magnesium sulfate	384 g
Mass of anhydrous magnesium sulfate	240 g

What is the value of x?

- A 1
 B 2
 C 4
 D 8
- 18 The chemical equation for the complete combustion of methane is as shown below.

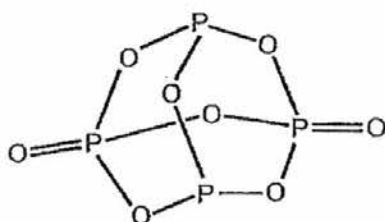


50 cm^3 of methane gas is mixed with 40 cm^3 of oxygen gas in a sealed vessel and burnt.

What are the volumes of the gases remaining, at the original temperature and pressure?

	Volume of methane/ cm^3	Volume of oxygen/ cm^3	Volume of carbon dioxide/ cm^3	Volume of steam/ cm^3
A	0	0	50	40
B	0	20	20	40
C	30	0	20	40
D	40	40	40	40

- 19 The structural formula of a molecule is shown in the figure below. Which one of the following shows the correct molecular formula and empirical formula of the molecule?

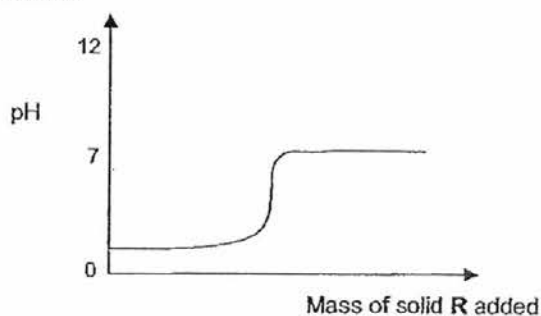


	Molecular formula	Empirical formula
A	PO ₂	P ₄ O ₈
B	P ₄ O ₆	P ₂ O ₃
C	P ₄ O ₈	PO ₂
D	P ₄ O ₈	P ₂ O ₄

- 20 Which of the following equations best represents the neutralisation reaction between hydrochloric acid and aqueous sodium hydroxide?

- A $\text{H}^+(\text{aq}) + \text{OH}^-(\text{aq}) \rightarrow \text{H}_2\text{O}(\text{l})$
 B $2\text{H}(\text{g}) + \text{O}(\text{g}) \rightarrow \text{H}_2\text{O}(\text{l})$
 C $2\text{H}^+(\text{aq}) + \text{O}^{2-}(\text{aq}) \rightarrow \text{H}_2\text{O}(\text{l})$
 D $\text{Na}^+(\text{aq}) + \text{Cl}^-(\text{aq}) \rightarrow \text{NaCl}(\text{aq})$

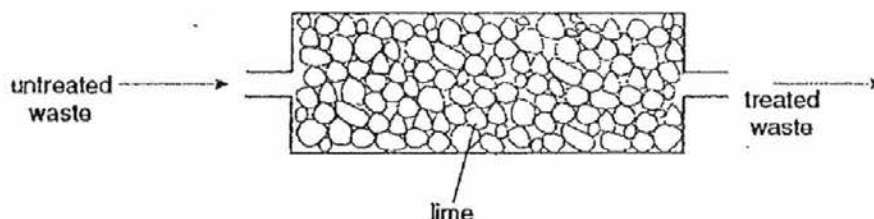
- 21 Solid R is gradually added to aqueous solution S. The changes in pH are shown on the graph below.



What are R and S?

	R	S
A	soluble basic oxide	hydrochloric acid
B	soluble basic oxide	sodium hydroxide
C	insoluble amphoteric oxide	hydrochloric acid
D	insoluble acidic oxide	sodium hydroxide

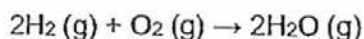
- 22 Lime (CaO) is used to treat industrial waste.



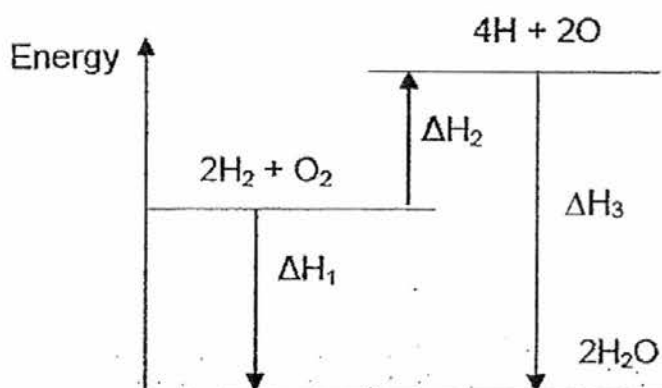
What pH change occurs in the treatment?

- | | <u>untreated waste</u> | | <u>treated waste</u> |
|---|------------------------|---|----------------------|
| A | acidic | → | neutral |
| B | alkaline | → | acidic |
| C | alkaline | → | neutral |
| D | neutral | → | acidic |
- 23 Which of the following solutions has the lowest pH?
- A 1 mol/dm³ of ethanoic acid
 B 1 mol/dm³ of hydrochloric acid
 C 1 mol/dm³ of sodium chloride
 D 1 mol/dm³ of sodium hydroxide
- 24 John was tasked to identify a bottle of chemical which contained a number of ions. He added aqueous sodium hydroxide into a sample of the solution and observed the following.
- Gas evolved upon gentle heating, turned moist red litmus paper blue
 - Dirty green precipitate produced, remained insoluble in excess sodium hydroxide
- Which ions can be correctly identified from the observations made?
- A Fe^{2+} and NO_3^-
 B Fe^{2+} and NH_4^+
 C Fe^{3+} and NO_3^-
 D Fe^{3+} and NH_4^+
- 25 Which of the following is the best pair of reagents to prepare copper(II) sulfate crystals?
- A copper and sulfuric acid.
 B copper(II) carbonate and barium sulfate.
 C copper(II) nitrate and sodium sulfate.
 D copper(II) oxide and sulfuric acid.

- 26 Hydrogen and oxygen react to form steam as in the following equation.



The following energy level diagram represents this reaction.



Which symbols represent the energy involved in bond breaking and formation?

	Energy involved in bond breaking only	Energy involved in bond formation only
A	ΔH_1	ΔH_2
B	ΔH_2	ΔH_3
C	ΔH_2	ΔH_1
D	ΔH_1	ΔH_3

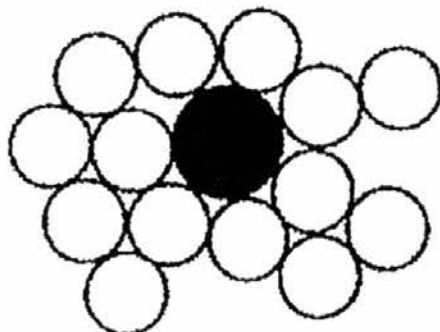
- 27 Which of the following is **not** an exothermic reaction?

A combustion
 B freezing
 C neutralization
 D photosynthesis

- 28 Which of the following is **not** true of metallic bonding?

A It gives rise to excellent electrical conductivity.
 B Its strength is indicated by the number of electrons lost.
 C It is the attraction between the metal ions in the metal structure.
 D It is the attraction between the metal ions with the sea of delocalised electrons in the metal structure.

- 29 The structure of brass is shown below.



Why is brass harder than copper?

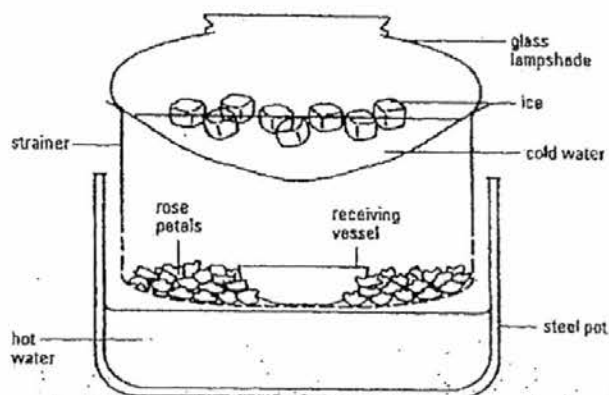
- A The difference in atomic radii of zinc atoms prevent sliding of copper atoms.
 - B The 'sea of electrons' from zinc attract all the atoms together.
 - C The zinc atoms form strong ionic bonds with copper atoms.
 - D The zinc atoms disrupt the atomic structure of copper atoms.
- 30 An element Y reacts with steam to form an oxide. The oxide reacts with aqueous sodium hydroxide to form a salt. It is also able to react with dilute hydrochloric acid to form a salt.

What can element Y be?

- A calcium
- B magnesium
- C sulfur
- D zinc

Section B (40 marks)

- 1 To obtain the fragrant oils used in perfumes, a method called steam distillation is often used. The diagram below shows the apparatus devised by a student. It can be used to obtain fragrant oils found in rose petals.



- (a) Explain why the upper container contains ice and cold water.

.....
 [1]

- (b) Suggest what happens as steam from hot water passes through the rose petals.

.....
 [1]

- (c) Two liquids would be collected in the receiving vessel. Suggest and explain a method to separate these two liquids.

.....
 [2]

- 2 Some common oxides are shown below.

calcium oxide	carbon monoxide	zinc oxide	nitrogen dioxide
copper(II) oxide	lithium oxide	sulfur dioxide	aluminium oxide

Choose from the list above to identify the following oxides.
Each oxide can be used once, more than once, or not at all.

- (a) An oxide that dissolves in water to form acid rain
..... [1]
- (b) Two oxides that can react with both acids and alkalis
..... [1]
- (c) An oxide that dissolves in water to form a solution of pH 14
..... [1]
- (d) A basic oxide that forms a coloured compound with dilute sulfuric acid
..... [1]
- (e) A gas that does not change the colour of either moist red or blue litmus paper
..... [1]

- 3 Use the information in the table below to answer the following questions.

Substance	Melting point (°C)	Boiling point (°C)	Electrical conductivity in solid state	Electrical conductivity in molten state
U	-219	-183	poor	poor
V	1085	2562	good	good
W	3727	no data available	poor	poor
X	714	no data available	poor	good
Y	-39	357	good	good
Z	119	445	poor	poor

(a) State and explain which one of the above substance **U**, **V**, **W**, **X**, **Y** or **Z** is

(i) an ionic compound.

.....
..... [2]

(ii) a simple covalent molecule.

.....
..... [2]

(b) Substance **W** is made of the same element as graphite.

(i) Identify substance **W**.

..... [1]

(ii) Graphite contains covalent bonds and has a melting point similar to that of substance **W**. Explain why the melting point of graphite is significantly higher than that of the substance stated in (a)(ii).

.....
.....
.....
..... [2]

- 4 A student investigated an egg shell and tabulated his results as follows.



Test		Observation
1	Dilute hydrochloric acid was added to the egg shell.	Observations 1 and 2
2	Sodium hydroxide solution was added to the colourless solution from test 1.	A white precipitate formed that did not dissolve in excess sodium hydroxide solution.
3	Silver nitrate solution was added to the colourless solution from test 1.	A white precipitate formed.

- (a) The student concluded that the egg shell contains carbonate ions. What should the observations 1 and 2 for Test 1 be?

.....
 [2]

- (b) The student concluded that the egg shell contains aluminium ions. Is the student's conclusion correct? Use the student's results to justify your answer.

.....

 [1]

- (c) (i) State the identity of the white precipitate in Test 3.

..... [1]

- (ii) The student concluded from the Test 3's result of the presence of chloride ions. Explain why the result is inconclusive.

.....
 [1]

- 5 Magnesium sulfate is found in Epsom salts that are used to soothe sore muscles in athletes. Sulfuric acid and magnesium oxide are used to make magnesium sulfate.

(a) Write the chemical equation, with state symbols, for the above reaction.

..... [2]

(b) Describe the experimental steps required to produce a dry sample of magnesium sulfate.

.....
.....
.....
.....
.....
.....
..... [3]

(c) Magnesium carbonate is another salt that can be indirectly prepared from sulfuric acid. State the steps and the chemicals required to prepare magnesium carbonate from sulfuric acid.

.....
..... [2]

- 6 The space ship, Zurit, landed as an analytical laboratory on Mars in 2012. The laboratory contained equipment which can determine the percentage of elements in a rock sample.

The percentage by mass of compound Z, determined using this type of equipment is given below:

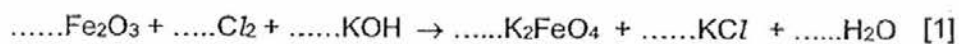
element	percentage by mass
potassium	39.3
iron	28.3
oxygen	32.3

- (a) Show that the empirical formula of Z is K_2FeO_4 .

[2]

- (b) K_2FeO_4 can be prepared in the laboratory by the reaction between iron(III) oxide, chlorine and potassium hydroxide.

- (i) Balance the chemical equation by filling in the blanks.



- (ii) A 2.00 g sample of Fe_2O_3 is added to 20.0 cm³ of 4.00 mol/dm³ KOH.

Find the limiting reagent for the reaction.

[2]

- (iii) Find the mass of K_2FeO_4 formed.

[1]

- 7 A new element called 'Delium' has been isolated. It has a low melting point and density. It is extremely reactive in air. It is also a good conductor of electricity. It has a chemical symbol of **De**.

- (a) Which group does this new element belong to?

[1]

- (b) Write a chemical equation, with state symbols, when Delium is placed in cold water.

[2]

- (c) Describe what will be observed if a few drops of Universal indicator was added into the cold water.

[1]

- (d) With reference to the bonding and structure of Delium, explain why Delium is a good conductor of electricity.

[2]

Section C (30 marks)

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

- 1 Read the information about properties of some of the metals found in the Periodic Table. The letters below does not represent the symbol of the metals in the Periodic Table. The initial temperature for the reaction is 30 °C.

Metal	Observation for the reaction of metal with dilute hydrochloric acid	Maximum Temperature reached/ °C
D	no bubbles at all	30
E	bubbling	42
G	slow bubbling	34
J	very vigorous bubbling	82
L	rapid bubbling	64
M	very few bubbles initially followed by steady bubbling	58

Metal	Density/ kgm ⁻³	Melting points/ °C	Atomic Radius/pm	Possible oxidation state(s) when it forms compound
D	10490	961	165	+1
E	7470	1246	161	+2, +3, +4, +6, +7
G	7140	419	142	+2
J	968	98	190	+1
L	1550	842	194	+2
M	1738	650	145	+3

Note: Density of water is 1000 kgm⁻³

- (a) Using information from the table, explain if the reaction of metals with hydrochloric acid is an exothermic or endothermic reaction.

.....

..... [2]

- (b) Arrange in decreasing order, the relative reactivity of the metals, starting with the most reactive metal. Explain how you derived at this answer.

.....

 [2]

- (c) Explain the observation when metal **M** reacted with dilute hydrochloric acid.

.....

 [2]

- (d) A student attempts to identify a transition metal from the table. Explain which is the most suitable metal.

.....
 [2]

- (e) Write a chemical equation, with state symbols, for the reaction between metal **J** with cold water.

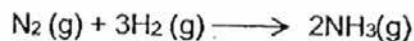
..... [2]

2 The following is an abstract from the Internet.

Nitrogen is an **element** with a melting point of $-210\text{ }^{\circ}\text{C}$ and boiling point of $-186\text{ }^{\circ}\text{C}$. Nitrogen is a colourless, odourless, tasteless and mostly inert diatomic gas at standard conditions. The extremely strong bond in nitrogen dominates nitrogen chemistry, causing difficulty for both organisms and industry in breaking the bond to convert the nitrogen into useful **compounds**. However, when these compounds burn, explode, or decay back into nitrogen gas they release large amounts of often useful energy.

- (a) Draw the electronic structure of nitrogen molecule, showing only the valence electrons.

- (b) Nitrogen reacts with hydrogen under optimum reacting conditions to form ammonia gas in the Haber Process. The equation is given below.



The table below states the different bond energies.

bond	energy (kJ/mol)
H-H	432
N-H	386
N=N	420
N≡N	940

Using the data provided in the table, calculate:

- (i) the total energy change for bond breaking.

[1]

- (ii) the total energy change for bond formation.

[1]

- (iii) the overall energy change of the reaction, ΔH .

[1]

- (iv) Hence, explain in terms of bond breaking and bond formation, if the Haber process is an endothermic or exothermic process.

.....

.....

.....

[2]

- (c) Draw a labeled energy profile diagram for the process of the Haber Process.

Indicate clearly on the diagram, the activation energy for the reaction with the symbol, E_a , the reactants and products, and ΔH of the reaction.

[3]

Either

- 3 The following table shows the preferred pH in which some crops grow best.

plant	apple	potato	blackcurrant	mint	onion	lettuce
pH	5.0 – 6.5	4.5 – 6.0	6.0 – 8.0	7.0 – 8.0	6.0 – 7.0	6.0 – 7.0

- (a) Apples grow best in weakly acidic soil. Explain what it means by the term 'weak acid'.

.....

- (b) (i) A farmer needs to treat the soil prior to replacing his potato plants with mint plants. Suggest and explain how the farmer can treat the soil to grow mint plants.

..... [2]

.....

.....

..... [2]

- (ii) Explain why the farmer should not add fertilisers such as ammonium nitrate to the treated soil.
Support your answer using a chemical equation.

.....

 [2]

- (c) An acid has the formula H_2XO_4 . A solution of the acid contains 5.0 g/dm^3 of H_2XO_4 . In a titration, 25.0 cm^3 of the acid reacted with 25.5 cm^3 of 0.1 mol/dm^3 KOH solution.

- (i) Given that the reacting mole ratio of $\text{H}_2\text{XO}_4 : \text{KOH} = 1 : 2$, find the number of moles of H_2XO_4 used.

[2]

- (ii) Hence, find the identity of X.

[2]

Or

3

The table gives some properties of the elements in Group VII. The properties for astatine are missing in the table.

element	melting point/ °C	boiling point/ °C	atomic radius/ pm
fluorine	-220	-188	64
chlorine	-101	-35	99
bromine	-7	59	114
iodine	113	183	133
astatine			

- (a) Which halogen is a liquid at room temperature and pressure?

..... [1]

- (b) Explain why astatine is in the same group as fluorine and bromine.

..... [1]

- (c) Describe the trend of melting point of the halogens. Hence, predict the melting point of astatine.

..... [2]

- (d) Describe the trend of another physical property that is not listed in the table.

..... [1]

- (e) Predict the molecular formula of astatine.

..... [1]

- (f) Chlorine gas was bubbled into a beaker containing aqueous potassium iodide.

- (i) Write the chemical equation, with state symbols, to represent the reaction.

..... [2]

- (ii) Explain why the reaction takes place.

..... [2]

~ End of Paper ~

The Periodic Table of the Elements

Group																	
I	II											III	IV	V	VI	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
23 Na sodium 11	24 Mg magnesium 12											27 Al aluminium 13	28 Si silicon 14	31 P phosphorus 15	32 S sulfur 16	35.5 Cl chlorine 17	40 Ar argon 18
39 K potassium 19	40 Ca calcium 20	45 Sc scandium 21	48 Ti titanium 22	51 V vanadium 23	52 Cr chromium 24	55 Mn manganese 25	56 Fe iron 26	59 Co cobalt 27	59 Ni nickel 28	64 Cu copper 29	65 Zn zinc 30	70 Ga gallium 31	73 Ge germanium 32	75 As arsenic 33	79 Se selenium 34	80 Br bromine 35	84 Kr krypton 36
85 Rb rubidium 37	88 Sr strontium 38	89 Y yttrium 39	91 Zr zirconium 40	93 Nb niobium 41	96 Mo molybdenum 42	101 Ru ruthenium 44	101 Rh rhodium 45	103 Pd palladium 46	106 Ag silver 47	108 Cd cadmium 48	112 In indium 49	115 Sn tin 50	119 Sb antimony 51	122 Te tellurium 52	128 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	210 Rn radon 86
Fr francium 87	Ra radium 88	Ac actinium 89															
*58-71 Lanthanoid series †90-103 Actinoid series																	
140 Ce cerium 58	141 Pr praseodymium 59	144 Nd neodymium 60	146 Pm promethium 61	150 Sm samarium 62	152 Eu europium 63	157 Gd gadolinium 64	158 Tb terbium 65	162 Dy dysprosium 66	165 Ho holmium 67	167 Er erbium 68	173 Yb ytterbium 70	175 Lu lutetium 71	176 Yt yttrium 39	177 Hf hafnium 72	178 Ta tantalum 73	181 W tungsten 74	183 Re rhenium 75
232 Th thorium 90	238 Pa protactinium 91	238 U uranium 92	238 Np neptunium 93	238 Pu plutonium 94	238 Am americium 95	238 Cm curium 96	238 Bk berkelium 97	238 Cf californium 98	238 Es einsteinium 99	238 Fm fermium 100	238 Md mendelevium 101	238 No nobelium 102	238 Lr lawrencium 103	238 Rf rutherfordium 104	238 Db dubnium 105	238 Sg seaborgium 106	238 Bh bohrium 107

Key

a

X

b

a = relative atomic mass
x = atomic symbol
b = proton (atomic) number

Key

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

a X b

End-Of-Year Examination 2016

Sec 3E

Pure Chemistry

Answers / Mark Scheme

Section A(30m)

1	2	3	4	5	6	7	8	9	10
A	D	B	D	D	B	C	C	B	B
11	12	13	14	15	16	17	18	19	20
C	D	B	B	D	D	C	C	C	A
21	22	23	24	25	26	27	28	29	30
C	A	B	B	D	B	D	C	A	D

Section B (40 m)

1(a)	To condense the oil vapour so that the fragrant oils can be collected in the receiving vessel.	1
(b)	As steam passes through the rose petals, the oil from the rose petals vapourises / evaporates .	1
(c)	Use separating funnel.	1
	Two liquids (Fragrant oils and water) collected are immiscible / Two liquids collected have different density .	1
Total:		4m
Marker's report: (a) Question is generally well done. Students need to remember that the focus is to condense the oil vapour and not the water vapour. (b) Some wrong terms are used such as 'diffuses' or 'picks up the scent'. Shows that students are not sure what the vapour. (c) Many students state the method used as 'fractional distillation' as they wrongly identified that oil and water are miscible liquids with different boiling point. They should note that oil and water are immiscible liquids.		

2(a)	sulfur dioxide / nitrogen dioxide	1
(b)	zinc oxide and aluminium oxide	1
(c)	lithium oxide	1
(d)	copper(II) oxide	1
(e)	carbon monoxide	1
Total:		5m

	Marker's report: Generally not very well done. Students are not familiar with the different properties of the oxides and have not correctly identified with the different examples of oxides, i.e. acidic, amphoteric, neutral, basic oxides	
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3(a)(i)	X It has high melting point and boiling point and conducts electricity in molten but not solid state. (no marks if substance wrongly identified)	1 1
(a)(ii)	Z or U. It has low melting and boiling point and does not conduct electricity. (no marks if substance wrongly identified)	1 1
(b)(i)	diamond	1
(b)(ii)	More energy is needed to break the strong covalent bonds between carbon atoms in graphite than; to overcome the weak intermolecular forces between molecules in substance Z.	1 1
Total:		7m
	Marker's report: (a) Students need to use the data from the table provided to answer the question. However, many did not fulfil this. There is no need to explain the properties. Some students stated the one property and not the other (b) Most were able to correctly identify diamond. For b(ii), it was rather poorly done. Key words such as break strong covalent bonds between carbon atoms and overcome weak van der Waal's forces between molecules are not stated. Some students used the key words 'break' and 'overcome' very loosely. Some students were clearly unsure of the type of bonding present in graphite or simple covalent molecule.	

4 (a)	Effervescence observed. The egg shell dissolved, forming a colourless solution / white precipitate is observed when the gas is bubbled into limewater.	1 1
(b)	No. If aluminium ions are present, they should form white precipitate which dissolves in excess sodium hydroxide solution to form a colourless solution in Test 2.	1
(c)(i)	silver chloride	1
(ii)	Chloride ions (Cl ⁻) present due to hydrochloric acid added in from Test 1.	1
Total:		5m
	Marker's report: (a) Many students are not able to state the second observation that the egg shell dissolved to form a colourless solution. Stating that 'water	

	and carbon dioxide produced' is not an observation as it cannot be seen. (b) Some students state that aluminium ions dissolve in excess sodium hydroxide. Note that it is the precipitate formed that dissolves. Not aluminum ions. (c) Only half of the cohort managed to identify correctly. (d) Students were not able to draw the link from test 1 that the hydrochloric acid added could have contributed to the presence of chloride ions in the solution.	
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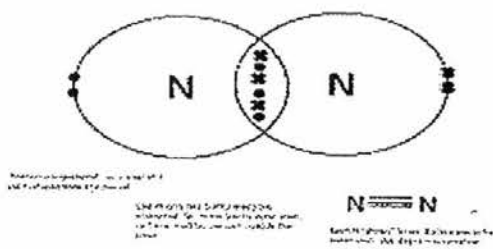
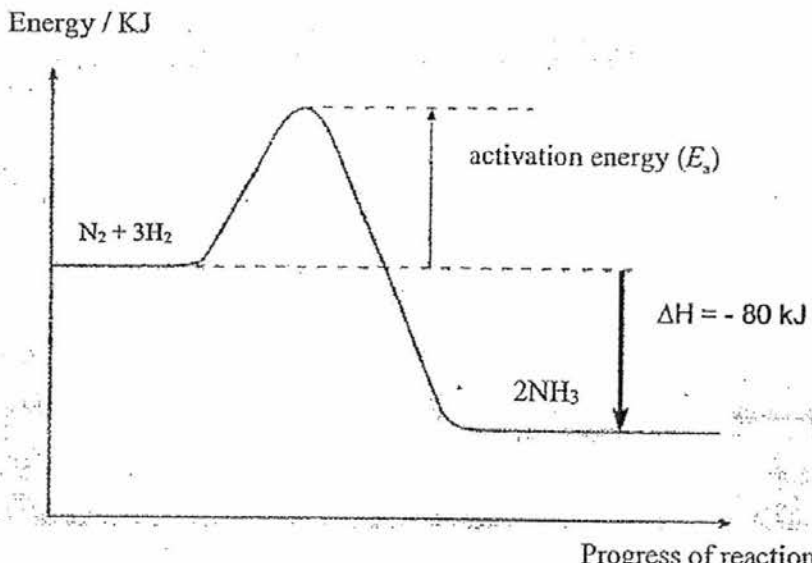
5(a)	$\text{MgO(s)} + \text{H}_2\text{SO}_4(\text{aq}) \rightarrow \text{MgSO}_4(\text{aq}) + \text{H}_2\text{O(l)}$ 1m for balanced equation 1m for state symbols 0 marks given if BCE is not attained.	2
(b)	• add magnesium oxide to sulfuric acid and <u>stir</u> • add the solid until it is <u>in excess</u> • <u>filter</u> and collect the <u>magnesium sulfate as filtrate</u> • <u>heat</u> the filtrate until it is <u>saturated</u> • let it <u>cool</u> and wait for <u>crystals to form</u> • <u>wash</u> crystals with small amount of <u>distilled water</u> • <u>dry</u> crystals between sheets of <u>filter paper</u> all 7 pts – 3 m 5-6 pts – 2 m 3-4 pts – 1 m	3
(c)	Add magnesium / magnesium oxide / magnesium hydroxide to sulfuric acid; Then add potassium carbonate / sodium carbonate / ammonium carbonate/carbonic acid 1m for just listing correct chemicals	1 1
Total:		7m
	(a) Most candidates are able to give the balanced chemical equation, some forget to include state symbols. (b) Candidates are supposed to use MgO and H₂SO₄, MgO should be in excess. MgSO₄ produced is filtered and collected as filtrate. Marks are still awarded for describing correctly the ways of obtaining the dry salt. (c) Majority of the candidates found difficulty in answering this question. They are supposed to make MgCO₃ using sulfuric acid as one of the starting reactant. This requires them to do 2 steps. Acid + insoluble excess to obtain MgSO₄ and then ppt to form the insoluble MgCO₃.	

6 (a)				
	K	Fe	O	
	Mass	39.4	28.3	32.3
	Ar	39	56	16

	<table border="1"> <tr> <td>No of moles</td> <td>$\frac{39.4}{39} = 1$</td> <td>$\frac{28.3}{56} = 0.5035$</td> <td>$\frac{32.3}{16} = 2.018$</td> <td rowspan="3">1</td> </tr> <tr> <td>Divide by smallest no</td> <td>$\frac{1}{0.5035}$</td> <td>$\frac{0.5035}{0.5035}$</td> <td>$\frac{2.018}{0.5035}$</td> </tr> <tr> <td>Ratio</td> <td>2</td> <td>1</td> <td>4</td> </tr> </table>	No of moles	$\frac{39.4}{39} = 1$	$\frac{28.3}{56} = 0.5035$	$\frac{32.3}{16} = 2.018$	1	Divide by smallest no	$\frac{1}{0.5035}$	$\frac{0.5035}{0.5035}$	$\frac{2.018}{0.5035}$	Ratio	2	1	4	
No of moles	$\frac{39.4}{39} = 1$	$\frac{28.3}{56} = 0.5035$	$\frac{32.3}{16} = 2.018$	1											
Divide by smallest no	$\frac{1}{0.5035}$	$\frac{0.5035}{0.5035}$	$\frac{2.018}{0.5035}$												
Ratio	2	1	4												
	Reject if round off at number of moles (minus 1m) No working shown (minus 1m)														
(b)(i)	$\text{Fe}_2\text{O}_3 + 3\text{Cl}_2 + 10\text{KOH} \rightarrow 2\text{K}_2\text{FeO}_4 + 6\text{KCl} + 5\text{H}_2\text{O}$			1											
(b)(ii)	No of moles of $\text{Fe}_2\text{O}_3 = \frac{2}{2(56) + 3(16)} = 0.0125 \text{ mol}$ No of moles of $\text{KOH} = \frac{20}{1000} \times 4 = 0.08 \text{ mol}$ 1 m for both no of moles Based on mole ratio $\text{Fe}_2\text{O}_3 : \text{KOH}$ 														

(b)	$2\text{De (s)} + 2\text{H}_2\text{O (l)} \rightarrow 2\text{DeOH (aq)} + \text{H}_2 \text{ (g)}$ 1m – correct balanced equation 1m – state symbols 0 marks given if BCE is not attained.	2
(c)	The solution will turn violet / purple in colour. Rej: Blue	1
(d)	Delium has a <u>giant metallic structure / giant lattice structure</u> , with a <u>sea of mobile delocalised electrons</u> to conduct electricity. Accepted : metallic bonding/metals (for this round)	1 1
Total:		6m
	(a) Generally well done (b) Many candidates either did not balance the equation or wrote De_2O , they failed to see that the reaction is with COLD WATER. (c) The alkali formed is a strong alkali, because De is Group I hence it should be violet/purple. Some candidates mentioned the colour as blue. (d) Majority of the candidates did not use structure/bonding to answer the question, some failed to use the keywords 'delocalised'. Metals do not use cations in conducting electricity.	

Section C (30 m)		
1(a)	exothermic there is an increase in temperature / a rise in temperature measured. Rej: heat given out.	1 1
1(b)	J, L, M, E, G, D The most reactive metal will react with hydrochloric acid to give the largest temperature rise / result in the highest maximum temperature reached. The next reactive metal will give a smaller temperature rise. Rej: more reactive more bubbling.	1 1
1(c)	M has a layer of oxide surrounding the metal. The acid reacts with some part of the metal exposed to produce hydrogen gas , thus very few bubbles observed. After all the oxide layer has reacted , the metal reacts vigorously with the acid to produce steady bubbling of hydrogen gas.	1 1
1(d)	E The metal has variable oxidation states .	1 1
1(e)	$2J(s) + 2H_2O(l) \rightarrow 2JOH(aq) + H_2(g)$ 1m for balanced chemical equation. 1m for correct state symbols. 0 marks given if BCE is not attained.	2
Total:		10m
	(a) Some candidates mentioned the increased in temperature but relate it the reaction as 'endothermic'. Candidates need to use information from the table to answer why it is an exothermic reaction, the table only provided information on temperature rise and not 'heat' energy. (b) Some candidates mixed up the reactivity of M and E. Majority of the candidates failed to relate metal reactivity to temperature rise but relate it to the bubbling. However, vigorously bubbling does not necessary means a reactive metal. (c) Majority of the candidates are able to mention the protective layer, but they failed to explain the latter observation of why the bubbling increases. (d) Some candidates mentioned G or E for their high melting point or density, but variable oxidation states is unique to transition metals. (e) Some candidates used their own metal formula instead of 'J' or gave J_2O as the product. Reaction is metal with cold water.	

2(a)	Nitrogen N₂  1m – correct number of electrons shared (3 pairs in the correct manner) 1m – different symbols of electrons used (dot and cross)	2
2(b)(i)	Total energy change for bond breaking = $3(432) + 940$ = +2236kJ	1
(ii)	Total energy change for bond formation = $2(3(386))$ = - 2316kJ	1
(iii)	Overall energy change, $\Delta H = +2236\text{kJ} - 2316\text{kJ}$ = -80kJ	1
(iv)	Since the amount of energy <u>released</u> in forming the N-H bonds is <u>greater</u> than the energy <u>absorbed</u> for breaking the N≡N and H-H bonds, therefore the Haber Process is an <u>exothermic</u> reaction.	1 1
	 1m – shape of graph i.e. exothermic graph 1m – labels on x and y axes 1m – labels of reactants, products, Ea and ΔH (correct directions of arrows)	3

	(a) Many students did not draw dot and cross for nitrogen molecule. Many drew just dot or cross for both N atoms. Some did not show 3 pairs of dot & cross in the overlapping space between both N atoms. Some did not understand the question and drew N's electronic structure. (b) For 2b(i) to 2b(iii), if students did not write the sign "+" or "-", overall 1m is deducted. For 2b(i) to 2b(iii), if students did not write the correct unit/missing unit, overall 1m is deducted. This time round, those students who wrote statements for 2b(i) and 2b(ii) as energy released and energy absorbed, were not penalised for the omitting of sign. (b)(iv) Very badly done as many students kept using words "energy used/required/ needed etc" (c) Energy profile diagram was also badly drawn as axes was not correctly labelled. Often, x-axis was labelled as process of reaction, time, etc. The direction of arrows was also not clear as many students drew double-headed arrows.	
	Total:	10m

Either

3(a)	Weak acid partially dissociates / ionises in water to give a low concentration of hydrogen ions .	1 1
3(b)(i)	Slaked lime, $\text{Ca}(\text{OH})_2$ or quicklime, CaO	1
	Addition of the above substances will <u>increase the pH / neutralise acid</u> so that it's suitable for growth of mint plant.	1
(ii)	The essential <u>ammonium/nitrogen</u> in fertilisers <u>will be lost as</u> the ammonium salts in fertilisers will react with the alkali (calcium hydroxide) to liberate <u>ammonia gas</u> .	1
	$2\text{NH}_4\text{NO}_3 + \text{Ca}(\text{OH})_2 \rightarrow \text{Ca}(\text{NO}_3)_2 + 2\text{H}_2\text{O} + 2\text{NH}_3$	1
3(c)(i)	No. of moles of $\text{KOH} = (25.5/1000) \times 0.1$ $= 0.00255 \text{ mol}$	1
	No. of moles of $\text{H}_2\text{XO}_4 = 0.00255 / 2$ $= 0.001275 \text{ mol}$	1
	Answer + unit: 1 mark	
(ii)	Concentration of $\text{H}_2\text{XO}_4 = 0.001275 / (25.0/1000)$ $= 0.051 \text{ mol/dm}^3$	1
	Relative molecular mass of $\text{H}_2\text{XO}_4 = 5.0 / 0.051$ $= 98.0 \text{ (3 s.f.)}$	
	X is sulfur.	1
	Answer + unit: 1 mark	
	(a) Many students omit the 2nd point to "form a low concentration of hydrogen ions". (b)(i) Some students just state that an alkali should be added to neutralize the acid, but did not suggest a suitable alkali. (b)(ii) Very poorly done by the students who attempted. They did not seem to understand ammonia gas will be liberated. (c)(i) and (c)(ii) It was well done by the students who chose this question.	

	Total: 10m
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Or

3(a)	bromine	1
(b)	Astatine has the same number of valence electrons as fluorine and bromine	1
(c)	The melting point of halogens increases down the group. Accept: 220 °C – 235 °C	1 1
(d)	The halogens become darker down the group.	1
(e)	At ₂	1
(f)(i)	Cl ₂ (g) + 2KI (aq) → 2KCl (aq) + I ₂ (aq) 1m for correct balanced chemical equation 1m for correct state symbols	2
(f)(ii)	The more reactive chlorine displaces the less reactive iodine from potassium iodide solution.	1 1
	(a) Well done by the students. (b) Some students wrote that the astatine will form an ion with -1 charge. Fundamentally not wrong, but did not answer the question directly of why will astatine form an ion with -1 charge? It was because Astatine has 7 valence electrons. In order to achieve a stable electronic configuration, it needs to gain 1 more electron to form an ion with -1 charge. (c) Many students did not attempt the melting point, or gave answers out of range. Some even left out units. (d) Density, change from gas to liquid to solid state as they go down the group etc, were all accepted. However, reactivity is not accepted. (e) Some students did not read the question and wrote as At ⁻ (f) I ₂ (aq) should be the correct answer. I ₂ (s) is given this time round as the notes given to the students was having an error. (f)(ii) Most students confused "displaced" and "replaced". They also often left out the 2 nd portion explaining where the less reactive iodine is found.	
	Total: 10m	

Marker's report for 5073	
S/No.	Remarks
	Section B
1	Most of the pupils can do part (a). A few pupils left blank and can only obtain ammonia gas. Some pupils thought the cation of A should be transition metals like Zinc/Lead. But, the fact that the compound can react to give 2 gases suggest it contains ammonium and carbonate! Most of the pupils can do part (b).
2	Parts (a)–(c) are quite well done. A few pupils drew the band 1 / 2 incorrectly and one drew many spots on the chromatogram. Quite a number of pupils did not answer Part (d) accurately. Common incorrect solutions include: "prevent air / wind from entering", "prevent contamination" etc.
3	Parts (a)–(d) are generally well done. A handful of pupils gave the suggested timing of N ₂ WITHOUT OBSERVING that the timing for N ₂ should be the same as CO.
4	Part (a)–(b) are generally well done. For part (a), pupils who didn't get it correct fail to illustrate the surrounding ions of Na ⁺ by Cl ⁻ to be 6 and Cl ⁻ by Na ⁺ to be 6 too. Hence, some drew on wrong plane. For part (b), some pupils did not read the instructions carefully and added more planes despite instructions given "one layer of graphite". This resulted in higher chance of mistakes as the number of bonds around each C atom is 3 instead of 2. Part (d) is averagely attempted. There are 2 parts to this question: soft and electrical conductivity. For soft, pupils need to mention the weak intermolecular forces of attraction BETWEEN layers hence layers can slide. Incorrect phrasing include "weak covalent bonds", sliding between atoms", "Weak intermolecular between atoms" as well as due to "weak intermolecular forces of attraction, melting point is low"! For the electrical conductivity, pupils need to mention unbonded electron (also known as free) and electron is delocalised.
5	Part (ai) is well attempted. For part (a ii), the reason for redox is very general. Pupils should anchor the explanation that o.s of silver in AgNO ₃ and AgBr is +1 while the o.s of bromine in KBr and AgBr is -1. However, because the reason is NOT redox, a general explanation is accepted due to leniency. Part (b) is averagely answered. Silver ion in silver bromide or silver bromide. Pupils should learn to view the REACTANTS so as to eradicate the chances of writing any substances in the products!!!!
6	Part (a) is poorly attempted. Pupils forgot to use reversible arrows ⇌ Part (b) is averagely attempted. The definition of reversible reaction is poorly presented. Part (c) is generally well done. Part (d) is averagely attempted. pupils should give answers from the graph and relate that at 550°C, the yield is much lesser than at 450°C.
7	Part (a) is generally well done. Marks are deducted due to missing plotting of points. Part (b) is generally well done. For the elegant presentation of answers, pupils need to have an APPARATUS to contain the gas. Some phrases are rejected: "into the gas" etc.

	Part (c) is badly done. Pupils need to be able to observe Zinc is more reactive than Copper. Instead, a lot of pupils proposed equations that merely result as mixture of ions: $\text{CuSO}_4 + \text{ZnCl}_2 \rightarrow \text{CuCl}_2 + \text{ZnSO}_4$ Part (d) is averagely done. Pupils need to add excess solid to dilute acid.
	Section C
8	Part (ai) is self attempted. Part (aii) is badly attempted. Pupils did not explain WHY due to insufficient oxygen, it is not suitable for mankind. Most quote phrases such as " due to shortage of oxygen, it is unsuitable for mankind to live in " (pupils copy from the question), " oxygen is essential" (why is it essential?) ". Pupils need to give reasons: for breathing/respiration/support lives. For the factor of hydrogen, it is well done. Part (b)-(d) are well done. Part (e) is poorly attempted. Pupils should think about what will happen if the substances existed at extreme temperature $\rightarrow$ they will exist in vapour state and it is constantly moving. Answers that there are no instrument / too hot to do estimation is incorrect.
9	Part (a) generally well done. Part (b) Only Manganese / Chromium can be accepted. Some pupils gave transition metals that does not exist as charges of 6+ Part (c) is badly done. Most pupils overlook if the metals are from group I, the products are ALKALIS. Part (di) generally well done. Part (dii) is poorly attempted. The concept of displacement of less reactive halogen from AQUEOUS solution is poorly demonstrated. Hence pupils can displace from oxides of halogen instead. Yet the conditions are not favourable. Pupils need to know that for DESIGN experiment, they do not need to make the chemicals from scratch. The starting materials can be aqueous solution of halogen! The equation writing is horrifying because the halogen J or L became MONATOMIC instead of DIATOMIC. Pupils lose 1 mark in average for this design experiment because they assumed that if they react J_2 with NaL is conclusive. It is the standard procedures for scientist to do the same reaction with L_2 using NaJ.
10	Part (a) is generally well done. A few pupils drew it incorrectly either using the mass number or the compound is not electronically stable. Part (b) is generally well done. Pupils need to remember that Upwards arrow is used for E_a and not both directions. Part (bi) is averagely attempted. Pupils need to use the results from the graph. Hence answers : heat energy is absorbed" is not accepted. Part (ci) is averagely attempted. Pupils either rank the MOST reactive first or swap the position of H and G. Part (bii) is generally well attempted. Part (cii) is averagely attempted. Pupils thought the reaction need to be extraction using CO. This trend of thought is short-sighted. Question requested for reaction with Coke (C). Pupils can give either CO_2 or CO. But the most favourable reaction should target to have CO_2 as product.