ZHONGHUA SECONDARY SCHOOL
End-Of-Year Examination 2017

CANDIDATE NAME		( )

CLASS	3	E	1

SCIENCE (CHEMISTRY) 5076 Chem

11 October, 2017

Secondary 3 Express 1 hour 30 minutes

Set by: **Mr Tan Li Chun**

Vetted by: **Ms Maybrie Ang**

READ THESE INSTRUCTIONS FIRST

Write your name, index number and class in the spaces at the top of this page and on all separate answer paper used.

Write in dark blue or black pen.

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

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

Section A

There are **twenty** 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 OTAS Answer Sheet.

Section B

Answer **all** questions.

Write your answers in the spaces provided on the question paper.

Section C

Answer all questions.

Write your answers in the spaces provided on the Question paper.

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

All essential working must be shown clearly.

A copy of the Periodic Table is printed on page 16.

For Examiner's Use	
Section A	20
Section B	30
Section C	20
Total	

Answer **all** the questions.

1 Diagram **A** shows a descending paper chromatography and diagram **B** shows an ascending paper chromatography.

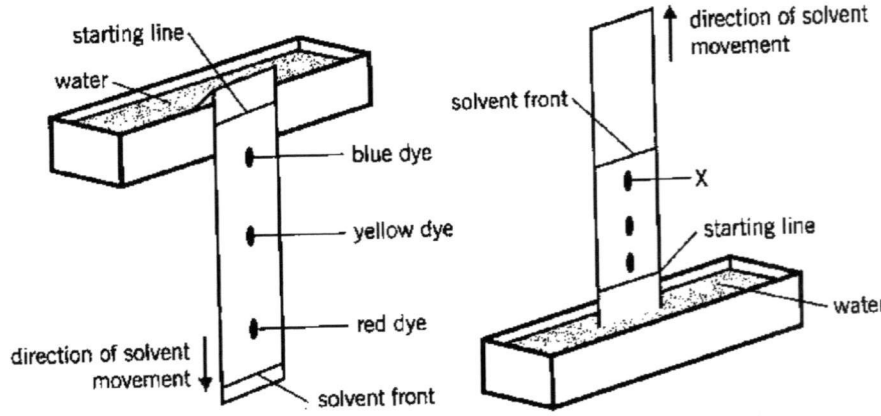


diagram **A** diagram **B**

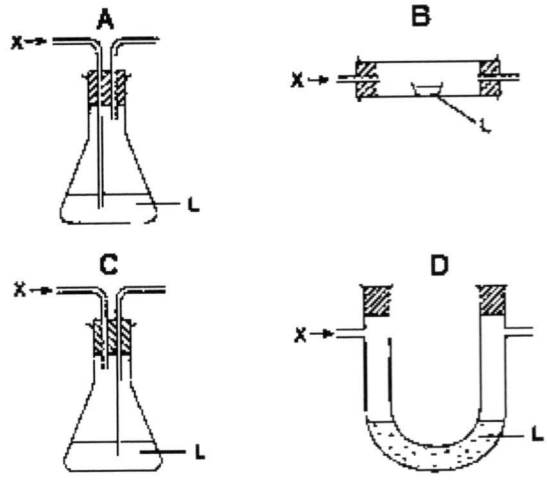
Both experiments are used to separate the same sample of ink for two minutes. The distance between the starting line and the solvent front in Diagrams **A** and **B** is 5 cm and 3 cm respectively after two minutes.

Which statement about these experiments is **not** correct?

A Blue is the least soluble in water in descending paper chromatography.
B The ink sample is made up of three different substances.
C The substances move faster in descending paper chromatography because they are more soluble in this setup
D Spot **X** is the red dye.

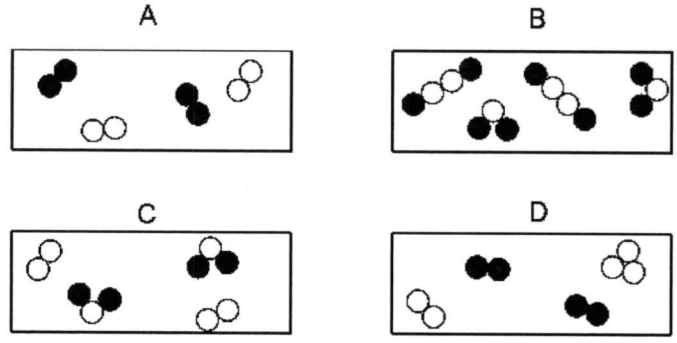
2 A contaminated sample of gas **X** can be purified by using liquid **L**.

Which experimental setup below is most suitable to be used to purify gas **X**?



3 ○ and ● represent atoms of different elements.

Which diagram shows a mixture of an element and a compound?



4 Which substance, **A** to **D** undergoes changes in physical states from room temperature to 0°C?

	melting point / °C	boiling point / °C
A	-192	-65
B	-15	4
C	40	65
D	90	385

5 Which of the following substances has its molecules in the most orderly arrangement?

A water at 0 °C
B ice at 0 °C
C water at 100 °C
D steam at 100 °C

6 The electronic structures of the atoms **P**, **Q** and **R** are given in the table below.

atom	electronic structure
P	2.1
Q	2.6
R	2.7

What are the formulae of the compounds formed between **P** and **Q**, and **P** and **R**?

	P and **Q**	**P** and **R**
A	PQ_2	P_2R_2
B	P_2Q	PR
C	PQ	P_2R
D	PQ_2	PR

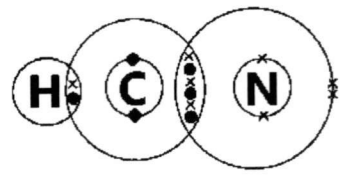
7 The table below shows the group which various elements belong to.

element	Group
W	I
X	III
Y	VI
Z	VIII

Which of the pair of elements will form a compound through the sharing of electrons?

A between atoms of elements **W** and **Z**
B between atoms of elements **X** and **Y**
C between atoms of element **Y**
D between atoms of element **Z**

8 The electronic structure of hydrogen cyanide is shown below:



Which is the correct structural formula of hydrogen cyanide?

A H–C–N
B H–C≡N
C H=C≡N
D H=C=N

9 Sulfuric acid ionises in aqueous solution as follows,

$$H_2SO_4\ (aq) \rightarrow 2H^+\ (aq) + SO_4^{2-}(aq)$$

What is the concentration of hydrogen ions in 1.25 mol/dm^3 of aqueous sulfuric acid?

A 0.625 mol/dm^3
B 1.25 mol/dm^3
C 2.50 mol/dm^3
D 3.75 mol/dm^3

10 Which quantity is the same for one mole of water and one mole of carbon dioxide gas?

A mass
B number of atoms
C number of molecules
D volume at r.t.p

11 Below are the overall equations for the manufacture of three fertilizers (underlined).

reaction **1**: $H_2SO_4 + 2NH_3 \rightarrow \underline{(NH_4)_2SO_4}$
reaction **2**: $2H_2SO_4 + Ca_3(PO_4)_2 \rightarrow \underline{Ca(H_2PO_4)_2} + 2CaSO_4$
reaction **3**: $3H_2SO_4 + Ca_3(PO_4)_2 + 6NH_3 \rightarrow \underline{2(NH_4)_3PO_4} + 3CaSO_4$

(Mr of H_2SO_4 : 98; Mr of $(NH_4)_2SO_4$: 132; Mr of $Ca(H_2PO_4)_2$: 234; Mr of $(NH_4)_3PO_4$: 149)

In each reaction, 98 tonnes of sulfuric acid was used. Which reaction gave the greatest, and which the least, mass of fertilizer?

	greatest mass	least mass
A	reaction 1	reaction 2
B	reaction 1	reaction 3
C	reaction 2	reaction 1
D	reaction 3	reaction 2

12 A 18 g sample of pure carbon is completely burned in oxygen.

$$C + O_2 \rightarrow CO_2$$

What volume of carbon dioxide gas is produced at room temperature and pressure?

A 12 dm^3 **B** 24 dm^3
C 36 dm^3 **D** 48 dm^3

13 The relative molecular mass, Mr, of copper(II) sulfate, $CuSO_4$, is 160.
The relative molecular mass, Mr, of water is 18.

What is the percentage by mass of water in copper(II) sulfate crystals, $CuSO_4.5H_2O$?

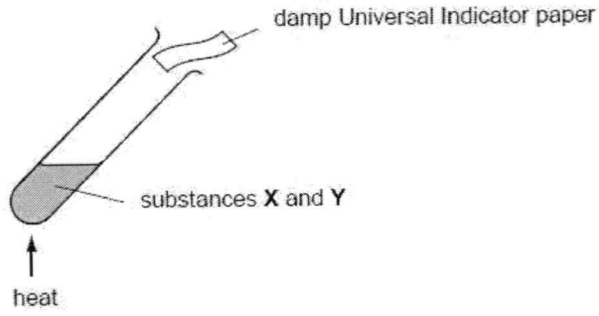
A 11.25 % **B** 50.56 %
C 10.11 % **D** 36.00 %

14 A solution of hydrochloric acid has a pH of 2. Excess zinc metal is added to the solution.

What is the pH of the solution at the end of the reaction?

A 2 **B** 5
C 7 **D** 11

15 The diagram shows two substances, **X** and **Y**, being heated together.



The Universal Indicator paper turns blue during the experiment.
What are substances **X** and **Y**?

A sodium carbonate and hydrochloric acid
B sodium carbonate and sodium hydroxide
C ammonium nitrate and hydrochloric acid
D ammonium nitrate and sodium hydroxide

16 Which of the following substance is not appropriate for use in the reaction with dilute sulfuric acid to prepare zinc sulfate?

A zinc **B** zinc nitrate
C zinc carbonate **D** zinc hydroxide

17 The reaction below shows fluorine reacts with water.

$$2F_2 + 2H_2O \rightarrow 4HF + O_2$$

Which of the following correctly shows the oxidation state of fluorine before and after the reaction?

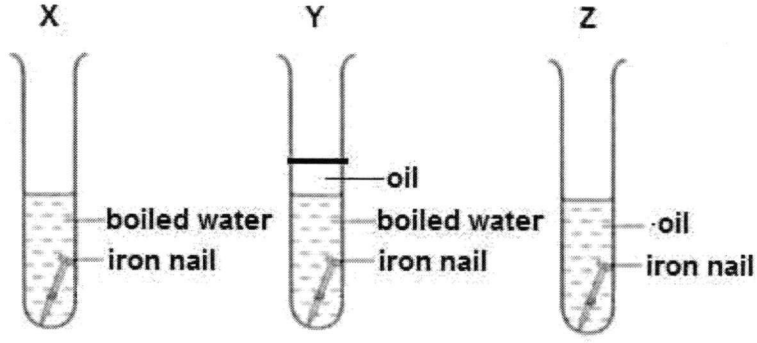
A 0 to -1 **B** -1 to 0
C remains at 0 **D** remains at -1

18 Alloys are usually harder and stronger than pure metals.

Which of the following property helps to explain this difference?

A number of valence electrons
B relative atomic mass
C density
D atomic size

19 Experiments are set up to investigate conditions for rusting of an iron nail.



In which test-tube(s) will the iron nail not rust?

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

20 Elements X, Y and Z are in the same period of the Periodic Table. Some information on the elements are shown below,

X is used in advertising lights.
Y forms a halide when react with a Group I metal.
Z forms a positive ion in order to achieve stable octet structure.

If X, Y and Z were placed in order of increasing atomic numbers, the order would be:

A XYZ
B ZYX
C YZX
D ZXY

Zhonghua Secondary School
End of Year Examination 2017
Secondary 3 Express

NAME: _____ ( )

CLASS: 3E1

For Examiner's Use	
Section B	30
Section C	20
Total	

Section B

Answer **all** the questions.

Write your answers in the spaces provided on the question paper.

B1 Choose from the following substances to answer the questions below.

oxygen	sodium nitrate	sodium oxide
magnesium	fluorine	sodium chloride
sulfur dioxide	sodium	neon

Each substance may be used once, more than one, or not at all.

(a) Two salts that can accelerate rusting of an iron nail when placed in its solution.

..... [1]

(b) The element that has the most number of valence electrons.

..... [1]

(c) The element which can form ions with an oxidation state of -2.

..... [1]

(d) A substance which dissolves in water to form an acid.

..... [1]

(e) An element which is a halogen.

..... [1]

(f) An element which is a more reactive metal than calcium.

..... [1]

B2 The boiling point and melting point for hydrogen chloride and potassium chloride are shown below.

substance	melting point / °C	boiling point / °C
hydrogen chloride	- 114	- 85
potassium chloride	770	1 420

(a) Complete the table below by describing,
- the type of bonds between atoms in each substance
- how their structures account for the difference in melting points.

	hydrogen chloride	potassium chloride
type of bond		
explain difference in melting point in terms of bonding and structures		

[3]

(b) Explain why molten potassium chloride can conduct electricity.

.....

..... [1]

(c) Describe the arrangement and movement of hydrogen chloride at r.t.p.

.....

.....

..... [2]

(d) Draw a 'dot and cross' diagram to show the bonding in hydrogen chloride. Draw the outer shells electrons only.

[2]

B3 Magnesium sulfate is a hydrated salt that can be prepared from sulfuric acid and magnesium oxide.

(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 from sulfuric acid and magnesium oxide.

.....

.....

.....

.....

.....

.....

..... [3]

B4 Magnesium reacts with hot steam to form an oxide and a gas.

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

..... [2]

(b) Describe a test for gas given off.

..... [1]

(c) The oxide dissolves readily in dilute hydrochloric acid but is insoluble in aqueous sodium hydroxide.

Explain what can be deduced about the nature of the oxide from this information.

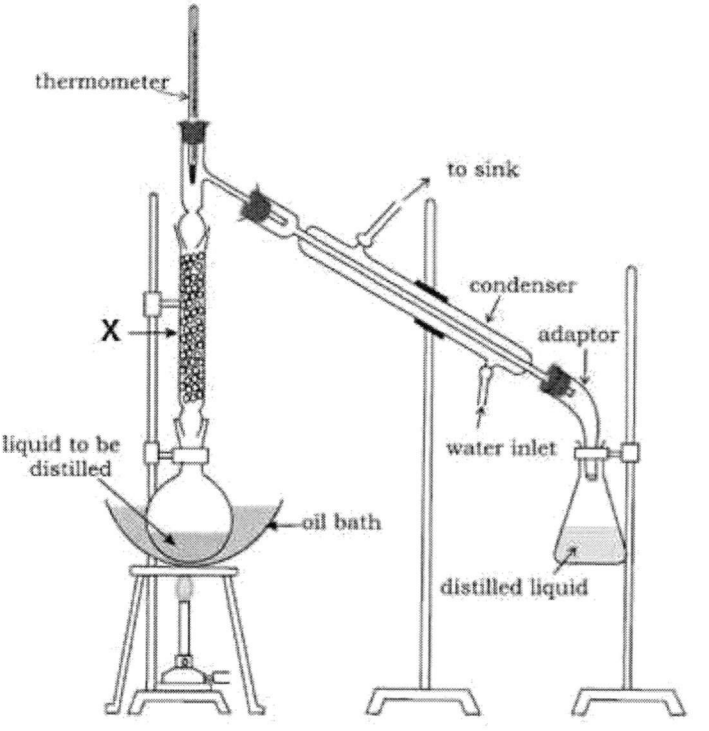
.....

.....

.....

..... [2]

B5 The apparatus below is used to collect water from a mixture of an organic solvent and water.



(a) Name the method of purification.

..... [1]

(b) Name apparatus **X** and states its function

name: ..... [1]

function: .....

..... [1]

(c) Suggest the purpose of the condenser.

..... [1]

(d) How could you tell that water is being separated using the above set-up?

..... [1]

(e) Suggest an advantage of using indirect heating with an oil bath instead of a water bath.

..... [1]

Section C

Answer **all** the questions.
Write your answers in the spaces provided.

C6 **(a)** The ease of obtaining a metal from its ore is related to the metal's position in the reactivity series. Suggest, with examples, why this is so.

.....

.....

.....

.....

.....

..... [3]

(b) In the modern blast furnace, a series of chemical reactions allows iron to be extracted from iron ore.

One of the reaction is shown below,

$$Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$$

Explain why this reaction is a redox reaction.

.....

.....

.....

..... [2]

(c) Explain with relevant chemical equations the purpose of adding limestone in the extraction of iron.

.....

.....

.....

.....

.....

..... [3]

(d) Magnetite, Fe_3O_4, is another form of iron oxide in iron ore.
Calculate the mass of iron that can be obtained from 464 kg of magnetite.

[2]

C7 The table below gives information about the chlorides of some elements in Period 3. The elements are labelled as **W, X and Y**. (You do not need to identify the elements)

element	formulae of chloride	melting point / °C	boiling point / °C	able to conduct electricity in aqueous state
W	WCl_2	714	1418	yes
X	XCl	790	1407	yes
Y	YCl_4	-70	58	no

(a) Arrange the elements **W, X,** and **Y** in order of increasing proton number.

..... [1]

(b) Which of these elements is likely to be non-metal?

..... [1]

(c) It is observed that an aqueous solution of WCl_2 is able to conduct electricity while solid WCl_2 is not able to conduct electricity. Explain the above observations.

.....

.....

.....

.....

.....

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..... [3]

(d) Which Group in the Periodic Table is element **X** likely to be found? Explain your answer.

.....

..... [1]

(e) A piece of element **X** is placed into a beaker of water.

(i) Describe the observation seen.

.....

.....

.....

..... [2]

(ii) Tom wants to collect a sample of hydrogen gas. He suggests reacting element **X** with excess sulfuric acid.

Do you agree with the method that Tom would like to use? Explain your answer.

.....

.....

.....

..... [2]

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
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 –		

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.).

Zhonghua Secondary School
Sec 3E1 Sc(Chem)
End of year Examination 2017

Section A MCQ

1	2	3	4	5
C	A	C	B	B
6	7	8	9	10
B	C	B	C	C
11	12	13	14	15
B	C	D	C	D
16	17	18	19	20
B	A	D	D	B

Section B

B1

a) Sodium chloride and sodium nitrate — 1
b) Neon — 1
c) Oxygen — 1
d) Sulphur dioxide — 1
e) Fluorine — 1
f) Sodium — 1

B2a

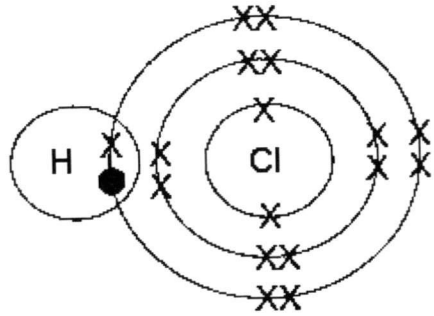
	hydrogen chloride	potassium chloride	
bonding	Covalent bonding	Ionic bonding	1
explain difference in melting point in terms of molecular structures	Exist as simple molecules Molecules are attracted to one another by weak intermolecular forces, there needs lesser energy to overcome forces of attraction resulting in lower mp	Has a giant crystal lattice structure Ions are attracted to one another by strong electrostatic forces of attraction therefore needs a lot of energy to overcome forces of attraction resulting in higher mp	1 1

Must be correct comparison [1 mark across]

b — Molten potassium chloride can conduct electricity due to the presence of free-moving ions acting as charge carriers. — 1

c — Random arrangement and far apart — 1

Random movement at high speed — 1

d	 Correct symbol and drawing for, - Hydrogen atom - Chlorine atom *outer shell shown is sufficient **must be covalent bond (no marks given if ionic bonds are drawn)	 1 1
B3a	$MgO\ (s) + H_2SO_4\ (aq) \rightarrow MgSO_4\ (aq) + H_2O\ (l)$ - correct formula - for state symbol	 1 1
b	1 add magnesium oxide <u>in excess</u> to sulfuric acid and stir and <u>filter excess magnesium oxide</u> (collect the <u>magnesium sulfate as filtrate</u>) 2 <u>heat</u> the filtrate until it is <u>saturated</u> let it <u>cool</u> 3 <u>wash</u> crystals with small amount of <u>distilled water and dry</u> crystals between sheets of <u>filter paper</u>	 1 1 1
B4a	$Mg\ (s) + H_2O\ (g) \rightarrow MgO(s) + H_2(g)$ Balanced equation States correctly stated	 1 1
b	<u>Use a lighted splint. lighted splint extinguished with pop</u>	
	basic oxide is formed as it <u>reacts with an acid but not with an alkali</u>	1 1
B5a	Fractional distillation	1
B	Fractionating column To separate miscible liquids into different fractions	1 1
C	To condense the vapours to liquid	1
D	Thermometer will show a constant temperature of 100°C	1
e	It allows heating of the mixture at temperature above 100°C.	1
	Section C	
C6a	Concept: The higher the metal is in the reactivity series, the more stable will be its compound. For example, *sodium is a very reactive metal which have a very stable sodium ore compound. (This compound is stable and thus difficult to extract sodium from the ore by reduction of carbon). The sodium metal could only be extracted by *electrolysis. On the other hand, the *less reactive metal e.g. copper, can be extracted easily by *reduction of carbon with its ore as their ore are less stable.	1 1 1

	Award max of 2 marks if no examples are quoted. Award max of 2 marks if students are able to quote examples and relate to the method used to extract the metals.	
b	$Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$ CO is reducing the Fe2O3 to Fe (as CO acts as the reducing agent) CO itself is oxidised to CO_2 in the process.	 1 1
c	$CaCO_{3(s)} \longrightarrow CaO_{(s)} + CO_{2(g)}$ $CaO_{(s)} + SiO_{2(s)} \longrightarrow CaSiO_{3(l)}$ *remove sand impurities (SiO_2) as slag ($CaSiO_3$)	1 1 1
d	464kg = 464 000g , Ar of Fe = 56, O = 16 Mr of Fe_3O_4 = 232, No of mole of Fe_3O_4 = 464 000 / 232 = 2000 mol 1 mol of Fe_3O_4, → 3 mol of Fe 2000 mol of Fe_3O_4, → 2 000 x 3 = 6 000 mol of Fe Mass of iron = 6 000 x 56= **336 000g = 336kg**	 1 1
C7a	X,W,Y	1
b	Y	1
c	WCl_2 is an ionic compound When dissolved in water, it forms mobile $W2^+$ and Cl^- ions which conduct electricity In solid state, the $W2^+$ and Cl^- ions are in fixed position held by strong electrostatic forces of attraction and not mobile.	1 1 1
d	High m.p / b.p suggestion that it is an ionic compound and it is in Group I since it forms XCl which means X forms a X^+ ion	1
ei	Floats on water and reacts vigorously with bubbles of gas formed	1 1
ii	Do not agree Element X will reacts very violently with an acid, producing a lot of heat produced / explosive / extreme exothermic reaction / Very dangerous and not advisable	1 1