West Spring Secondary School
MID-YEAR EXAMINATION 2018

Science (Chemistry) **5076/5078**

SECONDARY 4/5 EXPRESS / NORMAL (ACADEMIC)

Name _____ ( ) **Date** 10 May 2018

Class _____ **Duration:** 1 hr 45 min

Additional Materials: Periodic Table

READ THESE INSTRUCTIONS FIRST

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

The use of an approved scientific calculator is expected, where appropriate.
You may lose marks if you do not show your working or if you do not use appropriate units.

Section A (20 Marks)
Answer **all** questions.
Write your answers in the spaces provided on page 6.

Section B (45 Marks)
Answer **all** questions.
Write your answers in the spaces provided on the question paper.
Show **all** relevant workings.

Section C (20 Marks)
Answer **both** questions.
Write your answers in the spaces provided.
Show **all** relevant workings.

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

FOR EXAMINER'S USE	
Section A	/20
Section B	/45
Section C	/20
Total	/85

This document consists of **16** printed pages including this cover page.

Setter Mr. Joel Lee **[Turn over**

Section A

Answer all questions in the spaces provided on page 6.

1 The approximate pH values of four aqueous substances are shown.
Which substance could be used to neutralise excess acid in the stomach?

	substance	pH
A	baking soda	9
B	salt	7
C	orange juice	4
D	vinegar	3

2 Which two substances react without giving off a gas?

A citric acid and calcium carbonate
B hydrochloric acid and magnesium.
C nitric acid and aqueous ammonia.
D sodium hydroxide and ammonium sulfate.

3 Which ionic equation represents the reaction between aqueous potassium hydroxide and dilute sulfuric acid?

A $H^+ (aq) + OH^- (aq) \rightarrow H_2O (l)$
B $H_2SO_4 (aq) + 2K^+ (aq) \rightarrow K_2SO_4 (aq) + H_2 (g)$
C $2K^+ (aq) + SO_4^{2-} (aq) \rightarrow K_2SO_4 (aq)$
D $KOH (aq) + H^+ (aq) \rightarrow K^+ (aq) + H_2O (l)$

4 A student proposed a few methods to safely prepare a sample of sodium chloride in the laboratory:

1 sodium hydroxide and hydrochloric acid
2 sodium metal and hydrochloric acid
3 sodium nitrate and hydrochloric acid

Which of the above method(s) may be used?

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

5 Which of the following contains the greatest number of atoms?

A 0.5 mol of helium
B 30 dm^3 of krypton
C 40 g of calcium
D 100 g of gold

6 What is the mass of sodium hydroxide present in 500 cm^3 of 1.0 mol/dm^3 sodium hydroxide solution?

A 0.5 g
B 20 g
C 40 g
D 2 kg

7 In a reaction, 10 cm^3 of butene (C_4H_8) was burnt in 80 cm^3 of oxygen. The equation for the reaction is shown:

$$C_4H_8\,(g) + 6O_2\,(g) \rightarrow 4CO_2\,(g) + 4H_2O\,(l)$$

At the end of the reaction, what is the total volume of gas remaining?
(all volumes are measured at r.t.p.)

A 40 cm^3
B 60 cm^3
C 80 cm^3
D 100 cm^3

8 Which air pollutant below is **not** correctly matched to its source?

	pollutant	source
A	carbon monoxide	incomplete combustion of petrol in car engines
B	nitrogen oxides	lightning activity
C	sulfur dioxide	decomposition of organic matter
D	unburned hydrocarbons	incomplete combustion of petrol in car engines

9 The data below gives the concentration of various air pollutants, in parts per billion, in four different cities.

In which city are limestone buildings under the greatest threat from pollution?

	carbon monoxide	oxides of nitrogen	sulfur dioxide
A	5	45	11
B	17	11	23
C	25	8	32
D	108	5	23

10 Which statement about the elements of the Periodic Table is correct?

A Group 0 elements are unreactive metals.
B Group II elements tend to form positive ions.
C Group VII elements exist as single atoms.
D The elements become more metallic from the left of the Periodic Table to the right.

11 Fluorine, F, is an element in Group VII of the Periodic Table.
Which of the following statements about fluorine is **false**?

A Fluorine exists as diatomic molecules.
B Fluorine forms ions with a -1 charge.
C Fluorine has a higher melting point than chlorine.
D Fluorine is a non-metal.

12 The reaction between iron(III) ions and iodide ions is represented by the following ionic equation:

$$2Fe^{3+}\ (aq) + 2I^{-}\ (aq) \rightarrow 2Fe^{2+}\ (aq) + I_2\ (s)$$

Which statement about the reaction is correct?

A Fe^{2+} ions are oxidised by loss of electrons.
B Fe^{3+} ions are reduced by gain of electrons.
C Fe^{3+} ions are reduced by loss of electrons.
D I^{-} ions are oxidised by gain of electrons.

13 Aqueous solution **X** is known to contain a powerful oxidising agent.
To two separate samples of solution **X**, a solution of potassium iodide was added to one, while a solution of acidified potassium manganate(VII) was added to the other.

Which of the following correctly describes the colour of solution **X** in the respective samples?

	after addition of aqueous potassium iodide	after addition of aqueous acidified potassium manganate(VII)
A	brown	colourless
B	brown	purple
C	colourless	colourless
D	colourless	purple

14 The ionic equations below represent the reactions between four metals zinc, iron, **X** and **Y** and the aqueous ions of one of the other listed metals.

$$Zn + \mathbf{X}^{2+} \rightarrow Zn^{2+} + \mathbf{X}$$
$$Zn + Fe^{2+} \rightarrow Zn^{2+} + Fe$$
$$\mathbf{X} + Fe^{2+} \rightarrow \text{no reaction}$$
$$\mathbf{Y} + Zn^{2+} \rightarrow \mathbf{Y}^{2+} + Zn$$

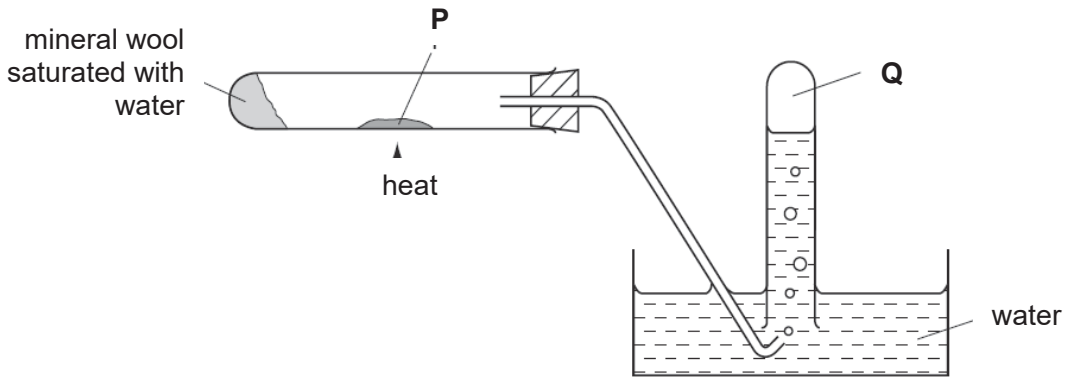
What is the correct order of reactivity of the metals?

	most reactive	→		least reactive
A	**X**	Fe	Zn	**Y**
B	**Y**	Fe	X	Zn
C	**Y**	Zn	Fe	**X**
D	Zn	**Y**	**X**	Fe

15 Which of the following explains why recycling ensures that metals will be available in the future?

A Dumping of metals in landfill sites is unsightly.
B Recycling avoids the environmental damage of opening new mines.
C Recycling costs less than obtaining metals from their ores.
D There are only limited amounts of metals in the Earth's surface.

16 In the experiment shown below, steam is passed over heated solid **P**, which reacts to give gas **Q**:



Which of the following could be **P** and **Q**?

	P	Q
A	copper	hydrogen
B	potassium	oxygen
C	silver	oxygen
D	zinc	hydrogen

17 Aqueous sodium hydroxide and aqueous ammonia were added separately to two different aqueous solutions each containing the same metallic ion. In both cases, a white precipitate was formed which dissolved when excess sodium hydroxide or ammonia was added.

What is the ion?

A Al^{3+}
B Ca^{2+}
C K^{+}
D Zn^{2+}

18 An aqueous solution of compound **Z** reacts with aqueous sodium hydroxide to form a green precipitate. A piece of aluminium foil is added to the mixture and heated; a gas that turns damp red litmus paper to blue is given off.

What is **Z**?

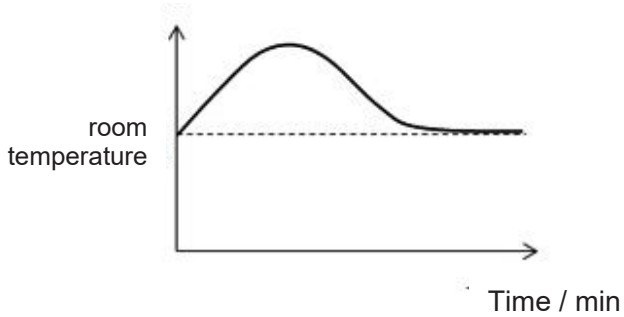
A ammonium nitrate
B copper(II) nitrate
C iron(II) chloride
D iron(II) nitrate

19 Which of the following processes is exothermic?

A Burning of petrol in car engines
B Evaporation of a water puddle
C Melting tar for the paving of roads
D Sublimation of dry ice

20 The dissolving of ammonium nitrate in water is an endothermic process.
Which graph correctly shows how the temperature of the mixture changes over time when ammonium nitrate is dissolved in water and the solution is allowed to stand?

A



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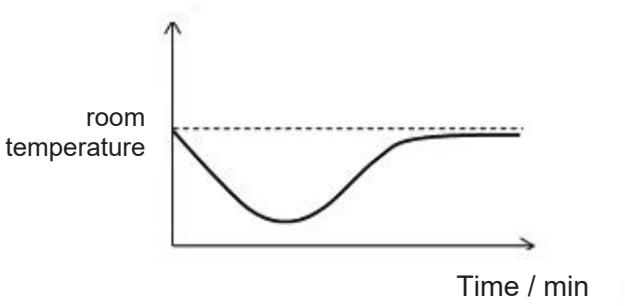

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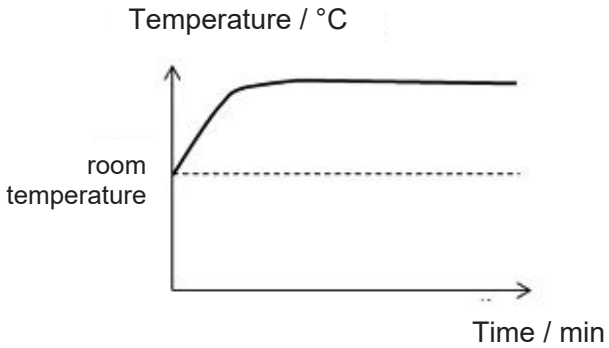
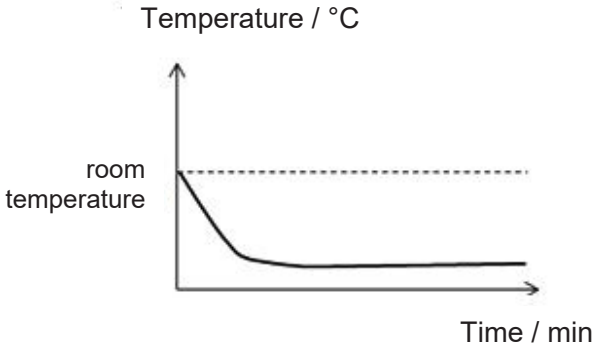


D



Answers

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

Section B

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

1 The physical and chemical properties of five unknown oxides are summarised in Table 1.1.

Table 1.1

unknown oxide	state at r.t.p	solubility in water	pH of aqueous solution	reacts with dilute hydrochloric acid?	reacts with dilute sodium hydroxide?
A	solid	soluble	14	yes	no
B	solid	insoluble	-	yes	yes
C	gas	soluble	7	no	no
D	solid	insoluble	-	yes	no
E	gas	soluble	2	no	yes

(a) Which oxide(s) is/are:

(i) non-metallic?

…….. [2]

(ii) able to form an alkali?

…….. [1]

(iii) amphoteric?

…….. [1]

(b) Give an example for your answer in **(a)(iii)**.

…….. [1]

(c) Suggest the identity of oxide **A**.

…….. [1]

2 Phosphorus is an element that does not react with water, but will react readily in air, forming an oxide.

Fig. 2.1 below shows a piece of phosphorus fastened to a copper wire and left for a few days in the set up. The water slowly rises up the tube.

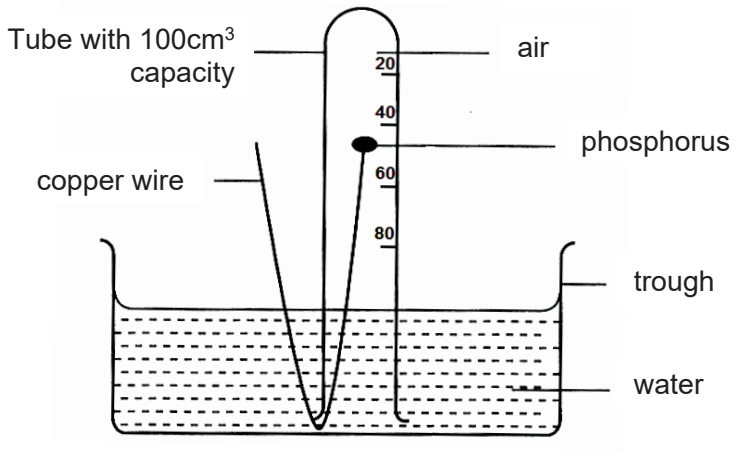


Fig. 2.1

(a) State the gas in air that phosphorus has reacted with.

…… [1]

(b) At which mark will the water level approximately be after a few days?

…… [1]

(c) State two gases that are left in the tube after a few days.

…… [2]

3 When a mixture of aluminium powder and zinc oxide is heated, the mixture burns vigorously with a bright flame, and may even explode. The reaction is illustrated by the equation below.

$$2Al + ZnO \rightarrow Al_2O_3 + 3Zn$$

(a) Is the reaction endothermic or exothermic? Explain your answer.

……

…… [2]

(b) State whether zinc oxide is oxidised or reduced. Explain your answer in terms of electron transfer.

……

……

…… [2]

4 A common reaction iron undergoes is rusting. Fig. 3.1 below shows an experiment where some iron nails have been exposed to different conditions in four test tubes **A**, **B**, **C** and **D**.

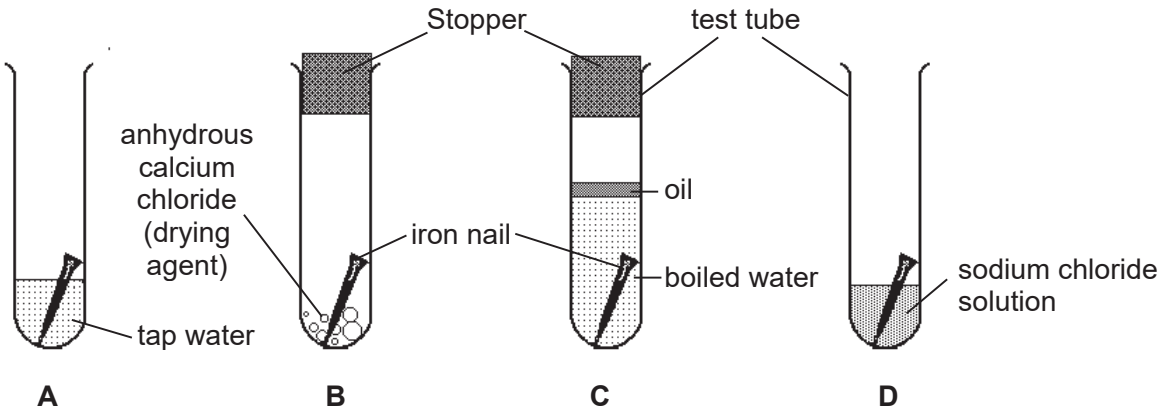


Fig. 3.1

(a) In which test tube(s) will the iron nail not rust? Explain your answer.

……

……

……

…….. [3]

(b) In which test tube will the iron nail rust the fastest?

…….. [1]

5 The electronic configurations of lithium, sodium and potassium are shown in Table 5.1.

Table 5.1

element	symbol	proton number	electronic configuration
lithium	Li	3	2,1
sodium	Na	11	2,8,1
potassium	K	19	2,8,8,1

(a) Explain why these three elements are in the same group of the Periodic Table.

……

…….. [1]

(b) For one of the metals in Table 5.1, name the products of its reaction with water.

…….. [2]

(c) Name one other element that is in the same group as the elements in Table 5.1.

…….. [1]

(d) Describe how the reactivity of the element in **(c)** would differ from the elements in Table 5.1.

…….. [1]

6 An unknown metal **M** forms the nitrate **M**NO_3. The compound is stable, but decomposes upon strong heating.

When a 17.0 g sample of **M**NO_3 was heated, it decomposed completely according to the equation:

$$2\mathbf{M}NO_3\,(s) \rightarrow 2\mathbf{M}NO_2\,(s) + O_2\,(g)$$

At the end of the reaction, 2400 cm^3 oxygen was collected.

(a) Is the above decomposition reaction exothermic or endothermic one? Explain your answer.

……

…….. [2]

(b) Calculate the number of moles of **M**NO_3 that decomposed.

[2]

(c) Calculate the molar mass of **M**NO_3, and hence determine the identity of **M**.

Identity of **M** : …… [3]

(d) Describe a test you would perform to confirm the identity of the oxygen produced.

……

…….. [2]

7 Group VII and Group 0 are found at the right side of the Periodic Table.

(a) What are the names given to elements in Group VII and Group 0?

…….. [1]

(b) Explain why the elements in Group 0 are unreactive.

…….

…….. [1]

(c) A student is given four substances below.

aqueous bromine	aqueous chlorine
aqueous potassium bromide	aqueous potassium chloride

Describe how she could use **two** of the substances to perform an experiment to show that chlorine is more reactive than bromine. Include the observations you would expect her to make, and construct a balanced chemical equation of the reaction.

…….

…….

…….

…….

…….. [3]

8 Fig. 8.1 describes some of the reactions of two unknown substances **A** and **B**.

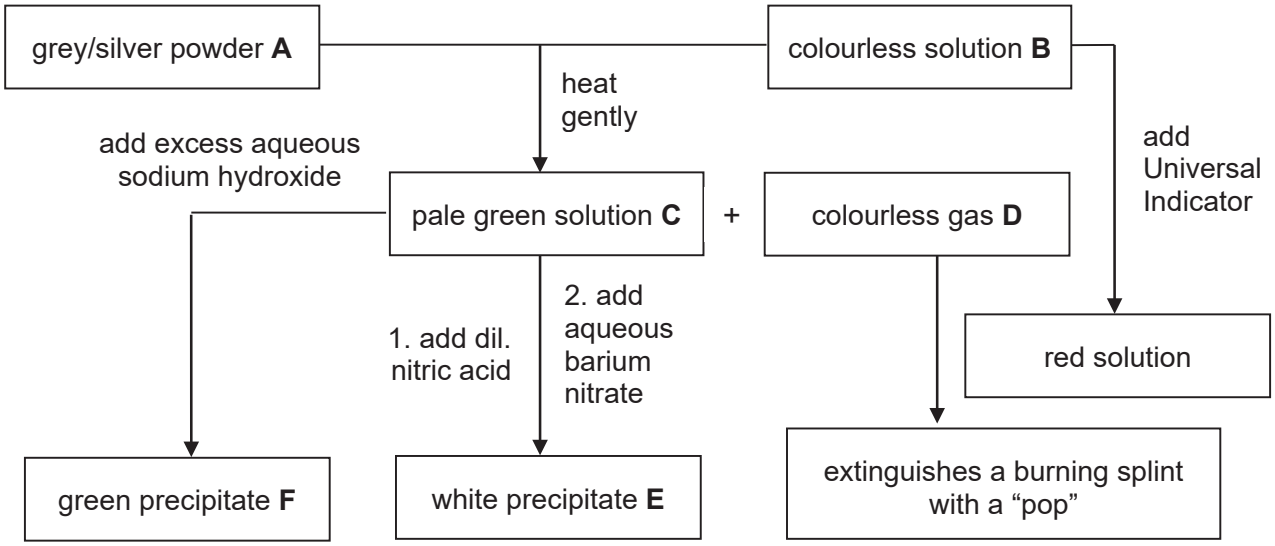


Fig. 8.1

(a) Identify unknown substances **A** – **F**.

A: .....

B: .....

C: .....

D: .....

E: .....

F: .....

[6]

(b) Write a balanced chemical equation for any one of the reactions in Fig. 8.1.

..... [2]

Section C

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

9 Iron is extracted from iron ore in the blast furnace, as shown in Fig. 9.1 below.

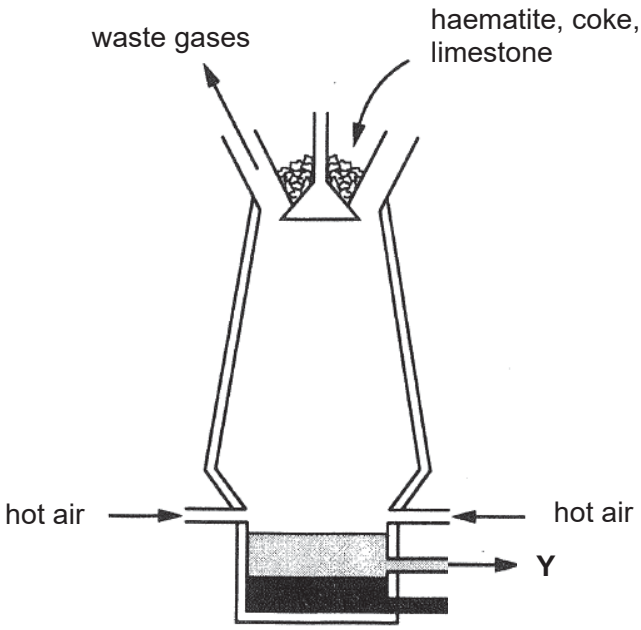


Fig. 9.1

(a) In the furnace, the coke is converted to carbon monoxide. A redox reaction then takes place between iron(III) oxide in haematite and carbon monoxide to produce iron and carbon dioxide.

(i) Write a balanced chemical equation for the reaction between iron(III) oxide and carbon monoxide.

…….. [1]

(ii) Explain why the reaction in **(i)** is a redox reaction.

…….

…….

…….. [2]

(iii) Identify the reducing agent in reaction **(a)(i)**.

…….. [1]

(b) Pure iron from the blast furnace is frequently mixed with other elements to form alloys. Give one example of this alloy, and explain why it is preferred to pure iron.

.....

..... [2]

(c) Identify substance **Y**, and explain how it is formed. Include the relevant chemical equation(s) in your answer.

.....

.....

.....

.....

..... [4]

10 Magnesium nitrate is commonly used as a dehydrating agent; it is also present in some fertilisers.

A student prepared a sample of magnesium nitrate by adding magnesium oxide to 200 cm^3 of nitric acid of an unknown concentration. The equation is shown below:

$$2HNO_3\ (aq) + MgO\ (s) \rightarrow Mg(NO_3)_2\ (aq) + H_2O\ (l)$$

In this particular reaction, 7.4 g of magnesium nitrate was collected at the end of the reaction.

(a) Given that the nitric acid reacted completely, calculate the moles of nitric acid that reacted and hence its concentration in mol/dm^3.

[3]

(b) Outline an experimental procedure to describe how pure crystals of zinc nitrate may be prepared using a similar method as above. State clearly the reagents that you use.

……

……

……

……

……

……

……

……

……

…….. [6]

(c) Explain why sodium nitrate cannot be prepared with the method in **(b)**.

……

…….. [1]

End of Paper

West Spring Secondary School
Science Department – Mid-Year Exam [2018]
Marking Scheme

Name of Setter(s): Joel Lee
Title of Assessment: Secondary 4 Express / 5 Normal (Academic)
Subject: Science (Chemistry) 5076/5078
Duration: 1hr 45mins

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

Section B [45 marks]			
Q/No	**Answer**	**Comments/ Suggestions to Markers**	**Marks**
1(a)(i)	Oxides **C** and **E**	CAO	2
1(a)(ii)	Oxide **A**	CAO	1
1(a)(iii)	Oxide **B**	CAO	1
1(b)	lead(II)/aluminium/zinc oxide	CAO	1
1(c)	Any Group I oxide (sodium oxide, potassium oxide etc.)		1
2(a)	Oxygen	CAO	1
2(b)	It will be at approximately the 80cm^3 mark.	CAO	1
2(c)	Any 2: Nitrogen / Argon / Carbon dioxide / Water vapour	CAO	2
3(a)	The reaction is exothermic. It gives burns vigorously/may explode, signifying that a lot of heat is given out to the surroundings.	CAO OWTTE	1 1
3(b)	Zinc oxide is reduced. Zn gains 2 electrons from Zn^{2+} in ZnO to Zn. (Students need to specify no. of electrons to get the mark.)	CAO	1 1
4(a)	The nail will not rust in tubes **B** and **C**. There is no moisture/water in tube B, and There is no oxygen in tube C.	CAO OWTTE OWTTE	1 1 1

4(b)	Tube **D**.	CAO	1
5(a)	They have the same number of valence electrons.	CAO	1
5(b)	Lithium/sodium/potassium hydroxide and hydrogen gas.	CAO	2
5(c)	Rubidium/caesium/francium	CAO	1
5(d)	It is more reactive.	CAO	1
6(a)	The reaction is endothermic, because heat needs to be supplied/heat is taken in for the reaction to start	OWTTE	2
6(b)	Moles of oxygen = 2400 / 24000 = 0.10 mol. Moles of **M**NO_3 = 0.10 x 2 = 0.20 mol.	CAO	1 1
6(c)	Molar mass of one mol. of **M**NO_3 = 17.0 / 0.2 = 85 g/mol A_r of **M** = 85 – [14 + (3x16)] = 23 Therefore **M** is sodium.	CAO (ecf allowed)	1 1 1
6(d)	Insert a glowing splint into a test tube containing the gas. If it relights, the gas is oxygen.	CAO	1 1
7(a)	Halogens (Group VII) and noble gases (Group 0)	CAO	1
7(b)	They have a fully filled valence shell, which confers stability.	CAO	1
7(c)	Mix aqueous chlorine and aqueous potassium bromide. The mixture of solutions will turn from colourless to brown as bromine is displaced. 2 KBr + Cl_2 → 2 KCl + Br_2	CAO	1 1 1
8(a)	**A**: iron **B**: sulfuric acid **C**: iron(II) sulfate **D**: hydrogen **E**: barium sulfate **F**: iron(II) hydroxide	1m each	6
8(b)	Fe + H_2SO_4 → $FeSO_4$ + H_2 $FeSO_4$ + 2NaOH → Na_2SO_4 + $Fe(OH)_2$ $FeSO_4$ + $Ba(NO_3)_2$ → $Fe(NO_3)_2$ + $BaSO_4$ (Any one)	CAO 1m for correct formula, 1m for balanced equation.	2

Section C [20 marks]			
9(a)(i)	$Fe_2O_3 + 3\ CO \rightarrow 2\ Fe + 3CO_2$		1
9(a)(ii)	It is a redox reaction as Fe_2O_3 is reduced to Fe, and CO is oxidised to CO_2. Fe_2O_3 loses oxygen while CO gains oxygen.	1m for stating oxidised and reduced species 1m for explanation	2
9(a)(iii)	CO is the reducing agent.	CAO	1
9(b)	(Stainless) steel is one iron-based alloy. It is preferred as it is stronger / more corrosion resistant than pure iron.	CAO	1 1
9(c)	**Y** is slag. The limestone added to the furnace decomposes to form calcium oxide and carbon dioxide. The calcium oxide reacts with acidic impurities / silicon dioxide in the haematite to form slag. (1m can be given for the role of limestone in removing acidic impurities, without mention of its decomposition) $CaO + SiO_2 \rightarrow CaSiO_3$	CAO OWTTE CAO	1 1 1 1
10(a)	Moles of $Mg(NO_3)_2$ = 7.4 / 148 = 0.050 mol. Moles of HNO_3 = 0.050 x 2 = 0.10 mol. Conc. of HNO_3 = 0.10 / (200/1000) = 0.50 mol/dm^3	CAO	1 1 1
10(b)	The reagents used are nitric acid and zinc metal/carbonate/oxide. 1. Add excess zinc metal/carbonate/oxide to nitric acid. 2. After the reaction is complete, filter to obtain zinc nitrate solution as the filtrate. 3. Heat the solution to obtain a saturated solution. 4. Cool the saturated solution to crystallise zinc nitrate. 5. Filter to obtain crystals of zinc nitrate, wash with cold distilled water and dry.	OWTTE	1 1 1 1 1 1
10(c)	Sodium carbonate, the starting material, is soluble in water.	OWTTE	1