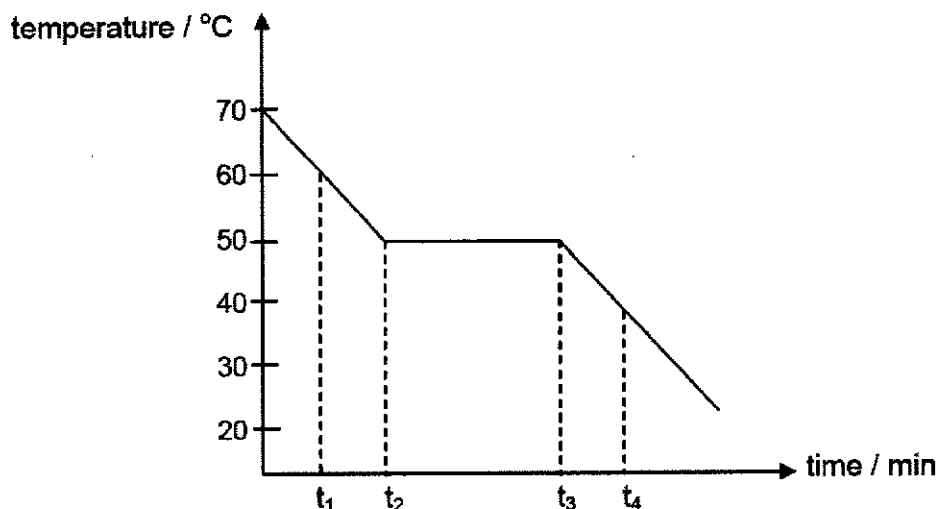




**Section A [30 marks]**

Answer **all** the questions in this section. Record your answer in **soft pencil** on the OMR sheet provided.

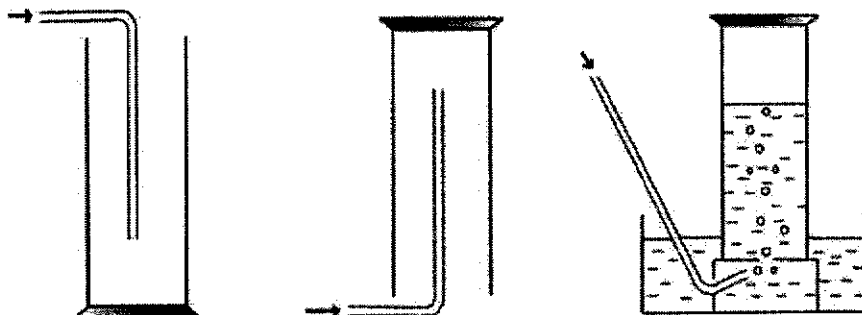
- A1** The graph shows the change in temperature with time when a sample of substance X is cooled from 70 °C and undergoes a freezing process.



Which of the following describes the change taking place?

- A** From  $t_1$  to  $t_2$ , the particles slide past each other freely.  
**B** From  $t_2$  to  $t_3$ , the particles lose kinetic energy and become closer together.  
**C** From  $t_2$  to  $t_3$ , the particles change from spaced far apart to being more closely packed.  
**D** From  $t_3$  to  $t_4$ , the particles move randomly at high speed.
- A2** At which temperature does an aqueous solution of sodium chloride begin to boil?
- A** 96 °C  
**B** 100 °C  
**C** 104 °C  
**D** 808 °C

- A3** Which of the following methods can be used to collect ammonia gas in the laboratory?

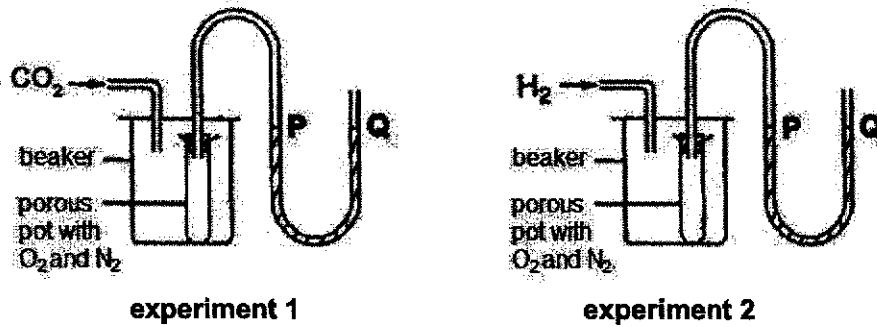


- A** 1 only      **B** 2 only      **C** 1 and 3      **D** 2 and 3

A4 Which one of the substances has been **wrongly** classified as an element, mixture or compound?

	property	classification
A	White solid melts over 56 °C – 58 °C.	mixture
B	Green powder on heating leaves a black residue and a colourless gas is evolved.	compound
C	Black powder burns in air to form a colourless gas.	element
D	Colourless solution produces two colourless gases when an electric current is passed through it	element

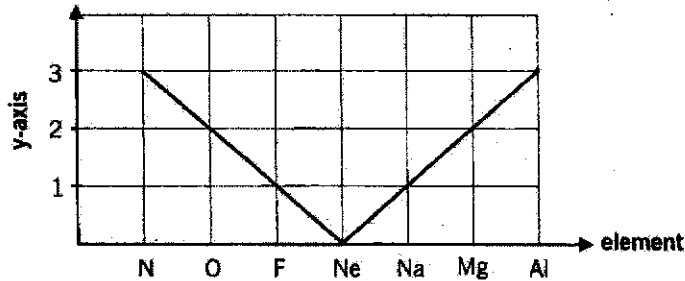
A5 Two experimental set-ups used to demonstrate diffusion of gases are shown in the diagram below. The gases in each porous pot are nitrogen and oxygen. In the first experiment, the gas introduced into the beaker is carbon dioxide while in the second experiment, the gas introduced is hydrogen.



What changes, if any, to the water levels P and Q would you expect to see in both experiments?

	experiment 1	experiment 2
A	P and Q remain the same.	P and Q remain the same.
B	P is lower than Q.	P is higher than Q.
C	P is higher than Q.	P is lower than Q.
D	P is higher than Q.	P is higher than Q.

A6 The graph below shows the information of seven elements in the Periodic Table.



What would be a suitable label for the y-axis?

- A the number of electron shells
- B the number of valence electrons
- C the number of chlorine atoms required to bond with the element
- D the number of pairs of shared electrons in its compound with chlorine

- A7** An element X forms a positive ion with the electronic configuration of 2, 8, 8.  
What is the atomic number of X?
- A** 17                      **B** 18                      **C** 19                      **D** 40
- A8** A manufacturer accidentally dropped some tiny industrial diamonds into lead(II) nitrate powder.  
Which steps could be used to recover the diamonds from the mixture?
- A** Shake with dilute hydrochloric acid. Filter the mixture and wash the residue with water.  
**B** Shake with dilute sulfuric acid. Filter the mixture and evaporate the filtrate to dryness.  
**C** Shake with water. Filter the mixture and evaporate the filtrate to dryness.  
**D** Shake with water. Filter the mixture and wash the residue with water.
- A9** A compound contains two elements, metal Y and non-metal Z.  
The compound consists of a lattice of positive ions and negative ions. Each positive ion is surrounded by eight negative ions and each negative ion is surrounded by four positive ions.  
Which ions are present in the compound, and what is its formula?

	ions present	formula
<b>A</b>	$Y^+ Z^{2-}$	$Y_2Z$
<b>B</b>	$Y^{2+} Z^-$	$YZ_2$
<b>C</b>	$Z^+ Y^{2-}$	$Z_2Y$
<b>D</b>	$Z^{2+} Y^-$	$ZY_2$

- A10** Phosphorus trichloride,  $PCl_3$ , is a molecule formed when the elements phosphorus and chlorine react together.  
How many electrons in the phosphorus atom are **not** involved in bonding?
- A** 2                      **B** 3                      **C** 5                      **D** 12

- A11** The following table gives the colour of various indicators and the pH range at which the indicator changes colour.

indicator	colour in acidic solution	pH range at which indicator changes colour	colour in alkaline solution
methyl orange	red	3 – 5	yellow
quinaldine red	colourless	1 – 3	red
phenolphthalein	colourless	8 – 10	pink

What is the colour of the solution when all three indicators are added to pure water?

- A** colourless              **B** yellow              **C** red              **D** orange
- A12** Which compound contains the greatest mass of carbon in 100g of the sample?
- A** CO                      **B**  $C_2H_6O_2$               **C**  $Cr_2(CO_3)_3$               **D**  $CO_2$

**A13** Some dry crystals of citric acid are placed on a piece of dry blue litmus paper. After five minutes, the litmus paper will

- A turn red.
- B remain blue.
- C be bleached.
- D turn red then bleached.

**A14** The table gives some statements about acids and bases and explanations for these statements. Which row shows both a correct statement and a correct explanation?

	statement	explanation
<b>A</b>	ammonia can be made by heating ammonium sulfate with calcium hydroxide	the hydroxide ion acts as a base and removes $H^+$ from the ammonium ion
<b>B</b>	the pH of a weak acid is higher than the pH of a strong acid of the same concentration	pH shows the extent of ionisation – the more ionised the acid is, the higher the pH
<b>C</b>	calcium hydroxide can be used to control pH in soils	metal hydroxides are acidic and can neutralise excess alkalinity
<b>D</b>	when an acid reacts with a metal, the metal is reduced	reduction is gain of electrons

**A15** Which pair of reagents would be most suitable to safely prepare a large sample of calcium sulfate in the laboratory?

- A calcium and dilute sulfuric acid
- B calcium carbonate and dilute sulfuric acid
- C aqueous calcium chloride and dilute sulfuric acid
- D aqueous calcium nitrate and aqueous sodium chloride

**A16** Which of the following compounds has both ionic and covalent bonds?

- A ammonium nitrate
- B brass
- C silicon dioxide
- D sodium iodide

**A17** The following shows some information about substance X.

- I. It has high melting point.
- II. It is insoluble in water.
- III. It does not react with aqueous sodium hydroxide.

What is the possible identity of substance X?

- A  $SO_2$
- B ZnO
- C  $Na_2O$
- D CuO

**A18** The reaction in which the same element is both oxidised and reduced is called a disproportionation reaction. Which equation is an example of a disproportionation reaction?

- A**  $3\text{Cu} + 8\text{HNO}_3 \rightarrow 3\text{Cu}(\text{NO}_3)_2 + 2\text{NO} + 4\text{H}_2\text{O}$   
**B**  $\text{Cl}_2 + 2\text{NaOH} \rightarrow \text{NaCl} + \text{NaOCl} + \text{H}_2\text{O}$   
**C**  $\text{Fe}_2(\text{SO}_4)_3 + 2\text{KI} \rightarrow 2\text{FeSO}_4 + \text{K}_2\text{SO}_4 + \text{I}_2$   
**D**  $2\text{Pb}(\text{NO}_3)_2 \rightarrow 2\text{PbO} + 4\text{NO}_2 + \text{O}_2$

**A19** Aqueous sodium hydroxide are added to copper(II) sulfate solution.

What would be observed when 20 cm<sup>3</sup> of 0.5 mol/dm<sup>3</sup> aqueous copper(II) sulfate was mixed with 30 cm<sup>3</sup> of 1.0 mol/dm<sup>3</sup> aqueous sodium hydroxide?

- A** dark blue solution  
**B** colourless solution  
**C** blue precipitate in colourless solution  
**D** blue precipitate in blue solution

**A20** Metal R and its compound undergo the following reactions.

- i.  $\text{RO} + \text{H}_2 \rightarrow \text{R} + \text{H}_2\text{O}$   
 ii.  $\text{R} + 2\text{HCl} \rightarrow \text{RCl}_2 + \text{H}_2$

What could metal R be?

- A** iron  
**B** magnesium  
**C** sodium  
**D** zinc

**A21** The table gives information of four different metals and some of their compounds.

metal	reaction with dilute hydrochloric acid	effect of heating the metal oxide with carbon	action of metal on a solution of Z chloride
W	effervescence observed	reduced	no observable change
X	no observable change	reduced	no observable change
Y	effervescence observed	not reduced	metal Z formed
Z	effervescence observed	not reduced	no observable change

Which of the following correctly shows the metals in decreasing order of reactivity?

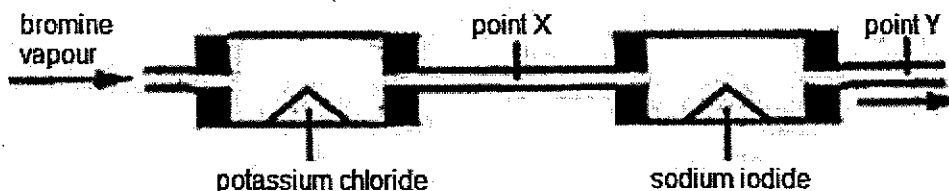
- A** Z, Y, W, X  
**B** Z, Y, X, W  
**C** Y, Z, W, X  
**D** X, W, Z, Y

**A22** Zinc carbonate decomposes upon heating to form zinc oxide. In an experiment, 5 g of zinc carbonate decomposes to form 2.7 g of zinc oxide.

What is the percentage yield of zinc oxide?

- A 54%                      B 83%                      C 85%                      D 120%

**A23** The reaction shown below was carried out. Which of the following gives the correct colour at point X and Y?



	point X	point Y
<b>A</b>	reddish-brown	purplish-black
<b>B</b>	reddish-brown	reddish-brown
<b>C</b>	greenish-yellow	purplish-black
<b>D</b>	greenish-yellow	greenish-yellow

**A24** Some properties of elements in the same group of the Periodic Table are listed.

- 1 number of valence electrons
- 2 number of protons
- 3 metallic character

Which property / properties increase(s) on descending the group?

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

**A25** Part of the Periodic Table is shown.


Which of the elements W, X, Y and Z would react together **least** violently?

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

**A26** Which statement about alloys is correct?

- A They are formed by a chemical reaction between a metal and one or more other substances.
- B There are strong electrostatic forces of attraction within the structure.
- C They are good conductors of electricity as they have mobile ions.
- D They can all be represented by a molecular formula.

**A27** Copper is a metal. Which statements about copper is/are **incorrect**?

- 1 Copper conducts heat because the positive ions are free to move.
- 2 Copper conducts electricity because the electrons are free to move.
- 3 Copper ions are held together because of their attraction for each other.
- 4 Copper has a high melting point due to the strong covalent bonds.

A 2 only                      B 4 only                      C 1 and 4                      D 1, 3 and 4

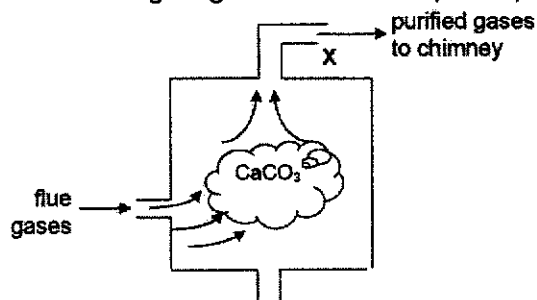
**A28** In which pair do **both** pollutants cause damage to buildings?

- A CFCs and carbon monoxide
- B methane and carbon dioxide
- C unburned hydrogen and nitrogen oxides
- D nitrogen dioxide and sulfur dioxide

**A29** A catalytic converter in a car exhaust system changes pollutants into less harmful products. Which change does **not** occur in a catalytic converter?

- A  $2\text{NO} + 2\text{CO} \rightarrow \text{N}_2 + 2\text{CO}_2$
- B  $2\text{C}_8\text{H}_{18} + 25\text{O}_2 \rightarrow 16\text{CO}_2 + 18\text{H}_2\text{O}$
- C  $2\text{CO} + \text{O}_2 \rightarrow 2\text{CO}_2$
- D  $2\text{NO}_2 \rightarrow \text{N}_2 + 2\text{O}_2$

**A30** The following diagram shows a simplified process of removal of flue gas.



Which gas **cannot** be removed via this method?

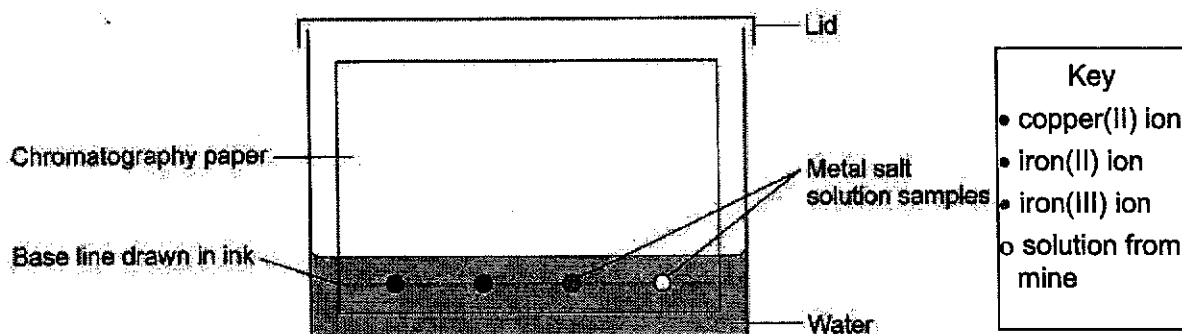
- A carbon monoxide
- B sulfur dioxide
- C nitrogen dioxide
- D phosphorus trioxide



**Section B [40 marks]**

Answer all the questions in this section.

- B1** A student analysed a sample of water from an abandoned mine to find out which metal ions were in the water. He used paper chromatography to test the sample of water from the mine and of solutions containing known metal ions.



He set the apparatus up as shown in the diagram.

- (a) State **two** errors the student made in the way he set up his apparatus. Explain how these errors will cause the experiment to fail.

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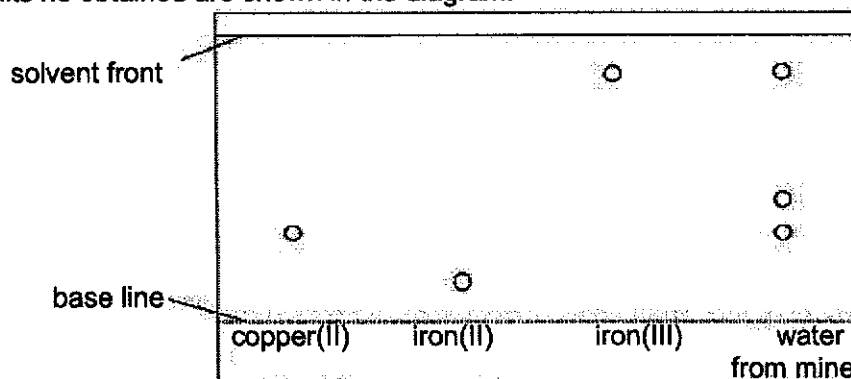
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[2]

- (b) Another student repeated the experiment, but without making any errors.

After the water had soaked up the chromatography paper he sprayed it with a locating agent, X, giving coloured precipitates which make the spots visible.

The results he obtained are shown in the diagram.



- (i) Suggest a common reagent, X, that can be used to identify the cations.

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[1]

- (ii) State the formula of the iron(III) compound formed upon adding the locating agent in (b)(i).

---

[1]

- (c) In a separate experiment, chromatography of a dye using water as a solvent gave a spot with  $R_f$  of 0.54. The data in the table is used to identify the substance that caused the spot.

substance	$R_f$ value when the solvent is:		
	water	ethanol	propanone
A	0.72	0.54	0.00
B	0.53	0.62	0.84
C	0.04	0.16	0.54
D	0.55	0.45	0.31

- (i) State **two** possible substances from the table above that caused the spot with  $R_f$  value of 0.54.

\_\_\_\_\_ [1]

- (ii) Describe how you would identify which one of the substances you identified in (c)(i) actually caused the spot.

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_ [1]

[Total: 6]

- B2** Barium is a metal found in Group II. In an experiment, barium chloride was prepared by adding 3.94 g of barium carbonate to 100 cm<sup>3</sup> of 0.250 mol/dm<sup>3</sup> of dilute hydrochloric acid.

- (a) Identify the limiting reagent. Show your reasoning clearly.

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_ [3]

- (b) Hence, calculate the volume of carbon dioxide gas produced.

\_\_\_\_\_  
\_\_\_\_\_ [2]  
[Total: 5]

**B3** Use the list of substances to answer the questions.

nitric acid

ethanoic acid

potassium nitrate

ammonium nitrate

ammonia

calcium hydroxide

(a) Which solid compound is added to soil to increase the pH?

\_\_\_\_\_ [1]

(b) Which compound turns the Universal Indicator yellow?

\_\_\_\_\_ [1]

(c) (i) Which two compounds can be reacted together to form an ammonium salt?

\_\_\_\_\_ [1]

(ii) Construct the chemical equation for the reaction in (c)(i).

\_\_\_\_\_ [1]

(d) One of the salts listed above, can be prepared using aqueous potassium carbonate.

(i) Name the method used to prepare a solution of this salt.

\_\_\_\_\_ [1]

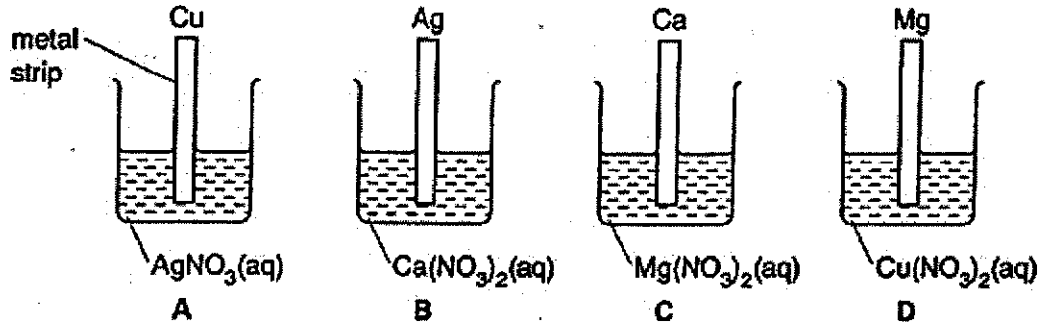
(ii) Describe how dry crystals can be obtained from an aqueous solution of this salt.

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

\_\_\_\_\_ [2]

[Total: 7]

**B4** The following experiment was set up.



(a) State the beaker(s) which did not have any visible observation.

\_\_\_\_\_ [1]

(b) Construct the ionic equation for beaker D.

\_\_\_\_\_ [1]

(c) Describe and explain your observations in beaker D.

\_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_ [3]

(d) In terms of oxidation states, explain why the reaction at beaker D is a redox reaction.

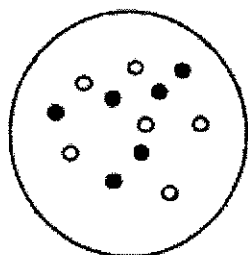
\_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_ [2]

(e) The experiment was repeated using strips of aluminium in all four beakers. There were no visible observations. Explain why.

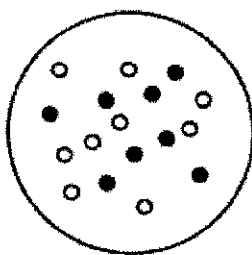
\_\_\_\_\_  
 \_\_\_\_\_ [1]

[Total: 8]

B5 The diagram below shows the nuclei of atoms W, X, Y and Z.

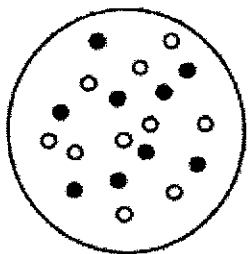


W

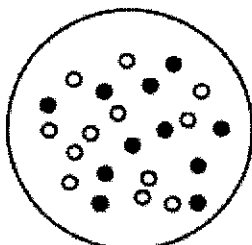


X

• - proton  
○ - neutron



Y



Z

- (a) (i) State the identity of W \_\_\_\_\_ [1]  
 (ii) State the electronic configuration of Z \_\_\_\_\_ [1]
- (b) Showing only the outer electrons, draw a 'dot-and-cross' diagram to show the bonding in the compound formed between
- (i) X and Z

[2]

- (ii) W and Y

[2]

[Total: 6]

**B6** The following table shows some substances and their properties.

substance	melting point / °C	boiling point / °C	electrical conductivity in	
			solid	liquid
P	3550	4830	poor	poor
Q	-78	-33	poor	poor
R	801	1413	poor	good
S	1085	2562	good	good
T	63	759	good	good

(a) Give the letter of a substance that is likely to have a

- (i) simple molecular structure \_\_\_\_\_ [1]
- (ii) giant ionic structure \_\_\_\_\_ [1]
- (iii) giant covalent structure \_\_\_\_\_ [1]

(b) Element T has a density lower than water. Suggest a possible identity of T.

\_\_\_\_\_ [1]

(c) In terms of bonding and structure, explain the difference in the melting point between substance Q and substance R.

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_ [4]

[Total: 8]

**Section C: Free Response Question [30 marks]**

Answer all the questions in this section.

C1 A student collected the following information for his science project.

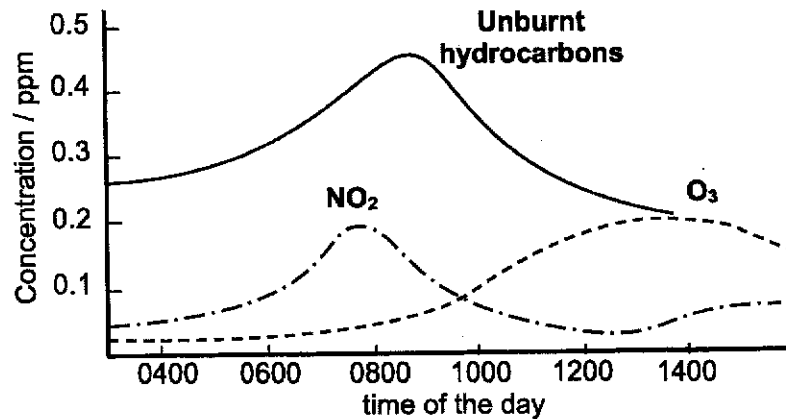
Table 1 shows the list of pollutants with its unhealthy and actual concentration in air.

Table 1

pollutant	unhealthy concentration / $\mu\text{g}/\text{m}^3$	actual concentration / $\mu\text{g}/\text{m}^3$
ozone	>100	52
sulfur dioxide	>15	11
carbon dioxide	>30	23
oxides of nitrogen	>40	44
unburnt hydrocarbon	—	3

Graph 1 shows how the concentration of three air pollutants varies with time.

Graph 1



The equation for the formation of ozone is given as follows:

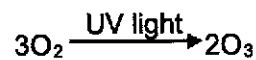


Table 2 is a list of all the sources of sulfur dioxide emission in Singapore.

Table 2

sources	emitters	SO <sub>2</sub> emissions / tonnes	percentage
oil refineries	Shell	27,701	93.1%
	Singapore Refining Company	22,996	
	ExxonMobil	23,904	
power stations	Power Seraya	66	1.7%
	TP Utilities (BMCC)	1,273	
other industries	ExxonMobil Petrochemical	2,129	5.1%
	other fuel oil users	1,932	
vehicles	petrol and diesel vehicles	110	0.1%
total		80,111	100%

source: <http://www.nea.gov.sg/anti-pollution-radiation-protection/air-pollution-control/air-quality-and-targets>

- (a) With reference to **Table 1**, describe the effect of the pollutant, which has exceeded the healthy level, on the environment.

\_\_\_\_\_ [1]

- (b) The student has made a mistake while compiling the list of gases in **Table 1**. Identify the mistake and explain your reasoning.

\_\_\_\_\_ [1]

- (c) Use information from **Graph 1** to answer the following questions.

- (i) Describe the changes in the concentration of nitrogen dioxide from 0400 hrs to 1200 hrs.

\_\_\_\_\_ [1]

- (ii) Explain the peaks in concentrations of the three air pollutants in **Graph 1** over the day.

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_ [2]

- (d) Based on the information on page 15, describe how sulfur dioxide as a pollutant is produced in Singapore.

\_\_\_\_\_ [1]

- (e) In Singapore, there are many air pollutants, some of which has been excluded from the data given on page 15.

- (i) Identify the pollutant which has been excluded from the data given and state its source.

\_\_\_\_\_ [1]

- (ii) Describe the effects of the pollutant mentioned in (e)(i) on human health.

\_\_\_\_\_ [1]



- (f) The percentages of carbon dioxide and oxygen have remained constant for the past 1 million years. Describe **two** main processes in the carbon cycle which has resulted in this effect. Construct chemical equations to support your answer.

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[3]  
[Total: 11]

- C2** Copper can be extracted by two different extraction methods involving low grade ore, chalcopyrite,  $\text{CuFeS}_2$ . The ore is first crushed in huge cylindrical ball mills. The following show information about these methods.

method	roasting and smelting	leaching
main process	<p>The concentrated ore is heated in the furnace to about 700 °C in the presence of oxygen according to the following equation:</p> $2\text{CuFeS}_2(\text{s}) + 3\text{O}_2(\text{g}) \rightarrow 2\text{FeO}(\text{s}) + 2\text{CuS}(\text{s}) + 2\text{SO}_2(\text{g})$ <p>The iron(II) oxide impurities are then removed by heating to over 1200 °C.</p>	<p>The ore is treated with dilute sulfuric acid and converts insoluble chalcopyrite into a solution containing <math>\text{Cu}^{2+}</math>, <math>\text{Fe}^{2+}</math>, <math>\text{Fe}^{3+}</math> and <math>\text{SO}_4^{2-}</math> ions.</p>
conversion	<p>Copper(II) sulfide is reduced to copper by further heating with oxygen to produce sulfur dioxide as a side product.</p>	<p>Copper are extracted from the above solution using scrap iron.</p>

- (a) The leaching process uses lesser energy than the roasting and smelting process. Use information from the table to explain why.

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[2]

- (b) Other than using less energy, suggest **two** more reasons to why extraction of copper by leaching is preferable to the roasting and smelting process.

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- (c) During the conversion phase of the leaching process, can zinc be used in place of scrap iron? Explain your reasoning.

[2]

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[2]

- (d) One of the uses of copper is to electroplate it on steel to prevent rusting. Compare the similarities and differences between electroplating and galvanising steel in preventing rust from forming.

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[4]

[Total: 10]

- C3** Sodium, potassium and rubidium are elements found in Group I of the Periodic Table while chlorine, bromine and iodine are elements found in Group VII of the Periodic Table. Here are some facts about these 6 elements arranged in alphabetical order.

element	melting point / °C	appearance
bromine	-7.2	
chlorine	-101.5	greenish-yellow gas
iodine	113.7	purplish-black solid
potassium	63.5	grey solid
rubidium	39.3	grey solid
sodium		grey solid

- (a) State the appearance of bromine in the table above. [1]
- (b) Predict the melting point of sodium and complete the table above. [1]
- (c) Describe the trend in melting point of the elements in Group I and Group VII of the Periodic Table.

\_\_\_\_\_ [1]

- (d) With reference to their electronic structure, explain why chlorine and sodium are in the same period while chlorine and bromine are in the same group of the Periodic Table.

\_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_ [2]

- (e) Describe an observation that could be made during the chemical reaction between chlorine gas and aqueous potassium bromide solution.

\_\_\_\_\_ [1]

- (f) 0.2 moles of an unknown metal X reacts with 14.2 g of chlorine gas.  
 (i) Calculate the empirical formula of the resultant product formed.

- \_\_\_\_\_ [2]
- (ii) A student claims that metal X could be sodium. Do you agree with the student? Explain your reasoning.

\_\_\_\_\_ [1]  
 \_\_\_\_\_ [Total: 9]

– END OF PAPER –

PartnerInLearning



# The Periodic Table of Elements

I		II		Group										III		IV	V	VI	VII	0																			
3 Li lithium	4 Be beryllium	21 Sc scandium	22 Ti titanium	23 V vanadium	24 Cr chromium	25 Mn manganese	26 Fe iron	27 Co cobalt	28 Ni nickel	29 Cu copper	30 Zn zinc	31 Ga gallium	32 Ge germanium	33 As arsenic	34 Se selenium	35 Br bromine	36 Kr krypton	1 H hydrogen	2 He helium																				
7 Na sodium	9 Mg magnesium	39 Y yttrium	40 Zr zirconium	41 Nb niobium	42 Mo molybdenum	43 Tc technetium	44 Ru ruthenium	45 Rh rhodium	46 Pd palladium	47 Ag silver	48 Cd cadmium	49 In indium	50 Sn tin	51 Sb antimony	52 Te tellurium	53 I iodine	54 Xe xenon	5 B boron	6 C carbon	7 N nitrogen	8 O oxygen	9 F fluorine	10 Ne neon																
11 K potassium	12 Ca calcium	37 Rb rubidium	38 Sr strontium	41 Nb niobium	42 Mo molybdenum	43 Tc technetium	44 Ru ruthenium	45 Rh rhodium	46 Pd palladium	47 Ag silver	48 Cd cadmium	49 In indium	50 Sn tin	51 Sb antimony	52 Te tellurium	53 I iodine	54 Xe xenon	11 Li lithium	12 Be beryllium	13 B boron	14 C carbon	15 N nitrogen	16 O oxygen	17 F fluorine	18 Ne neon														
19 K potassium	20 Ca calcium	55 Cs cesium	56 Ba barium	72 Hf hafnium	73 Ta tantalum	74 W tungsten	75 Re rhenium	76 Os osmium	77 Ir iridium	78 Pt platinum	79 Au gold	80 Hg mercury	81 Tl thallium	82 Pb lead	83 Bi bismuth	84 Po polonium	85 At astatine	86 Rn radon	19 K potassium	20 Ca calcium	21 Sc scandium	22 Ti titanium	23 V vanadium	24 Cr chromium	25 Mn manganese	26 Fe iron	27 Co cobalt	28 Ni nickel	29 Cu copper	30 Zn zinc	31 Ga gallium	32 Ge germanium	33 As arsenic	34 Se selenium	35 Br bromine	36 Kr krypton			
23 Na sodium	24 Mg magnesium	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	113 Nh nihonium	114 Fl flerovium	115 Mc moscovium	116 Lv livermorium	117 Ts tennessine	118 Og oganeson	89-103 actinoids	88 Ra radium	87 Fr francium	86 Rn radon	85 At astatine	84 Po polonium	83 Bi bismuth	82 Pb lead	81 Tl thallium	80 Hg mercury	79 Au gold	78 Pt platinum	77 Ir iridium	76 Os osmium	75 Re rhenium	74 W tungsten	73 Ta tantalum	72 Hf hafnium	71 Yb ytterbium	70 Lu lutetium

Key  
proton (atomic) number  
atomic symbol  
name  
relative atomic mass

lanthanoids		actinoids	
57 La lanthanum	58 Ce cerium	59 Pr praseodymium	60 Nd neodymium
89 Ac actinium	90 Th thorium	91 Pa protactinium	92 U uranium
89-103 actinoids	104 Rf rutherfordium	105 Db dubnium	106 Sg seaborgium
61 Pm promethium	62 Sm samarium	63 Eu europium	64 Gd gadolinium
65 Tm thulium	66 Dy dysprosium	67 Ho holmium	68 Er erbium
69 Yb ytterbium	70 Lu lutetium	71 Lu lutetium	72 Hf hafnium
89-103 actinoids	88 Ra radium	87 Fr francium	86 Rn radon

The volume of one mole of any gas is 24 dm<sup>3</sup> at room temperature and pressure (r.t.p.).



**FUHUA SECONDARY SCHOOL**  
**Sec 3E Chemistry**  
**End-of-Year Examinations 2019 – Mark Scheme**

**Section A: Multiple Choice Questions [30 marks]**

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

**Section B [40 marks]**

Q	Answer	Ma	Remarks [R: Reject]
B1	1) the base line was drawn in ink which will travel up the chromatogram and affect chromatogram results	1	
a	2) the base line / starting spots are below the solvent line, thus the salt solution samples will dissolve into the water instead of going up the chromatogram.	1	
bi	Aqueous sodium hydroxide or aqueous ammonia	1	
ii	Fe(OH) <sub>3</sub>	1	
ci	Substance B and D	1	
ii	Perform chromatography on mixture using ethanol / propanone as solvent. Results: In ethanol, substance B give R <sub>f</sub> value of 0.62 , D give R <sub>f</sub> value of 0.45 OR In propanone, substance B give R <sub>f</sub> value of 0.84, D give R <sub>f</sub> value of 0.31 [1]	1	
<b>Total</b>		<b>7</b>	<b>marks</b>
B2	No. of moles of barium carbonate = $3.94 / 197 = 0.02$	1	No. of moles
a	No. of moles of hydrochloric acid = $100 / 1000 \times 0.25 = 0.025$ Mole ratio of BaCO <sub>3</sub> : HCl = 1 : 2 0.02 moles of BaCO <sub>3</sub> requires 0.04 mole of HCl, but only 0.025 mole of HCl is given.	1	Reasoning
b	Mole ratio of HCl : CO <sub>2</sub> = 2 : 1 No. of moles of carbon dioxide is 0.0125 Volume of carbon dioxide = $0.0125 \times 24 = 0.3\text{dm}^3$	1	e.c.f. allowed.
<b>Total</b>		<b>5</b>	<b>marks</b>
B3a	Calcium hydroxide	1	
b	Ethanoic acid	1	
ci	Ammonia and nitric acid	1	
ii	HNO <sub>3</sub> + NH <sub>3</sub> → NH <sub>4</sub> NO <sub>3</sub>	1	
di	Titration	1	
ii	Heat the solution to saturation Cool and crystallisation will take place Filter to obtain potassium nitrate crystals as the residue. [;] Wash with cold distilled water [;] Dry between pieces of filter paper. [;]	2	

		<b>Total</b>	<b>7 marks</b>
B4a	Beaker B	1	
b	$\text{Mg(s)} + \text{Cu}^{2+}(\text{aq}) \rightarrow \text{Cu(s)} + \text{Mg}^{2+}(\text{aq})$	1	
c	<p>Pink/brown solid deposited at the bottom of the beaker / forms around magnesium strip</p> <p>Solution changes from blue to colourless / lighten in intensity of blue.</p> <p>Magnesium is more reactive than copper</p> <p>Magnesium displaces copper from its aqueous salt solution [Concentration of <math>\text{Cu}^{2+}</math> ions which causes the blue decreases.]</p>	3	2 points 1 mark Explanation without description or vice versa only yields 1 mark.
d	<p>Magnesium is oxidised as the oxidation state of magnesium increases from 0 in Mg to +2 in <math>\text{Mg}^{2+}</math> OR <math>\text{Mg}(\text{NO}_3)_2</math></p> <p>Copper is reduced as the oxidation state of copper decreases from +2 in <math>\text{Cu}^{2+}</math> OR <math>\text{Cu}(\text{NO}_3)_2</math> to 0 in Cu.</p> <p>Since both oxidation and reduction occurs simultaneously, this is a redox reaction.</p>	1	
e	Aluminium has an impervious/unreactive/inert oxide layer which adheres to its surface and prevents it from further reaction. (OR further contact with the solution)	1	
		<b>Total</b>	<b>8 marks</b>
5ai	Carbon	1	
ii	2,8,1	1	
bi		2	
cii		2	
		<b>Total</b>	<b>6 marks</b>
6ai	Q (low melting and boiling point)	1	
ii	R (don't conduct in solid but in molten)	1	
iii	P (extremely high melting point)	1	
b	Potassium / sodium / lithium	1	
c	<p>Q has a simple molecular structure.</p> <p>The <b>molecules</b> of Q are held loosely via weak intermolecular forces of attraction.</p> <p>R has a giant ionic lattice structure.</p> <p>The <b>oppositely charged ions</b> of R are held by strong electrostatic forces of attraction.</p> <p><b>More energy needs to be taken in to overcome</b> the forces of attraction in R than in Q, resulting in higher melting point.</p>	4	Each point 1 mark Reject: break Reject: intermolecular bond
		<b>Total</b>	<b>5 marks</b>



## Section C [30 marks]

Q	Answer	Mar	Remarks
C1a	Oxides of nitrogen when dissolved in water causes acid rain which corrodes metallic structure / lower pH of water bodies and kill aquatic life.	1	
b	Carbon dioxide. It is <b>not a pollutant</b> , but a greenhouse gas, thus, should not be included in the list of pollutants.	1	
ci	Concentration of nitrogen dioxide increases from 0400hrs to a peak at 0800hrs (of 0.2ppm) before decreasing till 1200hrs. (0.05ppm)	1 1	
ii	Concentration of unburnt hydrocarbon and nitrogen dioxide peak at around 0800 to 1000 hours due to heavy traffic during morning peak hours. These 2 pollutants are emitted from the exhaust of the vehicles. Concentration of ozone peaks/is the highest in the afternoon as the intensity of sunlight is strongest, thus the most UV light to aid in the formation of ozone.	1 1	R: lightning activity.
d	The main source of production is the oil refineries. Burning / combustion of fossil fuels which contains <b>sulfur impurities</b> .	1	R: volcano, coal-fired power stations
ei	Carbon monoxide. Incomplete combustion of fossil fuels / petrol due to insufficient oxygen in oil refineries / vehicles.	1	R: combustion of engine / oxygen (note: engine cannot burn)
ii	Carbon monoxide binds irreversibly with haemoglobin to form carboxyhaemoglobin, reduces the amount of oxygen transported to the vital organs, causing headaches, breathing difficulties and even death.	1	Both parts must be present.
f	In Photosynthesis, <b>plants</b> takes in carbon dioxide and gives out oxygen. $6\text{H}_2\text{O} + 6\text{CO}_2 \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2$ In respiration, <b>living things</b> takes in oxygen and gives out carbon dioxide. $\text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2 \rightarrow 6\text{H}_2\text{O} + 6\text{CO}_2$ Both photosynthesis and respiration are taking place at an <b>equal rate</b> for the past <b>1000 million years</b> .	1 1 1	Equations yield 1 mark max.
<b>Total</b>		<b>11 marks</b>	
C2a	The roasting and smelting required high thermal energy demands such as heating to a high temperature of 700 °C during the roasting of the ores, 1200 °C for the removal of iron(II) oxide impurities and additional heating of copper(II) oxide and oxygen during conversion (list any two) [1] as compared to leaching where no heating is required and the acid is added to the ore at room temperature.[1]		
b	Lesser fossil fuels burnt for leaching compared to roasting and smelting, hence reducing CO <sub>2</sub> produced, a greenhouse gas which leads to reduced effect on global warming OR leaching conserves limited / non-renewable resources such as fossil fuels. OR leaching made used of scrap iron, which is otherwise thrown to landfills, resulting in less land pollution while roasting and smelting produced more waste which will go into the landfills, causing more land pollution OR For leaching, no SO <sub>2</sub> gas is produced, an air pollutant which causes acid rain, unlike roasting and smelting.	2	Any 2 Reject: Less steps (almost the same)

c	No. Zinc is more reactive than iron [1] and will displace iron from the aqueous solution as well. [1] Copper obtained would be contaminated with iron.	2	A: comparison to copper for max 1 mark.
d	Both the <b>copper</b> and galvanised steel (i.e. <b>zinc</b> layer) act as a <b>protective layer</b> by preventing <b>oxygen and water</b> in the air from coming into contact with the steel. Zinc is <b>more reactive</b> than iron in steel. Hence, zinc can act as a <b>sacrificial metal</b> and <b>corrode in place</b> of steel. Copper is <b>less reactive</b> than iron in steel. Hence, if the steel is exposed, iron will <b>corrode/oxidises preferentially</b> over copper.	4	2 point 1 mark
<b>Total</b>		10 marks	
C3a	Reddish-brown liquid	1	
b	80 – 120	1	
c	Group I melting decreases down the group while group VII melting increases down the group.	1	
d	Chlorine and sodium both has <b>3 occupied</b> electron shells., thus they are in period 3 But chlorine and bromine have <b>7 valence electron</b> , thus they are in group VII.	1 1	
e	Solution changes from colourless to reddish-brown.	1	
fi	No of moles of chlorine atoms = $14.2 / 35.5 = 0.4$ Mole ratio of X:Cl = 0.2 : 0.4 Empirical formula is $XCl_2$	1 1	
ii	Not possible. Sodium forms a chloride with a formula of NaCl and not $NaCl_2$ .	1	
<b>Total</b>		9 marks	