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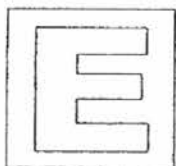
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GAN ENG SENG SCHOOL
End-of-Year Examination 2016



**CANDIDATE
NAME**

CLASS

**INDEX
NUMBER**

CHEMISTRY

Paper 1 Multiple Choice

5073/01

13 Oct 2016
1 hour

Sec 3 Express

Additional Materials: OTAS

Calculators are allowed in the examination

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.

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

Write your name, class and index number on the OTAS.

There are forty questions in 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.

Read the instructions on the OTAS very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.

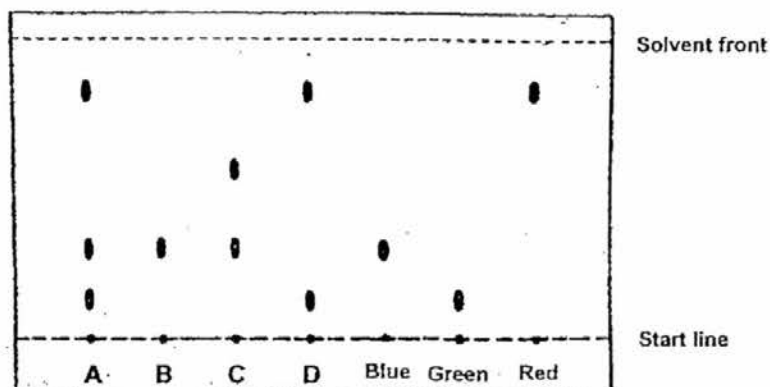
Any rough working should be done in this booklet.

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

Total Marks
40

- 1 The diagram below shows a chromatogram obtained using solution of three single dyes (blue, green and red) and four other solutions (A, B, C and D).

Which of the solutions contains a dye other than blue, green and red?



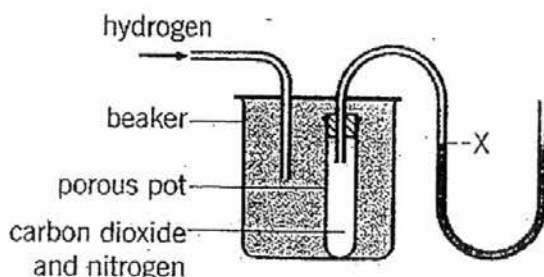
- 2 Five students each dissolved an ingestion tablet in 100 cm³ of water. They then each titrated 25.0 cm³ of their solutions in conical flasks with dilute hydrochloric acid, using the same indicator. The titration results are shown in the table below.

Student	P	Q	R	S	T
Titration value / cm ³	20.4	20.5	20.4	20.6	22.1

Which statement could explain the result obtained by Student T?

- A The burette was rinsed with hydrochloric acid.
 - B The conical flask was rinsed with hydrochloric acid.
 - C The pipette was rinsed with the tablet solution.
 - D The conical flask was rinsed with the tablet solution.
- 3 If a 10 cm³ pipette was not available, which of the following procedures would you use to measure a 10 cm³ portion of a solution in order to carry out accurate titration?
- A Measure 10 cm³ using a measuring cylinder.
 - B Measure 10 cm³ using a burette.
 - C Use a 20 cm³ pipette and divide the measure solution into two equal parts.
 - D Weigh 10 g of the solution.

- 4 A student set up the following experiment to demonstrate the diffusion of gases. The gas in the porous pot is a mixture of nitrogen and carbon dioxide. The beaker is filled with hydrogen.



What would he expect to observe for the water level at X over time?

- A The water level at X will remain unchanged.
 - B The water level at X will rise and then return to its original position after some time.
 - C The water level at X will drop and then return to its original position after some time.
 - D The water level at X will drop and remain there.
- 5 A sample of iodine crystals was heated at room temperature in the laboratory.
- In terms of behaviour of particles, which of the following will occur?
- A The forces of attraction between the particles increase.
 - B The particles begin to move rapidly and in random directions.
 - C The particles begin to slide past one another.
 - D The particles get denser.

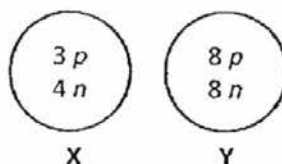
- 6 The table below shows the boiling points of some gases that are present in a sample of liquefied air.

Gas	Molar Mass / g	Boiling Point / °C
Nitrogen	28	-196
Oxygen	32	-182
Krypton	36	-153
Xenon	54	-108

When this sample of liquefied air undergoes fractional distillation, which gas will most likely be the last component to be collected as a distillate?

- A Nitrogen
- B Oxygen
- C Krypton
- D Xenon

- 7 The diagram below illustrates the structures of the atoms of 2 elements X and Y.



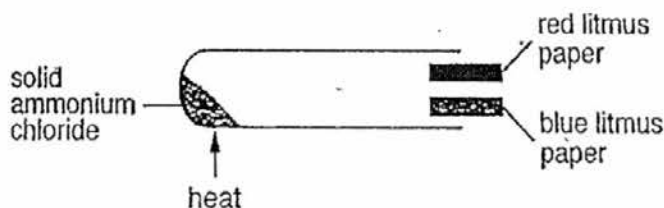
When these two elements combine to form a compound, the mass of 1 mol of the compounds formed is

- A 11 g
 B 14 g
 C 23 g
 D 30 g
- 8 The table below shows information about two particles D and E.

	Neutrons	Protons	Electronic Configuration
D	18	16	2,8,8
E	18	17	2,8,8

What are the identities of D and E?

- A Anions of different elements
 B Atoms of noble gases
 C Cations of the same element
 D Isotopes of the same element
- 9 A student heated some solid ammonium chloride, NH_4Cl , in a test tube and two gases, one of which is ammonia, were produced. The gas were tested with moist litmus paper using the set-up shown below.



Which of the following best describes the colour change of the moist litmus papers?

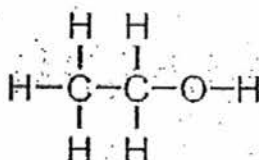
- A The red litmus paper turned blue and no further change was observed.
 B The red litmus paper turned blue first. After a while both pieces of litmus papers turned red.
 C The blue litmus paper turned red and no further change was observed.
 D The blue litmus paper turned red first. After a while both pieces of litmus papers turned blue.

- 10 Three particles X, Y, Z have the atomic composition shown in the table below.

Particles	No. of electron	No. of protons	Nucleon number
X	18	19	39
Y	19	19	39
Z	19	19	40

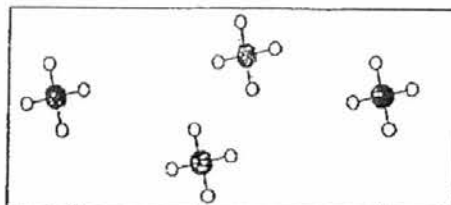
Which of the following statements is **not** correct?

- A Particle Y and particle Z are isotopes.
 - B Particle Y gives away an electron to form particle X.
 - C Particle Y is chemically more reactive than X.
 - D Particle Z can form ionic compounds with particles X and Y.
- 11 One molecule of ethanol can be represented using the diagram shown below.



What is the total number of unshared electrons in the ethanol molecule?

- A 2
 - B 4
 - C 8
 - D 16
- 12 The diagram represents the arrangement of atoms in a pure substance with chemical formula of DE_4 .



The substance is likely to

- A be soluble in water.
- B conduct electricity in the molten state.
- C possess high melting point and boiling point.
- D possess weak Van der Waal's forces of attraction between molecules.

- 13 The oxide of an element has a macromolecular structure.

Which of the following is true about the element or the oxide?

- A The chloride of the element is a covalent compound.
- B The element is in Group II.
- C The oxide is a conductor of electricity when dissolved in water.
- D The oxide is in liquid state at room temperature and pressure.

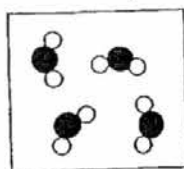
- 14 Osmium is a transition metal with the chemical symbol Os.

Which of the following is the correct formula of osmium(IV) oxide?

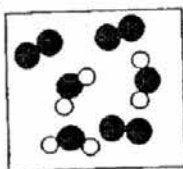
- A Os_2O
- B OsO_2
- C Os_4O
- D OsO_4

- 15 20 cm^3 of hydrogen is mixed with 20 cm^3 of oxygen in a reaction vessel at room temperature and pressure. This mixture is then burnt.

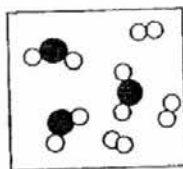
Which of the following diagrams represents the particles that remain in the reaction vessel?



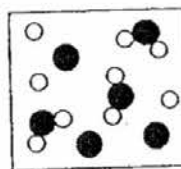
A



B

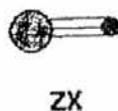
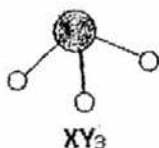


C



D

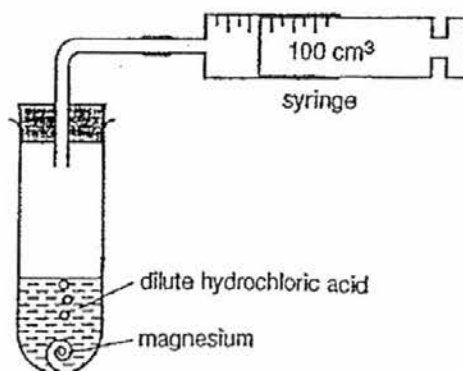
- 16 The model and formula for some molecules involving atoms of elements X, Y and Z are shown below.



Which of the following is the correct formula for a molecule of the compound formed between Y and Z?

- A YZ
- B ZY_3
- C ZY
- D YZ_3

- 17 An excess of aqueous hydrochloric acid is added to 0.10 mol of magnesium in the experimental set-up shown below.



Why is it impossible to measure the total volume of hydrogen produced in this experiment?

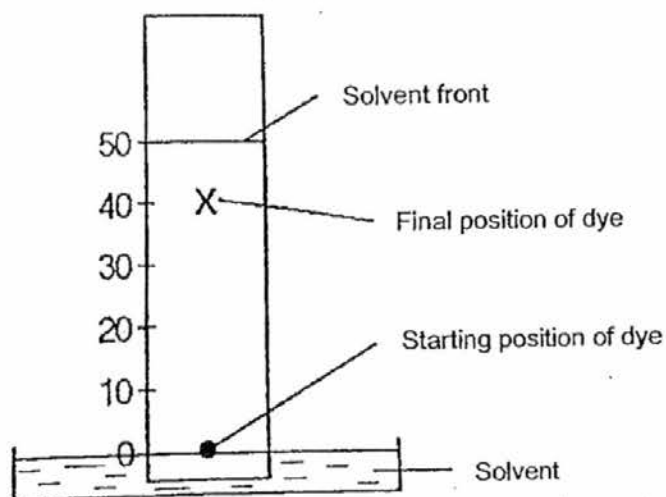
- A Air is present in the tube at the start.
 - B Hydrogen is less dense than air.
 - C Hydrogen is very soluble in hydrochloric acid.
 - D The total volume of hydrogen produced is greater than 100 cm³.
- 18 To reduce atmospheric pollution, the waste gases from a coal-burning power station are passed through powdered calcium carbonate.

Which waste gas will **not** be removed by the powdered calcium carbonate?

- A Carbon monoxide
 - B Nitrogen dioxide
 - C Phosphorous(V) oxide
 - D Sulfur dioxide
- 19 Which of the following equations suggests that a metal oxide, **MO**, exhibits some acidic properties in certain reactions?

- A $\text{MO(s)} + 2\text{H}^+(\text{aq}) \rightarrow \text{M}^{2+}(\text{aq}) + \text{H}_2\text{O(l)}$
- B $\text{MO(s)} + 2\text{OH}^-(\text{aq}) \rightarrow \text{MO}_2^{2-}(\text{aq}) + \text{H}_2\text{O(l)}$
- C $\text{MO(s)} + \text{H}_2\text{O(l)} \rightarrow \text{M}^{2+}(\text{aq}) + 2\text{OH}^-(\text{aq})$
- D $\text{MO(s)} + \text{NH}_4^+(\text{aq}) \rightarrow \text{M}^{2+}(\text{aq}) + \text{H}_2\text{O(l)} + \text{NH}_3(\text{g})$

- 20 The diagram represents the chromatogram for a dye.



Which fraction correctly shows the R_f value for the dye?

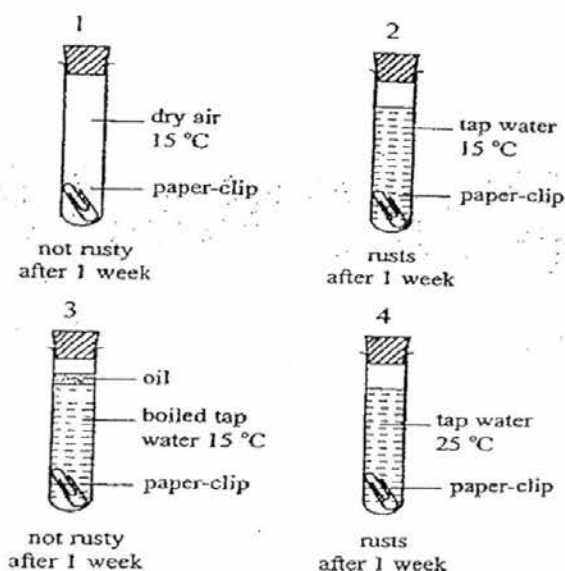
- A $\frac{1}{5}$
- B $\frac{4}{5}$
- C $\frac{5}{4}$
- D $\frac{5}{1}$
- 21 Which compound **cannot** be used to prepare iron(III) sulfate by reacting with sulfuric acid?
- A Iron(III) carbonate
- B Iron(III) chloride
- C Iron(III) hydroxide
- D Iron(III) oxide
- 22 A piece of zinc ribbon does not react when placed in a dilute solution of hydrogen chloride in ethanol. Which of the following changes will cause a reaction when carried out?
- A Adding water and stirring the mixture.
- B Cleaning the zinc ribbon with sand paper before reaction.
- C Saturating the solution by bubbling more hydrogen chloride gas.
- D Using zinc powder instead of ribbon.

- 23 Caesium is an element found in Group I of the Periodic Table.

Which of the following statements is true about the carbonate of caesium?

- A The carbonate has relatively low melting and boiling points.
- B The carbonate is the least stable to heat among all Group I carbonates.
- C The carbonate is very soluble in water.
- D The carbonate will undergo thermal decomposition to form more than two products.

- 24 Four experiments on rusting are shown below.



Which pair of experiments can be used to show that air is needed for iron to rust?

- A 1 and 3
- B 1 and 4
- C 2 and 3
- D 2 and 4

- 25 Selenium, Se, is in the same group of the Periodic Table as sulfur, S.

What is the formula of sodium selenide?

- A Na_2Se
- B NaSeO_4
- C Na_2SeO_3
- D Na_2SeO_4

- 26 An unclassified metal **M** has high density and a high melting point. Two chlorides formed by metal **M** includes **MCl** and **MCl₂**.
- Which of the following classification will **M** most likely belong to?
- A It is a Group II metal.
 - B It is a Group III metal
 - C It is a transition metal.
 - D It is an alkali metal.
- 27 What is the number of atoms present in 500 cm³ of nitrogen gas at room temperature and pressure?
- A 1.25×10^{22}
 - B 1.34×10^{22}
 - C 2.50×10^{22}
 - D 2.78×10^{22}
- 28 Which of the following statements about the halogens is correct?
- A The reactivity of halogens increases down the group.
 - B They dissolve in water to form colourless solutions.
 - C They exist as molecules having a pair of atoms.
 - D They form negative ions by losing one electron.
- 29 Metal **P** reacts rapidly with cold water but Metal **Q** only reacts with steam.
- Which of the following statements is **not** correct?
- A The carbonates of **P** requires a lower temperature to decompose than that of **Q**.
 - B The extraction of **P** uses electricity while **Q** is extracted by a reduction process.
 - C **P** can displace **Q** from a solution containing ions of **Q**.
 - D No reaction can be observed when the oxide of **P** is strongly heated with **Q**.
- 30 Which of the following statements about kinetic particle theory is **not** true?
- A The particles of a solid have very strong forces of attraction between them.
 - B The particles of a solid have more energy than those of a gas.
 - C The particles of a gas move faster than those of a liquid.
 - D The particles that make up matter are in constant motion.

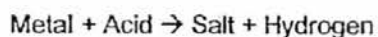
- 31 Pure and dry calcium sulfate can be prepared from a sample of pure calcium oxide in the process shown below.

..... → Filter the mixture → Wash with distilled water → Dry between filter paper

Which of the following steps is the most suitable for the above missing step?

- A Addition of aqueous sodium sulfate to calcium oxide.
- B Addition of barium sulfate and nitric acid to calcium oxide.
- C Addition of dilute nitric acid followed by dilute sulfuric acid.
- D Addition of dilute sulfuric acid to calcium oxide.

- 32 One method of preparing salts is shown in the reaction below.



Which of the following salts **cannot** be prepared by the following method?

- A Copper(II) chloride
- B Iron(II) chloride
- C Magnesium sulfate
- D Zinc sulfate

- 33 Ammonium salts will produce ammonia gas on heating with a solution of sodium hydroxide.

Which of the following sample of ammonium salt will produce the greatest volume of ammonia measured at room temperature and pressure?

- A 0.5 mol of $(\text{NH}_4)_3\text{PO}_4$
- B 0.5 mol of $(\text{NH}_4)_2\text{SO}_4$
- C 1.0 mol NH_4Cl
- D 1.0 mol NH_4NO_3

- 34 The table below shows some information of three different substances.

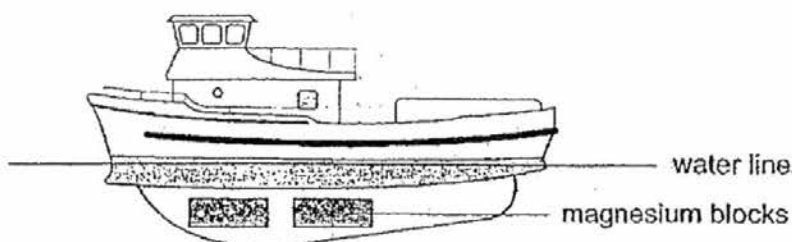
Substance	Stability to heating	Solubility in water	Solubility in alcohol
S	stable	insoluble	insoluble
T	stable	insoluble	soluble
U	not stable	soluble	insoluble

The following steps may be suitable to separate substance **U** from a mixture of these three substances.

- 1 Filtration
- 2 Dissolving in water
- 3 Dissolving in alcohol
- 4 Evaporation to dryness
- 5 Crystallisation

Which of the following order of steps shows the correct process of separating **U**?

- A 2, 1, 5
 B 3, 1, 4
 C 2, 3, 1, 5
 D 3, 1, 2, 4
- 35 Most boats are built with a body that consists of a high percentage of iron. Some magnesium blocks are attached to the hull below the water line to prevent the iron from rusting as shown in the diagram below.



Which statement explains why magnesium stops the iron from rusting?

- A Magnesium forms an alloy with iron.
 B Magnesium forms its ions more readily than iron.
 C Magnesium prevents oxygen in the water from reacting with iron.
 D Magnesium protects iron by forming a protective layer of magnesium oxide.

- 36 Which statement about the production of iron from iron(III) oxide in a blast furnace is correct?

- A Iron is obtained using carbon monoxide as the oxidising agent.
- B Iron(III) oxide is reduced by carbon dioxide.
- C Limestone is used to remove basic impurities.
- D Waste gases that exit the blast furnace includes nitrogen gas.

- 37 The table shows four elements, W, X, Y and Z with their atomic numbers.

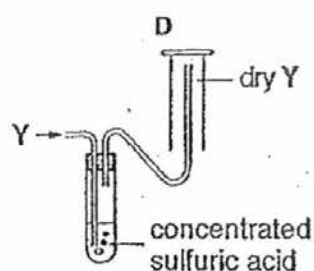
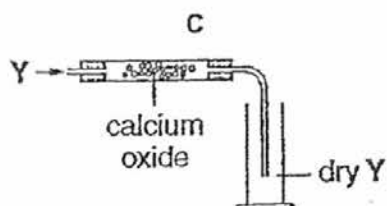
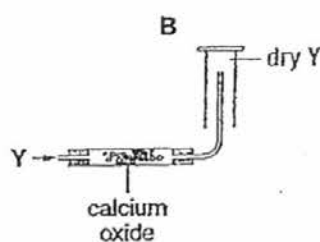
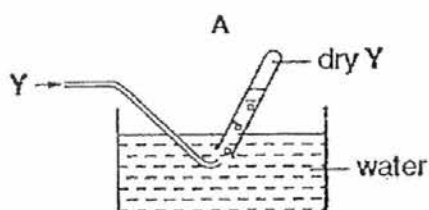
Elements	W	X	Y	Z
Atomic number	6	8	11	17

Which of the following shows the likely formula of the compounds formed from the four elements above?

	Compound with a giant lattice structure	A compound with a simple molecular structure
A	Y_2X	WX_2
B	WX	YZ
C	YW	WZ_4
D	YZ	ZW

- 38 A gas, Y, is less dense than air, very soluble in water and is alkaline.

Which of the following method can be used to collect a dry sample of the gas?



- 39 Substance **D** has chemical formula of $\text{NaAlSi}_3\text{O}_8$ while substance **E** has chemical formula of $\text{CaAl}_2\text{Si}_2\text{O}_8$. A student made three statements about these substances.

- I. **D** and **E** contain the same percentage by mass of oxygen.
- II. **D** and **E** contain different number of ions in 1 mole of substance.
- III. **D** contains approximately 1.6 times as much silicon by mass as **E**.

Which of the above statements are true?

- A I only
- B III only
- C I and II
- D II and III.

- 40 8 g of X_2O_3 , an oxide of element **X**, contains 5.6 g of **X**.

How many moles of **X** does 5.6 g of the element contain?

- A $\frac{2.4}{16} \times \frac{2}{3}$
- B $\frac{2.4}{16} \times \frac{3}{2}$
- C $\frac{8}{16} \times \frac{2}{3}$
- D $\frac{8}{16} \times \frac{3}{2}$

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	127 I Iodine 53	131 Xe Xenon 54	
133 Cs Caesium 55	137 Ba Barium 56	139 La Lanthanum 57	178 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	210 Po Polonium 84	222 Rn Radon 86	
Fr Francium 87	Ra Radium 88																

225 Fr Francium 87	227 Ac Actinium 89
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58-71 Lanthanoid series,
90-103 Actinoid series

140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	150 Sm Samarium 62	152 Eu Europium 63	157 Gd Gadolinium 64	159 Tb Terbium 65	162 Dy Dysprosium 66	165 Ho Holmium 67	167 Er Erbium 68	189 Tm Thulium 69	173 Yb Ytterbium 70	175 Lu Lutetium 71	
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

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

aXb
Key

The volume of one mole of any gas is 24dm³ at room temperature and pressure (r.t.p.).

a

X

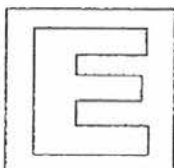
b

a = relative atomic mass

X = atomic symbol

b = proton (atomic) number

*58-71 Lanthanoid series,
†90-103 Actinoid series



GAN ENG SENG SCHOOL
End-of-Year Examination 2016



CANDIDATE
NAME

CLASS

INDEX
NUMBER

CHEMISTRY

Paper 2

5073/02

10 Oct 2016

1 hour 45 minutes

Sec 3 Express

Candidates answer on the Question Paper.

Calculators are allowed in the examination.

READ THESE INSTRUCTIONS FIRST

Write your class, index number and name on all the work you hand in.
Write in dark blue or black pen on both sides of the paper.
You may use a soft pencil for any diagrams or graphs.
Do not use staples, paper clips, highlighters, glue or correction fluid/tape.

Section A

Answer all questions.

Section B

Answer all questions. Question 10 has a choice of parts to answer.

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

A copy of the Periodic Table is found on page 18.

For Examiner's Use	
Section A	50
Section B	30
Total	80

Section A [50 marks]

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

For Examiner's use

- A1** Use the chemical symbols in the following list of substances to answer the questions. Each substance may be used once, more than once, or none at all.

Al	Ar	Br ₂	CaCO ₃	CO
CO ₂	He	Mg	S ₈	ZnO

- a** Which substance(s) is/are in liquid state at room temperature?

_____ [1]

- b** Which substance(s) can be used as a rust prevention method?

_____ [1]

- c** Which element has a valency of 3?

_____ [1]

- d** Which substance(s) is/are formed by the thermal decomposition of limestone?

_____ [1]

- e** Which substance(s) is/are used in light bulbs?

_____ [1]

- f** Which substance(s) contains more than one type of bonding?

_____ [1]

- g** Construct a chemical equation that shows a reduction reaction. Your reactants must be from the list above.

_____ [2]

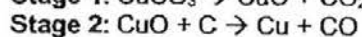
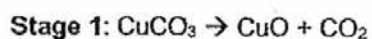
[Total: 8]

A2 Copper is a transition element that is mainly used for electrical wiring and motors.

- a** State two physical properties of copper that are different from lithium.

[1]

- b** Copper can be extracted from copper(II) carbonate in a two-stage process.



- i** State the condition for Stage 1 to take place.

[1]

- ii** Explain why potassium cannot be extracted from potassium carbonate by using the same process.

[2]

- c** State the formula of the following copper compounds.

- i** Copper(I) sulfide

[1]

- ii** Copper(II) nitrate

[1]

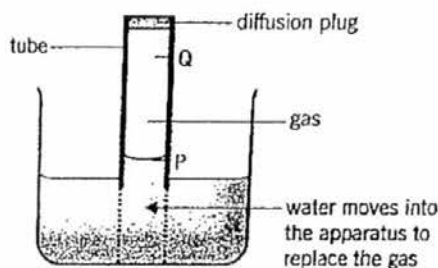
- d** In the space below, draw the dot-and-cross diagram of lithium oxide, showing only the valence electrons.

[2]

[Total: 8]

- A3** An experiment set-up shown below was used to investigate the rate of diffusion of different gases at room temperature and pressure. The rate of diffusion is determined by the time taken for the water level to rise from P to Q as the gases diffuses out of the diffusion plug.

For Examiner's use



The table below shows the results when different gases were placed in the tube.

Gas	Molecular formula	Time for water to rise from P to Q / s
Carbon dioxide	CO ₂	330
Oxygen	O ₂	220
Nitrogen	N ₂	180

- a** State the difference in time taken for water to rise between carbon dioxide and nitrogen. Explain your answer.

[3]

- b** Some ice cubes were added to the experiment with oxygen gas.

Predict whether the time taken for the water level to rise will increase, decrease or stay the same. Explain your answer.

[2]

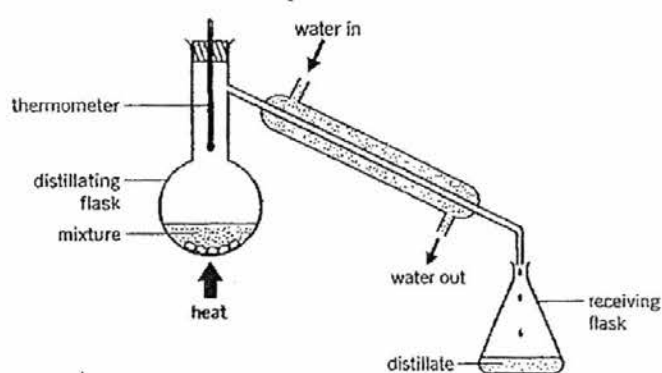
- c** Describe what will be observed when ammonia gas is being used in the above experiment. Explain your answer.

[2]

[Total: 7]

- A4** Gary carried out a separation of a mixture using the experimental set-up shown below.

For Examiner's use



- a** State **one** modification needed in this set-up and explain how it affects the results of the experiment process.

[2]

- b** The mixture to be separated contains Substances **R** and **S**. The table below shows the respective melting and boiling points of Substances **R** and **S**.

Substance	Melting point / °C	Boiling point / °C
R	-50	35
S	125	203

- i** Explain why it is not possible to collect Substance **R** as a distillate using this method.

[1]

- ii** State a modification that can be made in order for Substance **R** to be collected as a distillate.

[1]

[Total: 4 marks]

A5 De-scalers are chemicals that can be used to remove the scale, usually calcium carbonate, that are found on kettles. They are weak acids which include phosphoric acid (H_3PO_4) and methanoic acid (HCOOH).

- a** State what is meant by the term "weak acid".

[1]

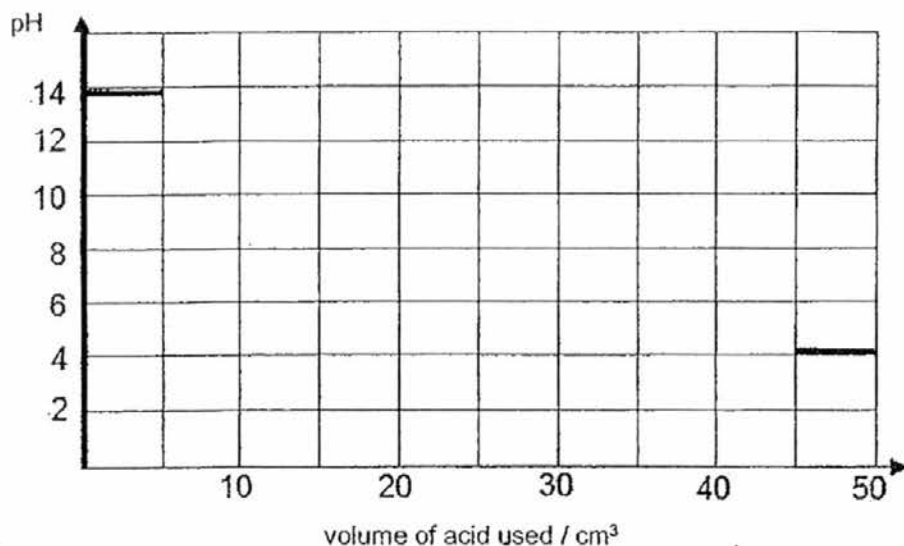
- b** Write the chemical equation to show the reaction between phosphoric acid and calcium carbonate.

[1]

- c** Suggest why acids such as sulfuric acid and nitric acid are not used in the manufacture of de-scalers.

[2]

- d** Methanoic acid is a monobasic acid. Some volume of 0.1 mol/dm^3 of methanoic acid was titrated against 25 cm^3 of 0.1 mol/dm^3 of aqueous sodium hydroxide in an experiment. Part of the pH curve of this experiment is shown below.



Complete the pH curve for the titration in the diagram above.

[2]

[Total: 6]

A6 The table below shows some information about elements, W, X, Y and Z.

For Examiner's use

Element	Proton Number
W	10
X	11
Y	16
Z	20

- a State, with a reason, which of the above elements forms an oxide that will cause a gas to be evolved when reacted with aqueous sodium carbonate.

[2]

- b i State the electronic configuration of Element X:

[1]

- ii In the space below, draw the ion formed by Element X, showing all the electrons in the ion.

[1]

- iii Describe what would be observed when a small piece of Element X is added to water.

[2]

- c Another element, **P** is in the same group in the Periodic Table as Element **Z**. It is found to be a more reactive element than Element **Z**.

For Examiner's use

- i Suggest why Element **P** would be more reactive than Element **Z**.

[2]

- ii Predict the electrical conductivity of the oxide of Element **P**.

[1]

[Total: 9 marks]

- A7 Information on four metals and some of their compounds are shown in the table below.

Metal	Action of dilute H_2SO_4 on metal	Effect of hydrogen on heated oxide of metal	Action of metal on chloride solution of V
S	Hydrogen formed	Reduced	No visible reaction
T	No visible reaction	Reduced	No visible reaction
U	No visible reaction	No visible reaction	V metal formed
V	Hydrogen formed	No visible reaction	No visible reaction

- a Arrange the metals in order of increasing reactivity.

[1]

- b Effervescence was observed when Metal **U** was added to a dilute solution of hydrochloric acid.

- i Suggest the identity of Metal **U**.

[1]

- ii Explain your answer in b(i).

[2]

- c i A compound of Metal V consists of 72.2% Metal V and 27.8% nitrogen by mass. Given that the relative atomic mass of Metal V is 24, determine the empirical formula of the compound, giving your answer using the letter V.

[2]

For Examiner's use

- ii If the relative formula mass of this compound is 300, determine the molecular formula of this compound.

[2]

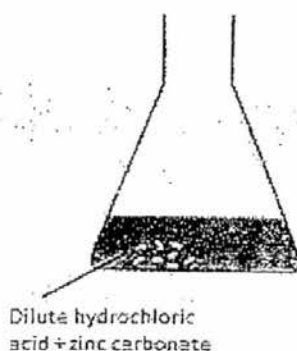
[Total: 8 marks]

SECTION B [30 marks]

For Examiner's use

Answer all **three** questions from this section.The last question is in the form either/ or and only **one** of the alternatives should be attempted.

- B8** Susie conducted an experiment where equal masses of zinc carbonate powder were added separately to acids of varying volume and concentration. Ethanoic acid is a weak monobasic acid. The incomplete set-up is shown below together with results from the experiment.



Experiment	Type of acid	Concentration of acid used / mol/dm ³
A	Dilute nitric acid	0.800
B	Dilute sulfuric acid	0.800
C	Dilute ethanoic acid	0.800

No more zinc carbonate powder was observed for all the beakers at the end of the experiment. The volume of gas evolved from each experiment was collected and measured.

- a** Complete the diagram above to depict the set-up that Susie could possibly have used for this experiment.

[1]

- b** Susie observed that the zinc carbonate in experiment **B** disappeared at a faster rate than that in experiment **A**. Suggest a reason for her observation.

[2]

- c Predict whether the volume of gas collected in Experiment C will be more than, equal to or less than that collected in Experiment A. Explain your answer.

[1]

- d Describe a test that can be used to confirm the identity of the gas produced.

[1]

- e Some zinc carbonate powder were strongly heated by Susie in a test-tube and he observed that the white residue produced was able to neutralise some sodium hydroxide solution when they were added to it. He concluded that the white residue was acidic in nature.

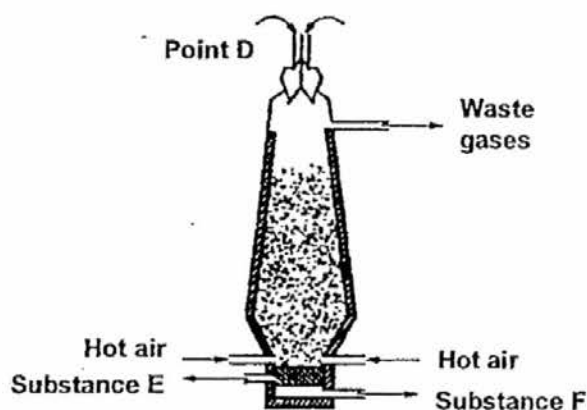
Explain whether his conclusion is correct.

[3]

[Total: 8]

- B9** Iron is industrially extracted in the blast furnace. Some raw materials are added in from Point **D** and hot air is blasted from the bottom of the furnace.

For Examiner's use



- a** Using suitable chemical equations, explain the purpose of adding coke at Point **D** into the furnace.

[2]

- b** The two products from this furnace are Substances **E** and **F**, found at the bottom of the furnace.

- i** State the raw material required for the formation of Substance **E**.

[1]

- ii** Explain how this raw material helps in the formation of both substances **E** and **F** in the blast furnace.

[3]

- c One method to prevent corrosion of iron is to convert it into stainless steel. Cast iron formed in the blast furnace is the starting material for the manufacture of stainless steel.

For Examiner's use

- i Describe how cast iron can be further processed to form alloys.

[2]

- ii Iron ore containing 58.5% iron(III) oxide was added into a blast furnace in the manufacture of a certain stainless steel that contains 83.5% iron.

Calculate the mass of iron ore that is required to manufacture 1 tonne of this stainless steel.

[4]

[1 tonne = 1.00×10^6 g]

[Total: 12]

EITHER

B10 The element chlorine is found in Group VII and is one of the halogen that is more commonly used in industrial applications. Two such applications are shown below.

a Phosphorus trichloride, PCl_3 , is a liquid that is widely used as one of the starting materials in the manufacture of insecticides and flame retardants. It can be prepared by passing pure dry chlorine gas over heated phosphorus powder, P_4 .

- i** Write a chemical equation, including state symbols, for the reaction between phosphorus and chlorine.

[2]

- ii** State the term used to describe a molecule of chlorine.

[1]

- iii** Draw a "dot-and-cross" diagram to show the arrangement of valence shell electrons in a molecule of phosphorus trichloride.

[2]

b Chlorine is found in most common bleaches in the form of sodium hypochlorite, NaClO . Bleach containing sodium hypochlorite can be neutralized by aqueous sodium thiosulfate, $\text{Na}_2\text{S}_2\text{O}_3$, shown in the equation below.



1.00 dm³ of a solution of sodium thiosulfate contains 12.4 g of $\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$.

- i** Calculate the molar concentration of the sodium thiosulfate solution.

[2]

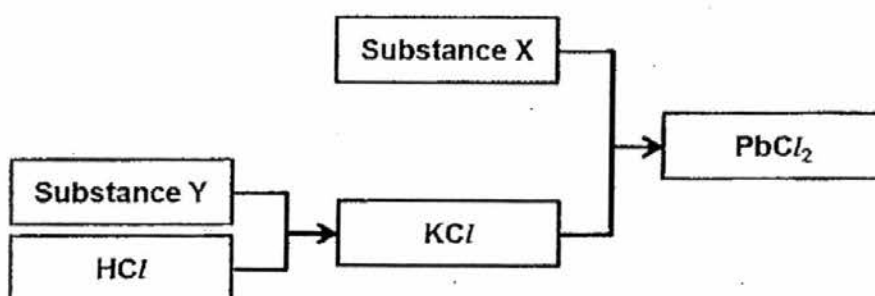
- ii 236 cm³ of this sodium thiosulfate solution and 125 cm³ of 0.1 mol/dm³ of sodium hydroxide solution were reacted with excess bleach to produce 0.52 g of sodium sulfate. Calculate the percentage yield of this reaction. [3]

For Examiner's use

[Total: 10]

OR

- B10** Lead(II) chloride occurs naturally as white crystals and are used in the manufacture of ceramics. It can be prepared in the laboratory as shown in the flow diagram below.



- a** Suggest the identities of Substances X and Y.

[2]

- b** Construct the ionic equation for the formation of lead(II) chloride.

[1]

- c** Describe the procedure used for the preparation of pure, dry lead(II) chloride crystals in the laboratory using Substance X and potassium chloride.

[3]

- d Discuss whether a sample of lead(II) chloride can be prepared with lead metal and copper(II) chloride solution as the reactants.

[2]

- e In an experiment, 200 cm^3 of 2 mol/dm^3 of potassium chloride was reacted with 450 dm^3 of 1 mol/dm^3 of Substance X. Calculate the mass of lead(II) chloride formed at the end of the reaction.

[2]

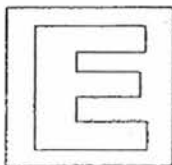
[Total: 10]

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

a **X**

Key

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



GAN ENG SENG SCHOOL
End-of-Year Examination 2016



**CANDIDATE
NAME**

CLASS

**INDEX
NUMBER**

CHEMISTRY

Paper 1 - Multiple Choice

5073/01

13 Oct 2016

1 hour

Sec 3 Express

Additional Materials: OTAS

Calculators are allowed in the examination

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.

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

Write your name, class and index number on the OTAS.

There are forty questions in 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.

Read the instructions on the OTAS very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.

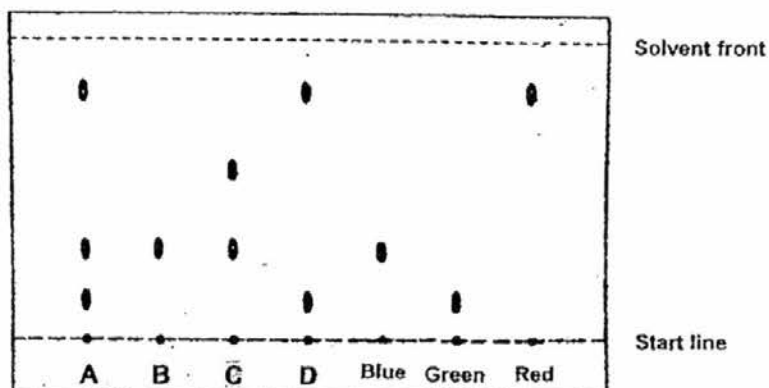
Any rough working should be done in this booklet.

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

Total Marks
40

- 1 The diagram below shows a chromatogram obtained using solution of three single dyes (blue, green and red) and four other solutions (A, B, C and D).

Which of the solutions contains a dye other than blue, green and red?



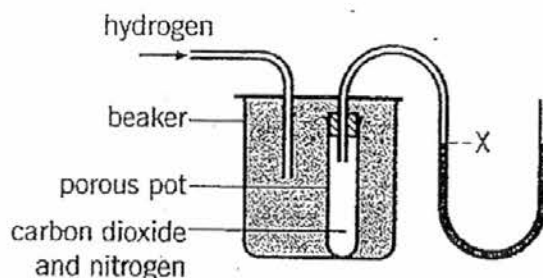
- 2 Five students each dissolved an ingestion tablet in 100 cm³ of water. They then each titrated 25.0 cm³ of their solutions in conical flasks with dilute hydrochloric acid, using the same indicator. The titration results are shown in the table below.

Student	P	Q	R	S	T
Titration value / cm ³	20.4	20.5	20.4	20.6	22.1

Which statement could explain the result obtained by Student T?

- A The burette was rinsed with hydrochloric acid.
 B The conical flask was rinsed with hydrochloric acid.
 C The pipette was rinsed with the tablet solution.
 D The conical flask was rinsed with the tablet solution.
- 3 If a 10 cm³ pipette was not available, which of the following procedures would you use to measure a 10 cm³ portion of a solution in order to carry out accurate titration?
- A Measure 10 cm³ using a measuring cylinder.
 B Measure 10 cm³ using a burette.
 C Use a 20 cm³ pipette and divide the measure solution into two equal parts.
 D Weigh 10 g of the solution.

- 4 A student set up the following experiment to demonstrate the diffusion of gases. The gas in the porous pot is a mixture of nitrogen and carbon dioxide. The beaker is filled with hydrogen.



What would he expect to observe for the water level at X over time?

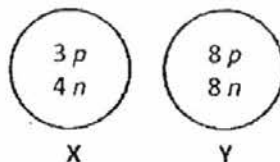
- A The water level at X will remain unchanged.
 B The water level at X will rise and then return to its original position after some time.
 C The water level at X will drop and then return to its original position after some time.
 D The water level at X will drop and remain there.
- 5 A sample of iodine crystals was heated at room temperature in the laboratory.
- In terms of behaviour of particles, which of the following will occur?
- A The forces of attraction between the particles increase.
 B The particles begin to move rapidly and in random directions.
 C The particles begin to slide past one another.
 D The particles get denser.
- 6 The table below shows the boiling points of some gases that are present in a sample of liquefied air.

Gas	Molar Mass / g	Boiling Point / °C
Nitrogen	28	-196
Oxygen	32	-182
Krypton	36	-153
Xenon	54	-108

When this sample of liquefied air undergoes fractional distillation, which gas will most likely be the last component to be collected as a distillate?

- A Nitrogen
 B Oxygen
 C Krypton
 D Xenon

- 7 The diagram below illustrates the structures of the atoms of 2 elements X and Y.



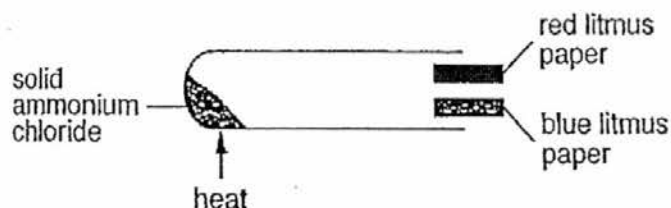
When these two elements combine to form a compound, the mass of 1 mol of the compounds formed is

- A** 11 g
B 14 g
C 23 g
D 30 g
- 8 The table below shows information about two particles D and E.

	Neutrons	Protons	Electronic Configuration
D	18	16	2,8,8
E	18	17	2,8,8

What are the identities of D and E?

- A** Anions of different elements
B Atoms of noble gases
C Cations of the same element
D Isotopes of the same element
- 9 A student heated some solid ammonium chloride, NH_4Cl , in a test tube and two gases, one of which is ammonia, were produced. The gas were tested with moist litmus paper using the set-up shown below.



Which of the following best describes the colour change of the moist litmus papers?

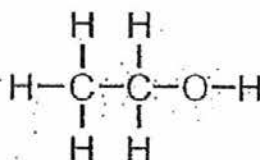
- A** The red litmus paper turned blue and no further change was observed.
B The red litmus paper turned blue first. After a while both pieces of litmus papers turned red.
C The blue litmus paper turned red and no further change was observed.
D The blue litmus paper turned red first. After a while both pieces of litmus papers turned blue.

- 10 Three particles X, Y, Z have the atomic composition shown in the table below.

Particles	No. of electron	No. of protons	Nucleon number
X	18	19	39
Y	19	19	39
Z	19	19	40

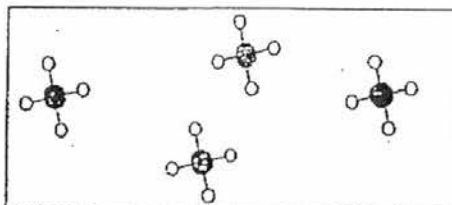
Which of the following statements is **not** correct?

- A Particle Y and particle Z are isotopes.
 B Particle Y gives away an electron to form particle X.
 C Particle Y is chemically more reactive than X.
 D Particle Z can form ionic compounds with particles X and Y.
- 11 One molecule of ethanol can be represented using the diagram shown below.



What is the total number of unshared electrons in the ethanol molecule?

- A 2
 B 4
 C 8
 D 16
- 12 The diagram represents the arrangement of atoms in a pure substance with chemical formula of DE_4 .



The substance is likely to

- A be soluble in water.
 B conduct electricity in the molten state.
 C possess high melting point and boiling point.
 D possess weak Van der Waal's forces of attraction between molecules.

- 13 The oxide of an element has a macromolecular structure.

Which of the following is true about the element or the oxide?

- A The chloride of the element is a covalent compound.
- B The element is in Group II.
- C The oxide is a conductor of electricity when dissolved in water.
- D The oxide is in liquid state at room temperature and pressure.

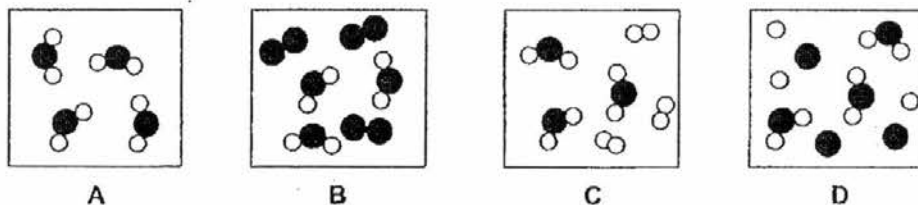
- 14 Osmium is a transition metal with the chemical symbol Os.

Which of the following is the correct formula of osmium(IV) oxide?

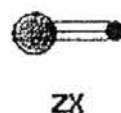
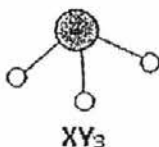
- A Os_2O
- B OsO_2
- C Os_4O
- D OsO_4

- 15 20 cm^3 of hydrogen is mixed with 20 cm^3 of oxygen in a reaction vessel at room temperature and pressure. This mixture is then burnt.

Which of the following diagrams represents the particles that remain in the reaction vessel?



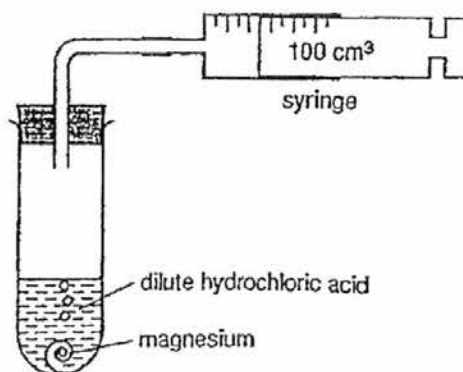
- 16 The model and formula for some molecules involving atoms of elements X, Y and Z are shown below.



Which of the following is the correct formula for a molecule of the compound formed between Y and Z?

- A YZ
- B ZY_3
- C ZY
- D YZ_3

- 17 An excess of aqueous hydrochloric acid is added to 0.10 mol of magnesium in the experimental set-up shown below.



Why is it impossible to measure the total volume of hydrogen produced in this experiment?

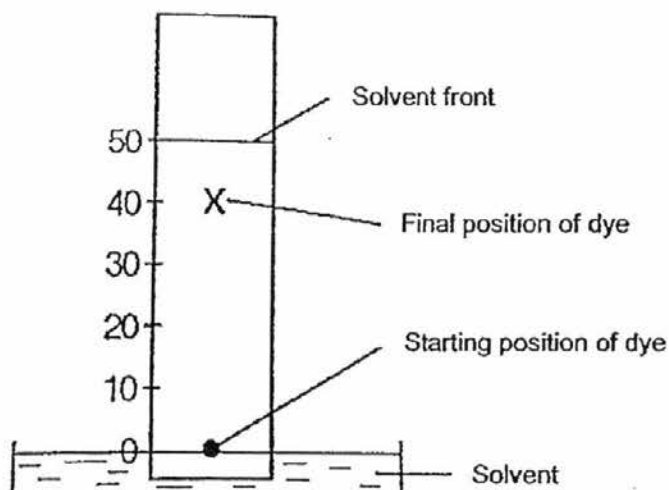
- A Air is present in the tube at the start.
 - B Hydrogen is less dense than air.
 - C Hydrogen is very soluble in hydrochloric acid.
 - D The total volume of hydrogen produced is greater than 100 cm³.
- 18 To reduce atmospheric pollution, the waste gases from a coal-burning power station are passed through powdered calcium carbonate.

Which waste gas will **not** be removed by the powdered calcium carbonate?

- A Carbon monoxide
 - B Nitrogen dioxide
 - C Phosphorous(V) oxide
 - D Sulfur dioxide
- 19 Which of the following equations suggests that a metal oxide, **MO**, exhibits some acidic properties in certain reactions?

- A $\text{MO(s)} + 2\text{H}^+(\text{aq}) \rightarrow \text{M}^{2+}(\text{aq}) + \text{H}_2\text{O(l)}$
- B $\text{MO(s)} + 2\text{OH}^-(\text{aq}) \rightarrow \text{MO}_2^{2-}(\text{aq}) + \text{H}_2\text{O(l)}$
- C $\text{MO(s)} + \text{H}_2\text{O(l)} \rightarrow \text{M}^{2+}(\text{aq}) + 2\text{OH}^-(\text{aq})$
- D $\text{MO(s)} + \text{NH}_4^+(\text{aq}) \rightarrow \text{M}^{2+}(\text{aq}) + \text{H}_2\text{O(l)} + \text{NH}_3(\text{g})$

- 20 The diagram represents the chromatogram for a dye.



Which fraction correctly shows the R_f value for the dye?

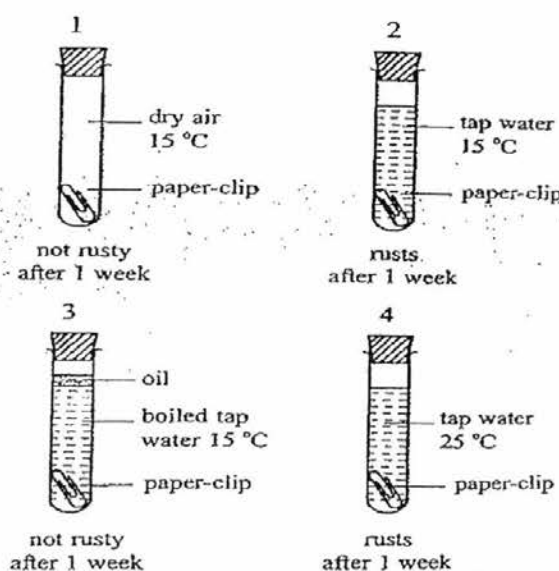
- A $\frac{1}{5}$
- B $\frac{4}{5}$
- C $\frac{5}{4}$
- D $\frac{5}{1}$
- 21 Which compound **cannot** be used to prepare iron(III) sulfate by reacting with sulfuric acid?
- A Iron(III) carbonate
- B Iron(III) chloride
- C Iron(III) hydroxide
- D Iron(III) oxide
- 22 A piece of zinc ribbon does not react when placed in a dilute solution of hydrogen chloride in ethanol. Which of the following changes will cause a reaction when carried out?
- A Adding water and stirring the mixture.
- B Cleaning the zinc ribbon with sand paper before reaction.
- C Saturating the solution by bubbling more hydrogen chloride gas.
- D Using zinc powder instead of ribbon.

- 23 Caesium is an element found in Group I of the Periodic Table.

Which of the following statements is true about the carbonate of caesium?

- A The carbonate has relatively low melting and boiling points.
- B The carbonate is the least stable to heat among all Group I carbonates.
- C The carbonate is very soluble in water.
- D The carbonate will undergo thermal decomposition to form more than two products.

- 24 Four experiments on rusting are shown below.



Which pair of experiments can be used to show that air is needed for iron to rust?

- A 1 and 3
- B 1 and 4
- C 2 and 3
- D 2 and 4

- 25 Selenium, Se, is in the same group of the Periodic Table as sulfur, S.

What is the formula of sodium selenide?

- A Na_2Se
- B NaSeO_4
- C Na_2SeO_3
- D Na_2SeO_4

- 26 An unclassified metal **M** has high density and a high melting point. Two chlorides formed by metal **M** includes **MC** and **MC₂**.

Which of the following classification will **M** most likely belong to?

- A It is a Group II metal.
- B It is a Group III metal.
- C It is a transition metal.
- D It is an alkali metal.

- 27 What is the number of atoms present in 500 cm³ of nitrogen gas at room temperature and pressure?

- A 1.25×10^{22}
- B 1.34×10^{22}
- C 2.50×10^{22}
- D 2.78×10^{22}

- 28 Which of the following statements about the halogens is correct?

- A The reactivity of halogens increases down the group.
- B They dissolve in water to form colourless solutions.
- C They exist as molecules having a pair of atoms.
- D They form negative ions by losing one electron.

- 29 Metal **P** reacts rapidly with cold water but Metal **Q** only reacts with steam.

Which of the following statements is **not** correct?

- A The carbonates of **P** requires a lower temperature to decompose than that of **Q**.
- B The extraction of **P** uses electricity while **Q** is extracted by a reduction process.
- C **P** can displace **Q** from a solution containing ions of **Q**.
- D No reaction can be observed when the oxide of **P** is strongly heated with **Q**.

- 30 Which of the following statements about kinetic particle theory is **not** true?

- A The particles of a solid have very strong forces of attraction between them.
- B The particles of a solid have more energy than those of a gas.
- C The particles of a gas move faster than those of a liquid.
- D The particles that make up matter are in constant motion.

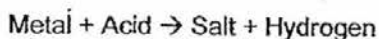
- 31 Pure and dry calcium sulfate can be prepared from a sample of pure calcium oxide in the process shown below.

..... → Filter the mixture → Wash with distilled water → Dry between filter paper

Which of the following steps is the most suitable for the above missing step?

- A Addition of aqueous sodium sulfate to calcium oxide.
- B Addition of barium sulfate and nitric acid to calcium oxide.
- C Addition of dilute nitric acid followed by dilute sulfuric acid.
- D Addition of dilute sulfuric acid to calcium oxide.

- 32 One method of preparing salts is shown in the reaction below.



Which of the following salts **cannot** be prepared by the following method?

- A Copper(II) chloride
- B Iron(II) chloride
- C Magnesium sulfate
- D Zinc sulfate

- 33 Ammonium salts will produce ammonia gas on heating with a solution of sodium hydroxide.

Which of the following sample of ammonium salt will produce the greatest volume of ammonia measured at room temperature and pressure?

- A 0.5 mol of $(\text{NH}_4)_3\text{PO}_4$
- B 0.5 mol of $(\text{NH}_4)_2\text{SO}_4$
- C 1.0 mol NH_4Cl
- D 1.0 mol NH_4NO_3

- 34 The table below shows some information of three different substances.

Substance	Stability to heating	Solubility in water	Solubility in alcohol
S	stable	insoluble	insoluble
T	stable	insoluble	soluble
U	not stable	soluble	insoluble

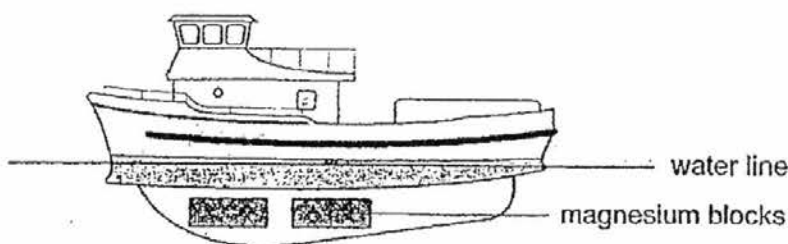
The following steps may be suitable to separate substance **U** from a mixture of these three substances.

- 1 Filtration
- 2 Dissolving in water
- 3 Dissolving in alcohol
- 4 Evaporation to dryness
- 5 Crystallisation

Which of the following order of steps shows the correct process of separating **U**?

- A** 2, 1, 5
B 3, 1, 4
C 2, 3, 1, 5
D 3, 1, 2, 4

- 35 Most boats are built with a body that consists of a high percentage of iron. Some magnesium blocks are attached to the hull below the water line to prevent the iron from rusting as shown in the diagram below.



Which statement explains why magnesium stops the iron from rusting?

- A** Magnesium forms an alloy with iron.
B ~~Magnesium forms its ions more readily than iron.~~
C Magnesium prevents oxygen in the water from reacting with iron.
D Magnesium protects iron by forming a protective layer of magnesium oxide.

- 36 Which statement about the production of iron from iron(III) oxide in a blast furnace is correct?
- A Iron is obtained using carbon monoxide as the oxidising agent.
 - B Iron(III) oxide is reduced by carbon dioxide.
 - C Limestone is used to remove basic impurities.
 - D Waste gases that exit the blast furnace includes nitrogen gas.

- 37 The table shows four elements, W, X, Y and Z with their atomic numbers.

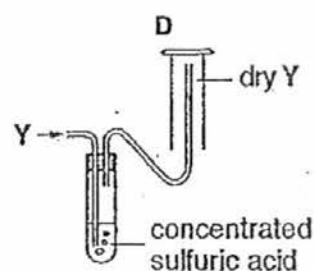
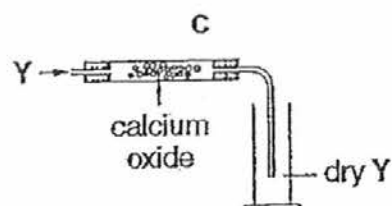
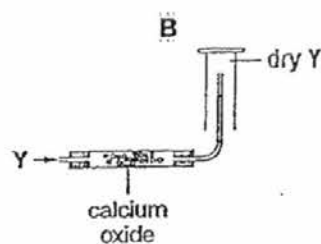
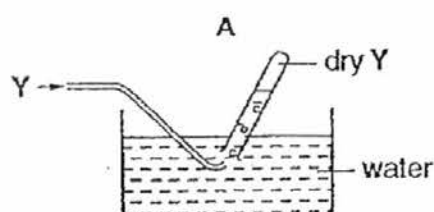
Elements	W	X	Y	Z
Atomic number	6	8	11	17

Which of the following shows the likely formula of the compounds formed from the four elements above?

	Compound with a giant lattice structure	A compound with a simple molecular structure
A	Y_2X	WX_2
B	WX	YZ
C	YW	WZ_4
D	YZ	ZW

- 38 A gas, Y, is less dense than air, very soluble in water and is alkaline.

Which of the following method can be used to collect a dry sample of the gas?



- 39 Substance D has chemical formula of $\text{NaAlSi}_3\text{O}_8$ while substance E has chemical formula of $\text{CaAl}_2\text{Si}_2\text{O}_8$. A student made three statements about these substances.

- I. D and E contain the same percentage by mass of oxygen.
- II. D and E contain different number of ions in 1 mole of substance.
- III. D contains approximately 1.6 times as much silicon by mass as E.

Which of the above statements are true?

- A I only
- B III only
- C I and II
- D II and III.

- 40 8 g of X_2O_3 , an oxide of element X, contains 5.6 g of X.

How many moles of X does 5.6 g of the element contain?

- A $\frac{2.4}{16} \times \frac{2}{3}$
- B $\frac{2.4}{16} \times \frac{3}{2}$
- C $\frac{8}{16} \times \frac{2}{3}$
- D $\frac{8}{16} \times \frac{3}{2}$

END OF PAPER

The Periodic Table of the Elements

Group																	
I	II	1 H Hydrogen 1										III	IV	V	VI	VII	0
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	127 I Iodine 53	131 Xe Xenon 54	
133 Cs Caesium 55	137 Ba Barium 56	139 La Lanthanum 57	178 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	210 Po Polonium 84	210 At Astatine 85	222 Rn Radon 86

*58-71 Lanthanoid series,
†90-103 Actinoid series

140 Ce Cerium	141 Pr Praseodymium	144 Nd Neodymium	150 Sm Samarium	152 Eu Europium	157 Gd Gadolinium	159 Tb Terbium	162 Dy Dysprosium	165 Ho Holmium	167 Er Erbium	169 Tm Thulium	173 Yb Ytterbium	175 Lu Lutetium
232 Th Thorium	238 Pa Protactinium	238 U Uranium	238 Pu Plutonium	244 Am Americium	244 Cm Curium	247 Bk Berkelium	251 Cf Californium	252 Es Einsteinium	257 Fm Fermium	261 Md Mendelevium	265 No Nobelium	269 Lr Lawrencium

The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.).

a

X

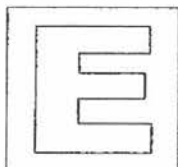
b

a = relative atomic mass

X = atomic symbol

b = proton (atomic) number

Key



GAN ENG SENG SCHOOL
End-of-Year Examination 2016



**CANDIDATE
NAME**

CLASS

**INDEX
NUMBER**

CHEMISTRY

Paper 2

5073/02

10 Oct 2016

1 hour 45 minutes

Sec 3 Express

Candidates answer on the Question Paper.

Calculators are allowed in the examination.

READ THESE INSTRUCTIONS FIRST

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

Write in dark blue or black pen on both sides of the paper.

You may use a soft pencil for any diagrams or graphs.

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

Section A

Answer **all** questions.

Section B

Answer **all** questions. Question 10 has a choice of parts to answer.

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

A copy of the Periodic Table is found on page 18.

For Examiner's Use	
Section A	50
Section B	30
Total	80

Section A [50 marks]

For Examiner's use

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

- A1** Use the chemical symbols in the following list of substances to answer the questions. Each substance may be used once, more than once, or none at all.

Al	Ar	Br ₂	CaCO ₃	CO
CO ₂	He	Mg	S ₈	ZnO

****No marks if answered using the chemical names.**

- a** Which substance(s) is/are in liquid state at room temperature?

Br₂ [1]

- b** Which substance(s) can be used as a rust prevention method?

Mg, Al (All or none) [1]

- c** Which element has a valency of 3?

Al [1]

- d** Which substance(s) is/are formed by the thermal decomposition of limestone?

CO₂ [1]

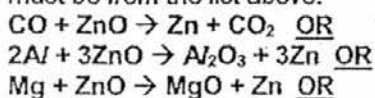
- e** Which substance(s) is/are used in light bulbs?

Ar [1]

- f** Which substance(s) contains more than one type of bonding?

CaCO₃ [1]

- g** Construct a chemical equation that shows a reduction reaction. Your reactants must be from the list above.



[1m correct reactants; 1m correct products and balanced] [Reject: Mg²⁺] [2]

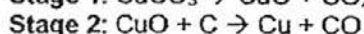
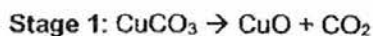
[Total: 8]

A2 Copper is a transition element that is mainly used for electrical wiring and motors.

- a State two physical properties of copper that are different from lithium.
 Hard, higher melting / boiling point, reddish-brown, higher density, [A: malleable, ductile, stronger. R: Cu forms coloured compounds/Cu is shiny/Cu is cut easily or any comparison based on chemical properties.]
 [1m for any two answers]

[1]

- b Copper can be extracted from copper(II) carbonate in a two-stage process.



- i State the condition for Stage 1 to take place.
 Presence of heat / heating of CuCO_3 [A: high temperature]
 [Reject: thermal decomposition]

[1]

- ii Explain why potassium cannot be extracted from potassium carbonate by using the same process.
 Potassium is higher than carbon in the reactivity series. [1] [A: Potassium is a very reactive metal.] Hence,
 K_2O cannot undergo reduction by carbon [1] to form potassium as potassium forms a very stable metal carbonate compound.

[2]

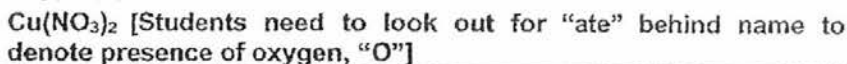
- c State the formula of the following copper compounds.

- i Copper(I) sulfide



[1]

- ii Copper(II) nitrate



[1]

- d In the space below, draw the dot-and-cross diagram of lithium oxide, showing only the valence electrons.

[2]



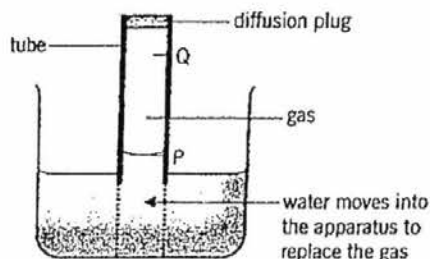
[1m for correct no. and structure of cation]

[1m for correct no. and structure of anion] [1m mark if "cross & dot" not shown on oxide ion.] [3E & 3G Students: Reminder to draw key even if no marks allocated for key to show understanding of concepts.]

[Total: 8]

- A3** An experiment set-up shown below was used to investigate the rate of diffusion of different gases at room temperature and pressure. The rate of diffusion is determined by the time taken for the water level to rise from P to Q as the gases diffuses out of the diffusion plug.

For Examiner's use



The table below shows the results when different gases were placed in the tube.

Gas	Molecular formula	Time for water to rise from P to Q / s
Carbon dioxide	CO ₂	330
Oxygen	O ₂	220
Nitrogen	N ₂	180

- a** State the difference in time taken for water to rise between carbon dioxide and nitrogen. Explain your answer.

CO₂ will cause the water to take a longer time to rise to Q. [1]

The relative molecular mass of carbon dioxide (44) is higher than

nitrogen (28). [1m for comparing actual M_r values]

[3]

The higher the relative molecular mass, the slower the rate of diffusion. [1]
Many students gave a numerical value e.g. 150s, without actually comparing which was faster.

- b** Some ice cubes were added to the experiment with oxygen gas.

Predict whether the time taken for the water level to rise will increase, decrease or stay the same. Explain your answer.

The time taken for the water level to rise will increase. [1]

The ice cubes will decrease the temperature of the gas therefore the gas

particles will lose energy and move slower. [1]

[2]

Some students believed that as ice melted, this would cause the water level to rise faster. Many students were able to explain why diffusion is slower but got confused by rate of diffusion vs time taken for water to increase, and thus stated that time taken will decrease.

- c** Describe what will be observed when ammonia gas is being used in the above experiment. Explain your answer.

For Examiner's use

The water level will rise sharply / rapidly / the fastest. [1]

Ammonia is very soluble in water and will dissolve and diffuse fastest. [1]

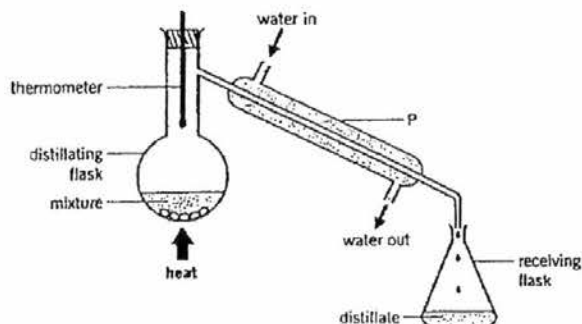
[2]

5

Students commonly did not consider the solubility of ammonia and thus believed that water level would rise faster compared to the experiments with other gases. Some students also have the misconception that a substance dissolving in water will cause the volume of water to increase appreciably.

[Total: 7]

- A4 Gary carried out a separation of a mixture using the experimental set-up shown below.



- a State **one** modification needed in this set-up and explain how it affects the results of the experiment process.

Bulb of thermometer should be at entrance to condenser [1] for more accurate monitoring of b.p of vapour. [1] / direction of water in should be from the bottom [1] for more efficient condensation of gaseous vapour [1]

[R: temperature instead of position of bulb of thermometer mentioned.]

[2]

- b The mixture to be separated contains Substances R and S. The table below shows the respective melting and boiling points of Substances R and S.

Substance	Melting point / °C	Boiling point / °C
R	-50	35
S	125	203

- i Explain why it is not possible to collect Substance R as a distillate using this method.

Substance R is a volatile liquid and will evaporate quickly at r.t.p.

[R: R has a low melting point.]

[1]

- ii State a modification that can be made in order for Substance R to be collected as a distillate.

Place the receiving flask in an ice bath.

[R: Put ice into receiving flask.]

[1]

[Total: 4 marks]

- A5 De-scalers are chemicals that can be used to remove the scale, usually calcium carbonate, that are found on kettles. They are weak acids which include phosphoric acid (H_3PO_4) and methanoic acid (HCOOH).

a State what is meant by the term "weak acid".

A weak acid partially dissociates in aqueous solution to produce H^+ ions. [1]

Reject: Hydrogen ions is partially ionised, acids are 'deionised', incomplete dissociation/ does not dissociate fully

b Write the chemical equation to show the reaction between phosphoric acid and calcium carbonate.

$2\text{H}_3\text{PO}_4 + 3\text{CaCO}_3 \rightarrow \text{Ca}_3(\text{PO}_4)_2 + 3\text{H}_2\text{O} + 3\text{CO}_2$ [1]

Many students used ' $\rightleftharpoons$ ' which is for reversible reaction, the CO_2 given off cannot be reversed back.

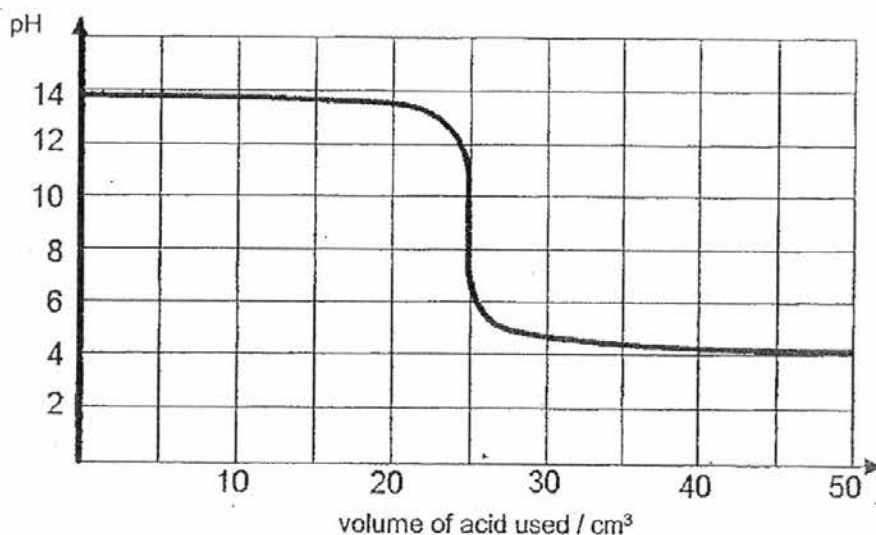
c Suggest why acids such as sulfuric acid and nitric acid are not used in the manufacture of de-scalers.

These are strong acids [1] that will cause a reaction to the metal on the

kettles after the scale is removed. [1] [2]

Reject: Corrode the kettle/ react with the kettle without referencing that the acids react specifically with acids.

d Methanoic acid is a monobasic acid. Some volume of 0.1 mol/dm^3 of methanoic acid was titrated against 25 cm^3 of 0.1 mol/dm^3 of aqueous sodium hydroxide in an experiment. Part of the pH curve of this experiment is shown below.



[1m for correct volume of acid]

[1m for correct end-point of approximate pH 7-11]

Complete the pH curve for the titration in the diagram above.

[2]

A6 The table below shows some information about elements, W, X, Y and Z.

For Examiner's use

Element	Proton Number
W	10
X	11
Y	16
Z	20

- a State, with a reason, which of the above elements forms an oxide that will cause a gas to be evolved when reacted with aqueous sodium carbonate.

Element Y. [1] Sulfur dioxide dissolves in water to give an acidic solution

that reacts with sodium carbonate to form carbon dioxide gas. [1]

[2]

Reject: Sulfur.

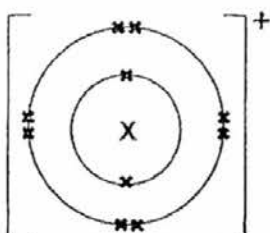
- b i State the electronic configuration of Element X.

2, 8, 1

[1]

- ii In the space below, draw the ion formed by Element X, showing all the electrons in the ion.

[1]



[no credit if any part missing]

[-1m if chemical symbol is anything other than X]

- iii Describe what would be observed when a small piece of Element X is added to water.

It will react vigorously with water. [1]

Sodium melts and darts across the surface of water/ burning with a yellow flame. [1]

[2]

Reject: React violently and explosively. Only a small piece of element X is added, might not have explosion.

- c Another element, P is in the same group in the Periodic Table as Element Z. It is found to be a more reactive element than Element Z.

For Examiner's use

- i Suggest why Element P would be more reactive than Element Z.

Element P contains more electron shells / has a larger atomic radii

than Element Z. [1] Valence electrons will be lost more easily due to

weaker forces of attraction from nucleus. [1]

[2]

Many students made reference to losing electrons easily without referring to the weakening of attractive forces between nucleus and the **valence** electrons.

- ii Predict the electrical conductivity of the oxide of Element P.

It can conduct electricity only when in molten AND aqueous state.
(Both must be included)

[1]

[Reject: only one state mentioned .][Total: 9 marks]

A7

Information on four metals and some of their compounds are shown in the table below.

Metal	Action of dilute H_2SO_4 on metal	Effect of hydrogen on heated oxide of metal	Action of metal on chloride solution of V
S	Hydrogen formed	Reduced	No visible reaction
T	No visible reaction	Reduced	No visible reaction
U	No visible reaction	No visible reaction	V metal formed
V	Hydrogen formed	No visible reaction	-

- a Arrange the metals in order of increasing reactivity.

T, S, V, U

[1]

- b Effervescence was observed when Metal U was added to a dilute solution of hydrochloric acid.

- i Suggest the identity of Metal U.

Barium / Calcium

[1]

- ii Explain your answer in b(i).

U is a reactive metal that is above iron in the reactivity series and is

able to react with acid. [1] However, it will have no visible reaction

with sulfuric acid because a layer of insoluble barium / calcium

sulfate formed that prevents further reaction. [1]

[2]

- c i A compound of Metal **V** consists of 72.2% Metal **V** and 27.8% nitrogen by mass. Given that the relative atomic mass of Metal **V** is 24, determine the empirical formula of the compound, giving your answer using the letter **V**.

For Examiner's use

[2]

Element	V	N
% by mass	72.2	27.8
Ar	24	14
No. of moles	3.008	1.986
Simplest ratio	1.515	1
Round ratio	3	2

Empirical formula: **V₃N₂**

[M1 for adequate working shown up till no. of moles]

[A1 for correct round ratio and empirical formula]

- ii If the relative formula mass of this compound is 300, determine the molecular formula of this compound.

[2]

$$\begin{aligned} \text{Mr of empirical formula} &= (3 \times 24) + (2 \times 14) \\ &= 100 \quad \text{[M1]} \end{aligned}$$

$$\begin{aligned} \text{Molecular formula} &= (\text{V}_3\text{N}_2) \times (300/100) \\ &= \underline{\text{V}_9\text{N}_6} \quad \text{[A1]} \end{aligned}$$

[Overall minus 1m if Mg is used instead of V for either or both parts]
 [Accept e.c.f. if all parts correct in (ii) but using answer in (i)]

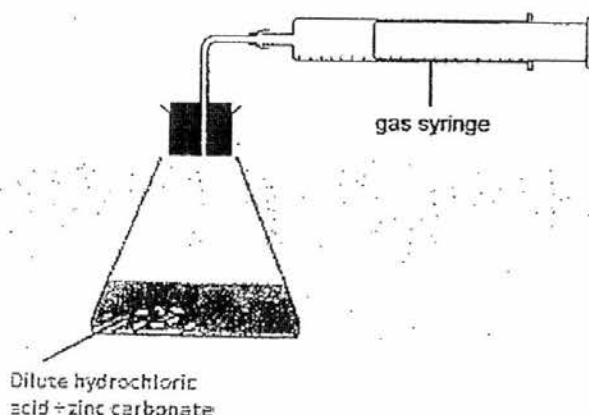
[Total: 8 marks]

SECTION B [30 marks]

For Examiner's use

Answer all **three** questions from this section.The last question is in the form either/ or and only **one** of the alternatives should be attempted.

- B8** Susie conducted an experiment where equal masses of zinc carbonate powder were added separately to 150 cm³ of acids of different concentration. Ethanoic acid is a weak monobasic acid. The incomplete set-up is shown below together with results from the experiment.



Experiment	Name of acid	Concentration of acid used / mol/dm ³
A	Dilute nitric acid	0.800
B	Dilute sulfuric acid	0.800
C	Dilute ethanoic acid	0.800

No more zinc carbonate powder was observed for all the beakers at the end of the experiment. The volume of gas evolved from each experiment was collected and measured. [This question is badly done as students did not read the question carefully by reading the context of this question.]

- a Complete the diagram above to depict the set-up that Susie could possibly have used for this experiment.

[1m for stopper / ensure no leakage of gas and gas syringe]

[Markings must be drawn on gas syringe to show that measurements can be made. R: Displacement over water method as Mr of CO₂ is .44 and slightly soluble in water. Students must consider the properties of the gas produced in this question to choose the best suitable apparatus.]

- b Susie observed that the zinc carbonate in experiment B disappeared at a faster rate than that in experiment A. Suggest a reason for her observation.

Sulfuric acid in experiment B is a dibasic acid where 1 mol of H₂SO₄ gives

2 mol H⁺ ions in solution [1] while nitric acid in experiment A is a

monobasic acid where 1 mol of HNO_3 gives 1 mol H^+ ions in solution. [1]
[R: Sulfuric acid is stronger than nitric acid if above concept on dibasicity is not elaborated.]

For Examiner's use

[2]

- c Predict whether the volume of gas collected in Experiment C will be more than, equal to or less than that collected in Experiment A. Explain your answer.
Same volume. Same number of moles of monobasic acids. [A: Same concentration of acids is used./ H^+ ions are produced.]
[R: All the ZnCO_3 has reacted with each of the acid.]

For Examiner's use

[1]

- d Describe a test that can be used to confirm the identity of the gas produced.

White precipitate will be formed when gas is bubbled into limewater.
[1m for both test and observations] [R: chalky/milky/identity of gas is not confirmed.]

[1]

- e Some zinc carbonate powder were strongly heated by Susie in a test-tube and he observed that the white residue produced was able to neutralise some sodium hydroxide solution when they were added to it. He concluded that the white residue was acidic in nature.

Explain whether his conclusion is correct.

Zinc carbonate will undergo thermal decomposition to produce zinc

oxide, which is the white residue. [1]

Zinc oxide is a metal oxide that is able to neutralise *alkaline* solution. [1]

His conclusion is wrong as the white residue should be amphoteric in

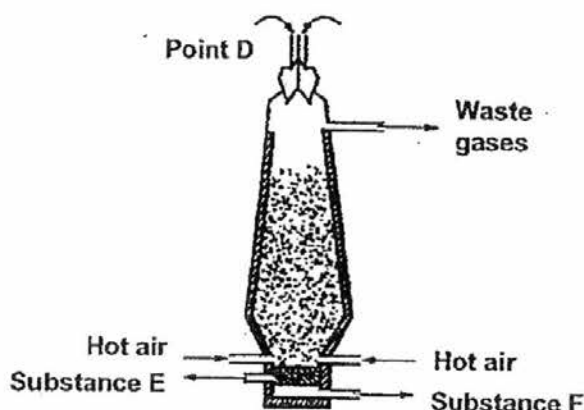
nature. [1]

[3]

[Total: 8]

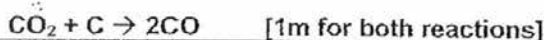
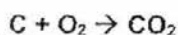
- B9 Iron is industrially extracted in the blast furnace. Some raw materials are added in from Point D and hot air is blasted from the bottom of the furnace.

For Examiner's use



- a Using suitable chemical equations, explain the purpose of adding coke at Point D into the furnace.

To produce the main reducing agent, carbon monoxide. [1]



[2]

Production of CO must be represented by the two equations, and no mark is given if the equations are not balanced.

Many students were able to produce the two equations but did not explain the purpose of producing CO.

R: Carbon monoxide is required to react with iron(III) oxide. (Students must specify the role of CO in this reaction)

- b The two products from this furnace are Substances E and F, found at the bottom of the furnace.

- i Name the raw material required for the formation of Substance E.

Limestone / calcium carbonate

[1]

Many students think that calcium oxide is the raw material. The raw materials are the raw substances added to the blast furnace – coke, limestone and haematite.

- ii Explain how this raw material helps in the formation of both substances E and F in the blast furnace.

Limestone / calcium carbonate will undergo thermal decomposition

to form calcium oxide and carbon dioxide. [1]

Calcium oxide removes the acidic impurities/reacts with silicon dioxide to form E. [1]

Carbon dioxide will react / be reduced by coke to produce more CO

and hence form more F. [1]

[3]

Students often missed out the last point, believing that by simply removing impurities, iron would be formed. Note that the question specifies that the raw material must help in the formation of the substances, and the formation of iron involves its reduction by carbon monoxide.

Marks are still awarded for the correct description of reactions involving the formation of E and F even if the wrong raw material was named in part i.

- c One method to prevent corrosion of iron is to convert it into stainless steel. Cast iron formed in the blast furnace is the starting material for the manufacture of stainless steel.

For Examiner's use

- i Describe how cast iron can be further processed to form alloys.

Cast iron have their impurities removed by oxidation in a furnace /

Pure oxygen is blown through heated cast iron. [1] Carbon and other metals are stirred into the molten iron to make different types of alloys. [1]

[2]

R: carbon and other elements are reacted with molten iron

R: Other metals are added to molten iron (main alloy of iron is steel, which contains carbon, hence carbon must be mentioned)

R: cast iron is alloyed by adding carbon and other elements

- ii Iron ore containing 58.5% iron(III) oxide was added into a blast furnace in the manufacture of a certain stainless steel that contains 83.5% iron.

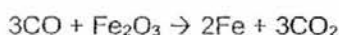
Calculate the mass of iron ore that is required to manufacture 1 tonne of this stainless steel.

[4]

Mass of iron needed to make 1 tonne of stainless steel
 $= (83.5/100) \times 1 \times 10^6$
 $= 8.35 \times 10^5 \text{ g}$

No. of moles of iron
 $= (8.35 \times 10^5) / 56$
 $= 1.491 \times 10^4 \text{ mol}$

M1



Mole ratio of Fe : Fe₂O₃
 2 : 1

M1

No. of moles of Fe₂O₃ required
 $= (1.491 \times 10^4) / 2$
 $= 7.455 \times 10^3 \text{ mol}$

M1

Mass of Fe₂O₃ required
 $= (7.455 \times 10^3) \times 160$
 $= 1.193 \times 10^6 \text{ g}$

Mass of iron ore required
 $= (1.193 \times 10^6) \times (100/58.5)$
 $= 2.04 \times 10^6 \text{ g}$
 $= 2.04 \text{ tonnes}$

A1

Very poorly done; out of the few students who attempted this question, some did not take into account the mole ratio or did not properly convert 1 tonne into g.

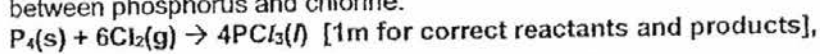
[Total: 12]

EITHER

B10 The element chlorine is found in Group VII and is one of the halogen that is more commonly used in industrial applications. Two such applications are shown below.

- a Phosphorus trichloride, PCl_3 , is a liquid that is widely used as one of the starting materials in the manufacture of insecticides and flame retardants. It can be prepared by passing pure chlorine gas over heated phosphorus powder, P_4 .

- i Write a chemical equation, including state symbols, for the reaction between phosphorus and chlorine.



then [1m for balanced with correct state symbols]

[2]

Many failed to realise that chlorine gas is Cl_2 .

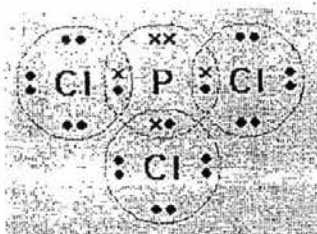
- ii State the term used to describe a molecule of chlorine.

Diatomic / simple molecule.

[1]

- iii Draw a "dot-and-cross" diagram to show the arrangement of valence shell electrons in a molecule of phosphorus trichloride.

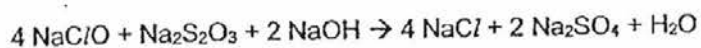
[2]



[1m for correct no. of shared electrons]

[1m for correct no. of unshared electrons]

- b Chlorine is found in most common bleaches in the form of sodium hypochlorite, NaClO . Bleach containing sodium hypochlorite can be neutralized by aqueous sodium thiosulfate, $\text{Na}_2\text{S}_2\text{O}_3$, shown in the equation below.



1.00 dm^3 of a solution of sodium thiosulfate contains 12.4 g of $\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$.

- i Calculate the molar concentration of the sodium thiosulfate solution.

[2]

No. of moles of sodium thiosulfate

$$= 12.4 / 248$$

$$= 0.05 \text{ mol}$$

[M1]

Molar concentration

$$= 0.05 / 1$$

$$= 0.05 \text{ mol} / \text{dm}^3$$

[A1]

[Otherwise, 1m for mass concentration calculated]

[Many did not take $5 \times (2+16)$ into consideration when calculating Mr]

- ii 236 cm³ of this sodium thiosulfate solution and 125 cm³ of 0.1 mol/dm³ of sodium hydroxide solution were reacted with excess bleach to produce 0.52 g of sodium sulfate. Calculate the percentage yield of this reaction. [3]

$$\begin{aligned}\text{No. of moles of Na}_2\text{S}_2\text{O}_3 \\ &= (236/1000) \times 0.05 \\ &= 1.18 \times 10^{-2} \text{ mol}\end{aligned}$$

$$\begin{aligned}\text{No. of moles of NaOH} \\ &= (125/1000) \times 0.1 \\ &= 1.25 \times 10^{-2} \text{ mol}\end{aligned}$$

M1

From equation,
1 mol of Na₂S₂O₃ requires 2 mol of NaOH
1.18 × 10⁻² mol of Na₂S₂O₃ requires 2.36 × 10⁻² mol of NaOH.

Therefore, NaOH is the limiting reagent here.

M1

$$\begin{aligned}\text{Mole ratio of NaOH : Na}_2\text{SO}_4 \\ &2 : 2 \\ &1.25 \times 10^{-2} : 1.25 \times 10^{-2}\end{aligned}$$

$$\begin{aligned}\text{Theoretical mass of Na}_2\text{SO}_4 \text{ produced} \\ &= (1.25 \times 10^{-2}) \times 142 \\ &= 1.775 \text{ g}\end{aligned}$$

$$\begin{aligned}\text{Percentage yield of Na}_2\text{SO}_4 \\ &= (0.52 / 1.775) \times 100\% \\ &= 29.3\% \text{ (3 s.f.)}\end{aligned}$$

A1

Note: allow e.c.f. from (bi) that may amount to full credit in (bii) if sufficient working is being shown for all the steps involved.

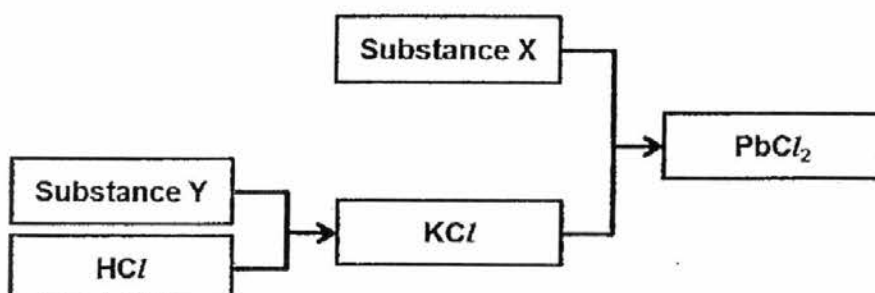
[Total: 10]

[-1m for no mention of need to determine limiting reagent at all]

[Many could not recognize and justify the limiting reagent, and hence used the wrong value towards calculation of mass of product. This is due to them not understanding that the amount (moles) of sodium thiosulfate solution should be calculated from the concentration that was already calculated previously]

OR

- B10 Lead(II) chloride occurs naturally as white crystals and are used in the manufacture of ceramics. It can be prepared in the laboratory as shown in the flow diagram below.



- a Suggest the identities of Substances X and Y.

Substance X is lead(II) nitrate / $\text{Pb}(\text{NO}_3)_2$. Substance Y is potassium

hydroxide / KOH / potassium oxide / K_2O / potassium carbonate / K_2CO_3 .

[All of none]

[1]

- b Construct the ionic equation for the formation of lead(II) chloride.

$\text{Pb}^{2+}(\text{aq}) + 2\text{Cl}^{-}(\text{aq}) \rightarrow \text{PbCl}_2(\text{s})$

[No credit if no/wrong state symbols]

[Only very few got this question correct]

[1]

- c Describe the procedure used for the preparation of pure, dry lead(II) chloride crystals in the laboratory using Substance X and potassium chloride.

- Add excess of a solution to the other solution in a beaker.

- Stir well to ensure no more precipitation / homogeneous mixture.

- Filter to obtain lead(II) chloride as residue.

- Wash the residue with distilled water and dry between pieces

of filter paper.

[1]

[1]

[1]

[Max 1m for first step if crystallization / heat till saturation is mentioned.]

[3]

- d Discuss whether a sample of lead(II) chloride can be prepared with lead metal and copper(II) chloride solution as the reactants.

Lead is more reactive than copper so it should be able to displace copper

from copper(II) chloride and form lead(II) chloride. [1] However, the

insoluble lead(II) chloride formed on the lead metal [1] will not allow any

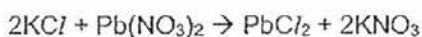
more reaction to take place. [Most only got the first mark and failed to realise that lead(II) chloride formed in this manner will stop any reaction] [2]

- e In an experiment, 200 cm³ of 2 mol/dm³ of potassium chloride was reacted with 450 cm³ of 1 mol/dm³ of Substance X. Calculate the mass of lead(II) chloride formed at the end of the reaction. [3]

Note: allow e.c.f. (up to full credit) if Substance X was identified to be another soluble lead compound other than lead(II) nitrate, and hence a wrong equation used.

No. of moles of KCl reacted
= (200/1000) × 2
= 0.400 mol

No. of moles of Substance X [Pb(NO₃)₂] reacted
= (450/1000) × 1
= 0.450 mol



Mole ratio of KCl : Pb(NO₃)₂
2 : 1

From the equation,
2 mol of KCl requires 1 mol of Pb(NO₃)₂
0.400 mol of KCl requires 0.200 mol of Pb(NO₃)₂

Therefore, KCl is the limiting reagent.

Mole ratio of KCl : PbCl₂
2 : 1
0.400 : 0.200

Mass of PbCl₂ formed
= 0.200 × 278
= 55.6 g (3 s.f.)

M1

M1

A1

[Total: 10]

[Poorly done. Same mistakes as not recognizing and justifying limiting reagent]

END OF PAPER

