

Candidate Name _____

Class _____

Index
Number



ST ANDREW'S SECONDARY SCHOOL
END-OF-YEAR EXAMINATION 2021
SECONDARY 3 EXPRESS

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CHEMISTRY

6092

Wednesday

6 October 2021

1 hour 45 minutes

INSTRUCTIONS TO CANDIDATES

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

READ THESE INSTRUCTIONS FIRST

Write your name, index number and class in the spaces provided in both the question paper and answer sheet. Write in dark blue or black pen.

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

Section A

Choose the most appropriate answer for Questions 1 to 30.

Answer **all** questions on the OTAS provided.

Section B and C

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

Electronic calculators may be used. You may lose marks if you do not show your working or if you do not use appropriate units.

A copy of the Periodic Table is printed on page 26.

FOR EXAMINER'S USE

90

This question paper consists of 26 printed pages.

Error Analysis

DO NOT ATTEMPT THIS PART DURING THE EXAM/TEST.

IT IS TO BE COMPLETED AFTER THE EXAM/TEST, AFTER YOU HAVE DONE CORRECTIONS FOR YOUR PAPER.

Name: _____ ()

Date: _____

Exam: CT1/Mid-Year/CT2/Final/Prelim

Everyone, not just the fastest and most competent, is capable of high achievement. Care, perseverance and craftsmanship are what count.

Mistakes are not a sign of weakness. Mistakes help me learn. Consistent effort and effective strategies are the main determinant of success

A) 3 things I have learnt from this paper.

1.) _____

2.) _____

3.) _____

B) 2 common mistakes I made in this paper.

1.) _____

2.) _____

C) Confession:

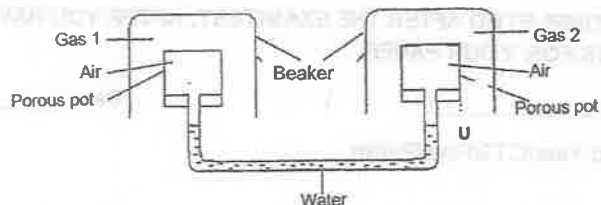
I could have done better if _____

Section A: Multiple Choice Questions [30 marks]

Choose the most appropriate answer for Question 1 to 30.

Answer all questions on the OTAS provided.

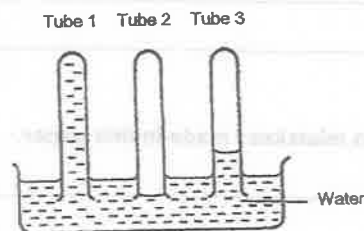
- 1 The apparatus in the experiment is set up using different gases in the two inverted beakers as shown.



Which pair of gases would cause an upward movement of water at U?

	Gas 1	Gas 2
A	carbon dioxide	hydrogen
B	hydrogen	carbon dioxide
C	methane	carbon dioxide
D	carbon dioxide	methane

- 2 Three dry test tubes were filled with different gases and placed in a trough of water. After a long time, the water had risen in two of the tubes as shown in the diagram.



Which gases could the tube have contained?

	tube 1	tube 2	tube 3
A	sulfur dioxide	chlorine	hydrogen
B	chlorine	sulfur dioxide	hydrogen
C	sulfur dioxide	hydrogen	chlorine
D	chlorine	hydrogen	sulfur dioxide

[Turn over

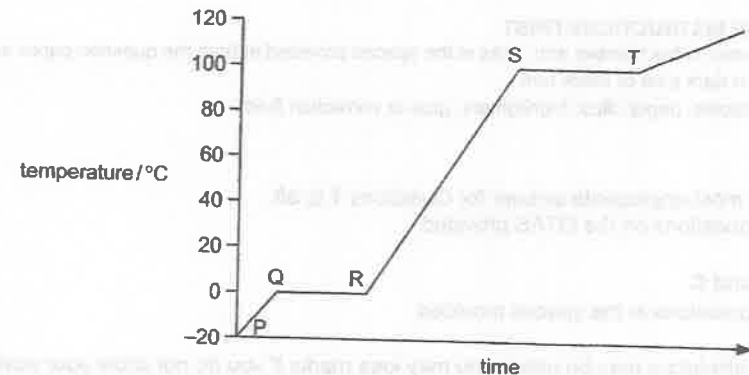
- 3 Five substances were prepared in the laboratory. The melting points and boiling points of the five substances were obtained and tabulated in the table below.

substance	melting point / °C	boiling point / °C
V	50	80
W	70	450
X	65	67
Y	-35	-12
Z	0	100

At what temperature would there be two liquids?

- A -20°C
B -15°C
C 20°C
D 95°C

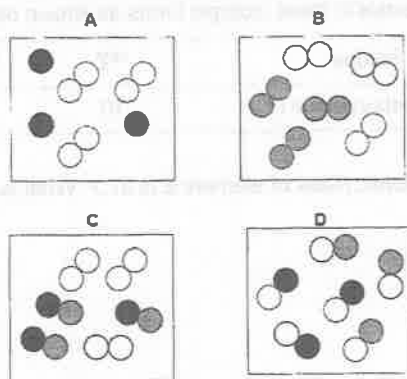
- 4 The graph below shows the change in temperature with time when ice at -20 °C is heated to 120 °C.



Which entry in the table shows the correct change taking place between the points?

	graph section	change
A	P to Q	average energy of particles remains constant
B	Q to R	particles gain energy
C	R to S	the volume of steam increasing
D	S to T	particles are gaining kinetic energy

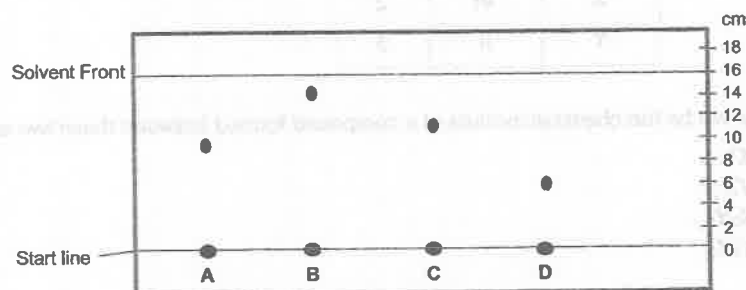
- 5 Which diagram best represents a mixture of an element and a compound?



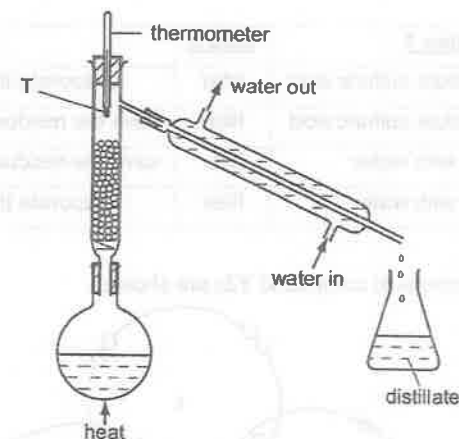
- 6 In gold jewellery, the metal gold is usually mixed with copper and silver. Which of the following changes in physical properties does not happen when the alloy is formed?

- A density decreases
B hardness increases
C colour changes
D malleability changes

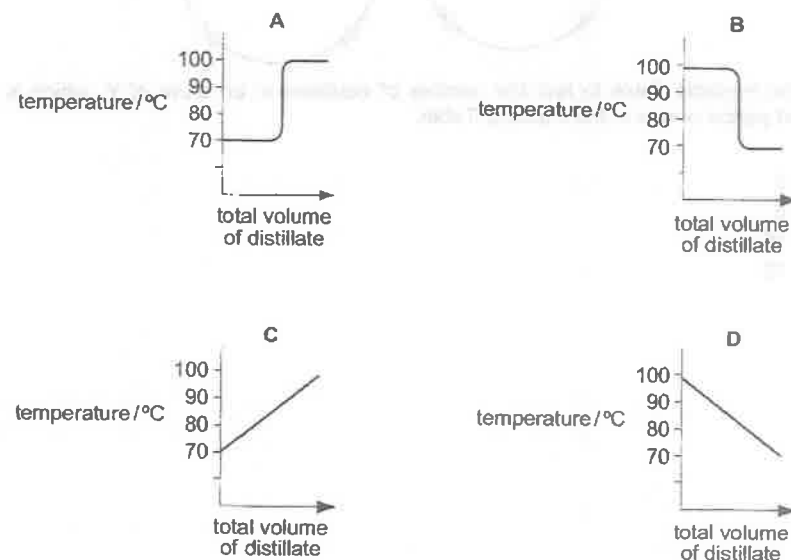
- 7 The R_f value of glucose for a particular solvent and temperature is known to be 0.65. In the chromatogram below developed using the same solvent and temperature, which spot is most likely to be glucose?



- 8 The diagram shows the apparatus used to separate two liquids, hexane (boiling point, 70 °C) and heptane (boiling point, 98 °C).



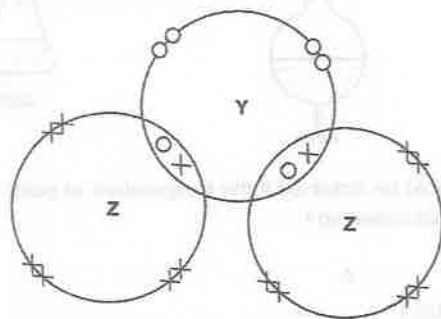
Which graph would be obtained if the temperature at point T was plotted against the total volume of distillate collected?



- 9 A manufacturer accidentally dropped some tiny industrial diamonds into copper(II) oxide powder. Which steps could be used to recover the diamonds from the mixture?

	step 1	step 2	step 3
A	shake with dilute sulfuric acid	filter	evaporate the filtrate to dryness
B	shake with dilute sulfuric acid	filter	save the residue and wash it with water
C	shake with water	filter	save the residue and wash it with water
D	shake with water	filter	evaporate the filtrate to dryness

- 10 The outer shell electrons in compound YZ_2 are shown.



Use the Periodic Table to find the number of neutrons in an atom of Y, which is in the second period or row of the Periodic Table.

- A 6
B 8
C 10
D 12

- 11 An element Z exists in three isotopic forms as shown below.

Isotope	^{86}Z	^{87}Z	^{88}Z
Isotopic abundance (%)	10	p	q

If the relative atomic mass of element Z is 87.7. What is the value of p?

- A 10
B 20
C 70
D 80

- 12 The chemical formula for the carbonate of chromium is $\text{Cr}_2(\text{CO}_3)_3$. Which of the following give the correct formula of compounds of chromium?

- A $\text{Cr}(\text{OH})_3$, $\text{Cr}(\text{NO}_3)_3$, $\text{Cr}(\text{SO}_4)_3$
B $\text{Cr}(\text{OH})_3$, $\text{Cr}(\text{NO}_3)_3$, $\text{Cr}_2(\text{SO}_4)_3$
C $\text{Cr}(\text{OH})_2$, $\text{Cr}(\text{NO}_3)_2$, CrSO_4
D CrOH_2 , $\text{Cr}(\text{NO}_3)_2$, $\text{Cr}_2(\text{SO}_4)_3$

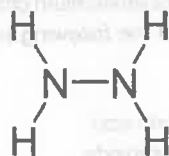
- 13 The table shows some information on elements X and Y.

Element	Group	Period
X	VI	2
Y	II	3

What will be the chemical formula of a compound formed between these two elements?

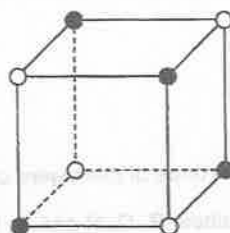
- A XY
B YX
C X_2Y_3
D Y_2X_3

- 14 The structure of hydrazine is as shown below.



How many valence electrons are there in one molecule of hydrazine that are not involved in bonding?

- A 4
B 6
C 8
D 10
- 15 The diagram shows the arrangement of the ions in an ionic crystal.



key

○ = +ve ion

● = -ve ion

Which compound **cannot** have this arrangement of its ions?

- A calcium oxide, CaO
B copper(II) sulfate, CuSO₄
C magnesium chloride, MgCl₂
D sodium chloride, NaCl
- 16 Which of the following statements is true about the size of the particles?
- A The potassium ion is larger than the potassium atom.
B The fluoride ion is smaller than the fluorine atom.
C The calcium atom is larger than the calcium ion.
D The sulfur atom is larger than the sulfide ion.

- 17 Which are the substances present in the resultant mixture when excess iron (II) nitrate is reacted with dilute sodium hydroxide solution?

- A iron (II) hydroxide and sodium hydroxide
B iron (II) hydroxide and sodium nitrate
C iron (II) hydroxide, iron (II) nitrate and sodium hydroxide
D iron (II) hydroxide, iron (II) nitrate and sodium nitrate

- 18 Which of the following equations suggests that a metal oxide, RO, behaves as an amphoteric oxide?

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

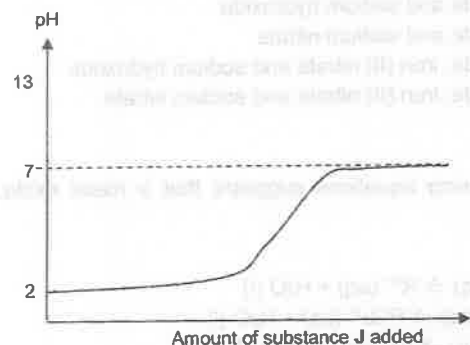
- 19 The table below gives information about four indicators used in acid-base titrations.

indicator	pH at which colour change takes place	colour at low pH	colour at high pH
bromothymol blue	6.0 - 7.6	yellow	blue
methyl orange	3.2 - 4.4	red	yellow
congo red	3.0 - 5.2	blue	red
phenolphthalein	8.3 - 10.0	colourless	pink

Which set of indicators when mixed together would produce a yellow solution at pH 2.9?

- A congo red and methyl orange
B bromothymol blue and congo red
C bromothymol blue and methyl orange
D phenolphthalein and bromothymol blue

- 20 A solution of **J** was added 0.5 cm^3 at a time, with stirring, to aqueous solution **M**. The changes in the pH of the mixture are shown in the graph below.



What could substance **J** and solution **M** be?

	substance J	substance M
A	aqueous ammonia	sulfuric acid
B	magnesium oxide	nitric acid
C	potassium oxide	hydrochloric acid
D	zinc oxide	ethanoic acid

- 21 A solution contains barium ions, zinc ions and one type of anion. What could the anion be?

- A chloride
B hydroxide
C carbonate
D sulfate

- 22 Which of the following pairs of reactants is most suitable for preparing the given salt?

	reactants	salt prepared
A	calcium carbonate and sulfuric acid	calcium sulfate
B	copper and sulfuric acid	copper (II) sulfate
C	magnesium oxide and sulfuric acid	magnesium sulfate
D	zinc nitrate and sulfuric acid	zinc sulfate

- 23 A gardener brought a bag of ammonium chloride and ammonium sulfate but had forgotten to label the bags. Which of the following tests would enable him to distinguish between the two chemicals?

- A Adding dilute hydrochloric acid
B Adding dilute sodium hydroxide
C Adding aqueous silver nitrate
D Adding zinc oxide

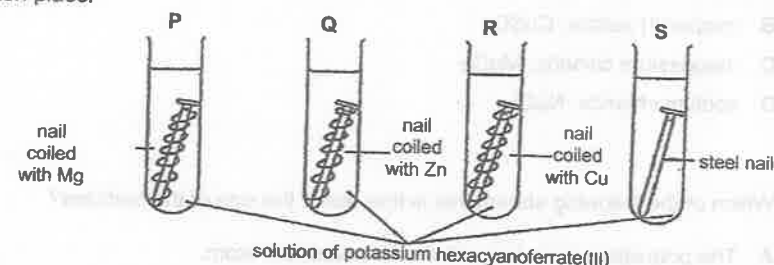
- 24 **Q** is a solid which conducts electricity and has a high melting point. On warming, **Q** partly dissolves in excess dilute hydrochloric acid, leaving behind a residue. What is **Q**?

- A brass
B graphite
C sodium chloride
D zinc

- 25 Four clean nails were prepared and three of them were coiled with metals as follows.

The nails were put into four test tubes, **P**, **Q**, **R** and **S**. Potassium hexacyanoferrate(III) solution was then poured into the tubes to cover the nails.

Potassium hexacyanoferrate(III) solution forms a dark blue colour with iron (III) ions that are present in the rust. The intensity of blue colour indicates the extent of rusting that has taken place.

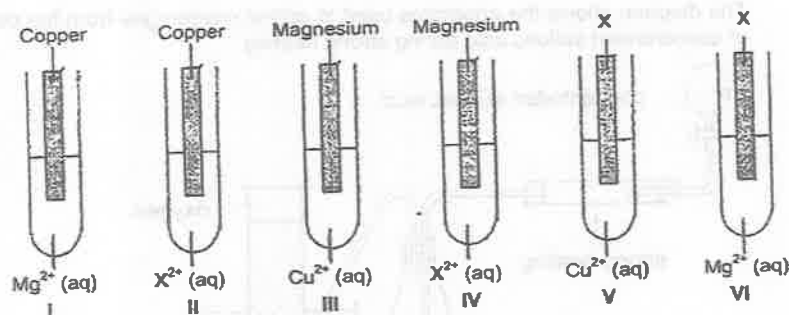


Which of the following correctly shows the order, in increasing intensity, of the blue colour observed in the four test tubes above?

- A P, Q, R, S
B P, Q, S, R
C R, S, Q, P
D S, R, Q, P

26 X is an unknown metal.

A student did the following experiments to compare the reactivity of magnesium, copper and metal X. Six tubes were arranged as shown in the diagrams below. Each tube contained a piece of metal half immersed in an aqueous solution containing ions of one of the other two metals.



The following observations were made

- There was a deposit seen in only three tubes including tube V.
- There was no deposit in tube VI.

Besides tube V, which two other tubes contain a deposit?

- A I and III
B II and III
C II and IV
D III and IV

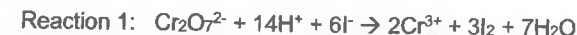
27 Which of the following does **not** represent 0.25 mol of nitrogen gas at room temperature and pressure?

- A 0.5 mol of nitrogen atoms
B 6 dm³ of nitrogen
C 1.5×10^{23} molecules
D 14 g of nitrogen

28 The chemical equations below represent the reactions used to determine the concentration of dichromate ions, $\text{Cr}_2\text{O}_7^{2-}$, that was present in a solution.

The first reaction involves the use of aqueous potassium iodide, which will form aqueous iodine as one of the products. The iodine formed is then titrated with aqueous thiosulfate, $\text{S}_2\text{O}_3^{2-}$, as shown in Reaction 2.

The volume of thiosulfate used in Reaction 2 can then be used to calculate the concentration of dichromate ions that was used in the solution.



3 mol of thiosulfate was found to have reacted with the iodine formed. Hence, what is the number of moles of dichromate ions, $\text{Cr}_2\text{O}_7^{2-}$, that was reacted in Reaction 1?

- A 0.5 mol
B 1.0 mol
C 1.5 mol
D 3.0 mol

29 What is the substance present in the blast furnace that will react with the acidic impurities of iron ore to form a salt?

- A calcium carbonate
B calcium oxide
C carbon monoxide
D coke

30 When skunks are threatened, they release a foul smell that contains a group of compounds known as thiols.

An example of a thiol is methanethiol, CH_3SH , which burns as follows:



A sample of 0.02g of methanethiol was completely burnt in oxygen. What would be the final volume of the resultant mixture of gases when cooled to room temperature and pressure?

- A 20 cm³
B 30 cm³
C 40 cm³
D 80 cm³

Section B [40 marks]

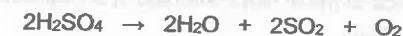
Answer all the questions in the spaces provided.

B1 The names of some substances are given in the following list.

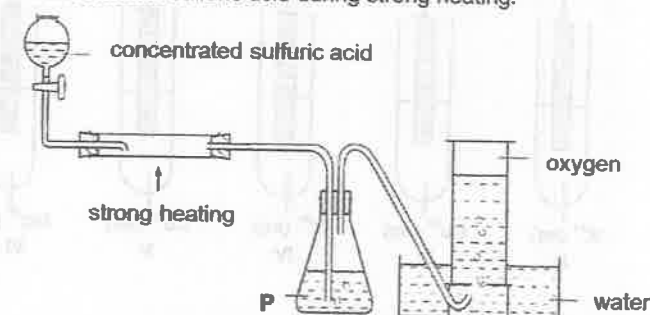
nickel helium graphite oxygen
silicon dioxide aluminium oxide carbon dioxide zinc hydroxide

Use the names of these elements to answer the questions below. You may use each name once, more than once or not at all.

- (a) Which of the substance(s) is/are non-metallic element(s)?
..... [1]
- (b) Which substance(s) has/have positive ions surrounded by a sea of electrons?
..... [1]
- (c) Which substance(s) can react with both sulfuric acid and sodium hydroxide?
..... [1]
- (d) Which substance(s) contain(s) both ionic and covalent bonds?
..... [1]
- (e) Which compound(s) exist(s) as simple molecules?
..... [1]

[Turn over**B2** Concentrated sulfuric acid will undergoes a decomposition on strong heating to produce sulfur dioxide gas, water vapour and oxygen.

The diagram shows the apparatus used to collect oxygen gas from the decomposition of concentrated sulfuric acid during strong heating.



- (a) Explain the role of substance P and suggest its identity.
..... [2]
- (b) The first few samples of oxygen gas collected are to be disposed. Explain.
..... [1]

B3 The melting and boiling points of the hydrides of some elements that are in the same period of the Periodic Table are given in the table below.

Formula	SiH ₄	PH ₃	H ₂ S	HCl
Melting point /°C	-185	-133	-85	-115
Boiling point /°C	-112	-88	-61	-85

(a) Using your knowledge of bonding and structure, explain the differences between the melting points of PH_3 and H_2S .

[3]

(b) Sodium also forms a hydride. Predict and explain how sodium hydride will differ from the hydrides in the table above.

[3]

(c) Draw the 'dot-and-cross' diagram to show the bonding in NaH. Show the outer shell electrons only.

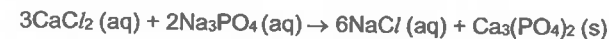
[2]

(d) Describe changes in terms of arrangement and movement between the particles of HCl when it is cooled from 0°C to -95°C.

..[2]

B4 Bones are formed when calcium ions and phosphate ions combine to form calcium phosphate, $\text{Ca}_3(\text{PO}_4)_2$.

This reaction can be carried out in the laboratory by adding a solution of calcium chloride to a solution of sodium phosphate.



(a) Write an ionic equation for this reaction.

[2]

(b) Suggest how the calcium phosphate can be separated from the mixture.

[1]

- B5 (a)** Stainless steel alloy is used to make some bicycle parts. What is meant by the term alloy?
[1]
- (b)** Explain how greasing to the metallic parts of the bicycle will help to slow down rusting.

[2]
- (c)** Other than strength, state the advantage of using stainless steel alloy to make bicycle parts.

[1]

- B6** When lead reacts with excess oxygen in the air, two different oxides can be formed according to the equations below.

Formation of lead (II) oxide: $2\text{Pb} + \text{O}_2 \rightarrow 2\text{PbO}$

Formation of lead (IV) oxide: $\text{Pb} + \text{O}_2 \rightarrow \text{PbO}_2$

1.03g of lead metal is heated in excess oxygen which forms only one product. The mass of the product is found to be 1.19 g.

By using the equations above and performing suitable calculations, determine which of the two oxides was formed.

[3]

- B7** Haematite and coke are used to make iron in the blast furnace.

- (a)** Explain, with relevant chemical equations, why coke is essential to the process of making iron from haematite.

[3]
- (b)** Iron from the blast furnace contain carbon and silicon as impurities. What is the source of silicon impurities in the blast furnace?
[1]
- (c)** Suggest why a thin layer of slag is often left on the molten iron after its extraction.

[1]

B8

The flowchart shows some reactions that substance **K** undergoes.

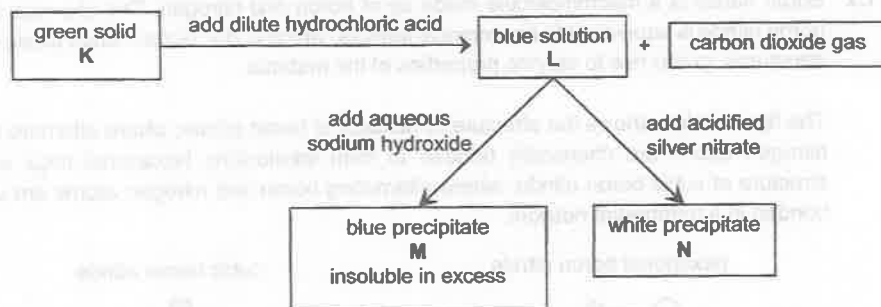


Fig. 8.1

(a) Name the

- (i) green solid **K**[1]
- (ii) blue solution **L**[1]
- (iii) blue precipitate **M**[1]
- (iv) white precipitate **N**[1]

(b) Give the ionic equation for the reaction between **K** and hydrochloric acid.

.....[1]

(c) (i) If one were to prepare a salt such as silver nitrate, explain why silver should not be reacted with nitric acid.

(ii) State the reagent that nitric acid should be reacted with to form silver nitrate.

.....[2]

[Turn over

Section C [20 marks]

Answer both questions in the spaces provided.

C1 Potassium perchlorate, KClO_3 , decomposes to form potassium chloride and oxygen.



(a) State a test to identify oxygen as the gas produced in this reaction.

.....[2]

(b) Calculate the percentage by mass of oxygen in potassium perchlorate.

(c) Calculate the maximum volume of oxygen formed at room temperature and pressure when 49 g of potassium perchlorate is completely decomposed.

[1]

[2]

(d) Potassium chloride can also be formed by burning potassium in chlorine, which is a violent reaction that produces a bright flame and a lot of heat.

- (i) Explain in terms of gain and loss of electrons, how potassium ions and chloride ions are formed when potassium reacts with chlorine.

.....

 [2]

- (ii) Using your knowledge about how metals could be extracted from their compounds, suggest a method that can extract potassium from potassium chloride.

..... [1]

- (iii) Predict and explain how calcium will react with chlorine as compared to the reaction between potassium and chlorine.

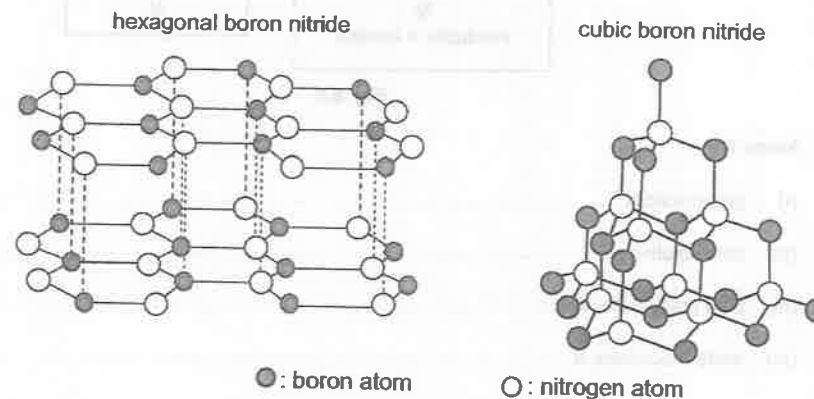
.....

 [2]

[Turn over

C2 Boron nitride is a macromolecule made up of boron and nitrogen. The chemical formula of boron nitride is equivalent to its empirical formula, which is BN. Boron nitride exists in multiple structures, giving rise to varying properties of the material.

The figure below shows the structure of hexagonal boron nitride, where alternate boron and nitrogen atoms are chemically bonded to form interlocking hexagonal rings as well as structure of cubic boron nitride, where alternating boron and nitrogen atoms are chemically bonded in a tetrahedral network.



- (a) Hexagonal boron nitride can be formed by reacting boric acid, H_3BO_3 , with ammonia. Water is formed in the reaction as a by-product. Write a balanced chemical equation for this reaction.

..... [2]

- (b) Hexagonal boron nitride is commonly used as an additive to cosmetic products such as eye-shadow powder and lipstick formulations, as it applies smoothly onto the skin. Explain how the structure of hexagonal boron nitride makes it suitable for use in cosmetic products.

.....

 [2]

- ..[2]

- [2]

- [2]

Turn over

The Periodic Table of Elements

Group																	
I	II	1 H hydrogen 1										III	IV	V	VI	VII	0
Key proton (atomic) number atomic symbol relative atomic mass																	
3 Li lithium 7	4 Be beryllium 9																
11 Na sodium 23	12 Mg magnesium 24	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium -	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57 – 71 lanthanoids		72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium -	85 At astatine -
87 Fr francium -	88 Ra radium -	89 – 103 actinoids		104 Rf rutherfordium -	105 Db dubnium -	106 Sg seaborgium -	107 Bh bohrium -	108 Hs hassium -	109 Mt meitnerium -	110 Ds darmstadtium -	111 Rg roentgenium -	112 Cn copernicium -	114 Fl flerovium -	116 Lv livermorium -			
lanthanoids																	
57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium -	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175			
89 Ac actinium -	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium -	94 Pu plutonium -	95 Am americium -	96 Cm curium -	97 Bk berkelium -	98 Cf californium -	99 Es einsteinium -	100 Fm fermium -	101 Md mendelevium -	102 No nobelium -	103 Lr lawrencium -			
actinoids																	

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