| Name | | Index Number | Class |
|------|--|--------------|-------|
|      |  |              |       |

# WOODGROVE SECONDARY SCHOOL
A SCHOOL OF CHOICE, A COMMUNITY OF DYNAMIC LEARNERS

## O LEVEL PRELIMINARY EXAMINATION 2020

| | |
|--|--|
| **LEVEL & STREAM** | : SECONDARY 4 EXPRESS |
| **SUBJECT (CODE)** | : CHEMISTRY (6092) |
| **PAPER NO** | : 1 |
| **DATE (DAY)** | : 17 SEPTEMBER 2020 (THURSDAY) |
| **DURATION** | : 1 HOUR |

**READ THESE INSTRUCTIONS FIRST**

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

Answer all multiple choice questions in the OMR answer sheet. For each question, there are four possible answers: **A, B, C** and **D**. Choose the most suitable answer and shade its letter in pencil on the OMR answer sheet.

A copy of the Periodic Table is printed in this paper.
The use of an approved scientific calculator is expected, where appropriate.

**DO NOT TURN OVER THE QUESTION PAPER UNTIL YOU ARE TOLD TO DO SO.**

| Student's Signature | | Parent's Signature | | For Examiner's Use | |
|---------------------|--|--------------------|--|--------------------|--|
| **Date** | | **Date** | | **Total** | / 40 |

This document consists of **18** printed pages including this cover page
Setter : Mdm Shuryati

**1**   In an experiment, a student reacts nitric acid with zinc powder. She wants to collect and measure the amount of gas produced at 30-second intervals.

Which apparatus is most suitable for collecting and measuring the amount the gas produced?

**A**

**B**

**C**

**D**
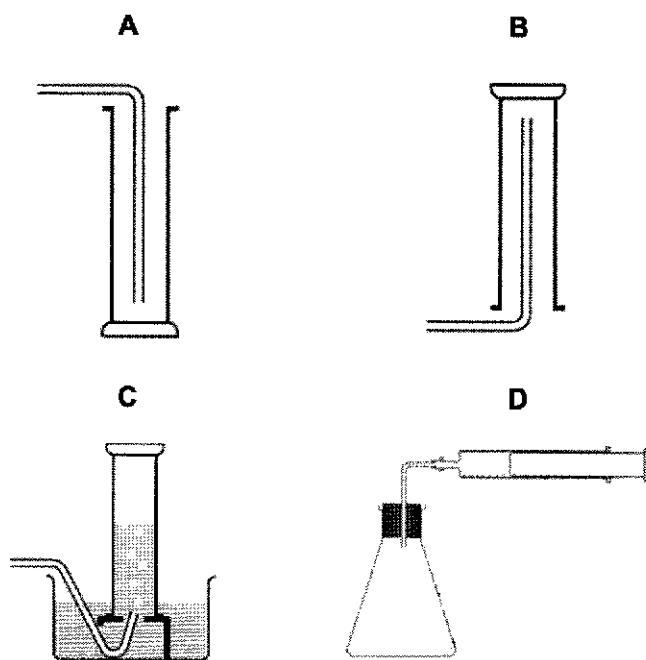
2    The apparatus shown is used to distill a dilute solution of ethanol in water.
     [boiling point of ethanol = 78 °C ; boiling point of water = 100 °C]
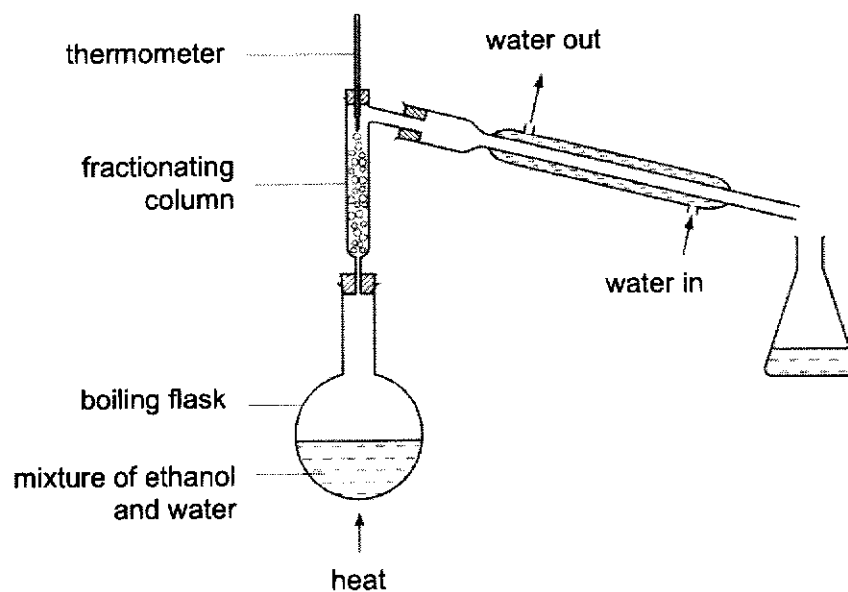


Which graph shows the change in concentration of the ethanol in the boiling flask as the distillation proceeds?
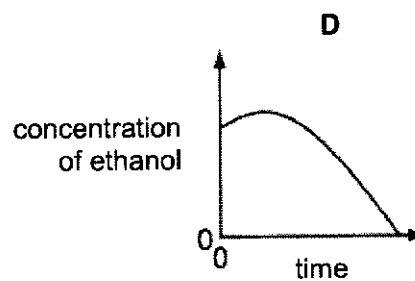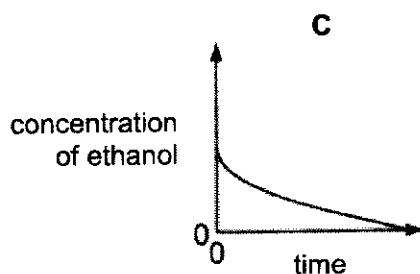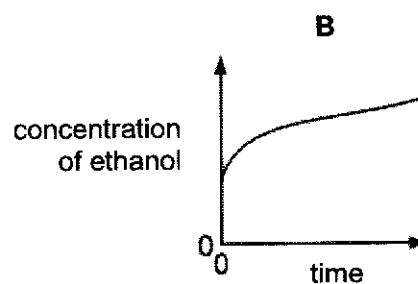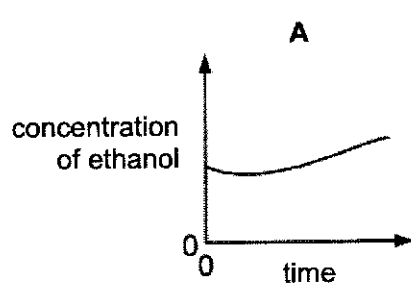
**3** In which of the following solid mixtures can the underlined substance be obtained by adding water, stirring and filtering?
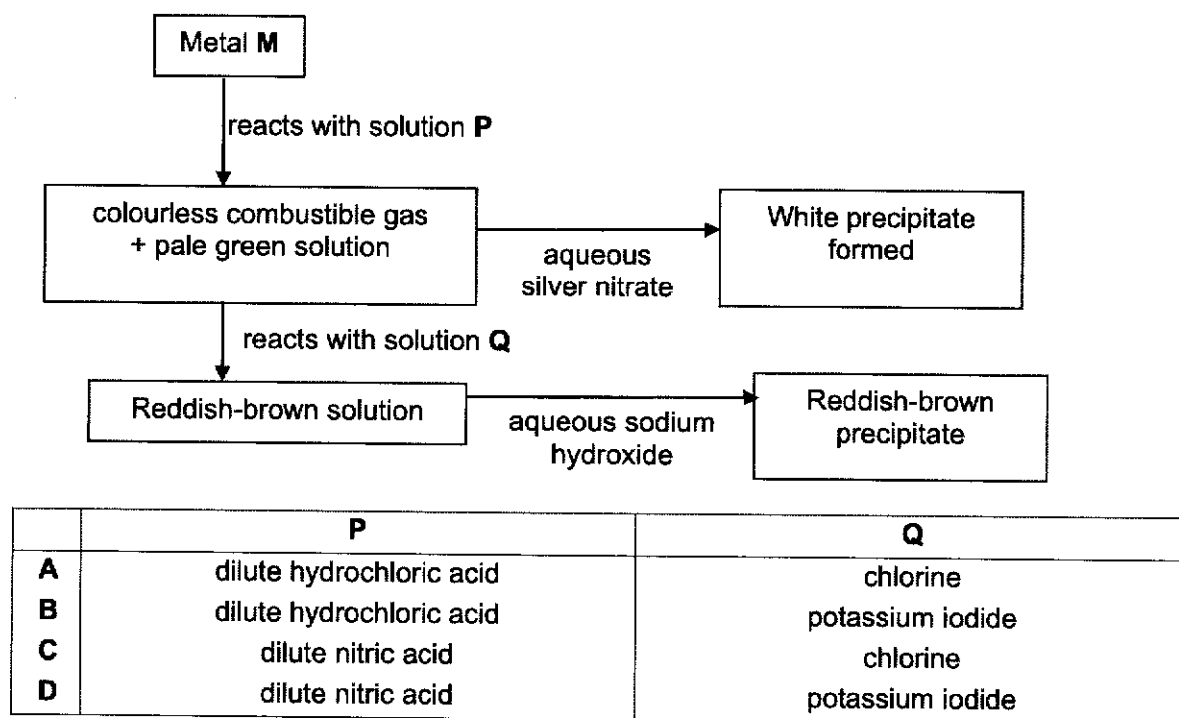
    **A**    Mixture of <u>copper</u> and copper(II) chloride
    **B**    Mixture of potassium chloride and <u>potassium hydroxide</u>
    **C**    Mixture of <u>sodium</u> and iron(II) sulfate
    **D**    Mixture of <u>zinc</u> and iron

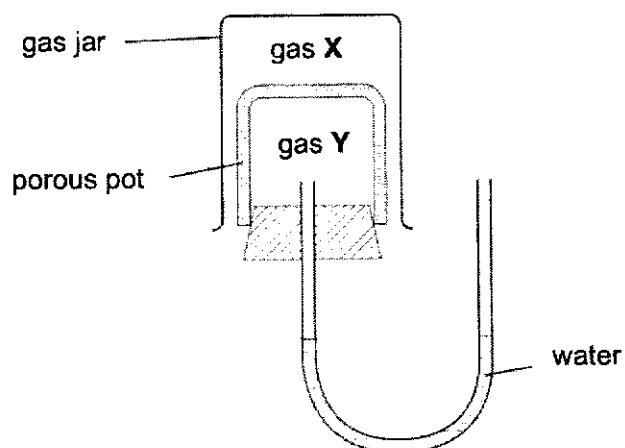**4** A series of chemical tests performed on an unknown solution produced the following results.

| test | observation |
| --- | --- |
| add aqueous sodium hydroxide | white precipitate formed, precipitate dissolved in excess aqueous sodium hydroxide |
| add acidified barium nitrate | white precipitate formed |

Which of the following substance could be present in the solution?

    **A**    aluminium chloride
    **B**    calcium carbonate
    **C**    sodium hydrogencarbonate
    **D**    zinc sulfate

**5** In the reaction scheme below, solutions **P** and **Q** are involved in some reactions. Identify **P** and **Q**.

Metal **M**

↓ reacts with solution **P**

colourless combustible gas + pale green solution

→ aqueous silver nitrate → White precipitate formed

↓ reacts with solution **Q**

Reddish-brown solution

→ aqueous sodium hydroxide → Reddish-brown precipitate

| | P | Q |
| --- | --- | --- |
| **A** | dilute hydrochloric acid | chlorine |
| **B** | dilute hydrochloric acid | potassium iodide |
| **C** | dilute nitric acid | chlorine |
| **D** | dilute nitric acid | potassium iodide |

6   The following apparatus was set up as shown below.



Which of the following pair of gases **X** and **Y** will result in **no** movement of the water in the U-shaped tube?

|   | gas **X** | gas **Y** |
|---|---|---|
| **A** | $H_2$ | He |
| **B** | $N_2$ | CO |
| **C** | $O_2$ | $CH_4$ |
| **D** | $SO_2$ | $NO_2$ |

**7** The information on two substances **P** and **Q** are given below.

| substance | P | Q |
|---|---|---|
| arrangement of particles | close and disorderly | far apart and disorderly |
| movement of particles | sliding around randomly | moving rapidly and randomly |

Four substances are given below.

| substance | description |
|---|---|
| 1 | copper at 100 °C |
| 2 | water at 25 °C |
| 3 | graphite at 30 °C |
| 4 | oxygen at 50 °C |

Which of the substances are **P** and **Q**?

| | P | Q |
|---|---|---|
| A | 1 | 2 |
| B | 2 | 4 |
| C | 3 | 1 |
| D | 4 | 3 |

8  In an experiment, a sample was vapourised, ionised and passed through an electric field. Analysis of the deflection occurring at the electric region revealed the following data for the sample.
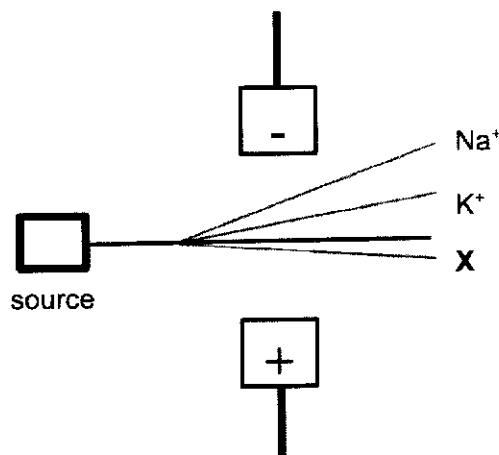


[Ar: Li, 7 ; F, 19 ; Na, 23 ; K, 39 ; Br, 80 ; Rb, 85]

What is a possible identity of the unknown particle, **X**?

A    $Br^-$
B    $F^-$
C    $Li^+$
D    $Rb^+$

9  Which of the following statements about an atom is correct?

A    The number of protons determine its chemical properties
B    The numbers of protons and neutrons determine its mass
C    Its nucleon number is the total number of neutrons in its nucleus
D    It is electrically neutral as there are equal numbers of protons and neutrons

10  Which of the following groups of substances contain an element, a compound and a mixture?

A    brass, rust, haematite
B    diamond, graphite, air
C    limestone, diamond, water
D    ozone, bronze, slag

11  Which of the following has substances with high melting points?

A    copper, sodium chloride, silicon dioxide
B    diamond, carbon dioxide, methane
C    glucose , ammonia, aluminium oxide
D    graphite, rubidium, magnesium oxide

12 The nucleon number of element **X** is 51. The ion **X³⁺** has 20 electrons.
What does the nucleus of the ion **X³⁺** contain?

Legend: n = neutrons; p = protons ; e = electrons

| A | 20e | 20p |
|---|-----|-----|
| B | 20p | 31n |
| C | 23e | 28n |
| D | 23p | 28n |

13 The diagram shows the arrangement of the ions in an ionic crystal.
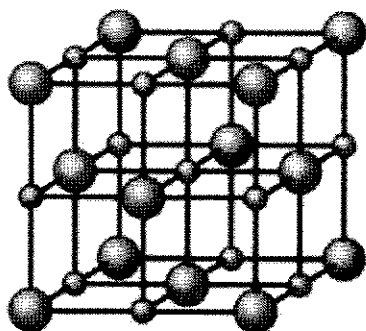


Which compound cannot have this arrangement of its ions?

A   lithium nitrate
B   zinc sulfate
C   sodium oxide
D   lead(II) sulfate

14 The diagram below shows the valence electrons of elements **X** and **Y**.
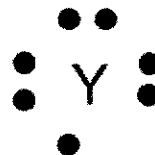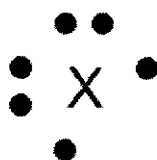


Which of the following correctly shows the type of bond and chemical formula of the compound formed between **X** and **Y**?

|   | type of bonds | chemical formula |
|---|---------------|------------------|
| A | covalent | $XY_2$ |
| B | ionic | XY |
| C | ionic | $X_2Y_3$ |
| D | covalent | $X_3Y_2$ |

**15** The structural formula of sulfuric acid is shown.
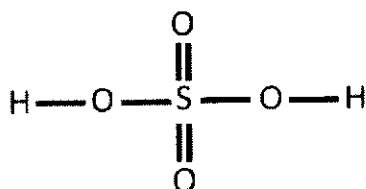


How many pairs of valence electrons are **not** involved in bonding in one sulfuric acid molecule?

A 5
B 8
C 10
D 16

**16** The equation shows the reaction between a metallic element **X** and water.

$$2X(s) + 2H_2O(l) \longrightarrow 2XOH(aq) + H_2(g)$$
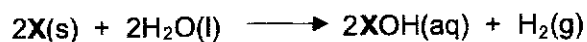
Which particles are responsible for the electrical conductivity in **X** and **XOH**?

| | X | XOH |
|---|---|---|
| A | electrons | cations |
| B | electrons | cations and anions |
| C | cations | electrons |
| D | cations | cations and anions |

**17** In the reaction below :

$$12H^+ + 2IO_3^- + 10Fe^{2+} \longrightarrow 10Fe^{3+} + I_2 + 6H_2O$$
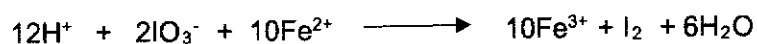
Which of the following is the oxidising agent?

A $H^+$
B $Fe^{2+}$
C $IO_3^-$
D $I_2$

**18** The ionic equation for a reaction is shown below:

$$Ca^{2+} + CO_3^{2-} \longrightarrow CaCO_3$$
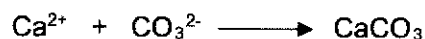
Which of the following conditions will make this reaction take place readily?

**A** Aqueous sodium carbonate is added to limewater.
**B** Calcium sulfate is added to aqueous sodium carbonate.
**C** Carbon dioxide is passed through aqueous calcium chloride.
**D** Calcium carbonate is crystallised from its saturated solution.

**19** A student set up four test-tubes to investigate the factors that cause the rusting of iron nails.
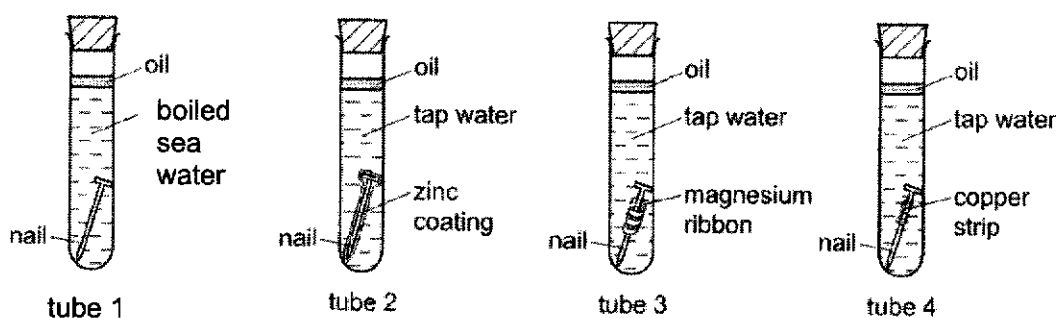


After leaving the tubes for one week, which tubes would show evidence of rusting?

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

**20** Which of the following pairs of compounds contain the same percentage by mass of nitrogen?

**A** $NO_2$ and $NH_4NO_3$
**B** $NH_4CNO$ and $(NH_2)_2CO$
**C** $N_2H_4$ and $NH_3$
**D** $(NH_2)_2CO$ and $NH_4Cl$

**21** Upon strong heating, a metal nitrate compound undergoes decomposition according to the following equation:

$$2XNO_3(s) \rightarrow 2X(s) + 2NO_2(g) + O_2(g)$$
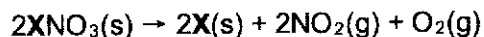
Complete decomposition of 3.40 g of the nitrate gives 240 cm³ of oxygen, measured at room temperature and pressure.

What is the relative atomic mass of **X**?

**A**   85
**B**   108
**C**   133
**D**   170

**22** Element **X** is extracted by the electrolysis of a molten compound of elements **X** and **Y**.
The electrode reactions are as shown:

$$\text{Cathode: } X^{2+} (l) + 2e^- \rightarrow X\ (l)$$

$$\text{Anode: }\ 2Y^{2-} (l) \rightarrow Y_2\ (g) + 4e^-$$
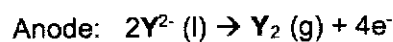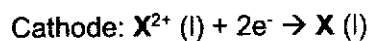
Which of the following could be the compound?

**A**   aluminium oxide
**B**   calcium chloride
**C**   magnesium oxide
**D**   potassium chloride

23  The diagram below shows an electrolytic cell. Initially, the bulb does **not** light up when the switch is closed.
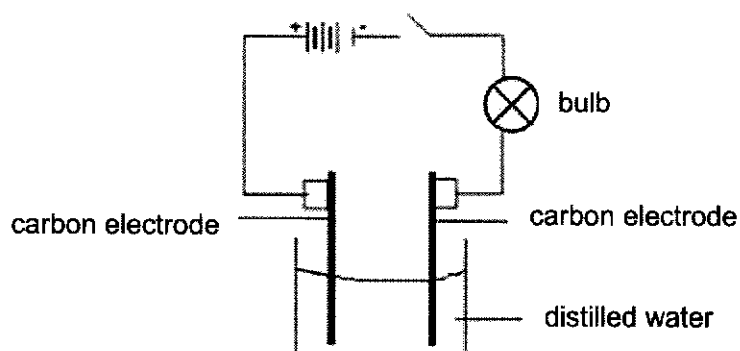


Which of the following substances, when added, will cause the bulb to be the brightest?

A   ethanoic acid
B   magnesium carbonate
C   sodium hydroxide
D   sugar

24  How will the addition of a catalyst affect the energy of particles and the activation energy of the reaction?

|   | energy of particles | activation energy |
|---|---------------------|-------------------|
| A | increases | decreases |
| B | increases | remains the same |
| C | remains the same | decreases |
| D | remains the same | remains the same |

**25** In the graph, curve **X** represents the results of the reaction between 1.0 g of granulated iron and excess acid at 30 °C.
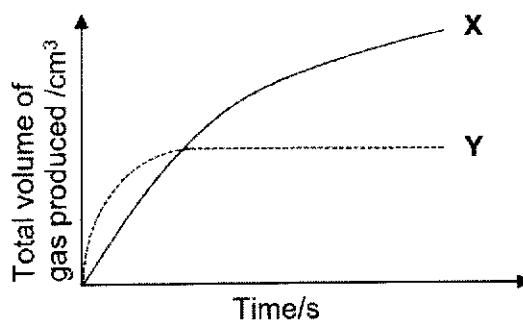


Which changes will produce curve **Y**?

A   Using 0.5 g of granulated iron at 20 °C.
B   Using 0.5 g of granulated iron at 40 °C.
C   Using 1.0 g of granulated iron at 20 °C.
D   Using 1.0 g of powdered iron at 20 °C.

**26** In which reaction is pressure **least** likely to affect the rate of reaction?

A   $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$
B   $HCl(g) + NH_3(g) \rightarrow NH_4Cl(s)$
C   $CO_2(g) + Ca(OH)_2(aq) \rightarrow CaCO_3(s) + H_2O(l)$
D   $NaOH(aq) + HCl(aq) \rightarrow NaCl(aq) + H_2O(l)$

**27** Study the reaction below:

$2KMnO_4(aq) + 5SO_2(g) + 2H_2O(l) \rightarrow K_2SO_4(aq) + 2MnSO_4(aq) + 2H_2SO_4(aq)$
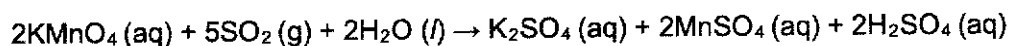
Which is the correct pair of oxidising and reducing agents and the corresponding observation in this reaction?

|   | oxidising agent | reducing agent | observations |
|---|---|---|---|
| A | $SO_2$ | $KMnO_4$ | colourless solution turns purple |
| B | $KMnO_4$ | $SO_2$ | purple solution decolourises |
| C | $KMnO_4$ | $H_2O$ | purple solution decolourises |
| D | $H_2SO_4$ | $MnSO_4$ | colourless solution turns purple |

**28** Which compound will eliminate acid in the soil but does **not** react with ammonium fertilisers?

A   calcium carbonate
B   calcium hydroxide
C   calcium nitrate
D   calcium oxide

**29** In which of the following reaction is zinc hydroxide **not** behaving as a base?

| A | $3Zn(OH)_2$ + $2H_3PO_4$ | $\longrightarrow$ | $Zn_3(PO_4)_2$ + $6H_2O$ |
|---|---|---|---|
| B | $Zn(OH)_2$ + $+(NH_4)_2SO_4$ | $\longrightarrow$ | $ZnSO_4$ + $2NH_3$ + $2H_2O$ |
| C | $Zn(OH)_2$ + $2HCl$ | $\longrightarrow$ | $ZnCl_2$ + $2H_2O$ |
| D | $Zn(OH)_2$ + $2NaOH$ | $\longrightarrow$ | $Na_2Zn(OH)_4$ |
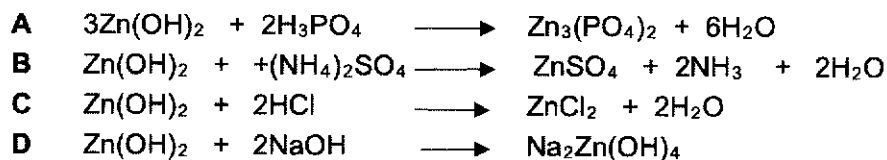
**30** Which pair of substances would **not** be suitable for producing a large quantity of carbon dioxide?

A    iron(II) carbonate and hydrochloric acid
B    lead(II) carbonate and hydrochloric acid
C    sodium carbonate and sulfuric acid
D    calcium carbonate and nitric acid

**31** Which reaction produces most of the carbon monoxide used to extract iron in the blast furnace?

A    burning coke in air
B    reacting coke with carbon dioxide
C    reacting iron oxide with coke
D    decomposition of limestone

**32** An element **X** reacts with iron to form two different compounds with the formulae FeX and Fe$_2$X$_3$.

What would the proton number of **X** likely to be?

A    5
B    7
C    8
D    9

**33** Approximately 40% of all iron and steel are produced by recycling.

The following statements are possible reasons for recycling iron.

1   Recycling reduces the amount of waste taken to landfill sites.
2   Recycling reduces the amount of pollution at the site of the ore extraction.
3   Iron ore contains a higher percentage of iron than scrap steel.

Which of the statements are correct?

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

34  Which of the following metals is extracted from its ore via reduction by carbon and would require the most energy to do so?

A   Copper
B   Iron
C   Lead
D   Zinc

35  Which of the following properties increases down the group in Group I?

A   ease of losing an electron
B   ionic charge
C   melting point
D   non-metallic character

36  The table gives the catalysts used in some industrial processes.

| process/reaction | catalyst |
|---|---|
| Cracking | aluminum oxide or silicon(IV) oxide |
| Esterification | concentrated sulfuric acid |
| Haber | iron |
| Manufacture of margarine | nickel |

How many different transition metals are included in the list of catalyst?

A   1
B   2
C   3
D   4

37  Which diagram best represents the structure of an alloy?

A



B



C



D
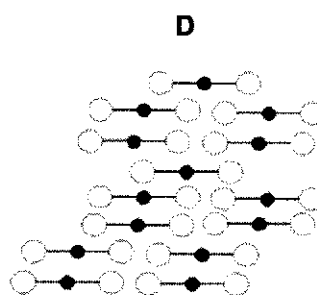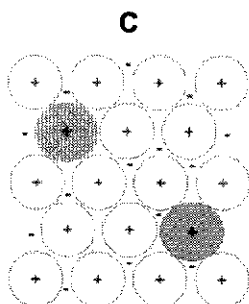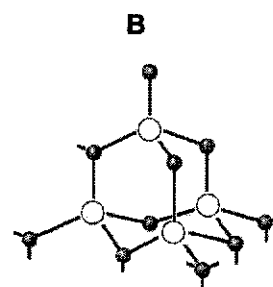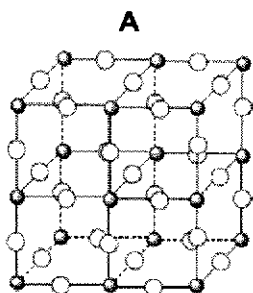


**38** The table shows the results of adding weighed pieces of iron to solutions **M** and **S**.

| solution used | initial mass of iron/g | final mass of iron after 15 minutes/g |
|---|---|---|
| M | 5 | 4 |
| S | 5 | 4 |

What could be the aqueous solutions **M** and **S** be?

| | M | S |
|---|---|---|
| A | copper(II) sulfate | silver nitrate |
| B | dilute hydrochloric acid | sodium chloride |
| C | iron(II)chloride | calcium chloride |
| D | magnesium chloride | dilute sulfuric acid |

**39** Which molecule has the greatest ozone-depleting potential?

A    CFC/Br

B    $CFCl_3$

C    $CF_4$

D    $CH_2F_2$

**40** An atmospheric pollutant can be removed by the process of oxidation.

Which pollutant is removed by this process?

**A**    carbon monoxide in a catalytic converter
**B**    nitrogen dioxide in a catalytic converter
**C**    nitrogen dioxide in acid rain by reaction with calcium carbonate
**D**    sulfur dioxide from the flue gases by reaction with calcium carbonate

# The Periodic Table of Elements

Group

**Key**

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

| I | II | III | IV | V | VI | VII | 0 |
|---|---|---|---|---|---|---|---|
| | | | | | | | 2 He helium 4 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 3 Li lithium 7 | 4 Be beryllium 9 | | | | | | |
| 11 Na sodium 23 | 12 Mg magnesium 24 | | | | | | |

| 5 B boron 11 | 6 C carbon 12 | 7 N nitrogen 14 | 8 O oxygen 16 | 9 F fluorine 19 | 10 Ne neon 20 |
|---|---|---|---|---|---|
| 13 Al aluminium 27 | 14 Si silicon 28 | 15 P phosphorus 31 | 16 S sulfur 32 | 17 Cl chlorine 35.5 | 18 Ar argon 40 |

1 H hydrogen 1

| 19 K potassium 39 | 20 Ca calcium 40 | 21 Sc scandium 45 | 22 Ti titanium 48 | 23 V vanadium 51 | 24 Cr chromium 52 | 25 Mn manganese 55 | 26 Fe iron 56 | 27 Co cobalt 59 | 28 Ni nickel 59 | 29 Cu copper 64 | 30 Zn zinc 65 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 31 Ga gallium 70 | 32 Ge germanium 73 | 33 As arsenic 75 | 34 Se selenium 79 | 35 Br bromine 80 | 36 Kr krypton 84 |

| 37 Rb rubidium 85 | 38 Sr strontium 88 | 39 Y yttrium 89 | 40 Zr zirconium 91 | 41 Nb niobium 93 | 42 Mo molybdenum 96 | 43 Tc technetium – | 44 Ru ruthenium 101 | 45 Rh rhodium 103 | 46 Pd palladium 106 | 47 Ag silver 108 | 48 Cd cadmium 112 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 49 In indium 115 | 50 Sn tin 119 | 51 Sb antimony 122 | 52 Te tellurium 128 | 53 I iodine 127 | 54 Xe xenon 131 |

| 55 Cs caesium 133 | 56 Ba barium 137 | 57 – 71 lanthanoids | 72 Hf hafnium 178 | 73 Ta tantalum 181 | 74 W tungsten 184 | 75 Re rhenium 186 | 76 Os osmium 190 | 77 Ir iridium 192 | 78 Pt platinum 195 | 79 Au gold 197 | 80 Hg mercury 201 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 81 Tl thallium 204 | 82 Pb lead 207 | 83 Bi bismuth 209 | 84 Po polonium – | 85 At astatine – | 86 Rn radon – |

| 87 Fr francium – | 88 Ra radium – | 89 – 103 actinoids | 104 Rf rutherfordium – | 105 Db dubnium – | 106 Sg seaborgium – | 107 Bh bohrium – | 108 Hs hassium – | 109 Mt meitnerium – | 110 Ds darmstadtium – | 111 Rg roentgenium – | 112 Cn copernicium – |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 113 Nh nihonium – | 114 Fl flerovium – | 115 Mc moscovium – | 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

**actinoids**

| 89 Ac actinium – | 90 Th thorium 232 | 91 Pa protactinium 231 | 92 U uranium 238 | 93 Np neptunium – | 94 Pu plutonium – | 95 Am americium – | 96 Cm curium – | 97 Bk berkelium – | 98 Cf californium – | 99 Es einsteinium – | 100 Fm fermium – | 101 Md mendelevium – | 102 No nobelium – | 103 Lr lawrencium – |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

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

# WOODGROVE SECONDARY SCHOOL
A SCHOOL OF CHOICE, A COMMUNITY OF DYNAMIC LEARNERS

# O LEVEL PRELIMINARY EXAMINATION 2020

| | |
|---|---|
| **LEVEL & STREAM** | : SECONDARY 4 EXPRESS |
| **SUBJECT (CODE)** | : CHEMISTRY (6092) |
| **PAPER NO** | : 2 |
| **DATE (DAY)** | : 2 SEPTEMBER 2020 (WEDNESDAY) |
| **DURATION** | : 1 HOUR 45 MINUTES |

## READ THESE INSTRUCTIONS FIRST

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

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

**Section B**
Answer all **three** questions, the last question is in the form either/or.
Answer all questions in the spaces provided.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.
A copy of the Periodic Table is printed in this paper.
The use of an approved scientific calculator is expected, where appropriate.

| For Examiner's Use | |
|---|---|
| | |
| A | /50 |
| B | /30 |

| Student's Signature | | Parent's Signature | | Total | /80 |
|---|---|---|---|---|---|
| Date | | Date | | | |

This document consists of **24** printed pages including this cover page
Setter : Mdm Shuryati

## Section A

Answer all the questions. Write your answers in the spaces provided on the question paper.

**A1** Hydrogen, deuterium and tritium are isotopes of one another.
Using this information, complete Table 1.1.

**(a)**

| name | formula | number of protons | number of neutrons | number of electrons |
|------|---------|-------------------|--------------------|--------------------|
| hydrogen atom | $^{1}_{1}H$ | 1 | | 1 |
| deuterium ion | $^{2}_{1}H^{+}$ | | | 0 |
| tritium ion | | | 2 | 2 |

[3]

**Table 1.1**

**(b)** Table 1.2 gives the relative abundance of each isotope in a mass spectrum of sample of germanium, Ge.

| mass | 70 | 72 | 74 |
|------|-----|-----|-----|
| relative abundance (%) | 24.4 | 32.4 | 43.2 |

**Table 1.2**

Use the data in Table 1.2 to calculate the relative atomic mass ($A_r$) of this sample of germanium.

$A_r$ of germanium = _____ [2]

**(c)** A student commented, "Isotopes of an element should all have the same chemical properties."
Do you agree with the student? Give a reason for your answer.

_____

_____

_____ [1]

**A2**   Table 2.1 shows the formulae of some reagents. Use the formulae to answer the questions that follow.

Each reagent can be used once, more than once, or not at all.

| $Na_2CO_3(aq)$ | $KOH(aq)$ | $CuCl_2(aq)$ |
|---|---|---|
| $Zn(s)$ | $Ba(NO_3)_2(aq)$ | $H_2SO_4(aq)$ |
| $(NH_4)_2SO_4(aq)$ | $PbCO_3(s)$ | $Ag(s)$ |

**Table 2.1**

**(a)**   Write the formulae of any two reagents which, when mixed together,

**(i)**   would produce a green insoluble salt,

_____   [1]

**(ii)**   would produce a white precipitate,

_____   [1]

**(iii)**   would produce a gas which turns moist red litmus blue,

_____   [1]

**(iv)**   would produce a pink solid,

_____   [1]

**(v)**   would produce a salt prepared by titration.

_____   [1]

**(b)**   Write the chemical equation, of the formation of salt in **A2(a)(i).**

_____   [1]

**A3** **(a)** Using the knowledge of the particulate model of matter, describe the changes in the particles in terms of arrangement and motion when dry ice is heated.

arrangement : _____

_____

_____ [1]

motion : _____

_____

_____ [1]

**(b)** A student separates four amino acids by paper chromatography using two different solvents.
The solvent front of solvent 1 takes five minutes to reach the end of the chromatogram while the solvent front of solvent 2 takes ten minutes.
Table 3.1 shows the $R_f$ values she obtained for these amino acids.

| amino acid | $R_f$ in solvent 1 | $R_f$ in solvent 2 |
|---|---|---|
| A | 0.2 | 0.5 |
| B | 0.1 | 0.4 |
| C | 0.8 | 0.9 |
| D | 0.3 | 0.4 |

**Table 3.1**

**(i)** Which amino acid travels fastest in both solvents?

_____ [1]

(ii)    The student wrote the following paragraph about the chromatography experiment that she has conducted.

'It is better to use solvent 2 as it allows me to find out the identity of the 4 amino acids. One source of error in this experiment is that the duration of chromatography for solvent 2 is longer than for solvent 1, thus it is an unfair experiment.'

Do you agree with the student? Explain your reasoning.

_____

_____

_____

_____

_____

_____

_____    [2]

**A4**    Fig. 4.1 shows the structures of substances **A** and **B**.

Substance **A**                                      Substance **B**
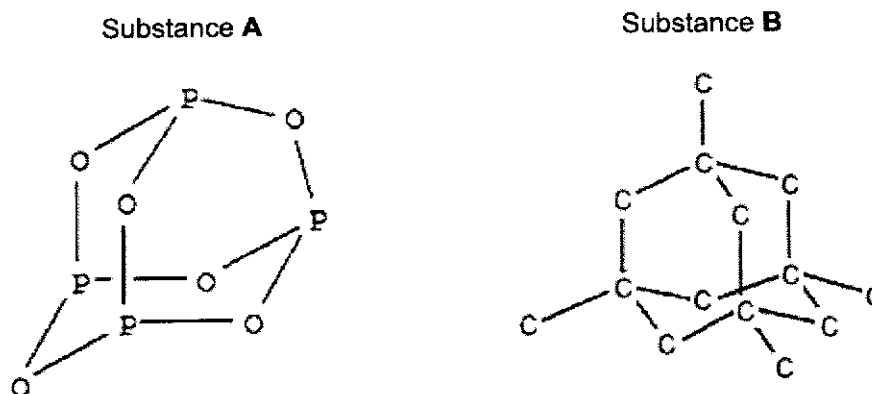


**Fig. 4.1**

(a)    Write down the molecular formula of substance **A**.

_____    [1]

(b)    Explain why substance **B** is a poor conductor of electricity.

_____

_____    [1]

**(c)** Substance **A** is a simple covalent molecule while substance **B** is a macromolecule.

With reference to the structures shown in Fig. 4.1, explain the difference in terms of structure and bonding between simple and giant molecular structures.

_____

_____

_____

_____ [2]

**(d)** What type of oxide is substance **A**? Explain your answer.

_____ [1]

**A5** **(a)** Dilute hydrochloric acid is added to a solution of sodium thiosulfate. The reaction is as shown below.

$2HCl$ (aq) + $Na_2S_2O_3$ (aq) $\longrightarrow$ $2NaCl$ (aq) + $SO_2$ (g) + S (s) + $H_2O$ (l)
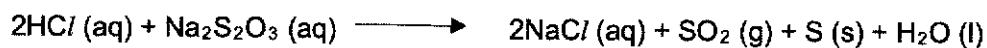
**(i)** Using your knowledge of particle collisions, explain clearly how the rate of reaction is affected with increasing pH.

_____

_____

_____

_____

_____

_____ [2]

**(ii)** In an experiment, 50.0 cm³ of 1.0 mol/dm³ dilute hydrochloric acid is added to 50.0 cm³ of 1.0 mol/dm³ sodium thiosulfate solution.
The mass of the precipitate is measured and recorded in Fig. 5.1
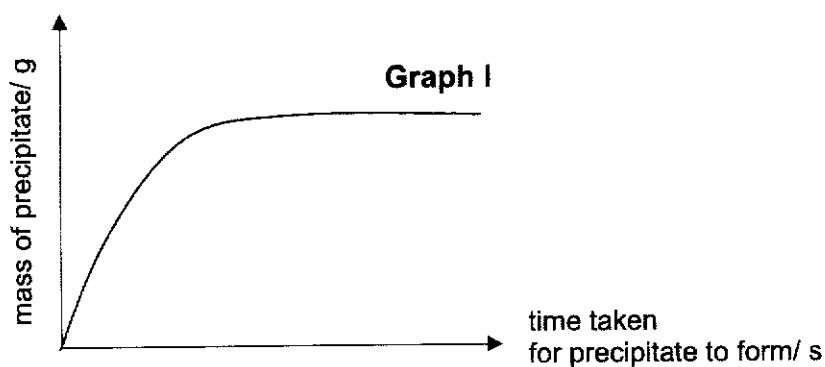


**Fig. 5.1**

Explain why the mass remains constant after some time.
Show all working.

[2]

**(iii)** On the graph in **(a)(ii)**, sketch the graph of the results you would expect if the thiosulfate solution is heated from room temperature to 50 °C.
Label this "**Graph II**'.                                                              [1]

**(b)** Fig. 5.2 shows an electric cell.
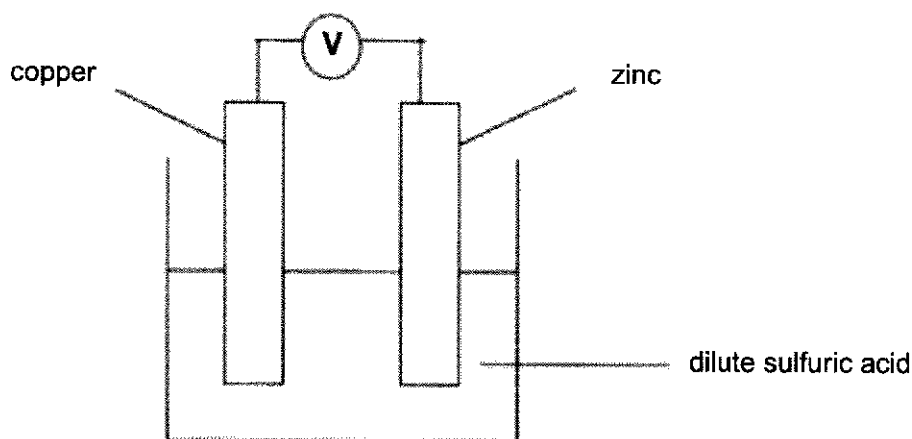


**Fig. 5.2**

**(i)** Indicate with arrows on the diagram to show the direction of the flow of electrons in the wire. [1]

**(ii)** The experiment is repeated with the zinc electrode replaced by iron.
State and explain the change in voltmeter reading obtained.

_____

_____

_____ [2]

**6** **(a)** Strontium, Sr is in the same group as calcium and barium in the Periodic Table.

**(i)** Explain in terms of atomic structure, why strontium is positioned below calcium but above barium in the Periodic Table.

_____ [1]

**(ii)** Strontium reacts with cold water.
Write a balanced equation for the reaction.

_____ [1]

**(iii)** Would you expect strontium to be more reactive or less reactive than calcium?
Explain your answer.

_____

_____ [1]

**(b)** A student compared the speed of decomposition of three metal carbonates.
She measured the volume of gas released over time using the apparatus shown in Fig. 6.1.



gas syringe

metal carbonate

heat
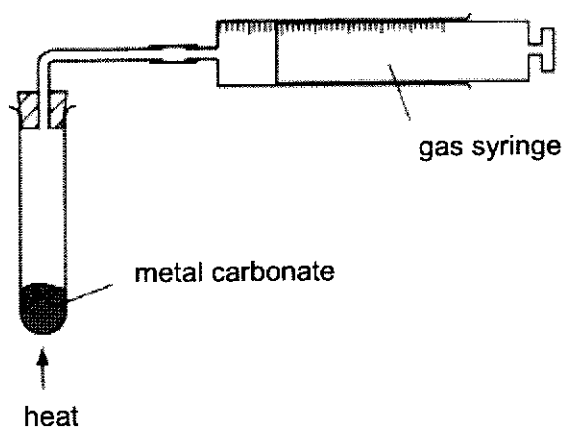
**Fig. 6.1**

State **one** thing that must be kept constant if the speed of decomposition of the three metal carbonates is to be compared.

_____ [1]

**(c)** Fig. 6.2 shows the graph of the volume of carbon dioxide released when the three metal carbonates decomposed when heated.
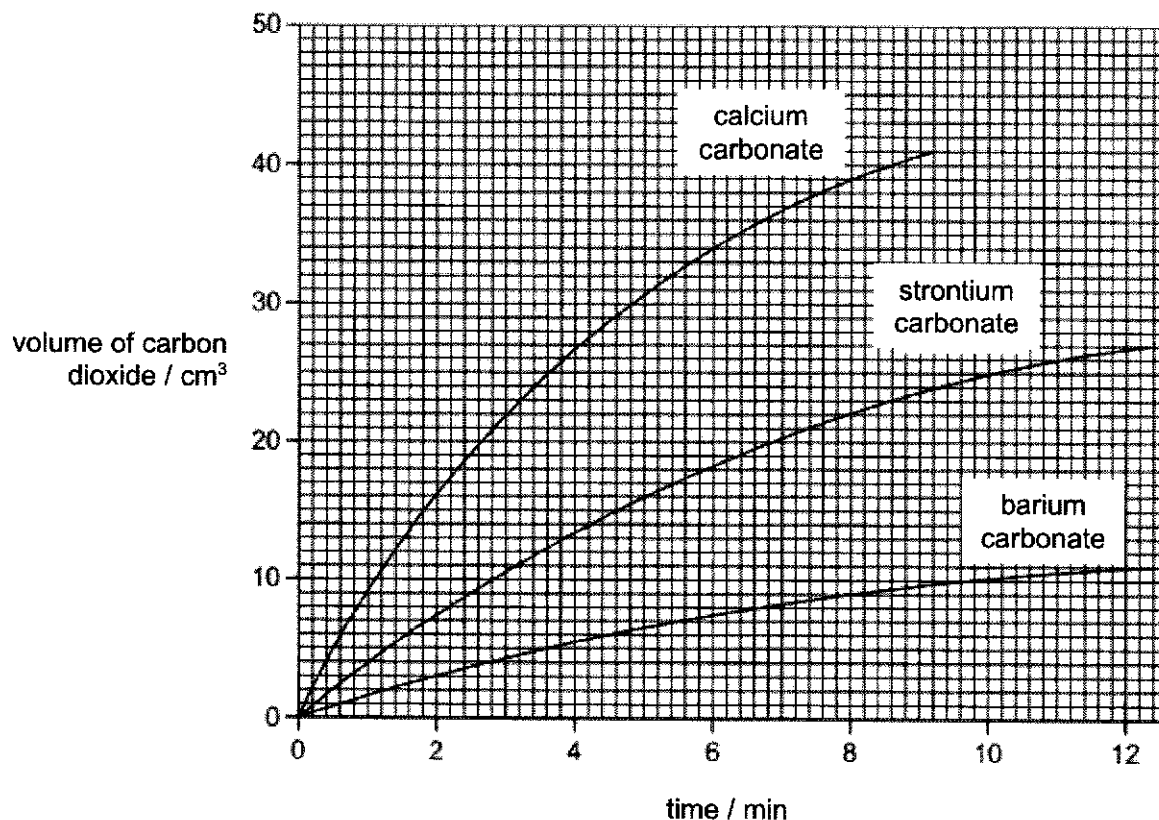


**Fig. 6.2**

**(i)** Explain how does the speed of the decomposition of these three metal carbonates relate to the position of calcium, strontium and barium in the Periodic Table?

_____

_____

_____ [2]

**(ii)** On Fig. 6.2, draw a graph when potassium carbonate was heated, assuming all other conditions remain the same.
Label the graph as **(c)(ii)**. [1]

(iii) When 0.1 mole of barium carbonate was heated, 15.00 g of barium oxide was formed.
Calculate the percentage yield of barium oxide.

[2]

(d) (i) Draw the 'cross and dot' diagram to show the arrangement of electrons in calcium oxide.
Show valence electrons only.

[2]

(ii) Explain the difference in the electrical conductivity between barium and barium oxide.

_____

_____

_____

_____

_____ [2]

**(e)** Iron is extracted in the blast furnace before it is made into alloys.

**(i)** Write the balanced chemical equation for the extraction of iron in the blast furnace.

_____ [1]

**(ii)** Describe the bonding in iron metal.

_____

_____ [1]

**(iii)** Explain why underwater pipes have a piece of magnesium attached to them.

_____

_____

_____

_____ [2]

**A7** Ammonia is produced via the Haber process.
The volume of gases in the reaction chamber is monitored throughout the reaction, and the results were plotted in the graph in Fig. 7.1.

volume of gas / dm³
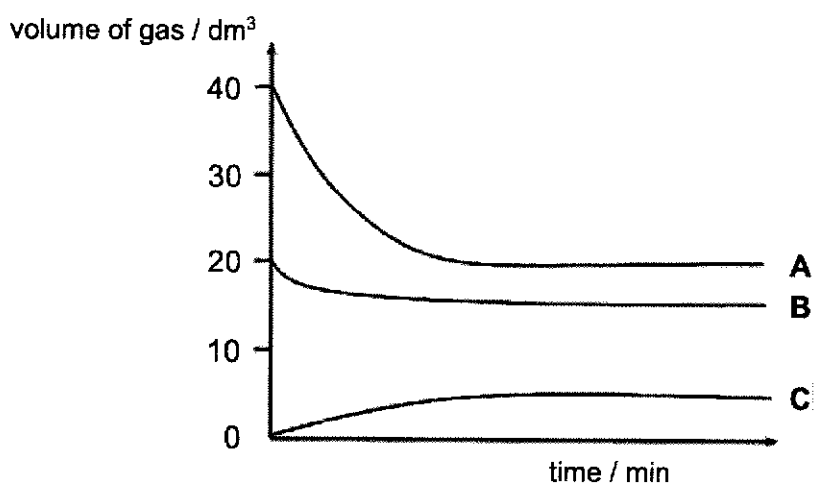


**Fig. 7.1**

**(a)** Write the equation for the formation of ammonia gas.

_____ [1]

**(b)** Deduce which gas each graph represents, and explain how you derived your answer.

_____

_____

_____

_____ [2]

## Section B

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

**B8**   **Read the information about some titration experiments.**

A pH probe attached to a computer measures pH changes during some titration experiments.
In the **experiment 1**, 0.2 mol/dm³ hydrochloric acid was added from a burette to 25 cm³ of dilute sodium hydroxide.
The pH probe measured the pH during the experiment.

Fig. 8.1 shows the results of the experiment 1.



pH

volume of acid added / cm³
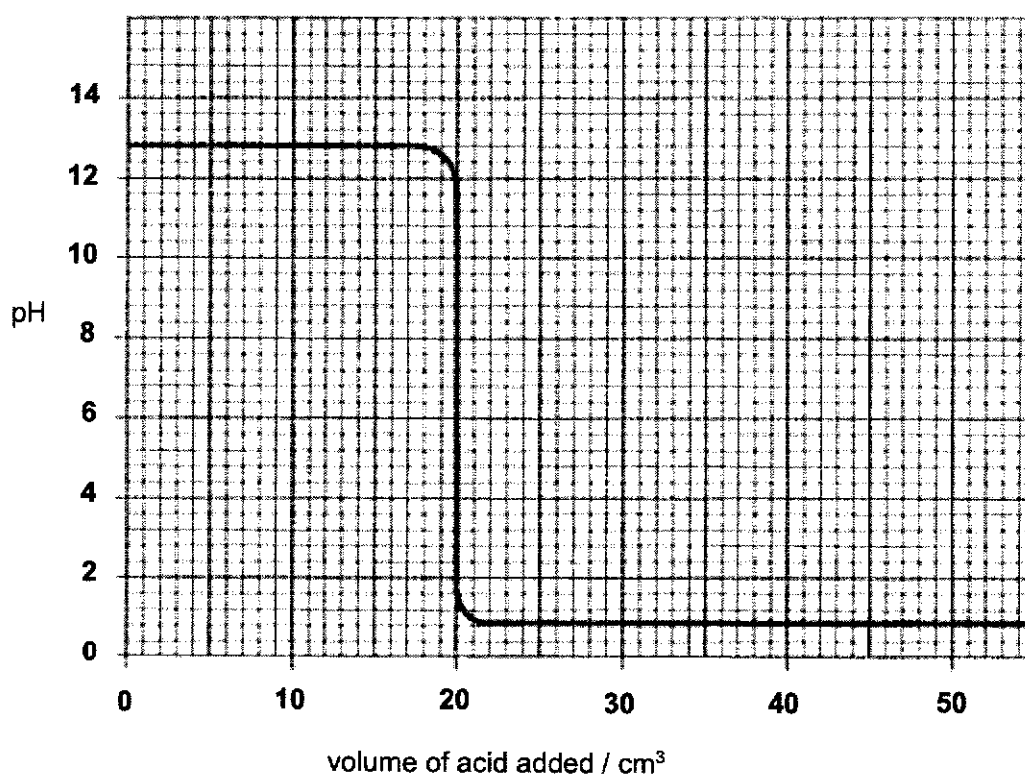
**Fig. 8.1**

In **experiment 2**, 0.2 mol/dm³ hydrochloric acid was added from a burette to 25 cm³ of dilute sodium carbonate.

Fig. 8.2 shows the results.
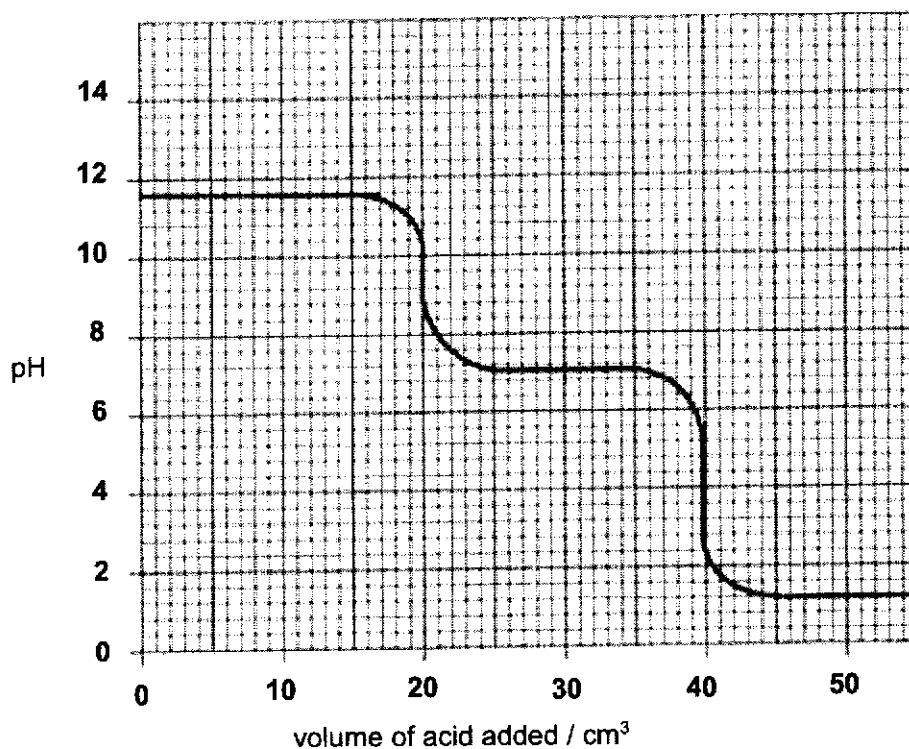


**Fig. 8.2**

The reaction between sodium carbonate and hydrochloric acid happens in two stages.

Stage 1: Sodium carbonate reacts with dilute hydrochloric acid to form sodium hydrogencarbonate (NaHCO₃) and a neutral salt.

Stage 2: Sodium hydrogencarbonate undergoes a further reaction with hydrochloric acid.

## Endpoints and indicators

The endpoint of each titration happens when the indicator changes colour.
Fig. 8.3 shows the colours of some indicators at different pH values. In between the colours, most indicators change colour gradually over a range of pH values.



gradual colour change
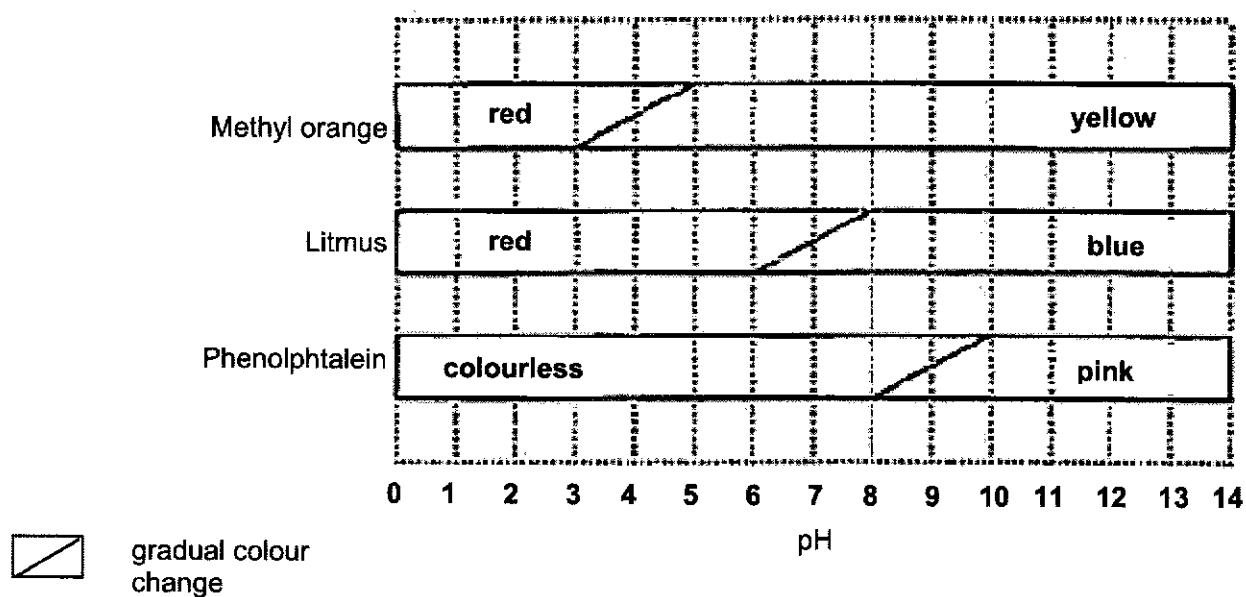
**Fig. 8.3**

**(a)** Use the information to calculate the concentration of sodium hydroxide used in **experiment 1**.

[3]

**(b)** A third experiment was carried out. A solution of sodium hydroxide of the same concentration as that used in experiment 1 was used. This time dilute hydrochloric acid of a concentration of 0.1 mol/dm³ was added from the burette.

On Fig. 8.1, sketch the graph you would expect from this experiment. [1]

**(c)** What is the pH of sodium hydrogencarbonate?

_____ [1]

**(d)** What is the name and formula of the neutral salt formed in **experiment 2** by the first stage of the reaction between sodium carbonate and hydrochloric acid?

_____ [1]

**(e)** Sodium carbonate is described as a weak alkali but sodium hydroxide is described as a strong alkali.

Use information from the graphs to explain why.

_____

_____

_____

_____ [2]

**(f)** Explain why any of the indicators in Fig. 8.3 can be used to give an accurate titration volume when hydrochloric acid is titrated with dilute sodium hydroxide.

_____

_____ [1]

**(g)** Explain why methyl orange would **not** be suitable to use when titrating sodium carbonate with dilute hydrochloric acid.

_____

_____ [1]

**B9** The electrolysis of concentrated aqueous hydrochloric acid was carried out using the apparatus as shown in Fig. 9.1.
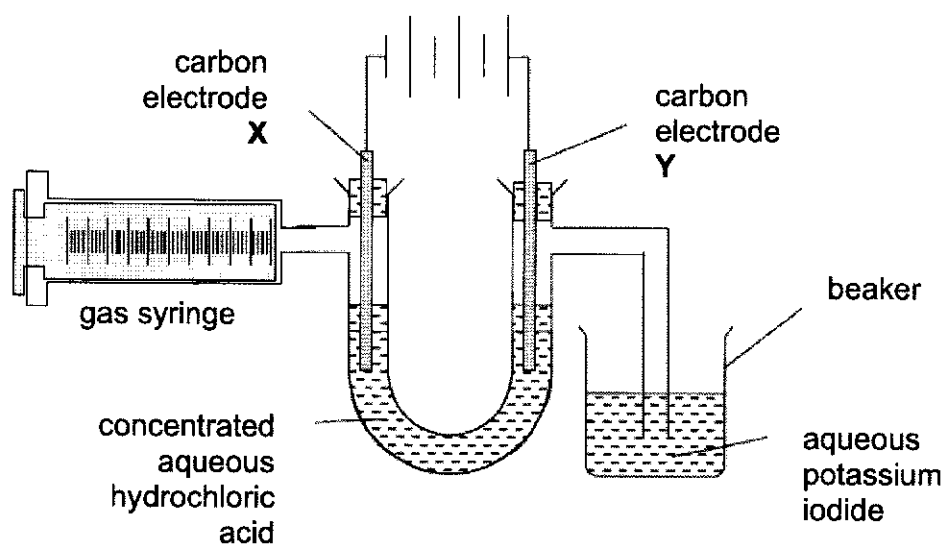


**Fig. 9.1**

**(a)** Construct the half equations for the reactions at the electrodes.

carbon electrode **X** _____

carbon electrode **Y** _____ [2]

**(b)** Predict the observations in the beaker containing aqueous potassium iodide as the electrolysis proceeds.
With the aid of a chemical equation, explain your answer.

_____

_____

_____

_____

_____

_____ [3]

**(c)** After the electrolysis was allowed to proceed for some time, it was observed that a new product was formed at carbon electrode **Y**.
State the identity of this new product. Explain your answer.

_____

_____

_____

_____ [2]

**(d)** Another experiment was carried out to electrolyse copper(II) sulfate solution using copper electrodes.
Student **A** commented that the colour intensity of the blue copper(II) sulfate solution will start to fade away throughout the experiment.

Student **B** commented that there will be no changes in the colour intensity of the blue copper(II) sulfate solution throughout the experiment.

Which student is correct? Explain your answer with the help of half equations.

_____

_____

_____

_____

_____

_____ [3]

**Either**

**B10** The structural formula of ethane is

```
        H     H
        |     |
   H -  C  -  C  -  H
        |     |
        H     H
```
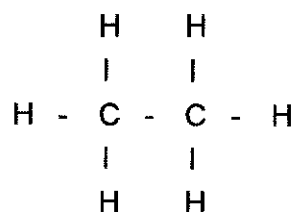
The combustion of ethane gas can be represented by the following equation.

$2C_2H_6 + 7O_2 \rightarrow 4CO_2 + 6H_2O$   $\Delta H = -2868$ kJ mol$^{-1}$

Some bond energy values are given in Table 10.1.

| bond | bond energy / kJ mol$^{-1}$ |
|------|------------------------------|
| C–H  | 410 |
| O=O  | 496 |
| C=O  | 805 |
| O–H  | 460 |

**Table 10.1**

**(a)** Draw an energy profile diagram for the combustion of ethane. Your diagram should indicate
  - the activation energy,
  - the enthalpy change of reaction, $\Delta H$.
  - the formulae of the reactants and products.

energy

progress of reaction

[3]

**(b)** Calculate the bond energy for the C–C bond.

[3]

**(c)** Calculate the energy released by the complete combustion of 48.0 cm$^3$ of ethane.

[2]

**(d)** The amount of carbon dioxide in the atmosphere is increasing due to our use of fossil fuels.

    **(i)** State the harmful effect of high concentration of carbon dioxide.

_____

_____ [1]

    **(ii)** One approach to the problem is to plant more trees.
Suggest why planting more trees is **not** a long term solution to the increase in the amount of carbon dioxide.

_____

_____ [1]

**Or**

**B10** **(a)** An oxyacid is a compound that contains hydrogen, oxygen and at least one other element. Iodine forms several types of oxyacids and their names and chemical formulae are given in Table 10.2.

| name of oxyacid acid | chemical formula | oxidation state of iodine |
|---|---|---|
| periodic acid | $HIO_4$ | |
| iodic acid | $HIO_3$ | |
| hypoiodous acid | $HIO$ | |

**Table 10.2**

**(i)** Complete Table 10.2 to show the oxidation states of iodine in the respective oxyacids. [2]

**(ii)** What is the formula of the anion present in periodic acid?

_____ [1]

**(iii)** Draw a 'dot-and-cross' diagram to show the bonding in a molecule of hypoiodous acid, HIO.
Show outer shell electrons only.

[2]

**(b)** Iodic acid is produced when iodine is mixed with water and chlorine, as shown in the equation below.

$I_2 + 6H_2O + 5Cl_2 \rightleftharpoons 2HIO_3 + 10HCl$
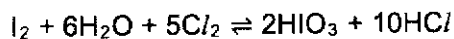
Explain, in terms of oxidation states, why this is a redox reaction

_____

_____

_____

_____ [2]

**(c)** Oxalic acid is made up of carbon, oxygen and hydrogen and it contains 26.7 % carbon and 2.20 % hydrogen by mass.

**(i)** Determine the empirical formula of oxalic acid.

[2]

**(ii)** The relative molecular mass of oxalic acid is 90.
Determine the molecular formula of oxalic acid.

[1]

**End of Paper**

# The Periodic Table of Elements

Group

**Key**

proton (atomic) number
atomic symbol
name
relative atomic mass

| I | II | III | IV | V | VI | VII | 0 |
|---|---|---|---|---|---|---|---|
| | | | | | | | 2 He helium 4 |

| 1 H hydrogen 1 | | | | | | | |

| I | II | | | | | | | | | | | III | IV | V | VI | VII | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3 Li lithium 7 | 4 Be beryllium 9 | | | | | | | | | | | 5 B boron 11 | 6 C carbon 12 | 7 N nitrogen 14 | 8 O oxygen 16 | 9 F fluorine 19 | 10 Ne neon 20 |
| 11 Na sodium 23 | 12 Mg magnesium 24 | | | | | | | | | | | 13 Al aluminium 27 | 14 Si silicon 28 | 15 P phosphorus 31 | 16 S sulfur 32 | 17 Cl chlorine 35.5 | 18 Ar argon 40 |
| 19 K potassium 39 | 20 Ca calcium 40 | 21 Sc scandium 45 | 22 Ti titanium 48 | 23 V vanadium 51 | 24 Cr chromium 52 | 25 Mn manganese 55 | 26 Fe iron 56 | 27 Co cobalt 59 | 28 Ni nickel 59 | 29 Cu copper 64 | 30 Zn zinc 65 | 31 Ga gallium 70 | 32 Ge germanium 73 | 33 As arsenic 75 | 34 Se selenium 79 | 35 Br bromine 80 | 36 Kr krypton 84 |
| 37 Rb rubidium 85 | 38 Sr strontium 88 | 39 Y yttrium 89 | 40 Zr zirconium 91 | 41 Nb niobium 93 | 42 Mo molybdenum 96 | 43 Tc technetium - | 44 Ru ruthenium 101 | 45 Rh rhodium 103 | 46 Pd palladium 106 | 47 Ag silver 108 | 48 Cd cadmium 112 | 49 In indium 115 | 50 Sn tin 119 | 51 Sb antimony 122 | 52 Te tellurium 128 | 53 I iodine 127 | 54 Xe xenon 131 |
| 55 Cs caesium 133 | 56 Ba barium 137 | 57 – 71 lanthanoids | 72 Hf hafnium 178 | 73 Ta tantalum 181 | 74 W tungsten 184 | 75 Re rhenium 186 | 76 Os osmium 190 | 77 Ir iridium 192 | 78 Pt platinum 195 | 79 Au gold 197 | 80 Hg mercury 201 | 81 Tl thallium 204 | 82 Pb lead 207 | 83 Bi bismuth 209 | 84 Po polonium - | 85 At astatine - | 86 Rn radon - |
| 87 Fr francium - | 88 Ra radium - | 89 – 103 actinoids | 104 Rf Rutherfordium - | 105 Db dubnium - | 106 Sg seaborgium - | 107 Bh bohrium - | 108 Hs hassium - | 109 Mt meitnerium - | 110 Ds darmstadtium - | 111 Rg roentgenium - | 112 Cn copernicium - | | 114 Fl flerovium - | | 116 Lv livermorium - | | |

**lanthanoids**

| 57 La lanthanum 139 | 58 Ce cerium 140 | 59 Pr praseodymium 141 | 60 Nd neodymium 144 | 61 Pm promethium - | 62 Sm samarium 150 | 63 Eu europium 152 | 64 Gd gadolinium 157 | 65 Tb terbium 159 | 66 Dy dysprosium 163 | 67 Ho holmium 165 | 68 Er erbium 167 | 69 Tm thulium 169 | 70 Yb ytterbium 173 | 71 Lu lutetium 175 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

**actinoids**

| 89 Ac actinium - | 90 Th thorium 232 | 91 Pa protactinium 231 | 92 U uranium 238 | 93 Np neptunium - | 94 Pu plutonium - | 95 Am americium - | 96 Cm curium - | 97 Bk berkelium - | 98 Cf californium - | 99 Es einsteinium - | 100 Fm fermium - | 101 Md mendelevium - | 102 No nobelium - | 103 Lr lawrencium - |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

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

## MARKING SCHEME
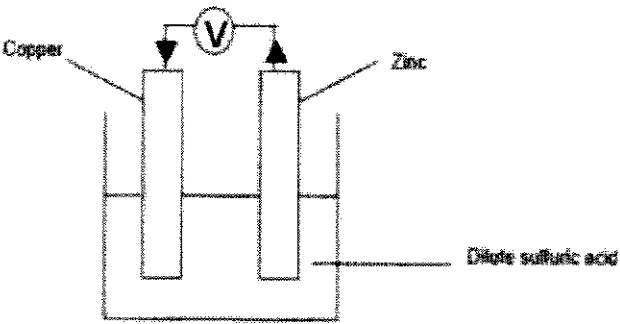## PRELIM EXAM CHEMISTRY 2020
### SETTER: MDM SHURYATI

PAPER 1

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|
| D | C | A | D | A | B | B | A | B | D |

| 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|---|
| A | D | C | A | B | B | C | A | D | B |

| 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |
|---|---|---|---|---|---|---|---|---|---|
| B | C | C | C | B | D | B | A | D | B |

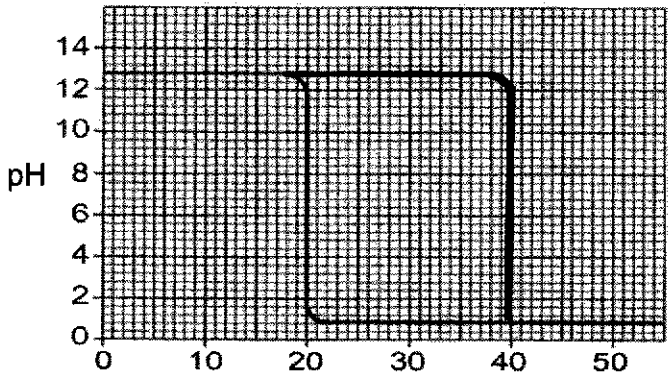| 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 |
|---|---|---|---|---|---|---|---|---|---|
| B | C | A | D | A | B | C | A | B | A |

## MARKING SCHEME
## PRELIM EXAM CHEMISTRY 2020
### SETTER: MDM SHURYATI

### Paper 2
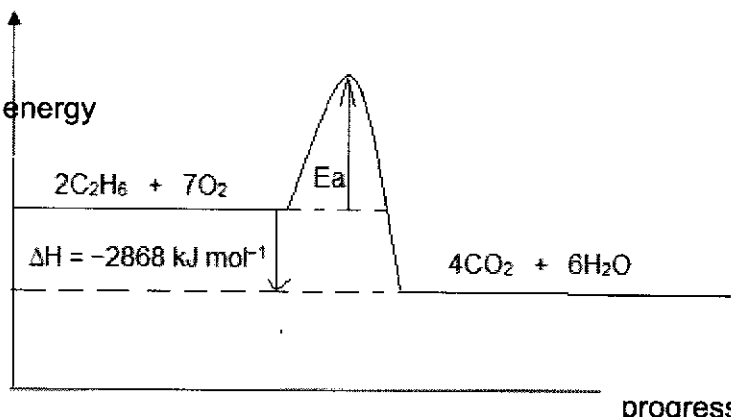
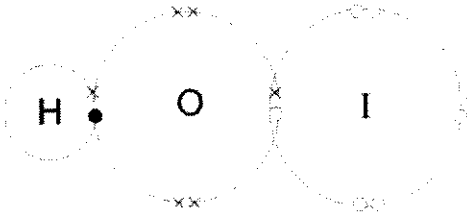| A1 | (a) | name | formula | number of protons | number of neutrons | number of electrons | |
|---|---|---|---|---|---|---|---|
| | | hydrogen atom | $^1_1H$ | 1 | **0** | 1 | 1 |
| | | deuterium ion | $^2_1H^+$ | **1** | **1** | 0 | 1 |
| | | tritium ion | $^3_1H^-$ | **1** | 2 | 2 | 1 |
| | | Each row – 1m | | | | | |
| | (b) | Ar of Ge = ( (24.4/100) x 70) + ((32.4/100) x 72) +((43.2/100) x 74) ; | | | | | 1 |
| | | = 72.4 (3sf) ; | | | | | 1 |
| | (c) | Agree; | | | | | 1 |
| | | All isotopes of the same element have same number of valence electrons. | | | | | |
| A2 | (ai) | $Na_2CO_3(aq)$; $CuCl_2(aq)$ | | | | | 1 |
| | (aii) | $Ba(NO_3)_2(aq)$; $(NH_4)_2SO_4(aq)$/ $H_2SO_4(aq)$ | | | | | 1 |
| | (aiii) | $KOH(aq)$; $(NH_4)_2SO_4(aq)$ | | | | | 1 |
| | (aiv) | $Zn(s)$; $CuCl_2(aq)$ | | | | | 1 |
| | (av) | $H_2SO_4(aq)$; $KOH(aq)$/ $Na_2CO_3(aq)$ | | | | | 1 |
| | (b) | $Na_2CO_3(aq) + CuCl_2(aq) \longrightarrow 2NaCl(aq) + CuCO_3(s)$ | | | | | 1 |
| A3 | (a) | arrangement : From closely-packed together; orderly to far apart; random | | | | | 1 |
| | | motion: From vibrate at fixed positions to move randomly and rapidly | | | | | 1 |
| | (bi) | C | | | | | 1 |
| | (bii) | I disagree because solvent 2 does not allow student to identify the 4 amino acids as B and D have identical Rf values hence cannot be distinguished; | | | | | 1 |
| | | Duration of chromatography is also not a source of error, because Rf is a ratio (of distance travelled by dye to distance travelled by solvent) / Rf is only dependent of solubility of component in a specific solvent./Rf values are not time dependent. | | | | | 1 |
| A4 | (a) | $P_4O_6$ | | | | | 1 |

2

| | | | |
|---|---|---|---|
| | **(b)** | Each carbon atom in substance B is bonded to 4 other carbon atoms, hence all 4 valence electrons are used for covalent bonding; <br> There are no mobile ions or electrons to conduct electricity. | 1 |
| | **(c)** | A: discrete single molecules with weak intermolecular forces of attraction; <br> B: an <u>extensive network</u> of many atoms bonded by strong covalent bonds. | 1 <br><br> 1 |
| | **(d)** | Phosphorus is a non-metal and non-metal oxides are usually acidic | 1 |
| **A5** | **(ai)** | The rate is lowered/ decreased; <br><br> Increased in pH occurs when H+ ions is removed from the solution which lowers the concentration of the H+ ions; <br><br> This means that number of effective collisions per second between H+ and reactant particles decreases, hence the rate decreases. | 1 <br><br><br><br> 1 |
| | **(aii)** | No of moles of HCl = 50/1000 x 1 = 0.05 mol <br> No of moles of sodium thiosulfate = 50/1000 x 1 = 0.05 mol; <br><br> From equation, <br> 2 mol HCl : 1 mol $Na_2S_2O_3$ <br> 0.05 mol HCl : 0.025 mol $Na_2S_2O_3$ (needed) < 0.05 mol (given) <br> Hence, HCl is limiting; <br><br> The reaction stopped as all the HCl has been used up [1]. | 1 <br><br><br> 1 |
| | **(aiii)** | Graph II: <br> Steeper gradient compared to Graph I <br> Mass of precipitate is the same as in Graph I | 1 |
| | **(bi)** |  | 1 |

| | (bii) | The voltmeter reading will be lower than that with zinc. | 1 |
| | | Iron is below zinc in the reactivity series. | |
| | | Hence, the closer the metals are in the reactivity series, the smaller the difference in voltage across the two electrodes. | 1 |
| **A6** | (ai) | Sr has one electron shell more than Ca but one less than Ba; | 1 |
| | (aii) | $Sr + 2H_2O \rightarrow Sr(OH)_2 + H_2$; | 1 |
| | (aiii) | Sr is more reactive, Sr is below Ca in the Periodic Table; reactivity increases down a group / Sr loses electrons more easily than Ca; | 1 |
| | (b) | temperature of Bunsen / distance of Bunsen from the tube / amount or mass/ no of moles of carbonate used; | 1 |
| | (ci) | calcium carbonate decompose faster than strontium carbonate which is faster than barium carbonate / correct trend i.e. decomposition is less rapid further down the group; | 1 |
| | | The ionic bonds between the ions in barium carbonate are stronger than in strontium carbonate which is stronger than in calcium carbonate/correct trend i.e the ionic bonds become stronger in the metal carbonates from calcium to strontium to barium. or reverse argument | 1 |
| | (cii) | on the x-axis | 1 |
| | (ciii) | Ratio of mole $BaCO_3$ : BaO is 1:1 | 1 |
| | | Mass of BaO $= 0.1 \times (137 + 16)$ | |
| | | $= 15.3$ g | |
| | | Percentage yield of BaO $= (15.00/15.3) \times 100\%$ | 1 |
| | | $= 98\%$ (2sf) | |
| | (di) | Ratio 1 calcium ion : 1 oxide ion; | 1 |
| | | calcium ion : correct number of valence electrons and charge | 1 |
| | | Oxide ion : correct number of valence electrons and charge | 1 |
| | (dii) | Barium: conduct electricity in solid and molten; presence of mobile electrons to move and carry current; | 1 |
| | | Barium oxide: does not conduct in solid; ions in fixed positions conduct electricity in molten and aqueous; presence of mobile ions to move and carry current | 1 |
| | (ei) | $Fe_2O_3 + 3CO \longrightarrow 2Fe + 3CO_2$ | 1 |
| | (eii) | Electrostatic forces of attraction between the positive iron ions and 'sea of mobile /delocalised electrons' | 1 |
| | (eiii) | Magenesium is more reactive than iron; | 1 |
| | | Air/Oxygen and water will react with magnesium instead of iron; | 1 |
| | | Magnesium will corrode instead of iron | |
| **7** | (a) | $N_2 + 3H_2 \rightleftharpoons 2NH_3$ | 1 |

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| | | | |
|---|---|---|---|
| | **(b)** | **C** is ammonia as its volume increases from zero. | 1 |
| | | **A** is hydrogen and **B** is nitrogen, as a greater volume of hydrogen is used up in the reaction as compared to nitrogen (according to the mole ratio of 3:1). | 1 |

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**SECTION B**

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| | | | |
|---|---|---|---|
| **B8** | **(a)** | No of mole hydrochloric acid   = 0.2 x 20/1000 <br>         = 0.004 moles | [1] |
| | | $\dfrac{\text{No of mole of NaOH}}{\text{No of mole HCl}}$     = $\dfrac{1}{1}$ <br> No of mole of NaOH     = 0.004 mol <br> *ratio to be shown* | [1] |
| | | Concentration of NaOH   = 0.004 /0/025 <br>           =0.16 mol/dm$^3$ | [1] |
| | **(b)** |  | 1 |
| | **(c)** | pH 9 (accept 9.3 to 9.5) | [1] |
| | **(d)** | sodium chloride, NaCl | [1] |
| | **(e)** | -pH of NaOH is hgher (pH 13). pH of sodium carbonate is lower (pH 11.6) <br> *(pH values must be given)* | [1] |
| | | -NaOH completely neutralises HCl (end point pH 7) <br> En-point of sodium carbonate and HCl is at acidic pH/(3.5 to 4.2) <br> *(pH 7 must be given)* | [1] |
| | **(f)** | The pH changes from 1.8 to 12(accept 0.8 to 12.2). <br> All the indicators show a colour change within this range. | [1] |
| | **(g)** | Cannot detect colour change at stage 1 <br> Can only detect colour change at stage 2 | [1] |
| **B9** | **(a)** | **X**: 2H$^+$(aq) + 2e$^-$ → H$_2$(g) <br> **Y**: 2Cl(aq) → Cl$_2$(g) + 2e$^-$ <br> 1 m for correct balanced equations <br> 1 m for correct state symbols | <br><br>1<br>1 |

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| | | | |
|---|---|---|---|
| | **(b)** | Colourless solution turns brown/A black solid is formed; | 1 |
| | | $Cl_2 + 2I^- \rightarrow I_2 + 2Cl^-$ ; (full equation accepted) | 1 |
| | | Chlorine is more reactive than iodine; | 1 |
| | | So chlorine will displace iodine from potassium iodide | |
| | **(c)** | Oxygen gas; | 1 |
| | | Over time, concentration of chloride ions decrease and hydroxide ions become preferentially/selectively discharged, producing oxygen. | 1 |
| | **(d)** | Student B. | 1 |
| | | Anode decreases in mass/ dissolves; | |
| | | Increase in mass at the cathode/ A reddish-brown solid deposited at the cathode; | 1 |
| | | At anode: Copper electrode dissolves to form copper(II) ions/ accept half equation; | 1 |
| | | At cathode: Copper(II) ions are preferentially/selectively discharged, forming copper metal/ accept half equation. **OR** | |
| | | Student B is correct; | |
| | | The concentration of copper(II) ions in the electrolyte <u>remains the same</u> because copper(II) ions are <u>added</u> to the electrolyte when <u>the anode dissolves</u> to form copper(II) ions; | [1] |
| | | and at cathode, the copper(II) ions are <u>preferentially discharged</u> at the cathode to form copper; | [1] |
| | | At cathode : $Cu^{2+}$ (aq) + 2e $\rightarrow$ Cu(s); <br> At anode : Cu (s) $\rightarrow$ $Cu^{2+}$ (aq) + 2e | [1] |

| Either B10 | (a) |  energy<br><br>$2C_2H_6 + 7O_2$  Ea<br><br>$\Delta H = -2868$ kJ mol$^{-1}$  $4CO_2 + 6H_2O$<br><br>progress of reaction<br><br>1 mark for correct graph<br>1 mark for indicating both Ea<br>1m for $\Delta H$ correctly with labels and direction | |
|---|---|---|---|
| | (b) | Total energy released during bond formation<br>$= 4 \times 2 \times 805 + 6 \times 2 \times 460 = 11960$ kJ | [1] |
| | | Total energy absorbed during bond breaking<br>$= 11960 - 2868 = 9092$ kJ | [1] |
| | | bond energy for the C – C bond<br>$= (9092 - 2 \times 6 \times 410 - 7 \times 496) \div 2 = 350$ kJ mol$^{-1}$<br><br>Accept any other logical method | [1] |
| | (c) | No of mol of ethane $= 48.0 \div 24000 = 0.00200$<br>Energy released $= 0.00200 \div 2 \times 2868 = 2.87$ kJ | [1]<br>[1] |
| | (di) | Greenhouse gas; leads to global warming | [1] |
| | (dii) | At night/in dark, plants continue to respire to produce carbon dioxide but do not undergo photosynthesis | [1] |

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| Or 10 | (ai) | name of oxyacid acid | chemical formula | oxidation state of iodine | |
|---|---|---|---|---|---|
| | | periodic acid | $HIO_4$ | +7 | |
| | | iodic acid | $HIO_3$ | +5 | |
| | | hypoiodous acid | HIO | +1 | [2] |

3 correct : 2m
2 correct : 1m

| | (aii) | $IO_4{}^-$ | |
|---|---|---|---|

| | (aiii) |  | |
|---|---|---|---|

1M for correct sharing of electrons between H and O and O and I
1M for correct number of valence electrons for H, O and I [2]

| | (b) | Iodine is oxidised as the oxidation state of iodine increases from 0 (in $I_2$) to +5 in ($HIO_3$). [1] | [1] |
|---|---|---|---|
| | | Chlorine is reduced as the oxidation state of chlorine decreases from 0 (in $Cl_2$) to -1 (in $HCl$). [1] | [1] |
| | | It is a redox reaction as iodine is oxidised and chlorine is reduced | |

| | (ci) | | carbon | hydrogen | oxygen | 1 |
|---|---|---|---|---|---|---|
| | | mass (in 100g) | 26.7 | 2.2 | 71.1 | |
| | | no of moles | 2.225 | 2.2/1 = 2.2 | 4.44 | |
| | | lowest ratio | 1 | 1 | 2 | |

or Any logical working

Empirical formula of oxalic acid = $CHO_2$ ; 1

| | (cii) | n (12 + 1 + 32) = 90 | |
|---|---|---|---|
| | | n = 2 | |
| | | molecular formula of oxalic acid = $C_2H_2O_4$ | 1 |

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