



Established in 1879

# Raffles Girls' School

(SECONDARY)

Name: \_\_\_\_\_

Class: \_\_\_\_\_

Register No: \_\_\_\_\_

## CHEMISTRY YEAR FOUR

### Pen-and-Paper Assessment

Tuesday

30 March 2021

1 hour

#### INSTRUCTIONS TO CANDIDATES

This question paper contains two sections.

##### Section A – 10 marks

Answer **ALL** the questions and shade your answers on the separate Answer Sheet.

##### Section B – 30 marks

Answer **ALL** the questions in the spaces provided. Write in dark blue or black pen. You may use a pencil for diagrams or graphs. Do not use correction tape or fluid.

#### INFORMATION FOR CANDIDATES

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 on page 12.

The use of an approved scientific calculator is expected, where appropriate.

The weighting for the paper is **20%**.

| For examiners' use |                |
|--------------------|----------------|
| Question / Section | Marks Obtained |
| A                  | 10             |
| B1                 | 5              |
| B2                 | 5              |
| B3                 | 6              |
| B4                 | 6              |
| B5                 | 8              |
| statement          |                |
| units              |                |
| s.f.               |                |
| Total marks        | 40             |

Parent's / Guardian's Name: \_\_\_\_\_

Signature: \_\_\_\_\_ Date: \_\_\_\_\_

**Section A – Multiple Choice Questions [10 marks]**

Answer all questions. For each question, there are four possible answers (**A**, **B**, **C**, and **D**). Choose the most appropriate answer and record your choice in the separate Answer Sheet provided.

- 1 Which process does **not** involve either oxidation or reduction?
- A formation of zinc from zinc oxide and carbon
  - B formation of water from hydrogen and oxygen
  - C formation of sulfuric acid from sulfur trioxide and water
  - D formation of ammonium sulfate from ammonia and sulfuric acid

- 2 The labels of two bottles containing colourless solutions fell off. One of the solutions is aqueous sodium nitrate and the other is aqueous sodium chloride.

Which of the following reagents would enable the bottles to be correctly labelled?

- A aqueous ammonia
  - B dilute nitric acid
  - C lead(II) nitrate solution
  - D sodium hydroxide solution
- 3 The pH of aqueous ammonia and aqueous potassium hydroxide, both of the same concentration, are 11.3 and 13.5 respectively.

Why are the pH values different?

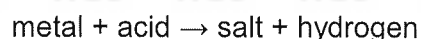
- A Aqueous ammonia partially ionises.
  - B Aqueous ammonia is a smaller molecule.
  - C Aqueous potassium hydroxide is more soluble in water.
  - D Aqueous potassium hydroxide releases fewer hydroxide ions.
- 4 An excess of aqueous ammonia is added to solutions containing  $\text{Cu}^{2+}$ ,  $\text{Fe}^{2+}$ ,  $\text{Ca}^{2+}$  and  $\text{Al}^{3+}$  ions separately.

Which of the following solutions will form precipitates with excess aqueous ammonia?

|   | $\text{Cu}^{2+}$ | $\text{Fe}^{2+}$ | $\text{Ca}^{2+}$ | $\text{Al}^{3+}$ |
|---|------------------|------------------|------------------|------------------|
| A | ✓                | ✓                | ✗                | ✗                |
| B | ✗                | ✓                | ✗                | ✓                |
| C | ✗                | ✓                | ✓                | ✗                |
| D | ✓                | ✓                | ✓                | ✓                |

key  
 ✓ = precipitate formed  
 ✗ = no precipitate formed

- 5 Which salt **cannot** be safely prepared by the following method in the laboratory?



- A iron(II) chloride
- B magnesium sulfate
- C potassium chloride
- D zinc sulfate

- 6 On heating a white solid, a yellow residue and a colourless, pungent gas is evolved which decolourises acidified potassium manganate(VII). On cooling, the residue changes to white.

What are the identities of the solid and gas?

|   | solid             | gas            |
|---|-------------------|----------------|
| A | lead(II) sulfite  | sulfur dioxide |
| B | zinc sulfite      | sulfur dioxide |
| C | ammonium chloride | ammonia        |
| D | sodium nitrate    | ammonia        |

- 7 Which gas sample contains the most number of molecules?

- A 4.00 g of hydrogen  
 B 14.0 g of nitrogen  
 C 24.0 dm<sup>3</sup> of carbon dioxide  
 D 36.0 dm<sup>3</sup> of hydrogen chloride

- 8 P and Q are elements in Period 3 of the Periodic Table whose oxides are soluble in water.

Effervescence is observed when iron(III) carbonate is added to a solution of the oxide of P while a reddish-brown precipitate is formed when iron(III) nitrate is added to a solution of oxide of Q.

What are P and Q?

|   | P         | Q          |
|---|-----------|------------|
| A | magnesium | phosphorus |
| B | silicon   | magnesium  |
| C | sodium    | chlorine   |
| D | sulfur    | sodium     |

- 9 14.2 g of X<sub>2</sub>O<sub>5</sub>, an oxide of element X, contains 6.20 g of X.

How many moles of X does 6.20 g of the element contain?

- A  $\frac{8.0}{16} \times \frac{2}{5}$   
 B  $\frac{8.0}{16} \times \frac{5}{2}$   
 C  $\frac{14.2}{16} \times \frac{2}{5}$   
 D  $\frac{14.2}{16} \times \frac{5}{2}$

- 10 Element X is obtained by heating its oxide with carbon.  
Element Y occurs naturally as a metal.  
Element Z reduces  $\text{Ca}^{2+}$  ions to Ca atoms.

What is the order of reactivity of X, Y and Z?

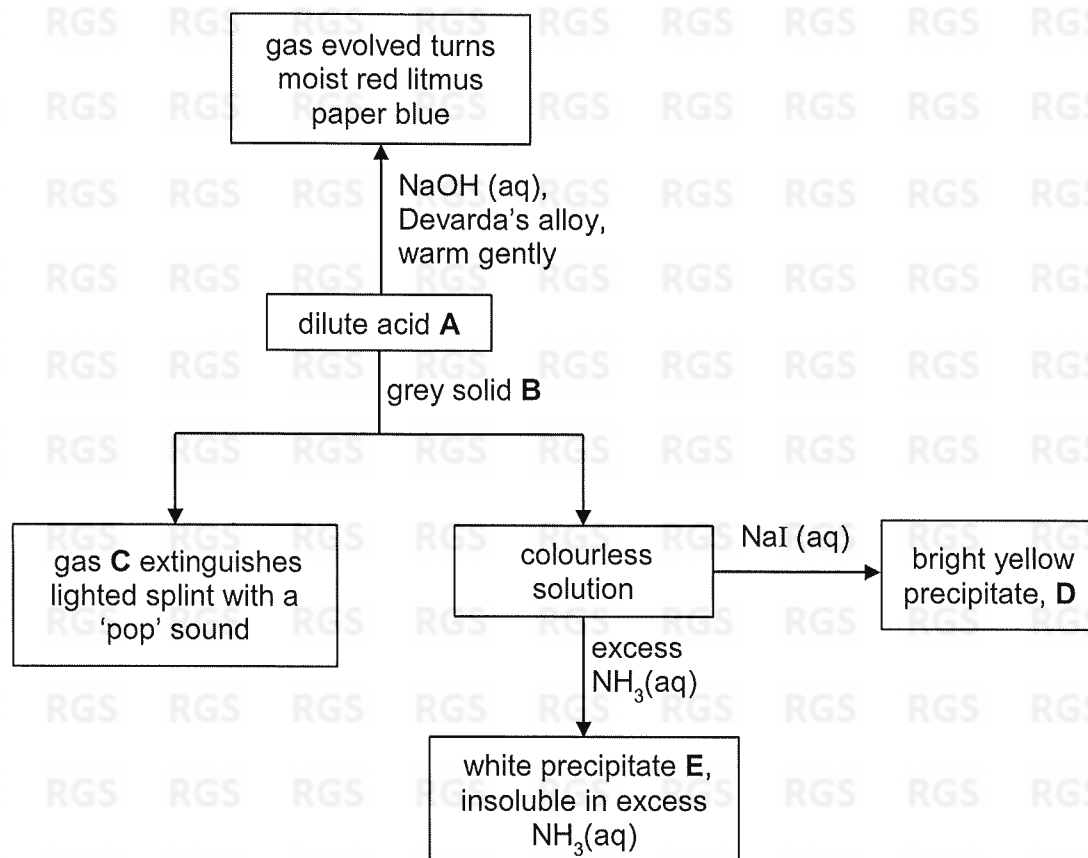
|   | most reactive | → | least reactive |
|---|---------------|---|----------------|
| A | X             | Z | Y              |
| B | Y             | Z | X              |
| C | Z             | X | Y              |
| D | Z             | Y | X              |

----- End of Section A -----

**Section B – Structured Questions [30 Marks]**

Answer **ALL** questions and write your answers in the spaces provided.

**B1** The diagram below shows the properties and reactions of substances **A**, **B**, **C**, **D** and **E**.



(a) Based on the information given above, identify the following substances.

**A** : .....

**B** : .....

**C** : .....

**D** : ..... [4]

(b) Write an ionic equation for the formation of precipitate **E**.

..... [1]

**B2** A student prepared a pure, dry sample of hydrated potassium nitrate by titration following the procedures below.

Step 1: Using a measuring cylinder, measure  $25.0\text{ cm}^3$  of potassium hydroxide solution into a clean and dry conical flask.

Step 2: Add one to two drops of thymol blue indicator into the conical flask.

Step 3: Add dilute sulfuric acid from the burette slowly into the conical flask. Swirl the conical flask thoroughly during the titration.

Step 4: Add the acid dropwise when approaching the end-point.

Step 5: Record the volume of acid used when the colour change is permanent.

Step 6: Repeat steps 1 to 4 using the volume of the acid recorded.

Step 7: Heat the solution to dryness to obtain hydrated potassium nitrate crystals.

Step 8: Wash the crystals with a small amount of cold distilled water and dry them between sheets of filter paper.

(a) There are **four** errors in the procedures.  
Identify the errors and correct the statements.

| Step No. | Corrected Statement |
|----------|---------------------|
|          |                     |
|          |                     |
|          |                     |
|          |                     |

[4]

(b) The hydrated potassium nitrate crystals are weighed and the mass of the crystals was found to be lower than expected.  
Suggest a reason for this.

[1]

**B3** Sodium carbonate forms hydrated salts with the general formula,  $\text{Na}_2\text{CO}_3 \cdot y\text{H}_2\text{O}$ .

A 4.55 g sample of one of these hydrates is dissolved in  $20.0 \text{ cm}^3$  of water to form a solution of  $0.980 \text{ mol/dm}^3$ . A sample of the solution is then titrated against dilute hydrochloric acid.

- (a) Write an ionic equation for the reaction between sodium carbonate solution and dilute hydrochloric acid.

..... [2]

- (b) Calculate the relative molecular mass of the hydrated sodium carbonate.

[2]

- (c) The relative molecular mass of another hydrated sodium carbonate was found to be 286. Calculate the value of  $y$  in this hydrated sodium carbonate.

[2]

- B4** Powdered samples of two metals, **X** and **Y**, were reacted with nickel(II) chloride and iron(II) chloride solutions in separate experiments.

|                | nickel(II) chloride solution              | iron(II) chloride solution                     |
|----------------|-------------------------------------------|------------------------------------------------|
| metal <b>X</b> | solution changes from green to colourless | no visible reaction                            |
| metal <b>Y</b> | solution changes from green to colourless | solution changes from pale green to colourless |

- (a) List the four metals (**X**, **Y**, nickel and iron) in decreasing order of reactivity.

[1]

- (b) (i) Write a balanced chemical equation, with state symbols, for the reaction between zinc and nickel(II) chloride solution.

[1]

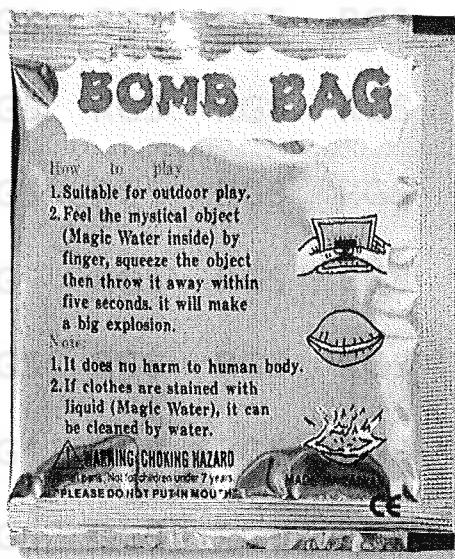
- (ii) Identify the reducing agent for the reaction in **b(i)**.  
Explain your answer in terms of oxidation state.

[2]

- (c) State and explain, which substance, nickel(II) carbonate or iron(II) carbonate, would decompose at a lower temperature.

[2]

**B5** A toy store sells 'bomb bag' as shown in the diagram below.



The contents of the 'bomb bag' include a small packet of liquid, 'magic water', and a mixture of two powders, citric acid and baking soda (sodium hydrogencarbonate). An 'explosion' occurs when the 'bomb bag' is squeezed.

(a) Suggest and explain the identity of the 'magic water' in the small packet.

Identity : .....

Explanation: .....

..... [2]

(b) Explain clearly what causes the 'explosion'.

.....

.....

..... [2]

(c) A student suggests replacing the baking soda with powdered zinc. Explain why this would not be a suitable replacement.

.....

.....

..... [2]

- (d) Another student wants to replicate the 'bomb bag' using dilute hydrochloric acid as the 'magic water' and baking soda only as the powder. Explain how the 'explosion' would differ, assuming that the amount of the acid used is the same.

[2]

----- End of Section B -----

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## The Periodic Table of Elements

| Group                        |                             |                                                                                                      |                             |                                 |                              |                              |                              |                            |                              |                                |                               |                               |                             |                             |                               |                               |                              |                             |
|------------------------------|-----------------------------|------------------------------------------------------------------------------------------------------|-----------------------------|---------------------------------|------------------------------|------------------------------|------------------------------|----------------------------|------------------------------|--------------------------------|-------------------------------|-------------------------------|-----------------------------|-----------------------------|-------------------------------|-------------------------------|------------------------------|-----------------------------|
| I                            | II                          | 1<br>H<br>hydrogen<br>1                                                                              |                             |                                 |                              |                              |                              |                            |                              |                                |                               | III                           | IV                          | V                           | VI                            | VII                           | 0                            |                             |
|                              |                             | <div>Key</div> <div>proton (atomic) number<br/>atomic symbol<br/>name<br/>relative atomic mass</div> |                             |                                 |                              |                              |                              |                            |                              |                                |                               |                               |                             |                             |                               |                               |                              |                             |
| 3<br>Li<br>lithium<br>7      | 4<br>Be<br>beryllium<br>9   |                                                                                                      |                             |                                 |                              |                              |                              |                            |                              |                                |                               | 5<br>B<br>boron<br>11         | 6<br>C<br>carbon<br>12      | 7<br>N<br>nitrogen<br>14    | 8<br>O<br>oxygen<br>16        | 9<br>F<br>fluorine<br>19      | 10<br>Ne<br>neon<br>20       |                             |
| 11<br>Na<br>sodium<br>23     | 12<br>Mg<br>magnesium<br>24 |                                                                                                      |                             |                                 |                              |                              |                              |                            |                              |                                |                               | 13<br>Al<br>aluminium<br>27   | 14<br>Si<br>silicon<br>28   | 15<br>P<br>phosphorus<br>31 | 16<br>S<br>sulfur<br>32       | 17<br>Cl<br>chlorine<br>35.5  | 18<br>Ar<br>argon<br>40      |                             |
| 19<br>K<br>potassium<br>39   | 20<br>Ca<br>calcium<br>40   | 21<br>Sc<br>scandium<br>45                                                                           | 22<br>Ti<br>titanium<br>48  | 23<br>V<br>vanadium<br>51       | 24<br>Cr<br>chromium<br>52   | 25<br>Mn<br>manganese<br>55  | 26<br>Fe<br>iron<br>56       | 27<br>Co<br>cobalt<br>59   | 28<br>Ni<br>nickel<br>59     | 29<br>Cu<br>copper<br>64       | 30<br>Zn<br>zinc<br>65        | 31<br>Ga<br>gallium<br>70     | 32<br>Ge<br>germanium<br>73 | 33<br>As<br>arsenic<br>75   | 34<br>Se<br>selenium<br>79    | 35<br>Br<br>bromine<br>80     | 36<br>Kr<br>krypton<br>84    |                             |
| 37<br>Rb<br>rubidium<br>85   | 38<br>Sr<br>strontium<br>88 | 39<br>Y<br>yttrium<br>89                                                                             | 40<br>Zr<br>zirconium<br>91 | 41<br>Nb<br>niobium<br>93       | 42<br>Mo<br>molybdenum<br>96 | 43<br>Tc<br>technetium<br>-  | 44<br>Ru<br>ruthenium<br>101 | 45<br>Rh<br>rhodium<br>103 | 46<br>Pd<br>palladium<br>106 | 47<br>Ag<br>silver<br>108      | 48<br>Cd<br>cadmium<br>112    | 49<br>In<br>indium<br>115     | 50<br>Sn<br>tin<br>119      | 51<br>Sb<br>antimony<br>122 | 52<br>Te<br>tellurium<br>128  | 53<br>I<br>iodine<br>127      | 54<br>Xe<br>xenon<br>131     |                             |
| 55<br>Cs<br>caesium<br>133   | 56<br>Ba<br>barium<br>137   | 57 – 71<br>lanthanoids                                                                               |                             | 72<br>Hf<br>hafnium<br>178      | 73<br>Ta<br>tantalum<br>181  | 74<br>W<br>tungsten<br>184   | 75<br>Re<br>rhenium<br>186   | 76<br>Os<br>osmium<br>190  | 77<br>Ir<br>iridium<br>192   | 78<br>Pt<br>platinum<br>195    | 79<br>Au<br>gold<br>197       | 80<br>Hg<br>mercury<br>201    | 81<br>Tl<br>thallium<br>204 | 82<br>Pb<br>lead<br>207     | 83<br>Bi<br>bismuth<br>209    | 84<br>Po<br>polonium<br>-     | 85<br>At<br>astatine<br>-    | 86<br>Rn<br>radon<br>-      |
| 87<br>Fr<br>francium<br>-    | 88<br>Ra<br>radium<br>-     | 89 – 103<br>actinoids                                                                                |                             | 104<br>Rf<br>Rutherfordium<br>- | 105<br>Db<br>dubnium<br>-    | 106<br>Sg<br>seaborgium<br>- | 107<br>Bh<br>bohrium<br>-    | 108<br>Hs<br>hassium<br>-  | 109<br>Mt<br>meitnerium<br>- | 110<br>Ds<br>darmstadtium<br>- | 111<br>Rg<br>roentgenium<br>- | 112<br>Cn<br>copernicium<br>- | 113<br>Nh<br>nihonium<br>-  | 114<br>Fl<br>flerovium<br>- | 115<br>Lv<br>livermorium<br>- | 116<br>Lv<br>livermorium<br>- | 117<br>Ts<br>tennessine<br>- | 118<br>Og<br>oganesson<br>- |
| lanthanoids                  |                             |                                                                                                      |                             |                                 |                              |                              |                              |                            |                              |                                |                               |                               |                             |                             |                               |                               |                              |                             |
| actinoids                    |                             |                                                                                                      |                             |                                 |                              |                              |                              |                            |                              |                                |                               |                               |                             |                             |                               |                               |                              |                             |
| 71<br>Lu<br>lutetium<br>175  |                             |                                                                                                      |                             |                                 |                              |                              |                              |                            |                              |                                |                               |                               |                             |                             |                               |                               |                              |                             |
| 103<br>Lr<br>lawrencium<br>- |                             |                                                                                                      |                             |                                 |                              |                              |                              |                            |                              |                                |                               |                               |                             |                             |                               |                               |                              |                             |

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