Pei Hwa Secondary School
Secondary 4 Pure Chemistry 6092
Practical: Planning Question Practices

Name: ………………………………… (   ) Class / TG : …………… Date: ………………..…

1 **X** is zinc powder contaminated with carbon.
Plan an experiment to purify **X** and determine the percentage purity of **X**.

You can assume all the apparatus and reagents normally found in a school laboratory are available.

In your method you should note any other assumptions that you make, include the measurements you would take and explain how you would use your results determine the percentage purity of **X**.

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2 Eggshells and cockleshells are some common substances that contain calcium carbonate. However, the percentage by mass of calcium carbonate in each of these substances varies.

(a) Outline a method you could use to determine whether an eggshell or a cockleshell contains a higher percentage by mass of calcium carbonate.

You can assume all the apparatus and reagents normally found in a school laboratory are available.

You should include in your answer the measurements you would take, and explain how your results would show which type of shell contain a higher percentage by mass of calcium carbonate.

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(b) State an assumption that is made in the experimental method outlined in **2(a)**.

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3 Metal carbonates undergo thermal decomposition to produce metal oxides and carbon dioxide. The more reactive a metal is, the more difficult it is to decompose its carbonate.

You are required to plan an experiment to determine the order of the reactivity of the metals calcium, copper and zinc by comparing the relative ease of decomposition of calcium carbonate, copper(II) carbonate and zinc carbonate.

You are **only** provided with samples of the three metal carbonates and **no other chemical reagents**. You can assume all the apparatus normally found in a school laboratory are available for your investigation.

Your plan should include a list of quantities that remain constant, measurements to be taken, and how your results would determine the reactivity of the given metals.

You may wish to use a labelled diagram to illustrate your answer.

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4 Agricultural limes are mixtures of calcium carbonate and calcium oxide. Farmers use agricultural limes on fields to neutralise acidity.

Plan an investigation to find out which of the two different agricultural limes, **Q** or **R**, will neutralise more acid.

You are provided with common laboratory apparatus and chemicals.

In your method, you should include the measurements you would take, and explain how your results can be used to determine which agricultural limes, **Q** or **R**, will neutralise more acid.

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5 When provided with a bottle of aqueous sodium carbonate of unknown concentration, there are many methods other than thermometric titration, which can be employed to determine its concentration.

Outline a method by which the concentration of aqueous sodium carbonate can be determined.

You can assume that all the apparatus and reagents normally found in a school laboratory are available.

In your method you should note any assumptions that you make, include the measurements you would take and explain how you would use your results to calculate the concentration of aqueous sodium carbonate.

You may not use a method involving temperature change.

[Ar: H, 1; Cl, 35.5]

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6 You are required to investigate the effect of concentration of hydrochloric acid on the rate of reaction.

You are only provided with hydrochloric acid of three different concentrations and magnesium strips. You can assume all the apparatus normally found in a school laboratory are available.

You should include in your answer

- an outline of the method used,
- the measurements you would take, and
- explain how your results can be used to determine the effect of concentration of acid on rate of reaction.

You may wish to use a labelled diagram to illustrate your answer.

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7 You are provided with three bottles of colourless solutions; one contains dilute hydrochloric acid, another contains aqueous sodium nitrate and the third contains aqueous sodium sulfide.

You are also provided with two pieces of information:

1. Sulfide ions can be oxidised to form sulfate ions.
2. Most barium salts are soluble in water except barium carbonate and barium sulfate.

You have access to all the apparatus normally found in a laboratory and a limited number of chemicals. The chemicals are magnesium and aluminium strips, acidified aqueous potassium manganate (VII), aqueous barium nitrate, and aqueous sodium hydroxide.

You are to plan an experiment with a positive result which identifies the contents in each of the three bottles. You are to also include the test and identity of any gas evolved. Chemical equations are not required.

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8 Copper(II) sulfate crystals have the formula $CuSO_4.\boldsymbol{x}H_2O$.

Plan an experiment to determine the value ***x*** in the formula above.

You are provided with common laboratory apparatus.

You should include in your answer the calculations needed to determine the value of ***x***.

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Answer Scheme

General points to include in answers for planning
Apparatus Variables: Constant variable, Variable to be changed Approach Observations and dependent variable measured Data Processing Conclusion (link back to the objective of experiment)

Question 1

1. Measure a fixed mass (2.00 g) of X using an electronic balance and place in a beaker. [1]
2. Add a fixed concentration and volume of an excess of dilute hydrochloric acid to X to ensure all zinc has reacted. Carbon remains unreacted. Stir until no more effervescence is seen. [1]
3. Filter mixture to obtain unreacted carbon as residue.
4. Wash residue with distilled water and dry between sheets of filter paper. [1]
5. Measure the mass of carbon as M_1 g. Mass of zinc in X is (2.00 – M_1) g [1]
6. The percentage purity of X is measured by (2.00 - M_1 / 2.00) x 100%   [1]

Question 2

(a)

1. Crush 0.5 g of egg shell and place them in a conical flask.
2. Measure out 50 cm^3 of 1 mol/dm^3 of dilute hydrochloric acid using a measuring cylinder and transfer into a conical flask. (Note: cannot use sulfuric acid)
3. Connect a gas syringe to the conical flask.
4. Continue to add more acid until no more effervescence is observed.
5. Measure and record the maximum volume of carbon dioxide gas collected in the gas syringe.
6. Repeat steps 1 to 5 with the same mass of cockleshell, keeping the volume and concentration of acid used constant.
7. The type of shell which produces a larger volume of carbon dioxide contains a higher percentage mass of carbonate.

(b)

Crushing of the shells is sufficient to expose all the calcium carbonate for reaction (i.e. there are no other substances coating the carbonate to prevent complete reaction) OR

The composition of a cockleshell and eggshell are consistent across different samples.

(i.e, the percentage of calcium carbonate in one cockleshell should be about the same in another. Similarly for eggshells).

Question 3

Method 1: Measure volume of CO_2 produced in a fixed time

1. Using an electronic balance, measure 5 g of calcium carbonate and transfer it into a boiling tube.
2. Attach the boiling tube to a gas syringe.
3. Heat the contents in the boiling tube using a Bunsen flame.
4. Collect and measure the volume of carbon dioxide gas produced over 1 minute of strong heating. Record the volume of gas collected.
5. Repeat steps 1 to 4 using copper(II) carbonate and zinc carbonate. Particle size of the metal carbonate used, as well as the strength of the Bunsen flame, should be kept constant.
6. The metal whose carbonate produces the largest volume of carbon dioxide gas in 1 minute is the least reactive.

Method 2: Measure time taken to produce a fixed volume of CO_2

1. Using an electronic balance, measure 5 g of calcium carbonate and transfer it into a boiling tube.
2. Attach the boiling tube to a gas syringe.
3. Heat the content in the boiling tube using a Bunsen flame.
4. Using a stopwatch, measure the time taken to produce 10 cm^3 of carbon dioxide gas. Record the time taken.
5. Repeat steps 1 to 4 using copper(II) carbonate and zinc carbonate. Particle size of the metal carbonate used, as well as the strength of the Bunsen flame, should be kept constant.
6. The metal whose carbonate which takes the shortest time to produce 10 cm^3 of carbon dioxide gas is the least reactive.

Question 4

Method 1

1. Using a measuring cylinder, add 50 cm^3 of dilute nitric acid of 1.0 mol/dm^3 and place it in a beaker.
2. Use a pH meter / add methyl orange into the acid.
3. Using an electronic balance, add 1 g of lime Q until the pH is 7 / colour of methyl orange changes from red to orange.
4. Note the mass of Lime Q added. Repeat the experiment with Lime R.
5. Conclusion: The lime which is required in smaller mass can neutralise more acid.

Method 2

1. Using an electronic balance, weigh 1 g of Lime Q and place it into a beaker.
2. Add dilute nitric acid to it gradually from a burette with methyl orange indicator / pH meter placed in the mixture, until the indicator changes colour from red to orange / pH is 7. Note the volume of nitric acid added.
3. Repeat the experiment with Lime R.
4. Conclusion: The lime which requires a large volume of acid can neutralize more acid.

Question 5

Suggested answer:
Measure a fixed volume / 25 cm^3 (and concentration) of the aqueous sodium carbonate given using a measuring cylinder (or pipette 25 cm^3) and pour it into a conical flask.

Add excess dilute hydrochloric acid of 1.00 mol/dm^3 (or fixed concentration) into the conical flask. (OR the string with the small test tube can be used, though that's mostly meant for solid) Immediately, stopper the conical flask and connect a gas syringe.

Measure and record the volume of CO_2 collected in the gas syringe once no more effervescence is observed / the reading remains constant.

Assumption is made that the setup is air tight, i.e. all gas evolved will be collected in the gas syringe.

Take the volume of CO_2 collected in dm^3 and divide by 24 to find the number of moles of CO_2.

The number of moles of CO_2 is equal to the number of moles of sodium carbonate.

Take the number of moles of sodium carbonate divide by the volume of sodium carbonate measured (earlier or state the volume) to find the concentration of sodium carbonate.

Question 6

Outline of method used

1. Prepare a piece of magnesium strip of 3 cm in length / of fixed mass using electronic balance [1] and measure out a fixed volume of hydrochloric acid of a certain concentration [1] using a measuring cylinder.
2. Set up the apparatus as shown in the diagram below.
3. Place the piece of magnesium ribbon into a conical flask / and immediately fit the delivery tube to the mouth of the conical flask, connecting to the gas syringe and start the stopwatch.

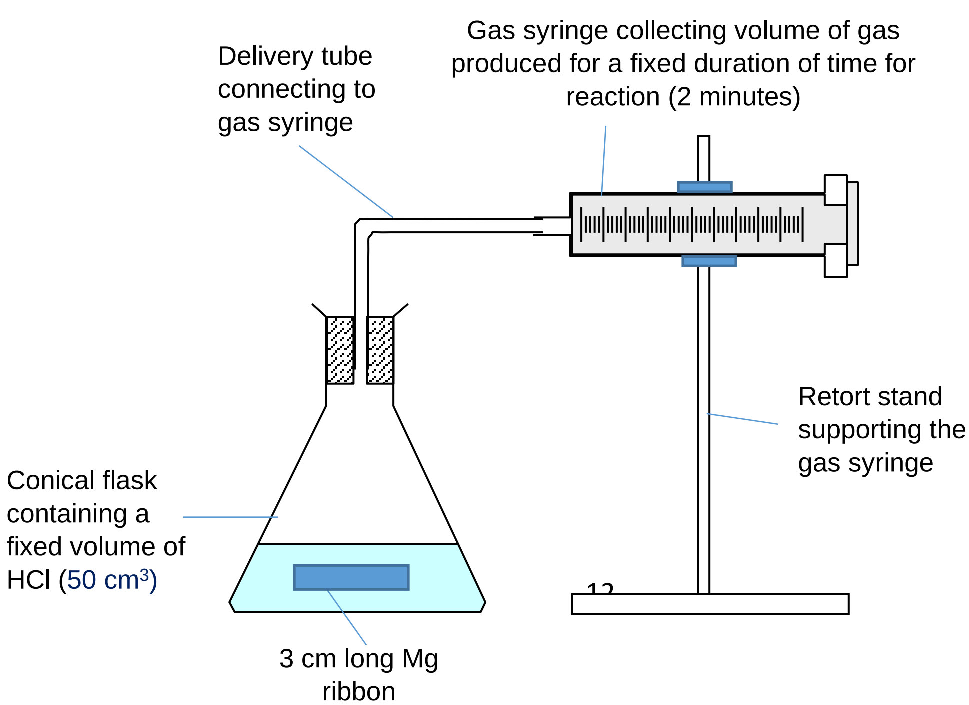
Measurements

4. Measure the volume of gas produced, collected in a gas syringe, after a fixed duration of time for reaction [1] / Measure the time taken for magnesium strip to react completely with acid (till no more effervescence observed)
5. Repeat the experiment from step 1 to 4 using the other two different solutions of hydrochloric acids with different concentration. Ensure that the volume of acid used, mass/length of magnesium ribbon used and temperature of the acid solution are kept constant.

Explain how your results can be used to determine the effect of concentration of acid on rate of reaction

6. From the results, deduce the relationship between the volume of gas collected for a fixed duration of time for reaction and the concentration of hydrochloric acid used. The larger the volume of gas collected, the faster the rate of reaction and the more concentrated the acid [1].

Diagram



Question 7

- Add **a magnesium ribbon** to **5 cm^3** of each colourless solution in separate test-tubes. (**Effervescence)** is observed in the test-tube that contains **hydrochloric acid**.
- Gas produced **extinguish a lighted splint with a pop sound** due to the presence of **hydrogen gas**.
- Add **2 cm^3 of acidified aqueous potassium manganate (VII)** to **5 cm^3** of the remaining two colourless solutions in separate test-tubes. **Purple acidified potassium managanate (VII) is decolourised** in the test-tube that contains sodium sulfide as sulfide ions are oxidized to form sulfate ions.
- Add **2 cm^3 of aqueous barium nitrate** to both test-tubes and a **white precipitate** of barium sulfate is formed, confirming the presence of sulfate ions/ sodium sulfite.
- *Note: do not penalize if student uses barium nitrate first, then potassium manganate (VII). Should still have two positive tests: purple to colourless, then white precipitate observed.*
- Add **2 cm^3 of aqueous sodium hydroxide and an aluminium strip** to **5 cm^3** of the remaining colourless solution in a test-tube. **Gently warm** the test-tube and (**effervescence)** is produced.
- Gas produced will turn **moist red litmus blue** due to the presence of **ammonia gas**.

Question 8

Using an electronic balance, measure $\mathbf{m_1}$ g of copper(II) sulfate crystal and place the crystals in a crucible.

Crucible is gently heated for the crystals to decompose until a **constant mass is obtained**.

Let it cool down, and use the electronic balance to meansure the mass of anhydrous copper(II) sulfate, which is $\mathbf{m_2}$ g.

Mass of water of crystallization = ($\mathbf{m_1} - \mathbf{m_2}$) g

Find the mole of $CuSO_4$ = $\mathbf{m_2}$ / M_r of $CuSO_4$

Find the mole of H_2O = ($\mathbf{m_1} - \mathbf{m_2}$) / M_r of H_2O

either :

x can be found by dividing mole of H_2O by mole of $CuSO_4$

or: $$X = \frac{\dfrac{m_1 - m_2}{M_r \text{ of } H_2O}}{\dfrac{m_2}{M_r \text{ of } CuSO_4}}$$

5.