

Chem!stry

Name: ()

Class:

Date: / /

Chemistry SPA Skill 3 – Planning an Experiment

Mass of Calcium Carbonate in Different Brands of Indigestion Tablets – Answer

a) Hypothesis

As the surface area to volume ratio of a solid increases, the rate at which it reacts with another chemical will increase. This is because there is an increase in the frequency of the effective collisions that take place between the two chemicals.

b) Variables

- Independent variable (*input variable* – what you modify):
Surface area of the indigestion tablet.
- Dependent variable (*output variable* – what you measure):
Rate at which carbon dioxide gas is produced, measured as:
Volume of carbon dioxide gas produced per unit time.
OR
Mass of carbon dioxide gas produced per unit time.
Decrease in mass of reaction per unit time.
- Constant (variables that must remain the same for all experiments):
Mass of indigestion tablet.
Concentration of the hydrochloric acid used.
Volume of the hydrochloric acid used.
Temperature of the experiment.

If in any doubt about what an independent and dependent variables are, then just clearly state what will be *changed*, what will be *measured* and what will *remain constant* during the experiments.

c) Brief Outline of the Experiment

A known volume and known concentration of hydrochloric acid will be poured into a conical flask. A whole (uncrushed) indigestion tablet will be added to the hydrochloric acid. The conical flask will be connected to a gas syringe, and the volume of hydrogen gas produced will be measured at regular time intervals. The experiment will be repeated using **i)** a slightly crushed indigestion tablet **ii)** a powdered indigestion tablet. All other variables (concentration of acid, volume of acid) will be kept constant. A graph of volume of carbon dioxide gas against time will be plotted for each experiment. The steeper the initial gradient, the greater the initial rate of the reaction.

OR

A known volume and known concentration of hydrochloric acid will be poured into a conical flask. The mouth of the conical flask will be plugged with some cotton wool. The conical flask of hydrochloric acid will be placed on a weighing machine along with a single, whole (uncrushed) indigestion tablet. The initial mass of the apparatus and reagents will be recorded. The indigestion tablet will then be added to the conical flask of hydrochloric acid, and the mass of the reaction measured at regular time intervals. The experiment will be repeated using **i)** a slightly crushed indigestion tablet **ii)** a powdered indigestion tablet. All other variables (concentration of acid, volume of acid) will be kept constant. A graph of mass against time will be plotted for each experiment. The steeper the initial gradient, the greater the initial rate of the reaction.

d) Apparatus and Reagents

EITHER

Hydrochloric acid of conc. 1.00 mol/dm^3

Indigestion tablets (of the same brand)

50 cm^3 Measuring cylinder

250 cm^3 Conical flask

Weighing machine

Delivery tube with stopper

100 cm^3 Gas syringe

Stopwatch

Pestle and mortar

Retort stand and clamp

OR

Hydrochloric acid of conc. 1.00 mol/dm^3

Indigestion tablets (of the same brand)

50 cm^3 Measuring cylinder

250 cm^3 Conical flask

Weighing machine

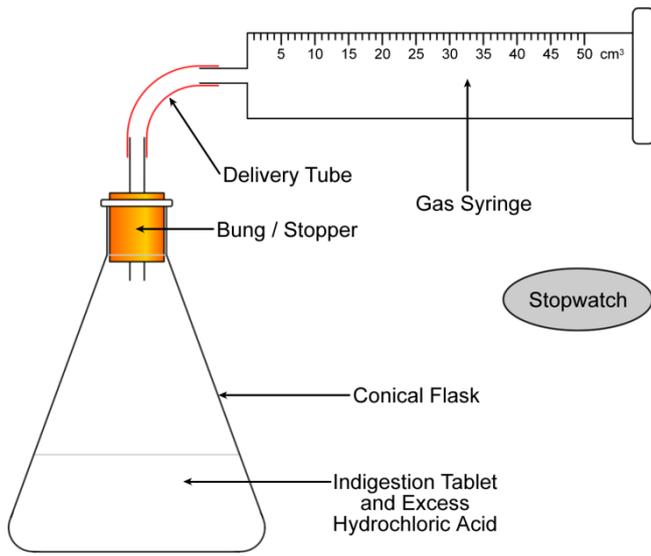
Cotton Wool

Stopwatch

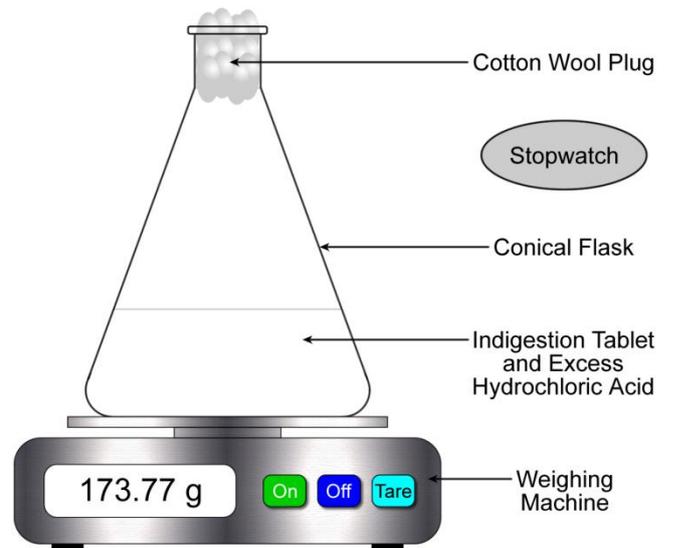
Pestle and mortar

e) Diagram

EITHER



OR



f) Step-by-step Method

Either

1. Use the 50 cm³ measuring cylinder to measure and pour 50 cm³ of 1.00 mol/dm³ hydrochloric acid into the 250 cm³ conical flask. (**Note:** This is assumed to be an excess of hydrochloric acid. Using an excess of hydrochloric acid ensures that the indigestion tablet reacts *completely*).
2. Use the weighing machine to determine the mass of a whole indigestion tablet. Record the mass of the tablet used in the results.
3. Clamp the 100 cm³ gas syringe horizontally in the retort stand and clamp.
4. Attach the delivery tube to the gas syringe.
5. Add the whole indigestion tablet to the hydrochloric acid in the conical flask and *immediately* start the stopwatch.
6. As quickly as possible, attach the stopper of the delivery tube firmly into the mouth of the conical flask. Ensure that the fit is air-tight.
7. Record the volume of carbon dioxide gas produced by the reaction every 30 seconds until the reaction is complete. Record the times and volumes in a suitable results table.
8. Wash and dry the conical flask.
9. Use the pestle and mortar to gently crush an indigestion tablet into 6 – 8 smaller pieces.
10. Use the weighing machine to ensure that the mass of the slightly crushed indigestion tablet is the same as the mass of the whole indigestion tablet. Gently crush a second tablet if extra mass needs to be added.
11. Repeat Steps 1, 5, 6, 7 and 8 using the slightly crushed indigestion tablet.
12. Use the pestle and mortar to crush an indigestion tablet into a fine powder.
13. Use the weighing machine to ensure that the mass of the powdered indigestion tablet is the same as the mass of the whole indigestion tablet. Crush a second tablet into a fine powder if extra mass needs to be added.
14. Repeat Steps 1, 5, 6, 7 and 8 using the powdered indigestion tablet.
15. Plot a graph of volume of carbon dioxide gas produced against time for all three experiments. The initial gradient of each graph gives the initial rate of reaction for each experiment.

Note: For all three experiments, the volume and concentration of hydrochloric acid and the mass of indigestion table used are the same / kept constant.

OR

1. Use the 50 cm³ measuring cylinder to measure and pour 50 cm³ of 1.00 mol/dm³ hydrochloric acid into the 250 cm³ conical flask. (**Note:** This is assumed to be an excess of hydrochloric acid. Using an excess of hydrochloric acid ensures that the indigestion tablet reacts *completely*).
2. Plug the mouth of the conical flask with a piece of cotton wool. (**Note:** This is to allow the carbon dioxide gas to escape from the flask while preventing any of the solution from spraying out of the flask due to the effervescence that is produced).
3. Place a whole indigestion tablet on the weighing machine next to the flask. Record the initial mass of the reaction at time = 0 seconds in the results.
4. Remove the cotton wool from the mouth of the conical flask and add the indigestion tablet to the hydrochloric acid. Start the stopwatch *immediately*.
5. Place the cotton wool back into the mouth of the conical flask.
6. Record the mass of the reaction every 30 seconds until the reaction is complete. Record the time and mass readings in a suitable results table.
7. Wash and dry the conical flask.
8. Use the pestle and mortar to gently crush an indigestion tablet into 6 – 8 smaller pieces.
9. Use the weighing machine to ensure that the mass of the slightly crushed indigestion tablet is the same as the mass of the whole indigestion tablet. Gently crush a second tablet if extra mass needs to be added.
10. Repeat Steps 1 to 7 using the slightly crushed indigestion tablet.
11. Use the pestle and mortar to crush an indigestion tablet into a fine powder.
12. Use the weighing machine to ensure that the mass of the powdered indigestion tablet is the same as the mass of the whole indigestion tablet. Crush a second tablet into a fine powder if extra mass needs to be added.
13. Repeat Steps 1 to 7 using the powdered indigestion tablet.
14. Plot a graph of mass of reaction against time for all three experiments. The initial gradient of each graph gives the initial rate of reaction for each experiment.

Note: For all three experiments, the volume and concentration of hydrochloric acid and the mass of indigestion table used are the same / kept constant.

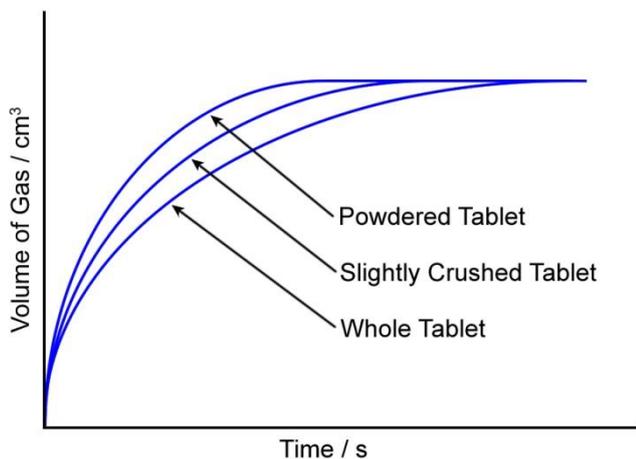
g) Results and Manipulation of the Results

EITHER	
Time / s	Volume of Gas / cm ³
0	
30	
60	
90	
120	
150	
180	
210	
240	
270	
300	

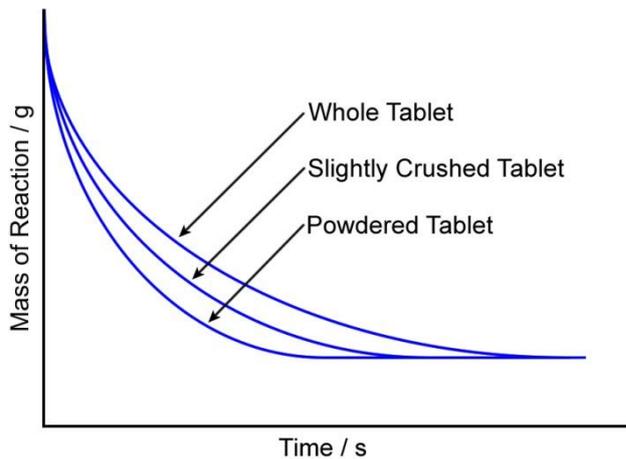
OR	
Time / s	Mass of Reaction / g
0	
30	
60	
90	
120	
150	
180	
210	
240	
270	
300	

- There will need to be a results table for **i)** whole tablet, **ii)** slightly crushed tablet and **iii)** powdered tablet.

EITHER
Graph of Volume of Gas Produced Against Time



OR
Graph of Mass of Reaction Against Time



- The graph for the reaction between the powdered indigestion tablet and hydrochloric acid has a steeper initial gradient than the reaction using the slightly crushed tablet, which in turn has a steeper initial gradient than the whole tablet. Therefore, chewing the indigestion tablet (increasing its surface area to volume ratio) will cause it to neutralise the hydrochloric acid in the stomach more quickly.

h) Source of Error

- It is difficult to control the extent to which the tablet is crushed and the surface area of the tablet (whole, slightly crushed and powdered) cannot be quantified. This makes it difficult to quantify the exact affect that the surface area of the indigestion tablet has on the rate of the chemical reaction.
- There is a slight delay in adding the indigestion tablet to the acid and then attaching the stopper to the mouth of the conical flask. During this time, some carbon dioxide gas will escape from the reaction. This will reduce the volume of carbon dioxide gas collected in the gas syringe which will in turn cause the rate of reaction to appear slower.
- Carbon dioxide gas is slightly soluble in water, therefore not all of the carbon dioxide gas that is produced will **i)** be collected in the gas syringe **ii)** escape from the apparatus. This will **i)** reduce the volume of carbon dioxide gas collected in the gas syringe **ii)** reduce the change in mass of the reaction which will in turn cause the rate of reaction to appear slower.