Lab Reports

When carrying out investigations, it is important that scientists keep records of their plans and results, and share their findings. In order to have their investigations repeated (replicated) and accepted by the scientific community, scientists generally share their work by publishing papers in which details of their design, materials, procedure, evidence, analysis, and evaluation are given.

Lab reports are prepared after an investigation is completed. To ensure that you can accurately describe the investigation, it is important to keep thorough and accurate records of your activities as you carry out the investigation.

Investigators use a similar format in their final reports or lab books, although the headings and order may vary. Your lab book or report should reflect the type of scientific inquiry that you used in the investigation and should be based on the following headings, as appropriate. (See **Figure 1** for a sample lab report.)

Title

At the beginning of your report, write the number and title of your investigation. In this course the title is usually given, but if you are designing your own investigation, create a title that suggests what the investigation is about. Include the date the investigation was conducted and the names of all lab partners (if you worked as a team).

Purpose

State the purpose of the investigation. Why are you doing this investigation?

Question

This is the question that you attempted to answer in the investigation. If it is appropriate to do so, state the question in terms of independent and dependent variables.

Hypothesis/Prediction

Based on your reasoning or on a concept that you have studied, formulate an explanation of what should happen (a hypothesis). From your hypothesis you may make a prediction, a statement of what you expect to observe, before carrying out the investigation. Depending on the nature of your investigation, you may or may not have a hypothesis or a prediction.

Design

This is a brief general overview (one to three sentences) of what was done. If your investigation involved independent, dependent, and controlled variables, list them. Identify any control or control group that was used in the investigation.

Materials

This is a detailed list of all materials used, including sizes and quantities where appropriate. Be sure to include safety equipment such as goggles, lab apron, latex gloves, and tongs, where needed. Draw a diagram to show any complicated setup of apparatus.

Procedure

Describe, in detailed, numbered, step-by-step format, the procedure you followed in carrying out your investigation. Include steps to clean up and dispose of waste.

Observations

This includes all qualitative and quantitative observations that you made. Be as precise as appropriate when describing quantitative observations, include any unexpected observations, and present your information in a form that is easily understood. If you have only a few observations, this could be a list; for controlled experiments and for many observations, a table will be more appropriate.

Analysis

Interpret your observations and present the evidence in the form of tables, graphs, or illustrations, each with a title. Include any calculations, the results of which can be shown in a table. Make statements about any patterns or trends you observed. Conclude the analysis with a statement based only on the evidence you have gathered, answering the question that initiated the investigation.

Evaluation

The evaluation is your judgment about the quality of evidence obtained and about the validity of the prediction and hypothesis (if present). This section can be divided into two parts:

- Did your observations provide reliable and valid evidence to enable you to answer the question? Are you confident enough in the evidence to use it to evaluate any prediction and/or hypothesis you made?
- Was the prediction you made before the investigation supported or falsified by the evidence? Based on your evaluation of the evidence or prediction, is the hypothesis supported or should it be rejected?

Investigation 2.5 – The Effect of Concentration on Reaction Time

Conducted: December 15, 2001

By: Barry L. and Lakshmi B.

Purpose

The purpose of this investigation is to test one of the ideas of the collision–reaction theory.

Question

How does changing the concentration of hydrochloric acid affect the time required for the reaction of hydrochloric acid with a fixed quantity of zinc?

Hypothesis/Prediction

According to the collision–reaction theory, if the concentration of hydrochloric acid is increased, then the time required for the reaction with zinc will decrease. The reasoning that supports this hypothesis is that a higher concentration produces more collisions per second between the hydrochloric acid particles and the zinc atoms. More collisions per second would produce more reactions per second and therefore, a shorter time required to consume the zinc.

Experimental Design

Different known concentrations of excess hydrochloric acid react with zinc metal. The time for the zinc to completely react is measured for each concentration of acid solution. The independent variable is the concentration of hydrochloric acid. The dependent variable is the time for the zinc to be consumed. The temperature of the solution, the quantity of zinc, the surface area of the zinc in contact with the acid, and the volume of the acid are all controlled variables.

Materials

lab apron
four 10-mL graduated cylinders
clock or watch (precise to nearest second)
stock solutions of $HCl_{(aq)}$: 2.0 mol/L, 1.5 mol/L, 1.0 mol/L, 0.5 mol/L
safety glasses
four 18 × 150-mm test tubes and test-tube rack
four pieces of zinc metal strip, 5 mm × 5 mm
a solution of a weak base (baking soda)

Procedure

1. 15 mL of 2.0 mol/L $HCl_{(aq)}$ was transferred into an 18 × 150-mm test tube.
2. A piece of $Zn_{(s)}$ was carefully placed into the hydrochloric acid solution. The starting time of the reaction was noted.
3. The time required for all of the zinc to react was measured and recorded.
4. Steps 2 to 4 were repeated using 1.5 mol/L, 1.0 mol/L, 0.5 mol/L $HCl_{(aq)}$.
5. Any acid remaining in the solutions was neutralized with a solution of the weak base and then poured down the sink with large amounts of water.

Figure 1
Sample Lab Report

Observations

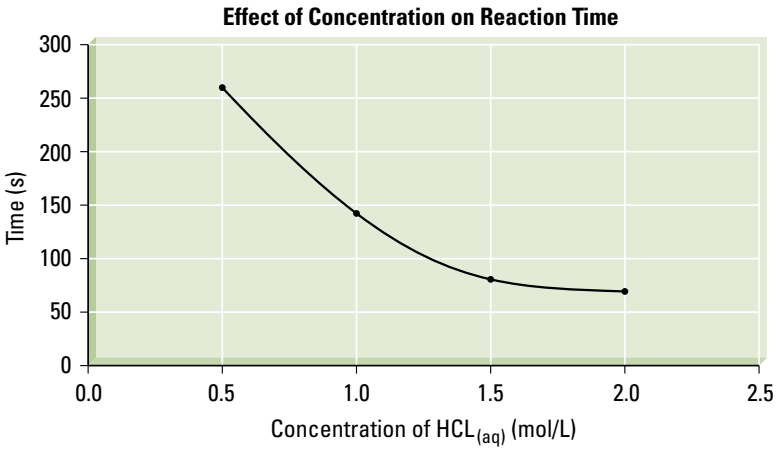
The Effect of Concentration on Reaction Time

Concentration of $HCl_{(aq)}$ (mol/L)	Time for reaction(s)
2.0	70
1.5	80
1.0	144
0.5	258

Analysis

The evidence is plotted on a graph of time vs. concentration of $HCl_{(aq)}$ (below). The graph tends to level off at the two highest concentrations. From this trend we can predict, both from the graph and from common sense, that if you keep increasing the concentration, the reaction time will never reach zero. We might also predict that as the concentration gets very low, the time required for all of the zinc to react will become very long.

Based on the evidence gathered in this investigation, increasing the concentration of hydrochloric acid decreases the time required for the reaction of hydrochloric acid with a fixed quantity of zinc.



Evaluation

The design, materials, and skills used in this investigation are adequate because this experiment produced the type of evidence needed to answer the question with a high degree of certainty. The variables were easy to measure, manipulate, and control.

The procedure is also considered to be adequate since the steps are simple and straightforward. We could have improved the procedure by extending the range of concentrations, by stirring, and by performing more than one trial for each concentration.

Sources of uncertainty in this investigation include the purity of the zinc metal strip, the concentration of the stock acid, and the determination of when the last bit of zinc had reacted.

The hypothesis is supported by the evidence, which clearly shows that the reaction time decreased as the concentration increased. Based on the evidence, the collision–reaction theory is also acceptable.

Synthesis

Other investigations using one of the controlled variables (e.g., temperature of the acid, surface area of the zinc) as the independent variable could be carried out to determine their effect on the reaction rate. Additional investigations studying the effect of concentration on reaction rate using different reactants and reaction types could be conducted.