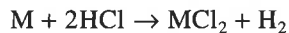
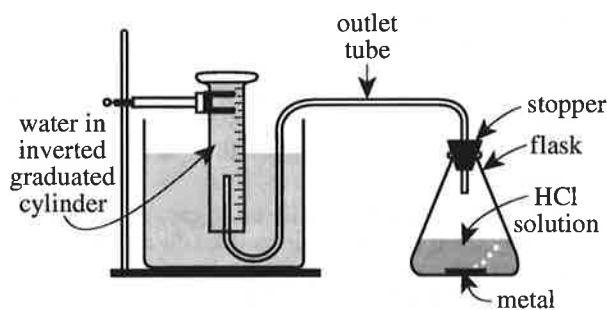


Passage III

When a solid metal (M) such as iron (Fe), nickel (Ni), or zinc (Zn) is placed in an aqueous hydrochloric acid (HCl) solution, a reaction that produces H_2 gas occurs:



Two experiments were conducted to study the production of H_2 in this reaction. The apparatus shown in the diagram below was used to collect the H_2 gas produced in each trial.



diagram

As H_2 was produced in the stoppered flask, it exited the flask through the outlet tube and displaced the water that had been trapped in the inverted graduated cylinder. (This displacement occurred because the H_2 did not dissolve in the water.) The volume of water displaced equaled the volume of gas (H_2 and water vapor) collected.

In each trial of the experiments, Steps 1–3 were performed:

1. The apparatus was assembled, and 25 mL of a 4 moles/L HCl solution was poured into the empty flask.
2. A selected mass of Fe, Ni, or Zn was added to the flask, and the stopper was quickly reinserted into the flask.
3. When H_2 production ceased, the volume of water that was displaced from the graduated cylinder was recorded.

The apparatus and its contents were kept at a selected temperature throughout Steps 2 and 3. The atmospheric pressure was 758 mm Hg throughout all 3 steps.

Experiment 1

In each trial, a selected mass of Fe, Ni, or Zn was tested at 30°C (see Figure 1).

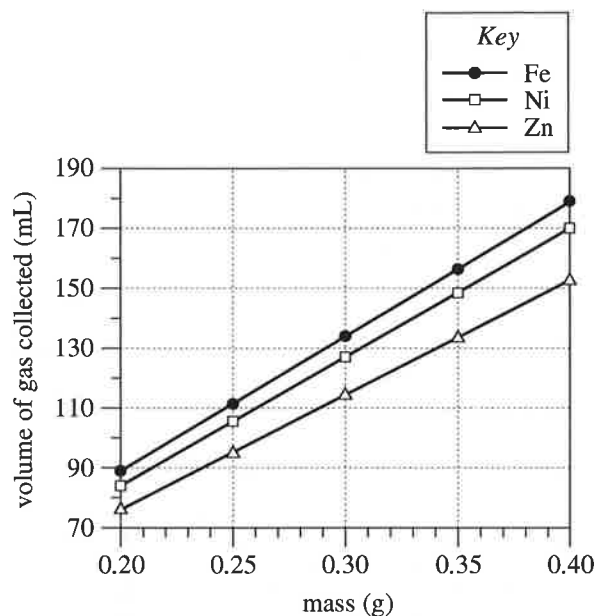


Figure 1

Experiment 2

In each trial, 0.30 g of Fe, Ni, or Zn was tested at a selected temperature (see Figure 2).

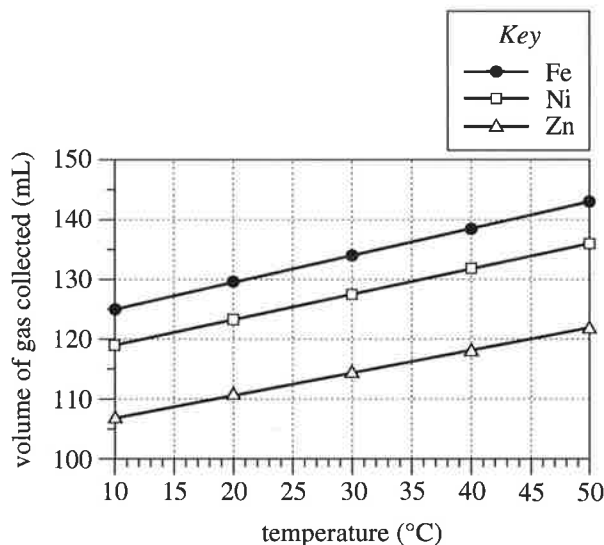


Figure 2



14. Consider the volume of gas collected in the trial in Experiment 2 for Ni at 30°C. The same approximate volume of gas was collected in the trial in Experiment 1 for what mass of Ni?
- F. 0.20 g
G. 0.25 g
H. 0.30 g
J. 0.35 g
15. How many temperatures were tested in Experiment 1, and how many temperatures were tested in Experiment 2?
- | | Experiment 1 | Experiment 2 |
|----|--------------|--------------|
| A. | 1 | 1 |
| B. | 1 | 5 |
| C. | 5 | 1 |
| D. | 5 | 5 |
16. Which of the following statements describes a difference between Experiments 1 and 2? In Experiment 1:
- F. only Fe was tested, but in Experiment 2, Fe, Ni, and Zn were tested.
G. Fe, Ni, and Zn were tested, but in Experiment 2, only Fe was tested.
H. the same mass value of each metal was tested, but in Experiment 2, multiple mass values of each metal were tested.
J. multiple mass values of each metal were tested, but in Experiment 2, the same mass value of each metal was tested.
17. Which of the following variables remained constant throughout both experiments?
- A. Atmospheric pressure
B. Mass of metal
C. Temperature
D. Volume of gas collected
18. If a temperature of 5°C had been tested in Experiment 2, would the volume of gas collected for Zn more likely have been greater than 107 mL or less than 107 mL?
- F. Greater than 107 mL, because for a given metal, the volume of collected gas increased as the temperature decreased.
G. Greater than 107 mL, because for a given metal, the volume of collected gas increased as the temperature increased.
H. Less than 107 mL, because for a given metal, the volume of collected gas decreased as the temperature decreased.
J. Less than 107 mL, because for a given metal, the volume of collected gas decreased as the temperature increased.
19. Consider the balanced chemical equation in the passage. Based on this equation, if 10 moles of HCl are consumed, how many moles of H₂ are produced?
- A. 5
B. 10
C. 15
D. 20
20. Suppose that the trial in Experiment 1 with 0.25 g of Zn is repeated, except that the inverted graduated cylinder is replaced by inverted test tubes, each completely filled with 60 mL of water. Based on Figure 1, how many test tubes will be needed to collect all the gas?
- F. 1
G. 2
H. 3
J. 4