

Passage II

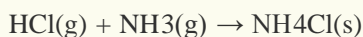
A student studying how gases diffuse derived the following formula:

$$\frac{\text{distance Gas A travels}}{\text{distance Gas B travels}} = \frac{\sqrt{\text{molecular weight of Gas B}}}{\sqrt{\text{molecular weight of Gas A}}}$$

The following experiments were conducted to test her formula and to study factors affecting the rate at which gases diffuse.

Experiment 1

When hydrogen chloride (HCl) and ammonia (NH₃) vapors react, they form solid ammonium chloride (NH₄Cl):



A swab soaked with HCl solution was inserted into one end of a glass tube (1 cm diameter), and, simultaneously, a swab soaked with NH₃ solution was inserted into the other end, so that the swabs were 10 cm apart. The distance that each vapor traveled could be determined because, at the point they made contact, a white ring of NH₄Cl formed (see Figure 1). The reaction was done at different temperatures. The time it took for the ring to start to form and its distance from the HCl swab were measured for each trial (see Table 1).

Table 1

Trial	Temperature (°C)	Time (sec)	Distance of ring from HCl swab (cm)
1	20	33	4.0
2	30	30	4.1
3	40	26	4.1
4	50	23	4.0

Using the formula, the student predicted that the distance of the ring from the HCl swab would be 4.06 cm, so the student concluded that her formula was correct.

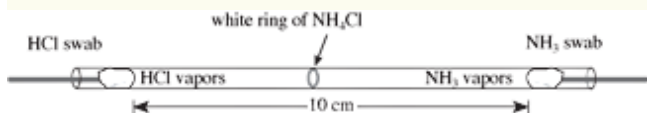


Figure 1

Experiment 2

Experiment 1 was repeated, but the temperature was held constant at 20°C and the diameter of the tube was varied for each trial (see Table 2).

Table 2

Trial	Tube diameter (cm)	Time (sec)	Distance of ring from HCl swab (cm)
5	1.0	33	4.0
6	1.2	33	4.0
7	1.4	33	4.1
8	1.6	33	4.0

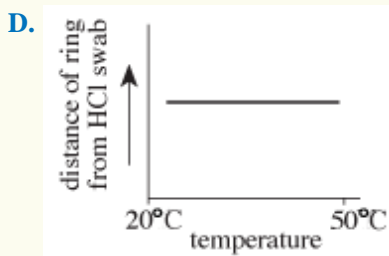
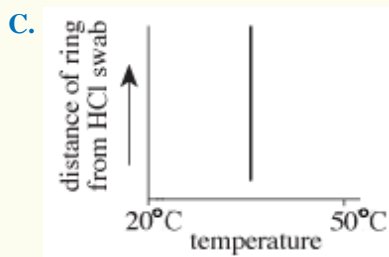
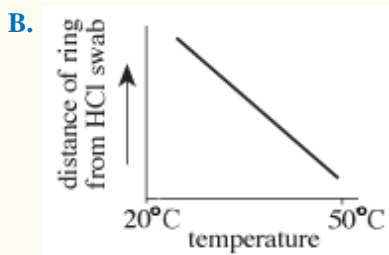
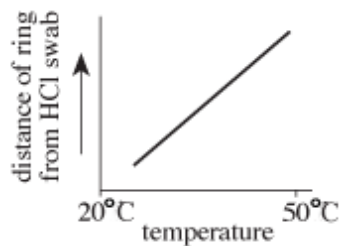
Experiment 3

Experiment 2 was repeated, but the diameter of the tube was kept constant at 1 cm and longer tubes were used so that the distance between the swabs could be varied for each trial (see Table 3).

Table 3

Trial	Distance between swabs (cm)	Time (sec)	Distance of ring from HCl swab (cm)
9	10	33	4.0
10	20	67	8.1
11	30	101	12.2
12	40	133	16.2

- Which of the following best describes the difference between the procedures used in Experiments 1 and 2? In Experiment 1, the:
 - temperature was varied; in Experiment 2, the diameter of the tube was varied.
 - diameter of the tube was varied; in Experiment 2, the temperature was varied.
 - distance between the swabs was varied; in Experiment 2, the temperature was varied.
 - temperature was varied; in Experiment 2, the distance between the swabs was varied.
- Which of the following sets of trials in Experiments 1, 2, and 3 were conducted with identical sets of conditions?
 - Trials 2, 3, and 4
 - Trials 1, 5, and 9
 - Trials 4, 7, and 9
 - Trials 10, 11, and 12
- Based on the results of Experiment 1, which of the following graphs best shows the relationship between the temperature and the distance of the ring from the HCl swab?
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4. If a trial in Experiment 3 had been performed with the swabs 25 cm apart, the distance from the HCl swab to the ring would most likely have been closest to:

- F.** 8 cm.
- G.** 10 cm.
- H.** 12 cm.
- J.** 14 cm.

5. If another student wanted to test a factor that was not studied in Experiments 1–3, which of the following should he do next? He should test how the diffusion rates of gases are affected by:

- A.** atmospheric pressure.
- B.** tube length.
- C.** temperature.
- D.** tube diameter.

6. The student concluded that NH_3 diffuses at a greater rate than HCl. Do the results of Experiments 1–3 support her conclusion?

- F.** No; in Trials 1–9 the HCl vapors traveled farther than the NH_3 vapors.

- G.** No; in Trials 1–9 the NH₃ vapors traveled farther than the HCl vapors.
- H.** Yes; in Trials 1–9 the HCl vapors traveled farther than the NH₃ vapors.
- J.** Yes; in Trials 1–9 the NH₃ vapors traveled farther than the HCl vapors.

- 1. A
- 2. G
- 3. D
- 4. G
- 5. A
- 6. J

Bell Work, Tuesday, 3/11/14

Experiment 1



Trial	Temp (°C)	Time (sec)	Distance of ring from HCl swab (cm)
1	20	33	4.0
2	30	30	4.1
3	40	26	4.1
4	50	23	4.0

Experiment 2

Trial	Tube diameter (cm)	Time (sec)	Distance of ring from HCl swab (cm)
5	1.0	33	4.0
6	1.2	33	4.0
7	1.4	33	4.1
8	1.6	33	4.0