

## Factors Affecting the Rate of Diffusion

The rate at which diffusion happens can be affected by several factors, including molecular size, temperature and concentration. Some students wanted to study the effects of these factors on the rate of diffusion, so they conducted three separate experiments.

### Experiment 1 – Effect of molecular size

1. [SP 3] Write a hypothesis predicting the effect of molecular size on the rate of diffusion.

The students filled a Petri dish with agar and made three holes in the agar using a cork borer. They filled one hole with 1% Congo red solution, another with 1% methylene blue solution and the third with 1% potassium permanganate solution. After one hour, they measured the distance in millimeters that each substance had diffused into the agar surrounding each hole. They recorded their results in Table 1.

**Table 1. Distance traveled through agar by each molecule**

Solution	Molecular Mass (g/mol)	Distance traveled (mm)
Congo red		3.1
Methylene blue		6.3
Potassium permanganate		13.2

2. What is agar and why do you think agar was used in this experiment?
3. a) The students forgot to look up the molecular masses of the substances they used. Find the mass of each molecule and add it to Table 1.  
b) [SP 5, SP 6] From the results of the first experiment, what can you say about the effect of molecular size on the rate of diffusion?

### Experiment 2 – Effect of temperature

4. [SP 3] Write a hypothesis predicting the effect of temperature on the rate of diffusion.

In this experiment, the students prepared three beakers. One contained water at 50°C, a second contained room temperature water and a third water at 0°C. They added a drop of potassium permanganate to the center of each beaker and observed the distribution of the purple color 15 minutes later. Their results are shown in Table 2.

**Table 2 Distribution of potassium permanganate in each beaker**

Temperature (°C)	Distribution of color
0	Barely spread out
Room temperature	Somewhat spread out
50	Really spread out

5. [SP 5, SP 6] From the results of the second experiment, what can you say about the effect of temperature on the rate of diffusion?
6. [SP 4] The students were careful not to disturb the beakers during the 15 minutes. Why was this important?

### Experiment 3 – Effect of concentration

7. [SP 3] Write a hypothesis predicting the effect of concentration on the rate of diffusion. The students were a little stuck on how to discover which of three solutions, 1%, 5% and 10% potassium

permanganate, would diffuse fastest.

8. [SP 4] Design a protocol they can use to investigate the answer.

The students followed your procedure and recorded their results in Table 3.

**Table 3. Distance traveled through agar by each solution**

Solution	Distance traveled (mm)
1% potassium permanganate	3.2
5% potassium permanganate	14.8
10% potassium permanganate	27.4

9. [SP 5, SP 6] From the results in experiment 3, what can you say about the effect of concentration on the rate of diffusion?
10. [SP 5] For each of the three experiments, draw a graph to show the relationship between each of the three factors and the rate of diffusion.
11. [SP 3, SP 6] a) For each factor, did the results support or reject your hypothesis?  
b) For each factor, is the relationship between the factor and the rate of diffusion direct or inverse?
12. [SP 7] Give an explanation for the effect of each of these three factors on the rate of diffusion.
13. [SP 7] Parts of this experiment had to be left for a long time.
  - a) Considering the length of time involved, what limitation does diffusion pose to organisms? (Diffusion is a slow process, so it is only useful to organisms over very short distances)
  - b) Describe an adaptation you have that mitigates the limitation.