# The Evolution of the Atmosphere of Mars

### Applying Principles of Gases to the Atmosphere of Mars

In a previous exercise, “Planetary Atmospheres and Escape of Gas”, we explored the properties of temperature and pressure in a gas, and the speeds of particles in a planetary atmosphere. We noted that a given type of gas particle has a peak velocity at the “most probable speed”, with a wide range of speeds above the most-probable speed. If the most probable speed is at least 20% of the escape velocity of a planet, fast-moving particles will have a chance to “leak away” from that planet’s atmosphere.

1. Is Mars a particularly massive planet, or does it have a relatively low mass compared to other planets of the Solar System?

2. Is Mars likely to have a high or low escape velocity compared to other planets of the Solar System? Why?

3. Is Mars likely to have experienced a significant loss of gases from its atmosphere over time, compared to other planets of the Solar System?

Early in the history of Mars, it had an active geology, including many volcanoes, some of which are still visible (although probably not active) today. Martian volcanoes, when active, released quantities of new gas like carbon dioxide into the atmosphere, a process called “outgassing.”

4. How do you think these two factors – outgassing from volcanoes, and any loss of gases which exceeded the escape velocity of Mars – would affect the balance of the Martian atmosphere?

5. Over time, Mars cooled, and its geology became less and less active. Volcanism more or less shut down. Once volcanoes were no longer outgassing, what do you think would happen to the atmosphere of Mars?

6. The fact that Mars had an active geology early in its history implies that it may also have had a significant magnetic field (due to molten iron in its core). This would have protected the atmosphere of Mars from having gas stripped away by interactions with the solar wind. Would this protection have continued up to the present, when Mars has lost almost all of its active geology?

7. Based on the “Planetary Atmospheres and Escape of Gas” activity, what happens to gas pressure when you decrease the number of particles in a given volume?

8. Based on your answer to the previous three questions, what do you think has happened to the gas pressure in the Martian atmosphere over its lifetime?

9. As Mars lost the heat that powered its previously active geology, what would have happened to the temperatures at the Martian surface?

10. Water requires a specific range of surface temperatures and atmospheric pressures to be present in liquid form on a planet’s surface. We have evidence that in the past, there was liquid water on the surface of Mars. Would you expect that liquid water to still be present? Why or why not?

11. Two students are having a discussion.

*Student 1: “I think that due to the low temperatures on the surface of Mars after active geology mostly stopped, a lot of the liquid water on the Martian surface would have frozen. ”*

*Student 2: “I disagree. The escape of gas from Mars’ atmosphere would lead to lower pressures, which would cause more evaporation of water molecules into the atmosphere, which could then escape.”*

Would you agree with either student, both, or neither? In what respects? Explain.