SCH3U1

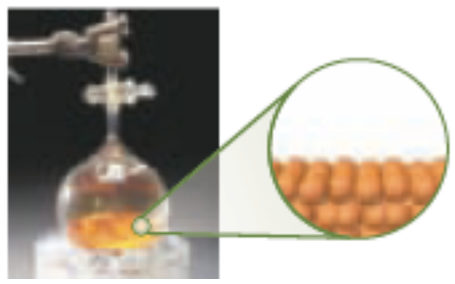
Gases & Atmospheric Chemistry

- So far, we have looked at **solids** and **liquids** (Solutions)
- Now we will look at **gases** and the laws that govern their behaviour in chemical reactions

Images taken from: MHR Chemistry 11

What's so special about gases??

State	Properties	Particles
Solid	• Constant shape • Constant volume • Almost incompressible	• Particles are organized in a regular pattern (this is also known as having "low disorder") and they vibrate in a fixed position.



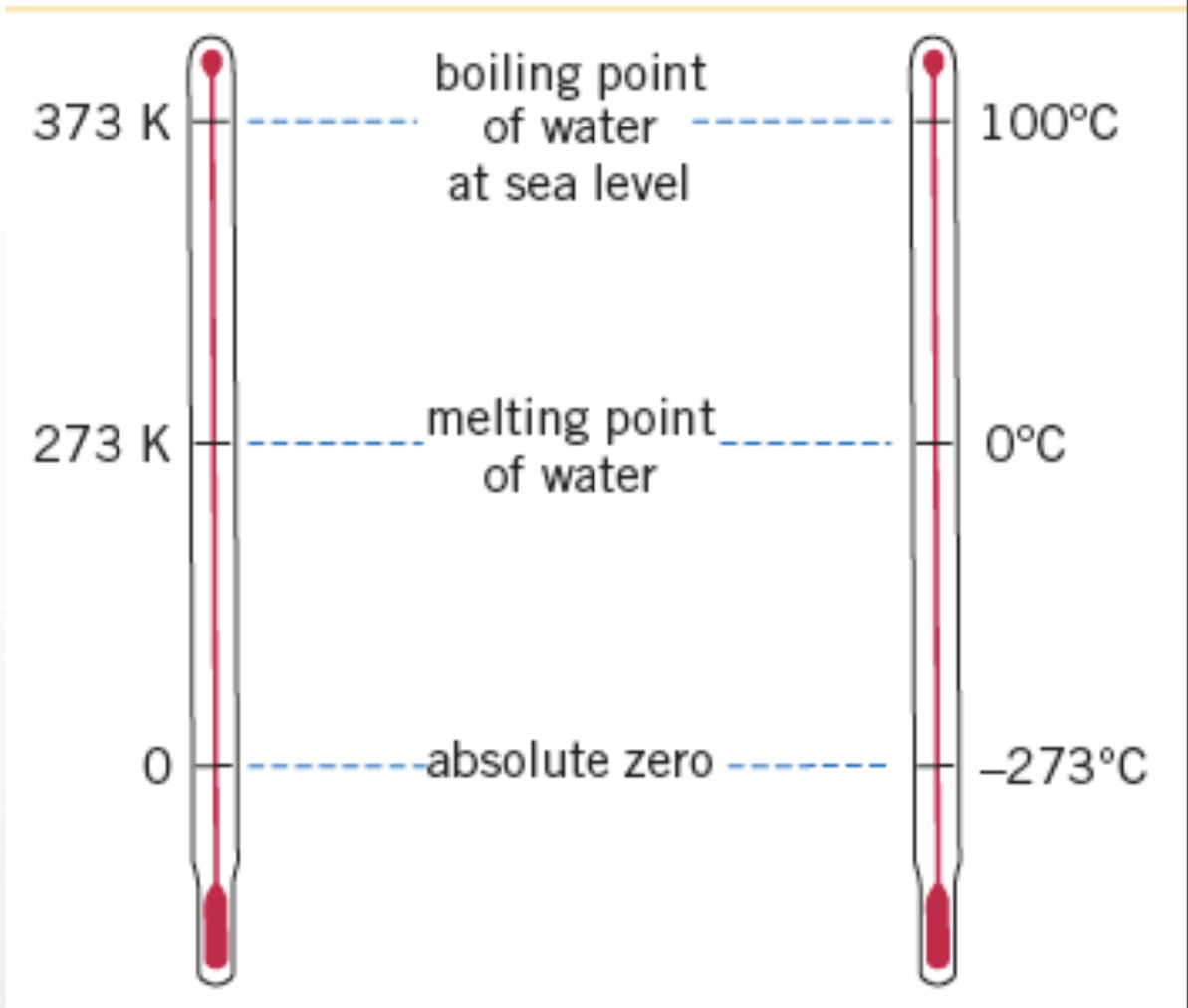
- This means that in order to study a gas, we need to know about other factors that affect volume such as **TEMPERATURE** and **PRESSURE**

4 Factors Affecting Gases

- Amount (in moles)
- Volume (in L)
- Temperature (in K)
- Pressure (in a delightful variety of units)

Temperature

- Most of the time when working with gases, we will need to have temperature converted to Kelvin
- K = °C + 273



Try it!

16. Make the following temperature conversions.

a. 27.3°C to K

b. −25°C to K

c. 373.2 K to °C

d. 23.5 K to °C

- a. 300.3 K
- b. 248 K
- c. 100.2 °C
- d. -249.5 °C

Pressure

- The amount of force exerted per area (P=F/A)
- Under standard conditions, the pressure is:

$$1\ \text{atm} = 760\ \text{mmHg} = 760\ \text{torr} = 101\ 325\ \text{Pa} = 101.325\ \text{kPa} = 1.01325\ \text{bar} = 14.7\ \text{psi}$$

Table 11.3 Units of Pressure Used for Various Instruments

Unit of Pressure	Symbol	Examples of Instruments That Use the Unit
standard atmosphere	atm	Gas compressors, pneumatic tools (tools such as jackhammers driven by compressed gas)
millimetres of mercury	mmHg	Blood pressure meters, barometers
torr	torr	Vacuum pumps
pascal	Pa	Pressure sensors in pipelines
kilopascal	kPa	Tire inflation gauges; heating, ventilating, and air-conditioning systems
bar	bar	Pressure sensors in scuba gear, steam traps used to remove condensed water from pipes carrying steam
millibar	mb	Barometers
pounds per square inch	psi	Hydraulic pumps, tire inflation gauges

Converting

- Convert 732 mmHg into kPa
- We know that 760 mmHg = 101.325 kPa
- 732 mmHg x $\frac{101.325 \text{ kPa}}{760 \text{ mmHg}}$ = 97.6 kPa

Try it!

9. Convert each of the following to the indicated unit.

a. 3.58 atm to kPa

b. 20.5 psi to atm

c. 770 mmHg to kPa

d. 470 torr to Pa

- a. 362.7 kPa
- b. 1.4 atm
- c. 102.7 kPa
- d. 62661 Pa

- What do you think happens to pressure as you go up a mountain?

Pressure Changes

- Pressure decreases as you ascend
- This is why people require oxygen tanks for very high climbs - there isn't enough oxygen molecules in the air to support the person's breathing!

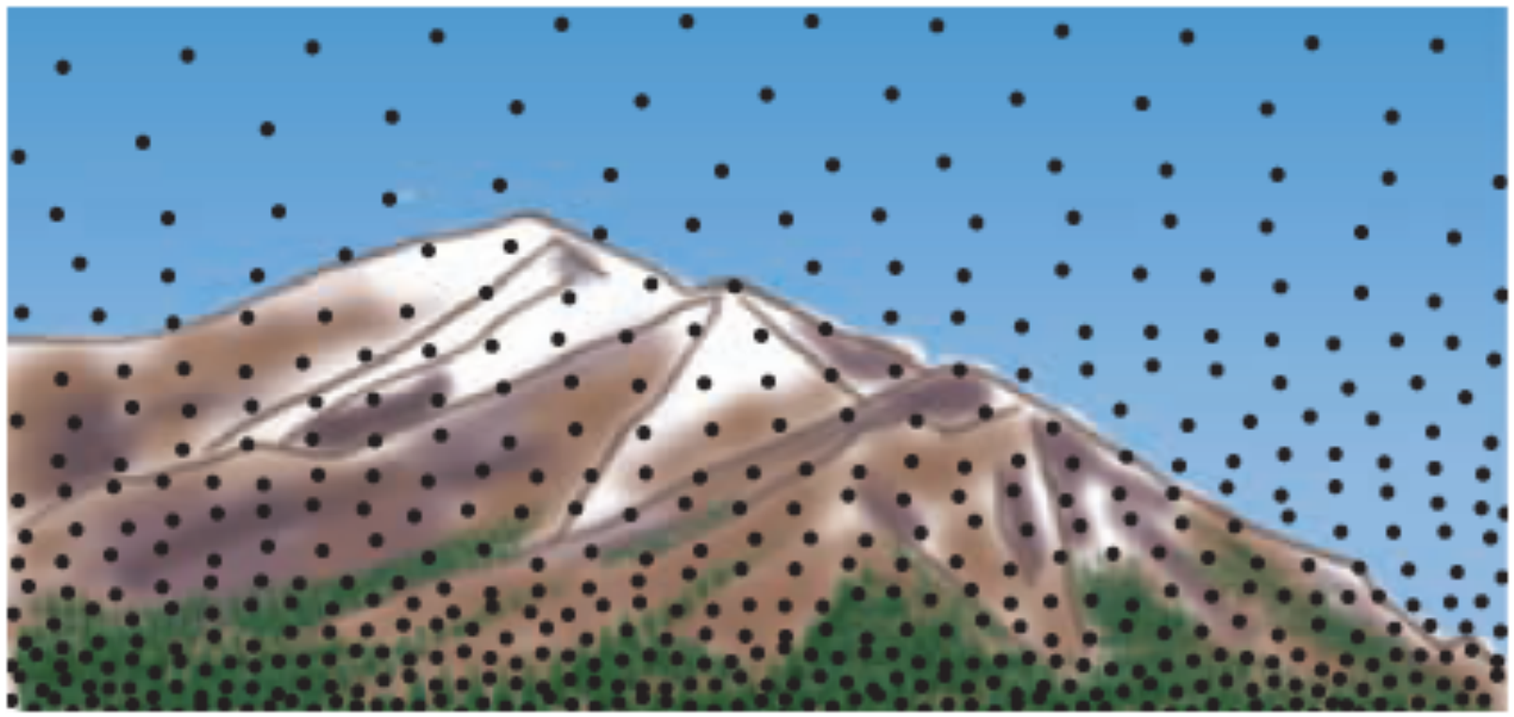


Figure 11.9 In this diagram, the dots represent air molecules. People often refer to the air "thinning" at increased altitudes. This means that there are fewer gas molec in the air for a given volume at lower atmospheric pressure.

Machu Picchu, Peru

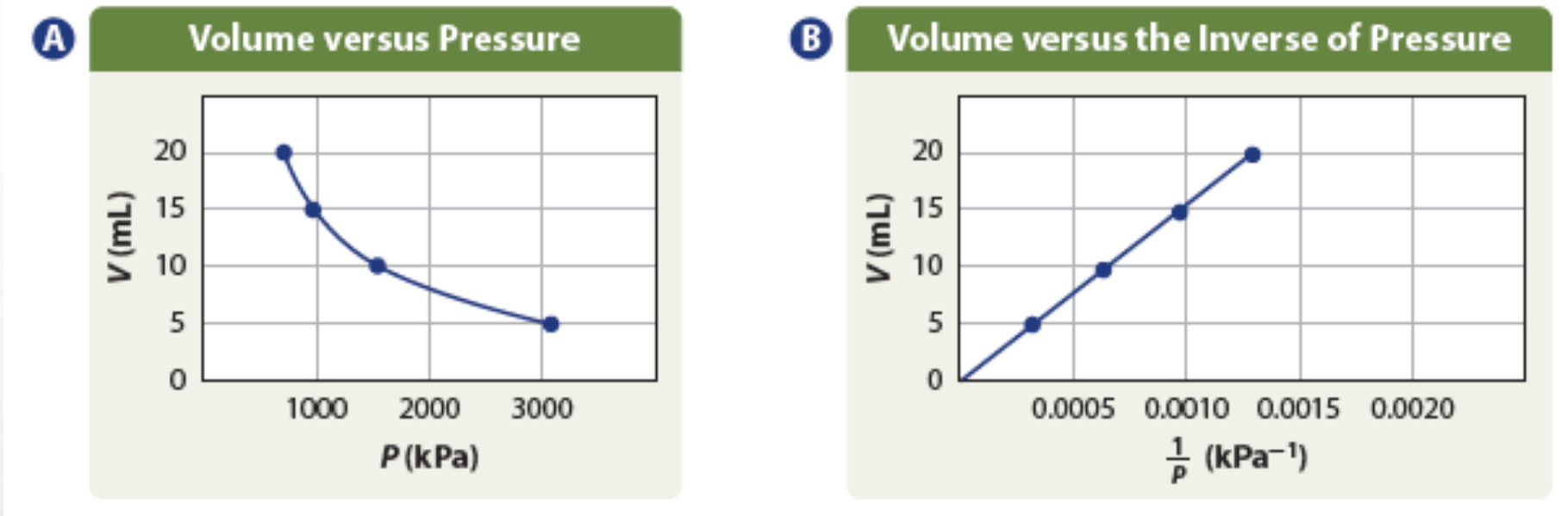
- 2430 m (7950 ft) above sea level
- Symptoms of altitude sickness:
  - dizziness, shortness of breath, tingling in fingers

Working with Gases

- The problem with gases is that they have no fixed volume. You must know the conditions (pressure and temperature) in which the gas is in to determine the volume.
- There are 3 laws which show us the relationship between Pressure, volume and temperature:
  - Boyle's law
  - Charles' law
  - Avogadro's law

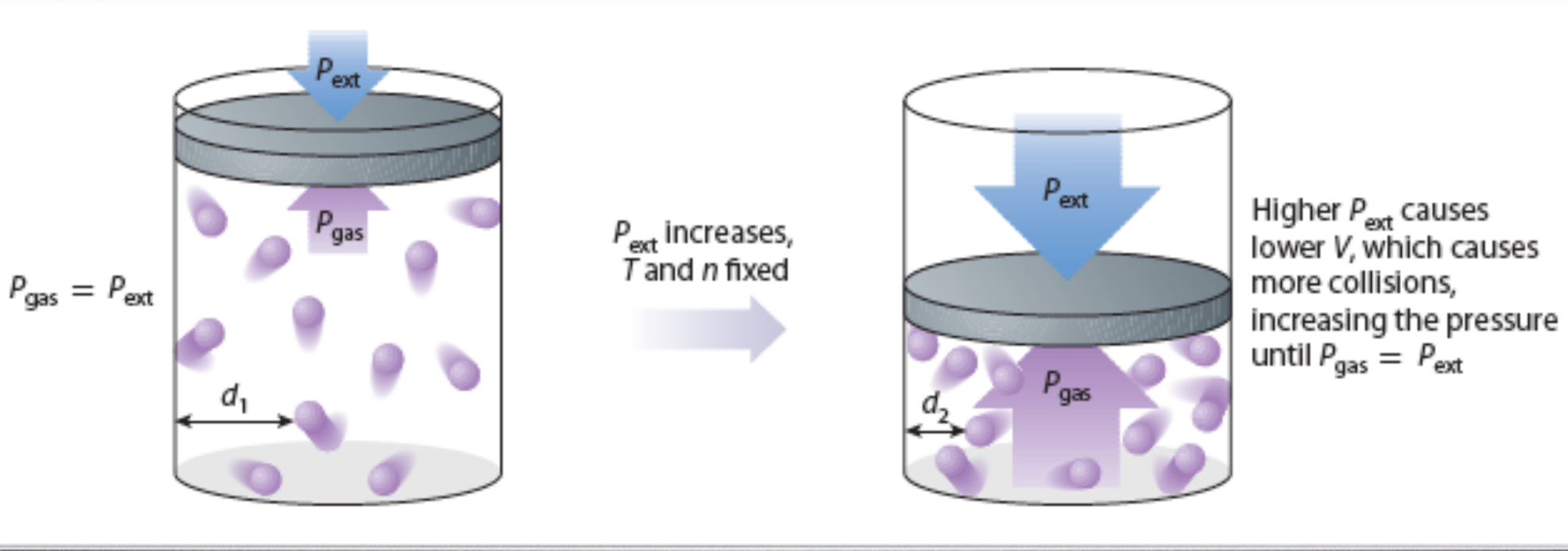
Boyle's Law

- The pressure exerted by a given mass of gas at constant temperature is inversely proportional to the volume occupied by the gas
- Graphically:

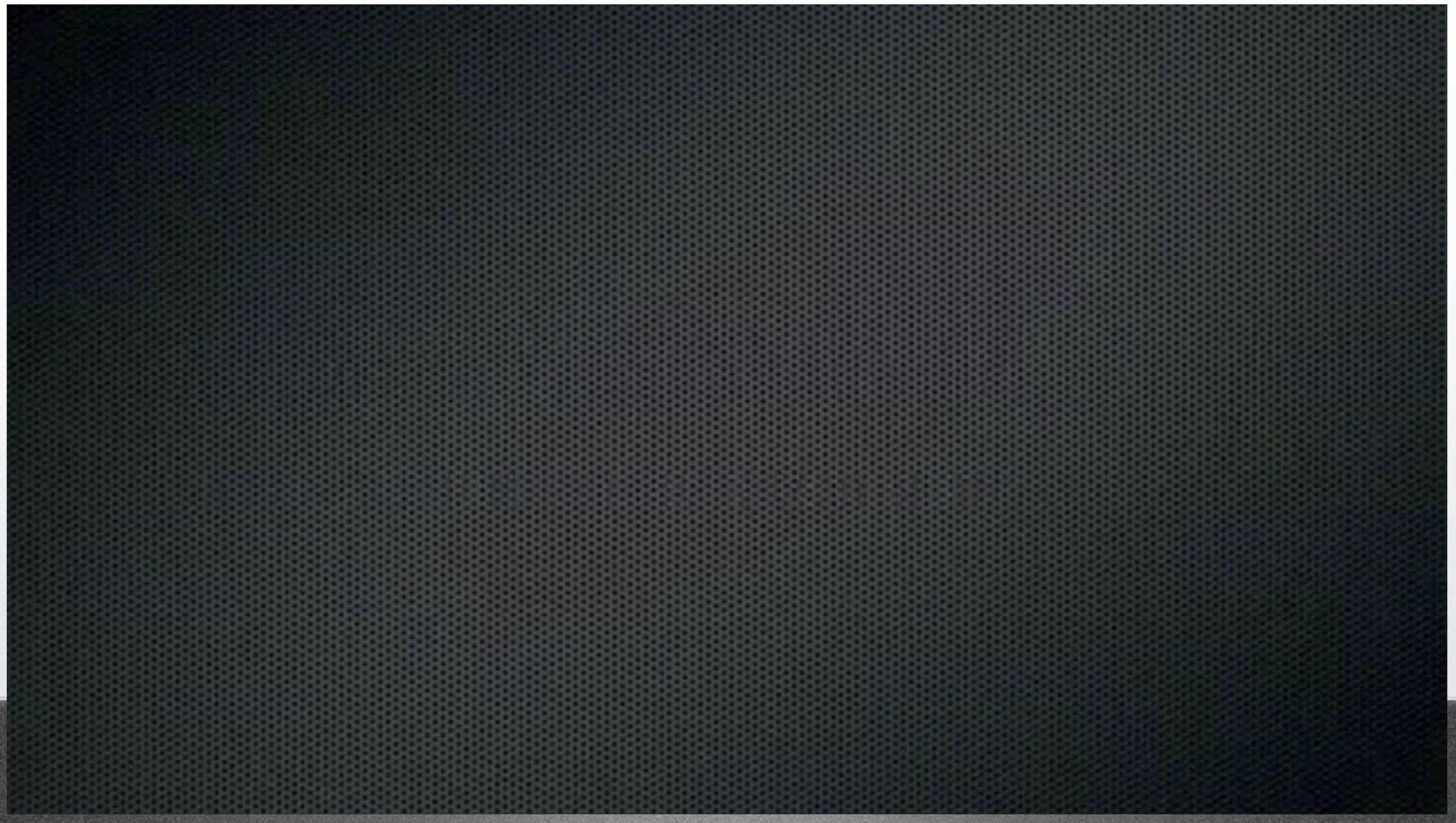


Boyle's Law

- When pressure goes up, volume goes down
- PV = constant
  - $P_1V_1 = P_2V_2$



What happens to marshmallows during a pressure change?



Try it!

1. A balloon with a volume of 5.0 L is filled with air at 101.325 kPa pressure. The balloon is taken to Banff, where the atmospheric pressure is only 91 kPa (1386 m above sea level). If the temperature is the same in both places, what will be the new volume of the balloon?

5.6 L

2. If a sample of gas has a volume of 100 mL when the pressure is 150 kPa, what is its volume when the pressure is increased to 200 kPa? (Temperature & mass are constant.)

75 mL

3. A balloon contains 5.0 L of air at a pressure of 149 kPa. If the temperature remains constant, what will be the pressure in the balloon if its volume is decreased to 4.0 L ?

186 kPa

Try it!

- p. 514 #1-10, odd questions

Note: Assume that the temperature and amount of gas are constant in all of the following problems.

1. 1.00 L of a gas at 1.00 atm pressure is compressed to 0.437 L. What is the new pressure of the gas?
2. A container with a volume of 60.0 mL holds a sample of gas. The gas is at a pressure of 99.5 kPa. If the container is compressed to one-quarter of its volume, what is the pressure of the gas in the container?
3. Atmospheric pressure on the peak of Mount Everest can be as low as 0.20 atm. If the volume of an oxygen tank is 10.0 L, at what pressure must the tank be filled so that the gas inside would occupy a volume of 1.2×10^3 L at this pressure?
4. If a person has 2.0×10^2 mL of trapped intestinal gas at an atmospheric pressure of 0.98 atm, what would the volume of gas be (in litres) at a higher altitude that has an atmospheric pressure of 0.72 atm?
5. Decaying vegetation at the bottom of a pond contains trapped methane gas. 5.5×10^2 mL of gas are released. When the gas rises to the surface, it now occupies 7.0×10^2 mL. If the surface pressure is 101 kPa, what was the pressure at the bottom of the pond?
6. The volume of carbon dioxide in a fire extinguisher is 25.5 L. The pressure of the gas in this can is 260 psi. What is the volume of carbon dioxide released when sprayed if the room pressure is 15 psi?
7. A 50.0 mL sample of hydrogen gas is collected at standard atmospheric pressure. What is the volume of the gas if it is compressed to a pressure of 3.50 atm?
8. A portable air compressor has an air capacity of 15.2 L and an interior pressure of 110 psi. If all the air in the tank is released, what volume will that air occupy at an atmospheric pressure of 102 kPa?
9. A scuba tank with a volume of 10.0 L holds air at a pressure of 1.75×10^4 kPa. What volume of air at an atmospheric pressure of 101 kPa was compressed into the tank if the temperature of the air in the tank is the same as the temperature of the air before it was compressed?
10. An oxygen tank has a volume of 45 L and is pressurized to 1200 psi.
    a. What volume of gas would be released at 765 torr?
    b. If the flow of gas from the tank is 6.5 L per minute, how long would the tank last?