Section 13.1

Describing the Properties of Gases

Objectives

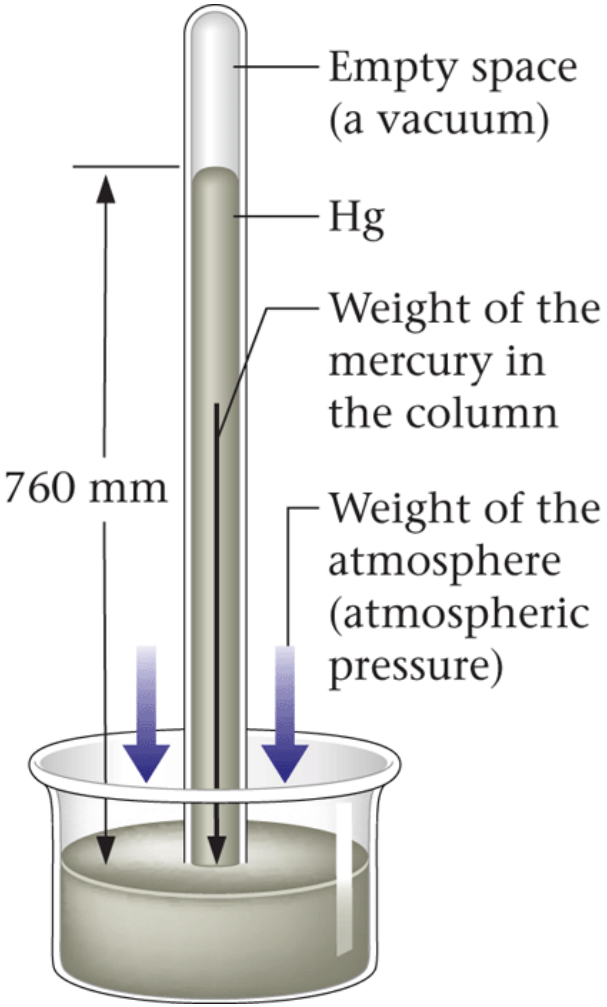
1. To learn about atmospheric pressure and how barometers work
2. To learn the units of pressure
3. To understand how the pressure and volume of a gas are related
4. To do calculations involving Boyle's Law
5. To learn about absolute zero
6. To understand how the volume and temperature of a gas are related
7. To do calculations involving Charles's Law
8. To understand how the volume and number of moles of a gas are related
9. To do calculations involving Avogadro's Law

Describing the Properties of Gases

A. Pressure

Measuring Pressure

- Barometer – device that measures atmospheric pressure
  - Invented by Evangelista Torricelli in 1643

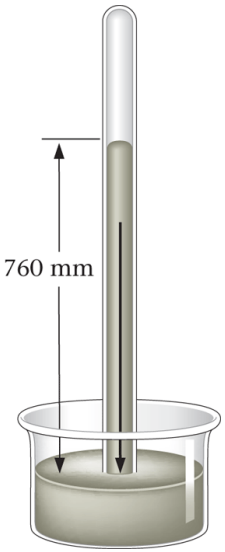


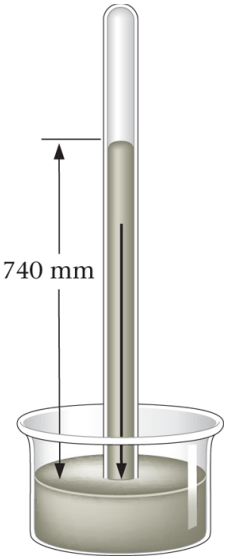
Describing the Properties of Gases

A. Pressure

Atmospheric Pressure

– Changing weather conditions



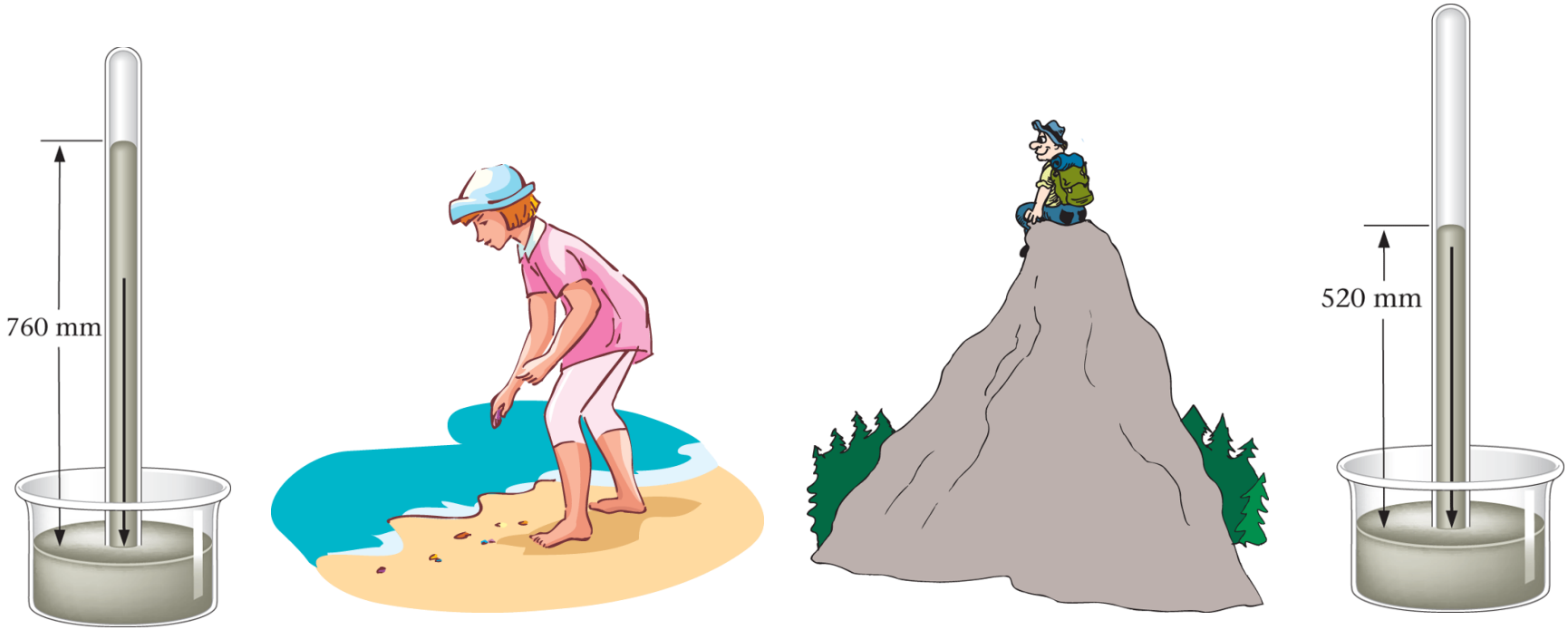


Describing the Properties of Gases

A. Pressure

Atmospheric Pressure

– Changing altitude



Describing the Properties of Gases

A. Pressure

Units of Pressure

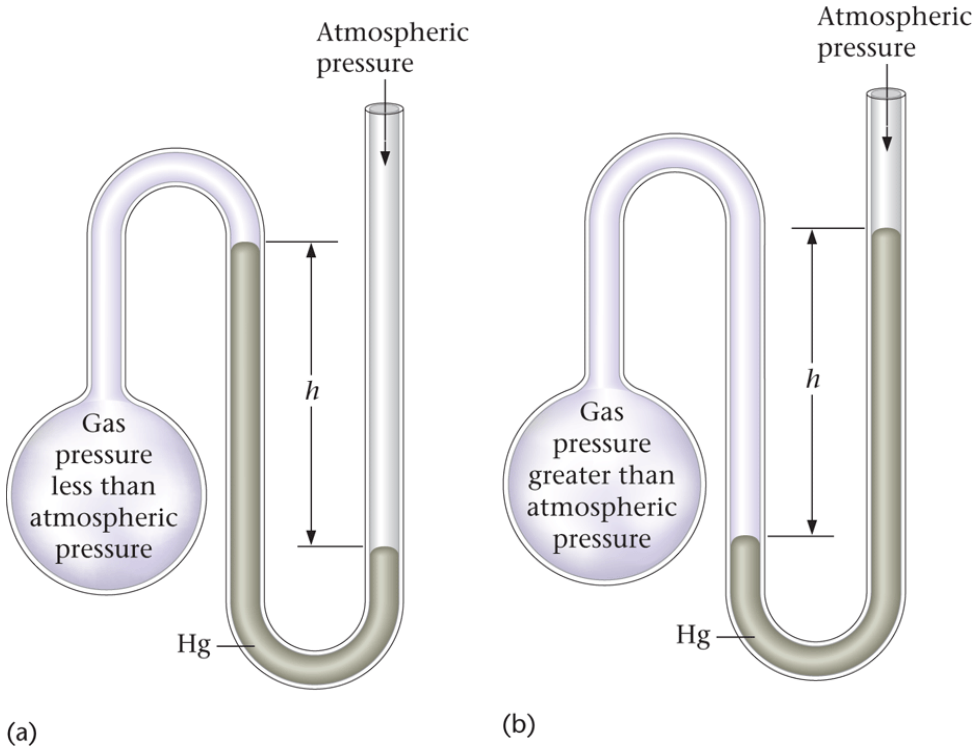
1 standard atmosphere
= 1.000 atm
= 760.0 mm Hg
= 760.0 torr
= 101,325 Pa

Describing the Properties of Gases

A. Pressure

Units of Pressure

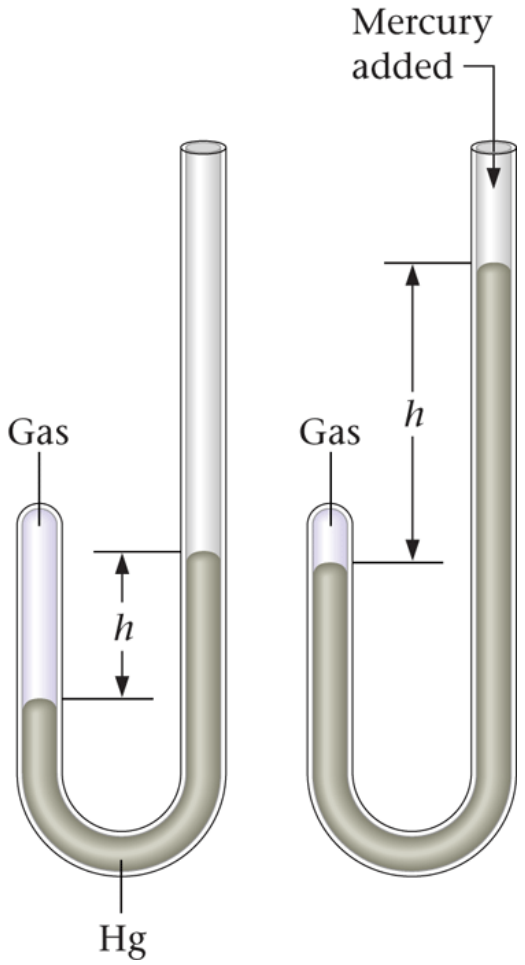
- A manometer measures the pressure of a gas in a container.



Describing the Properties of Gases

B. Pressure and Volume: Boyle's Law

- Robert Boyle's experiment



Describing the Properties of Gases

B. Pressure and Volume: Boyle's Law

Table 13.1

A Sample of Boyle's Observations (moles of gas and temperature both constant)

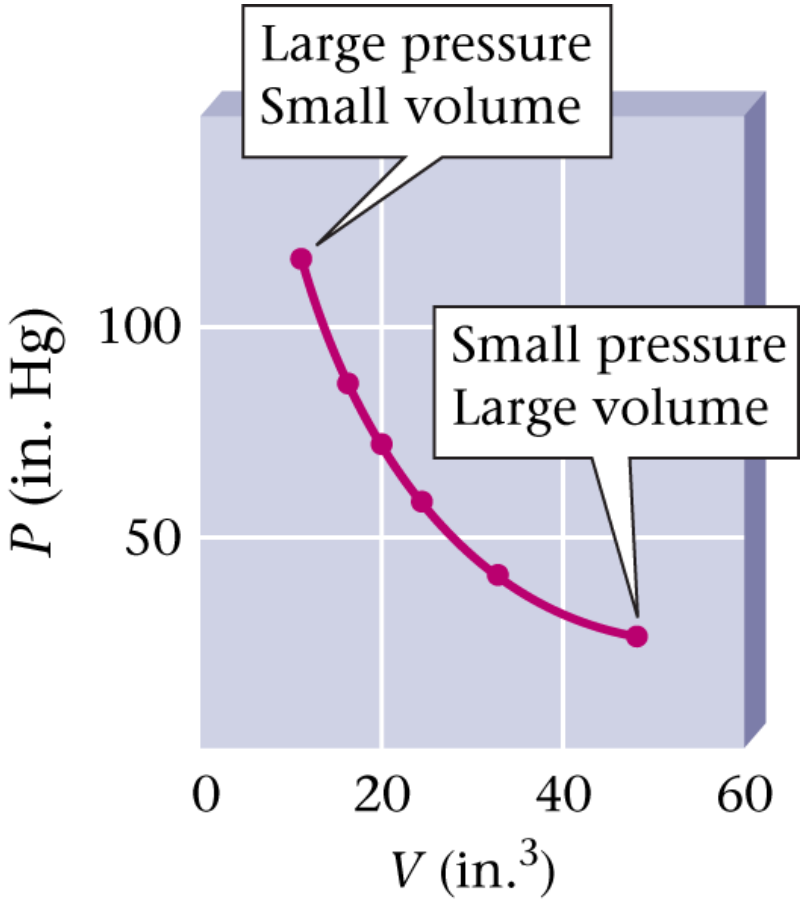
Experiment	Pressure (in. Hg)	Volume ($in.^3$)	Pressure × Volume (in. Hg) × ($in.^3$)	
			Actual	Rounded*
1	29.1	48.0	1396.8	1.40×10^3
2	35.3	40.0	1412.0	1.41×10^3
3	44.2	32.0	1414.4	1.41×10^3
4	58.2	24.0	1396.8	1.40×10^3
5	70.7	20.0	1414.0	1.41×10^3
6	87.2	16.0	1395.2	1.40×10^3
7	117.5	12.0	1410.0	1.41×10^3

*Three significant figures are allowed in the product because both of the numbers that are multiplied together have three significant figures.

Describing the Properties of Gases

B. Pressure and Volume: Boyle's Law

- Graphing Boyle's results



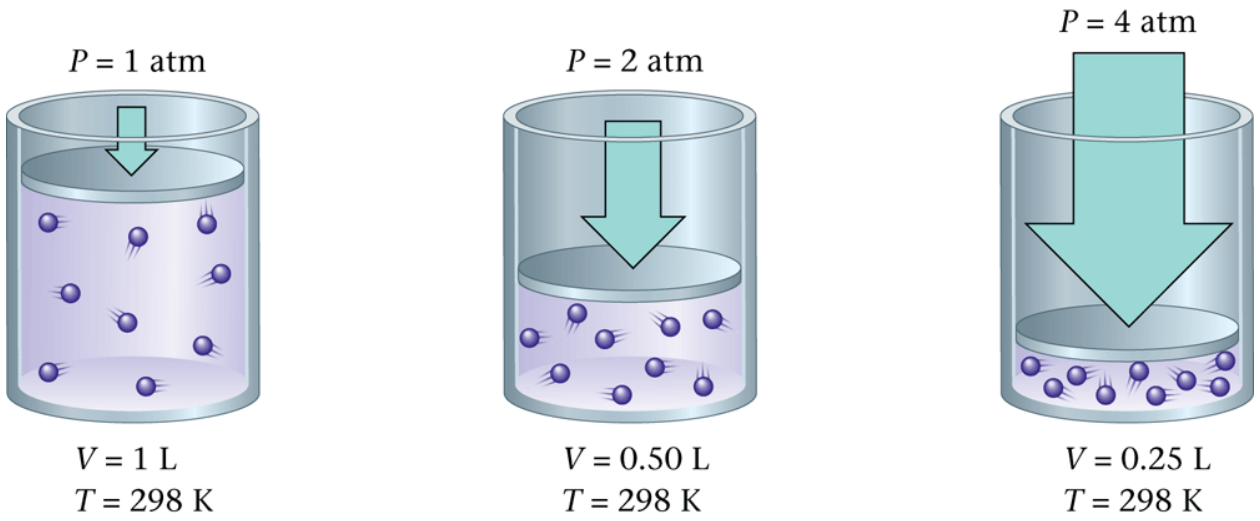
Describing the Properties of Gases

B. Pressure and Volume: Boyle's Law

- This graph has the shape of half of a hyperbola with an equation

  $PV = k$

- Volume and pressure are inversely proportional.
  - If one increases the other decreases.



Describing the Properties of Gases

B. Pressure and Volume: Boyle's Law

Another way of stating Boyle's Law is

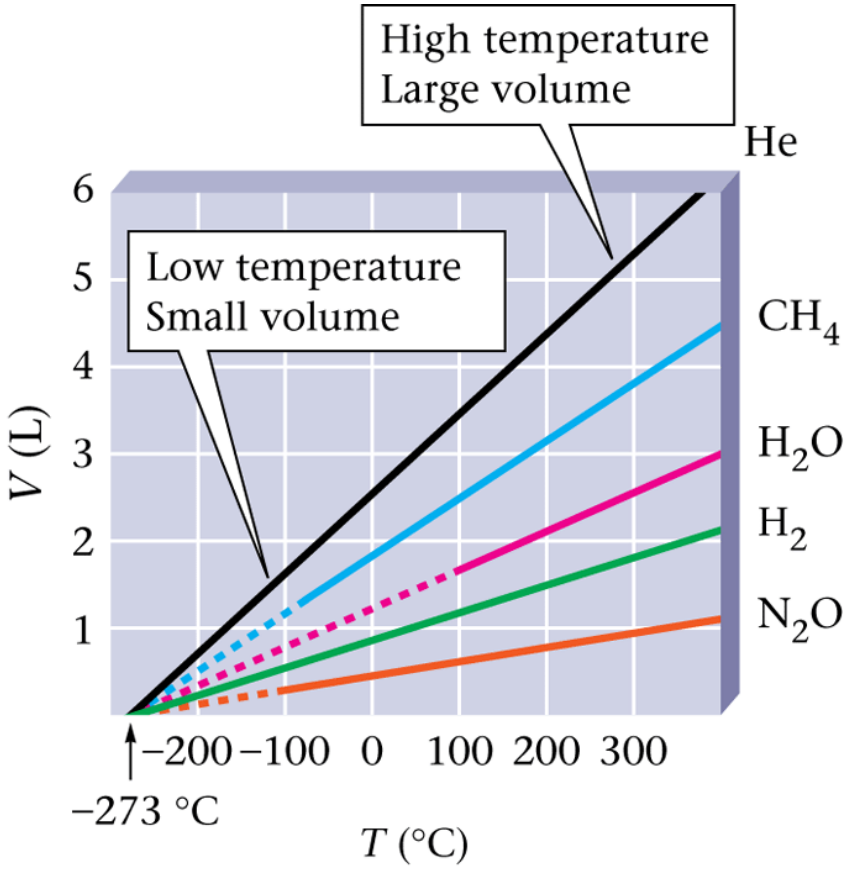
$$P_1V_1 = P_2V_2$$

(constant temperature and amount of gas)

Describing the Properties of Gases

C. Volume and Temperature: Charles's Law

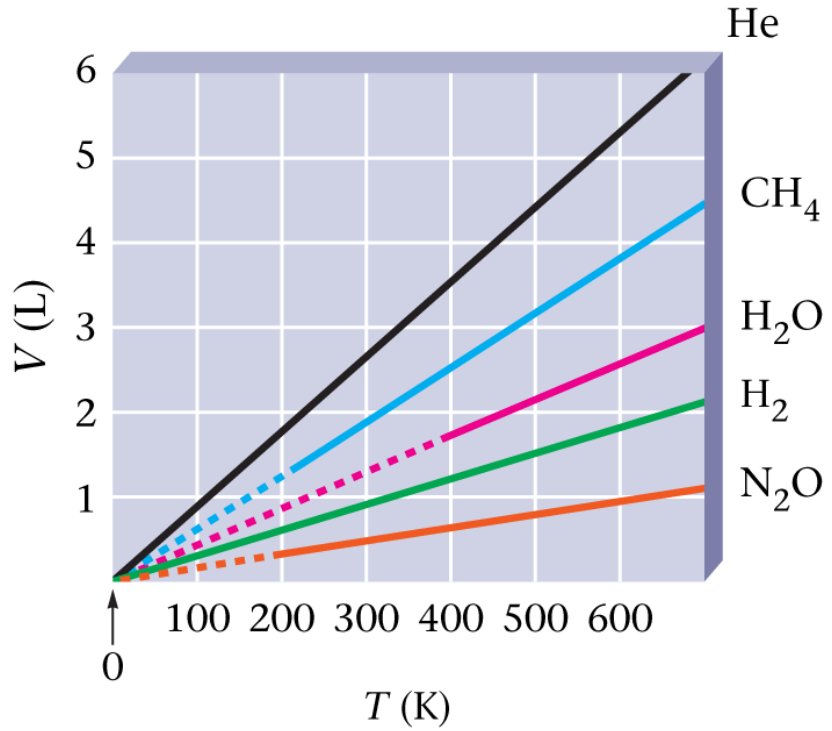
- Graphing data for several gases



Describing the Properties of Gases

C. Volume and Temperature: Charles's Law

- It is easier to write an equation for the relationship if the lines intersect the origin of the graph.
  - Use absolute zero for the temperature



Describing the Properties of Gases

C. Volume and Temperature: Charles's Law

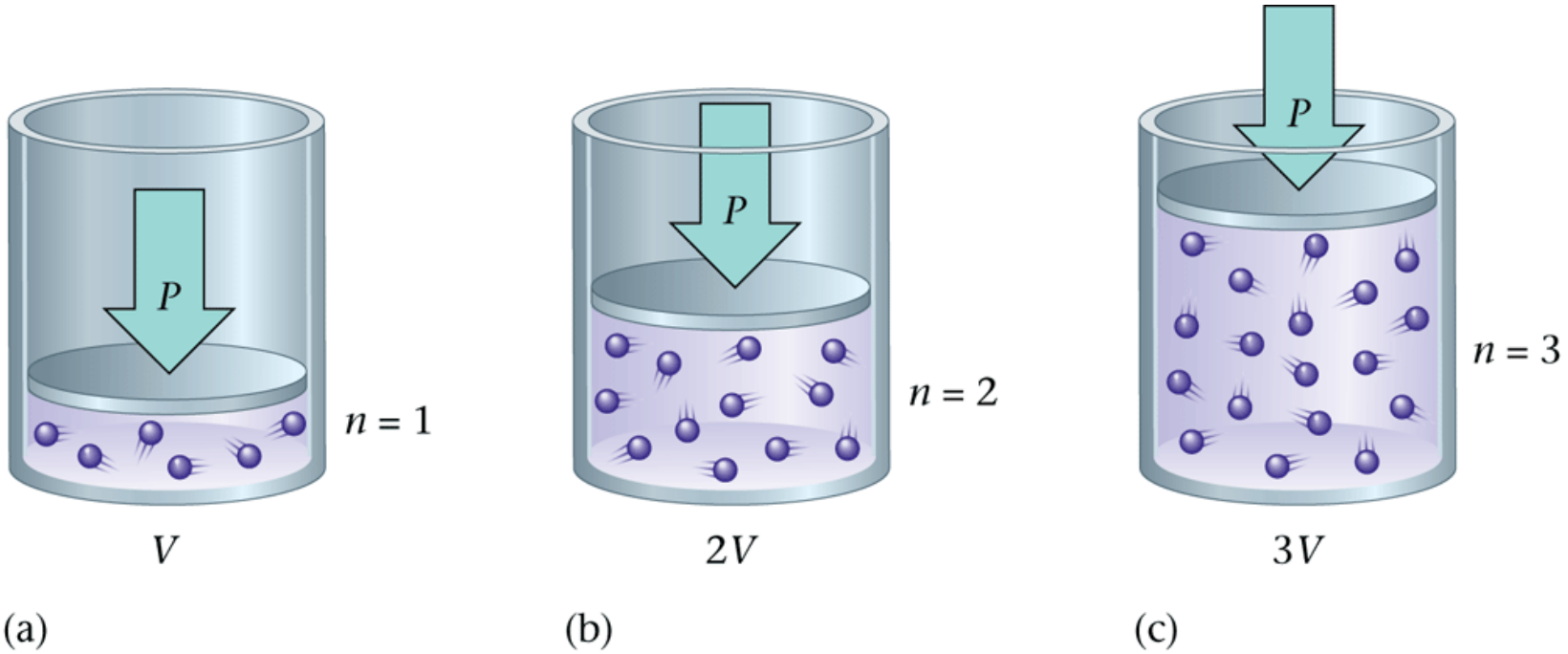
- These graphs are lines with an equation
  $V = bT$ *(where T is in kelvins)*
- Volume and temperature are directly proportional.
  - If one increases the other increases.
- Another way of stating Charles's Law is

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

(constant pressure and amount of gas)

Describing the Properties of Gases

D. Volume and Moles: Avogadro's Law



Describing the Properties of Gases

D. Volume and Moles: Avogadro's Law

- Volume and moles are directly proportional.
  - If one increases the other increases.
  - $V = an$
  - constant temperature and pressure
- Another way of stating Avogadro's Law is

$$\frac{V_1}{n_1} = \frac{V_2}{n_2}$$

(constant temperature and pressure)