W-GC General Chemistry 3/16

F = ART

R = universal gas constant

$8.14 \frac{atm \cdot L}{mol \cdot K}$

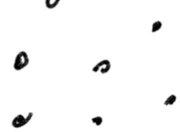
<u>Ideal</u> <u>Gas</u>

solid —heat→ (melt) Liquid —heat→ (vaporize) ~~Gas~~ ideal gases

Solid

- vibrational
- no translational movement
- dense

Liquid



- particles farther apart, but still influence each other.
- vibrational and some translational movement
- less dense

Ideal gases

- particles so far apart they do not influence each other.
- vibrational, a lot of translational movement
- least dense

Ideal Gas Law

$$PV = nRT$$

P = Pressure
atm
1 atm = 760 torr
760 mmHg
101.3 kPa

n = # of moles

V = Volume

R = Universal Gas Constant
8.314

T = Absolute Temperature (K)

$$PV = nRT$$

$\uparrow P \quad V \downarrow$

Pressure Volume inversely related

$\uparrow P = T \uparrow$

Gases

Chapter 5

Elements that exist as gases at 25⁰C and 1 atmosphere

STP → Standard Temperature and Pressure

273
25
298K

1A	2A	3B	4B	5B	6B	7B	8B	8B	8B	1B	2B	3A	4A	5A	6A	7A	8A
H																H	He
Li	Be											B	C	N	O	F	Ne
Na	Mg											Al	Si	P	S	Cl	Ar
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
Fr	Ra	Ac	Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg							

TABLE 5.1 Some Substances Found as Gases at 1 atm and 25°C

Elements	Compounds
H_2 (molecular hydrogen)	HF (hydrogen fluoride)
N_2 (molecular nitrogen)	HCl (hydrogen chloride)
O_2 (molecular oxygen)	HBr (hydrogen bromide)
O_3 (ozone)	HI (hydrogen iodide)
F_2 (molecular fluorine)	CO (carbon monoxide)
Cl_2 (molecular chlorine)	CO_2 (carbon dioxide)
He (helium)	NH_3 (ammonia)
Ne (neon)	NO (nitric oxide)
Ar (argon)	NO_2 (nitrogen dioxide)
Kr (krypton)	N_2O (nitrous oxide)
Xe (xenon)	SO_2 (sulfur dioxide)
Rn (radon)	H_2S (hydrogen sulfide)
	HCN (hydrogen cyanide)*

*The boiling point of HCN is 26°C, but it is close enough to qualify as a gas at ordinary atmospheric conditions.

Physical Characteristics of Gases

- Gases assume the volume and shape of their containers.
- Gases are the most compressible state of matter.
- Gases will mix evenly and completely when confined to the same container.
- Gases have much lower densities than liquids and solids.

NO_2 gas

$$\text{Pressure} = \frac{\text{Force}}{\text{Area}}$$

(force = mass x acceleration)

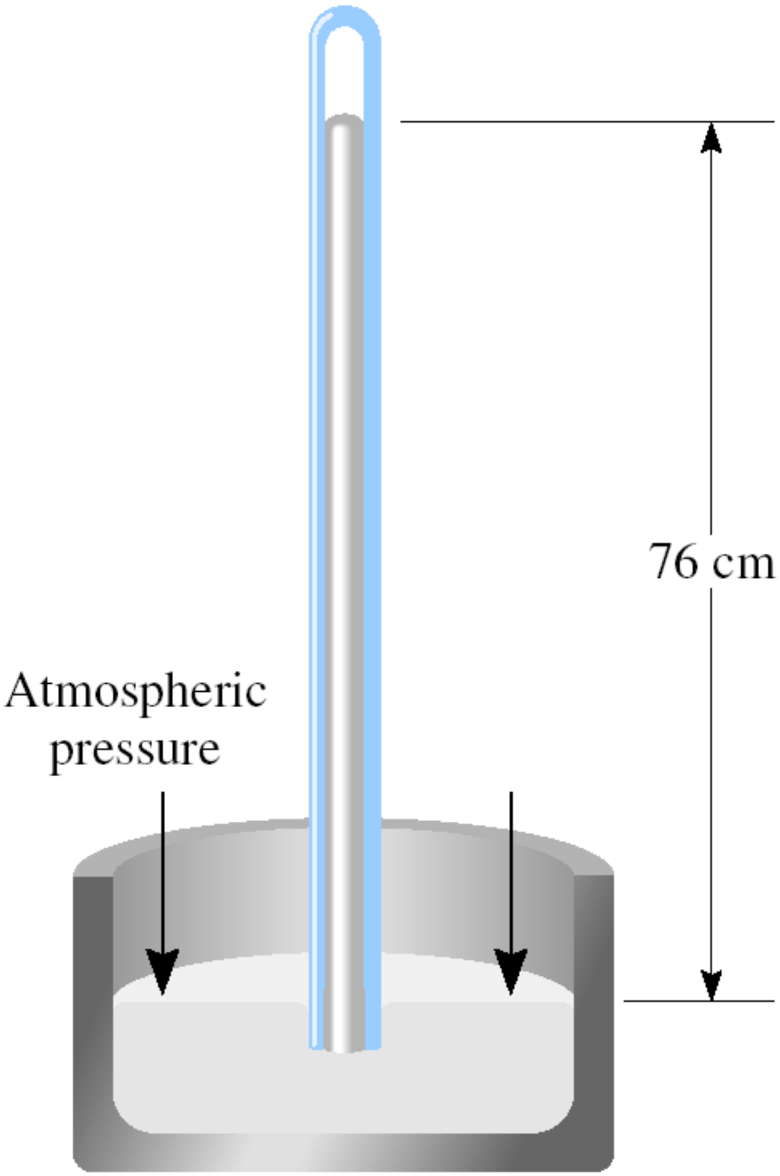
Units of Pressure

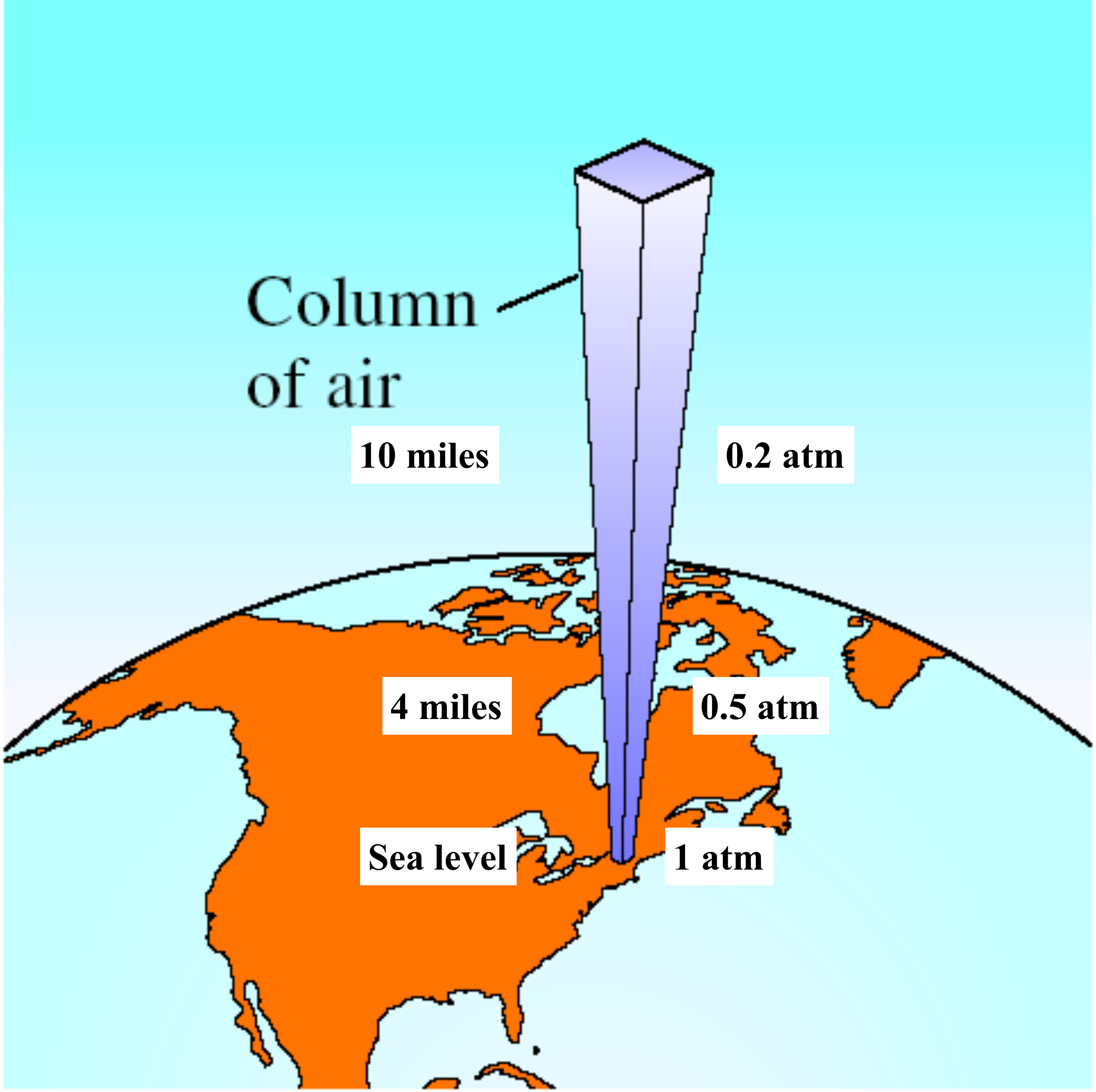
1 pascal (Pa) = 1 N/m^2

1 atm = 760 mmHg = 760 torr

1 atm = 101,325 Pa

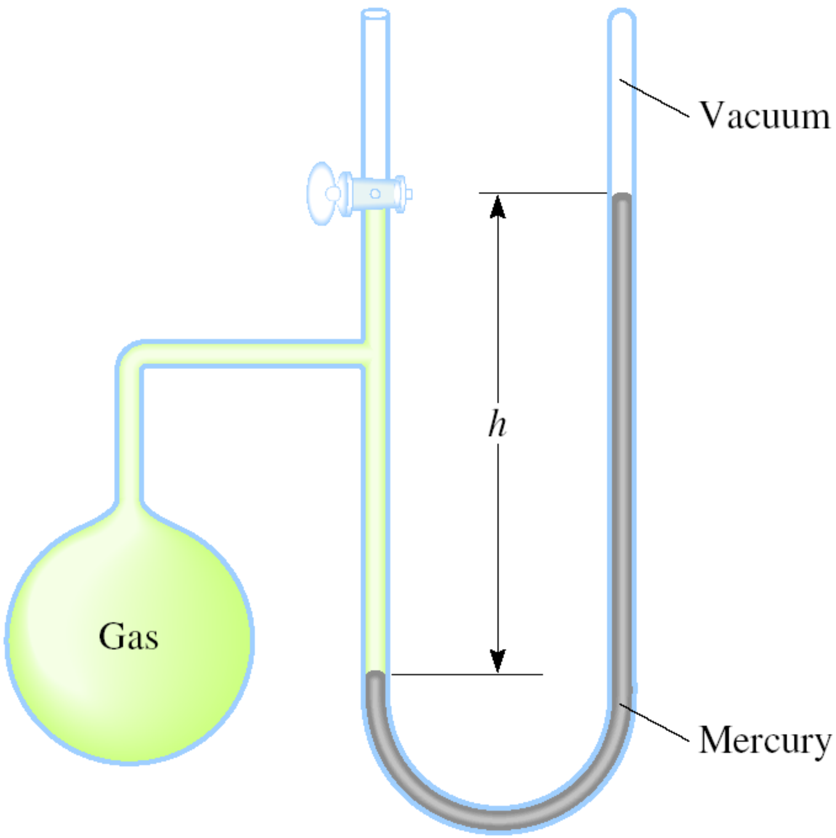
101.3 kPa




Column
of air
10 miles
0.2 atm
4 miles
0.5 atm
Sea level
1 atm

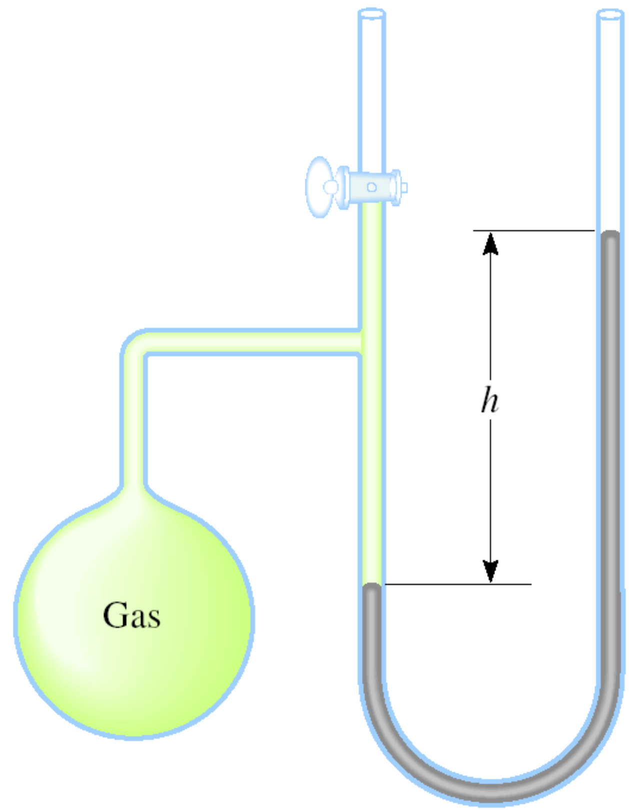
Manometers Used to Measure Gas Pressures

closed-tube



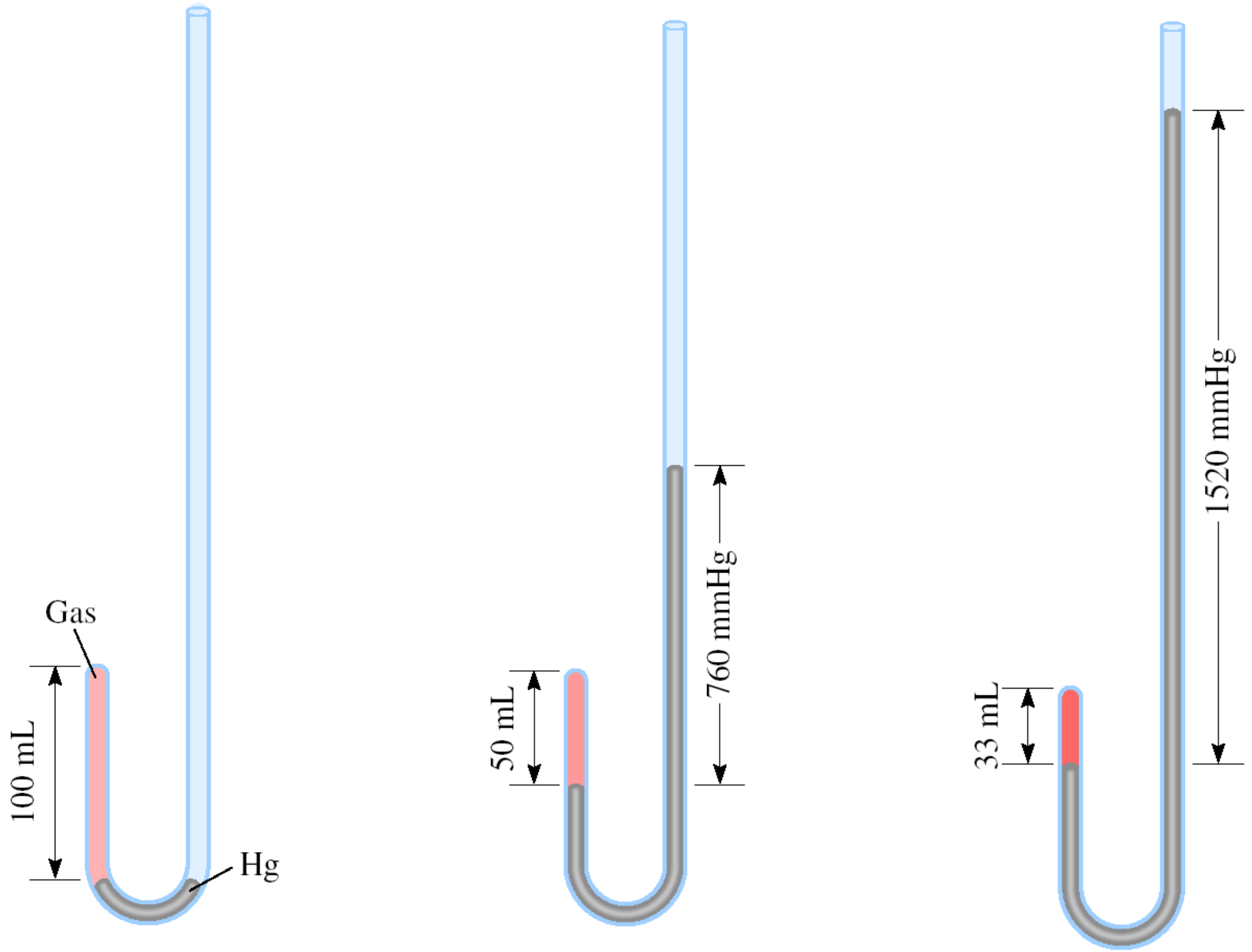
$$P_{gas} = P_h$$

open-tube



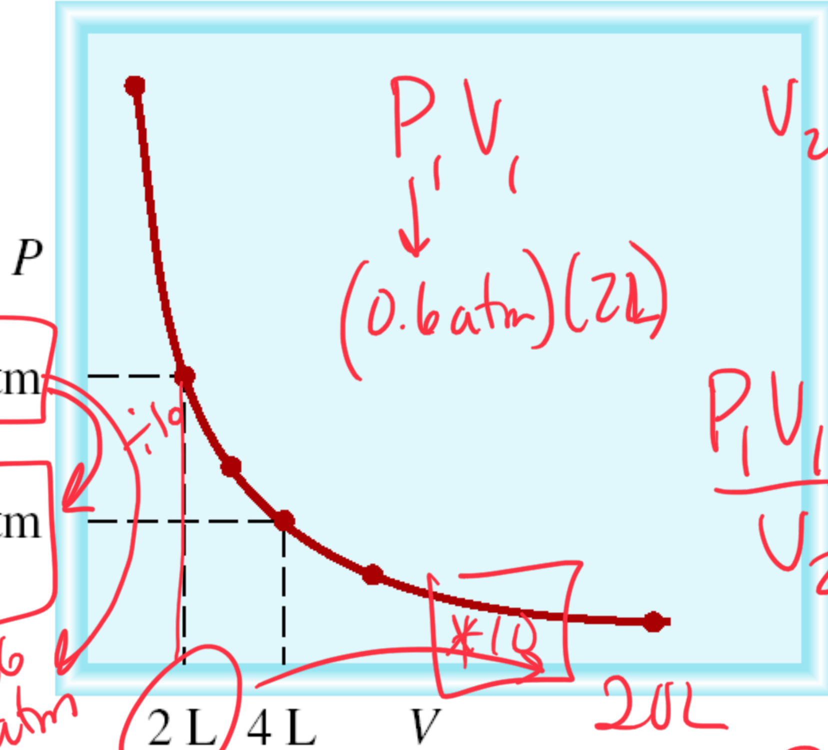
$$P_{gas} = P_h + P_{atm}$$

Apparatus for Studying the Relationship Between Pressure and Volume of a Gas

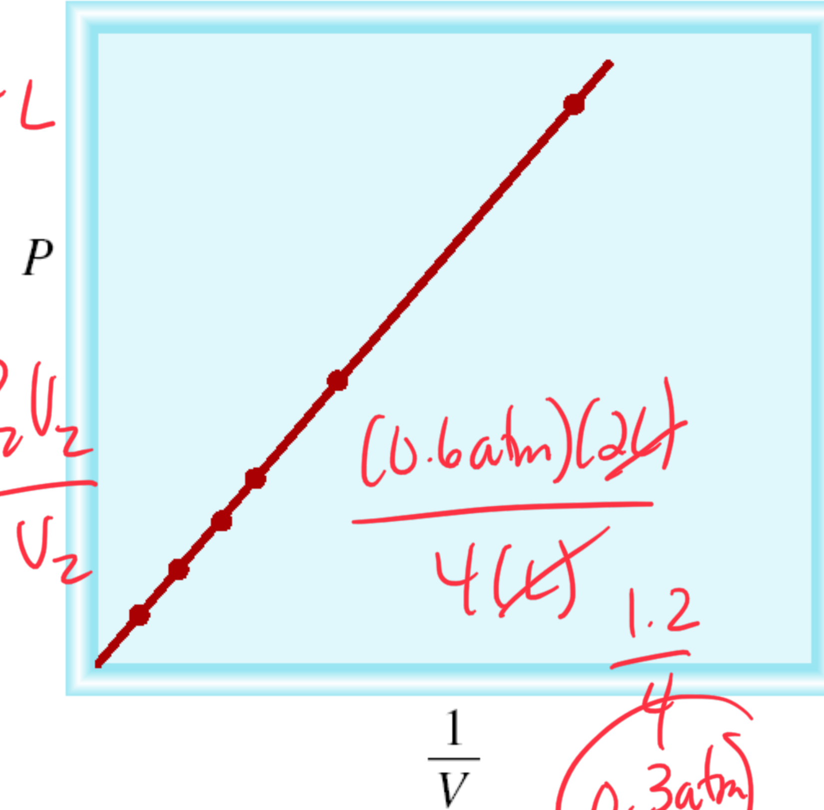


As *P* (h) increases *V* decreases

Boyle's Law



$P \propto 1/V$



$P \times V = \text{constant}$

$P_1 \times V_1 = P_2 \times V_2$

Constant temperature
Constant amount of gas

inversely related

A sample of chlorine gas occupies a volume of 946 mL at a pressure of 726 mmHg. What is the pressure of the gas (in mmHg) if the volume is reduced at constant temperature to 154 mL?

P_2

$$\frac{P_1V_1}{V_2} = \frac{P_2V_2}{V_2}$$

$$\frac{P_1V_1}{V_2} = \frac{(726\ \text{mmHg})(946\ \text{mL})}{154\ \text{mL}}$$

4459 mmHg

$$P\ x\ V = constant$$

$$P_1 \text{ x } V_1 = P_2 \text{ x } V_2$$

$P_1 = 726$ mmHg $\qquad P_2 = ?$

$V_1 = 946$ mL $\qquad V_2 = 154$ mL

$$P_2 = \frac{P_1 \text{ x } V_1}{V_2} = \frac{726 \text{ mmHg x } 946 \text{ mL}}{154 \text{ mL}} = 4460 \text{ mmHg}$$