Ch. 10 & 11 - Gases

I. Physical Properties

(p. 303 - 312)

A. Kinetic Molecular Theory

b Particles in an ideal gas…

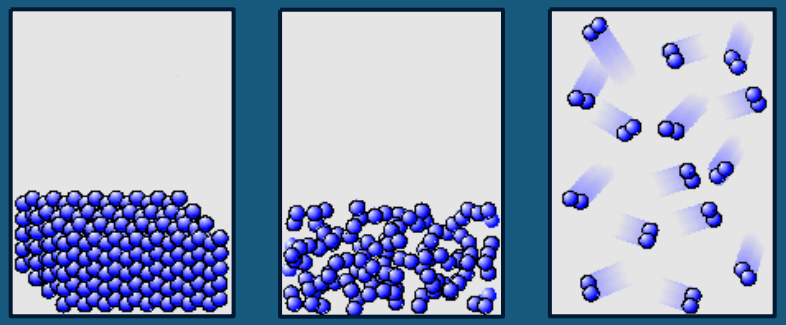
- have no volume.
- have elastic collisions.
- are in constant, random, straight-line motion.
- don’t attract or repel each other.
- have an avg. KE directly related to Kelvin temperature.

B. Real Gases

- Particles in a REAL gas…
  - have their own volume
  - attract each other
- Gas behavior is most ideal…
  - at low pressures
  - at high temperatures
  - in nonpolar atoms/molecules

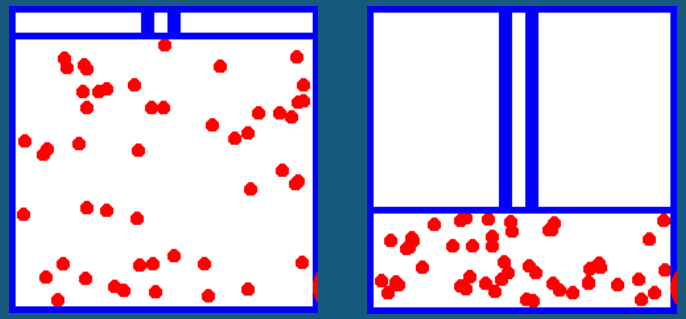
C. Characteristics of Gases

- Gases expand to fill any container.
  - random motion, no attraction
- Gases are fluids (like liquids).
  - no attraction
- Gases have very low densities.
  - no volume = lots of empty space



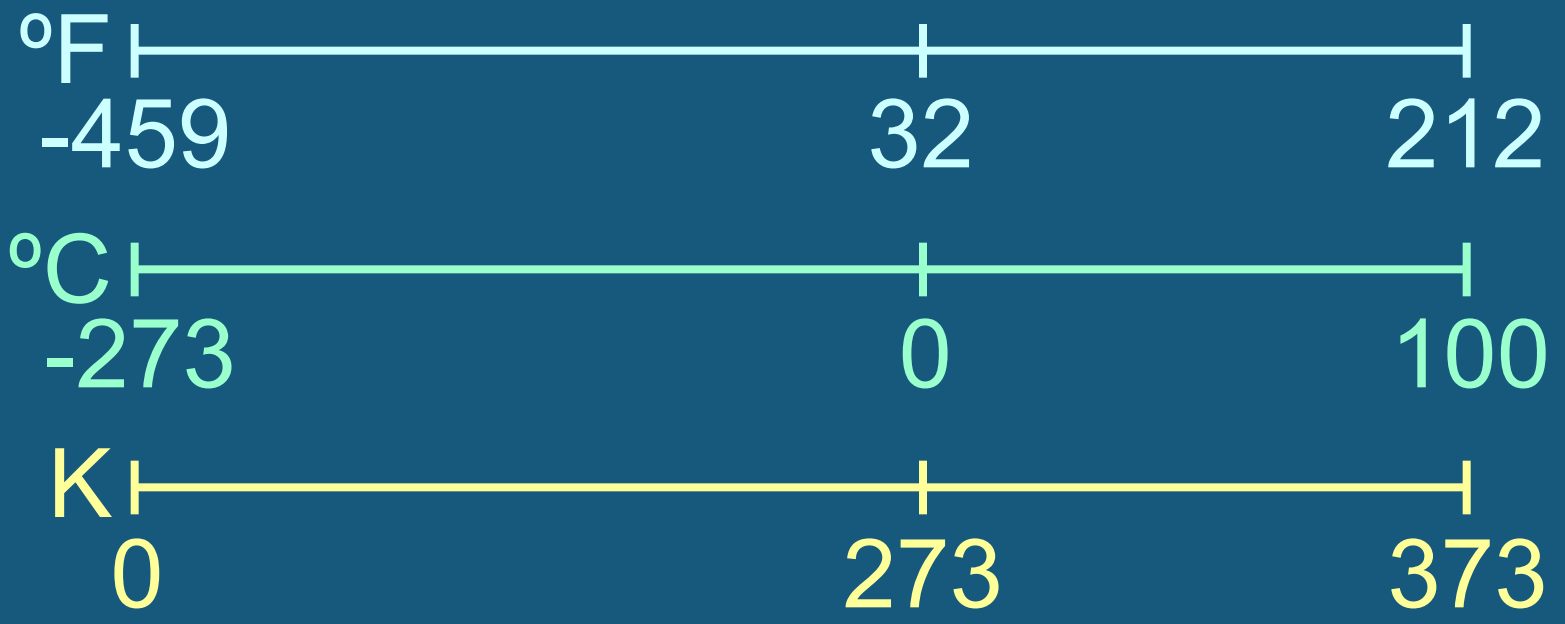
C. Characteristics of Gases

- Gases can be compressed.
  - no volume = lots of empty space
- Gases undergo diffusion & effusion.
  - random motion



D. Temperature

b Always use absolute temperature (Kelvin) when working with gases.



$$°C = \frac{5}{9}(°F - 32) \qquad K = ºC + 273$$

E. Pressure

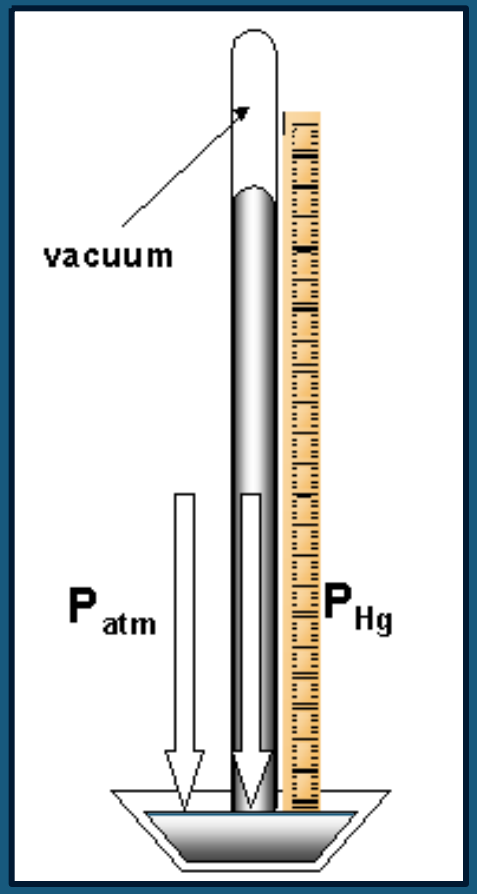
$$pressure = \frac{force}{area}$$

Which shoes create the most pressure?

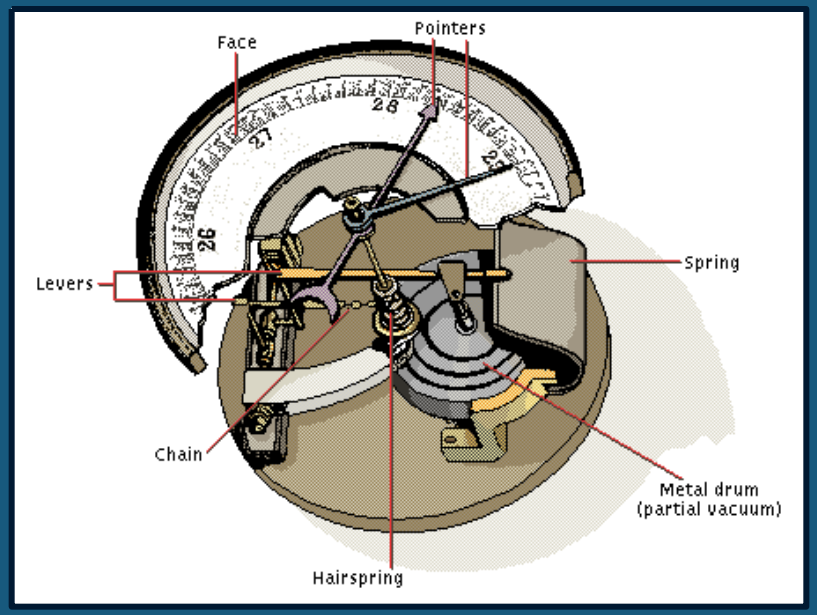
E. Pressure

b Barometer

- measures atmospheric pressure



Mercury Barometer

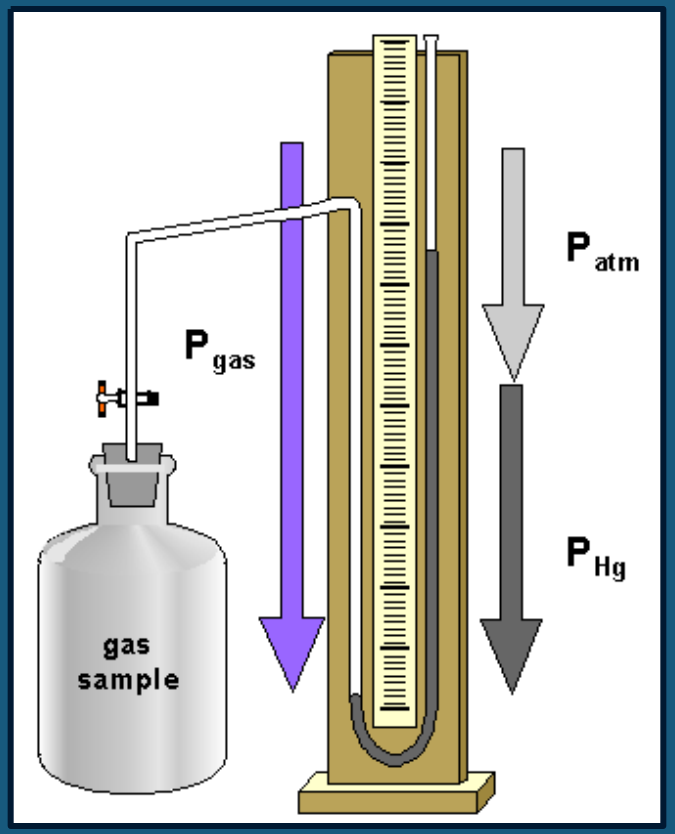


Aneroid Barometer

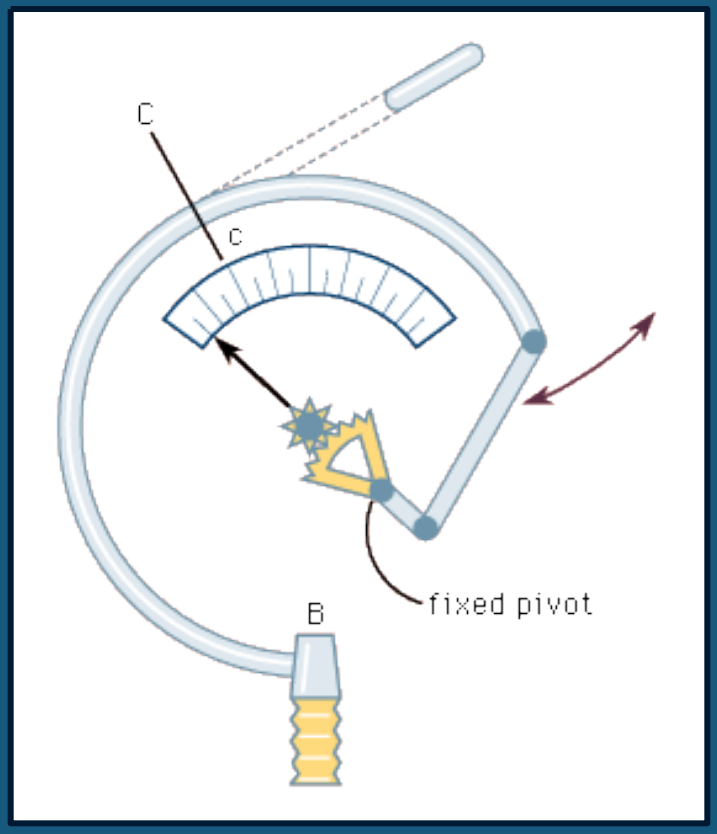
E. Pressure

b **Manometer**

- measures contained gas pressure



U-tube Manometer



Bourdon-tube gauge

E. Pressure

b **KEY UNITS AT SEA LEVEL**

101.325 kPa (kilopascal)

1 atm

760 mm Hg

760 torr

14.7 psi

$$kPa = \frac{N}{m^2}$$

F. STP

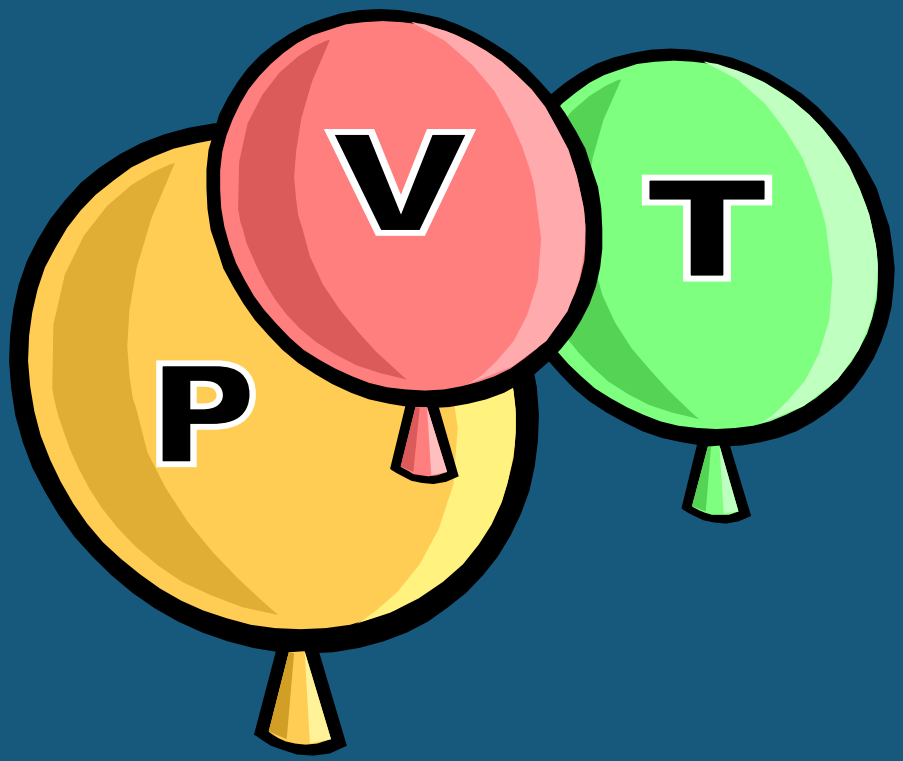
Standard Temperature & Pressure

0°C 273 K

-OR-

1 atm 101.325 kPa

Ch. 10 & 11 - Gases

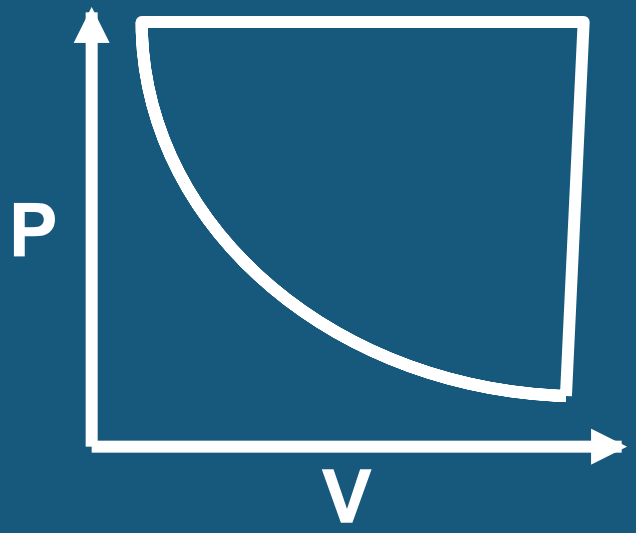


II. The Gas Laws

(p. 313-322)

A. Boyle's Law

Volume (mL)	Pressure (torr)	P·V (mL·torr)
10.0	760.0	7.60×10^3
20.0	379.6	7.59×10^3
30.0	253.2	7.60×10^3
40.0	191.0	7.64×10^3

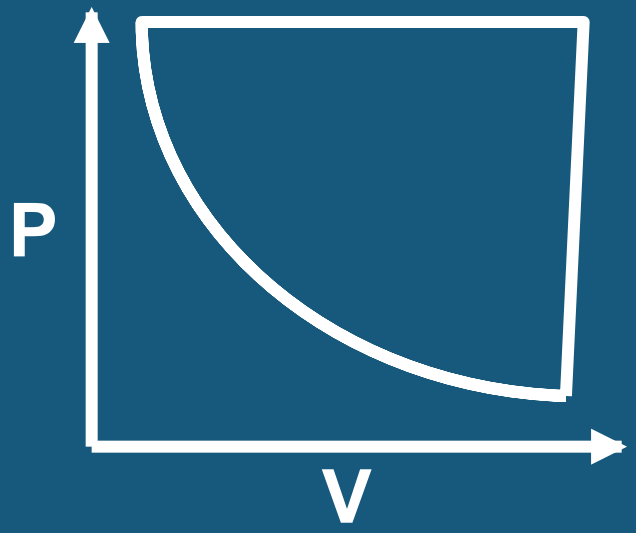


$$PV = k$$

A. Boyle's Law

b The pressure and volume of a gas are inversely related

- at constant mass & temp

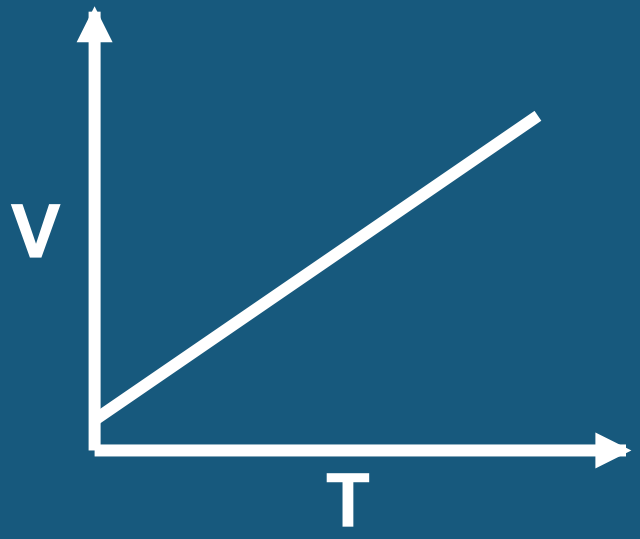


$$PV = k$$

A. Boyle's Law

B. Charles' Law

Volume (mL)	Temperature (K)	V/T (mL/K)
40.0	273.2	0.146
44.0	298.2	0.148
47.7	323.2	0.148
51.3	348.2	0.147

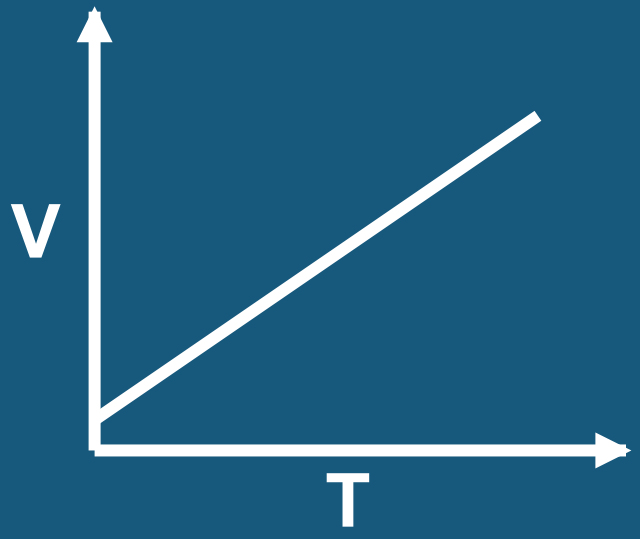


$$\frac{V}{T} = k$$

B. Charles' Law

b The volume and absolute temperature (K) of a gas are directly related

- at constant mass & pressure

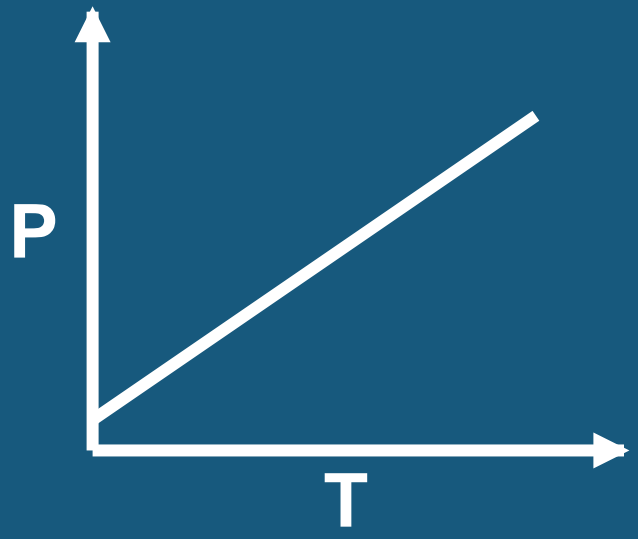


$$\frac{V}{T} = k$$

B. Charles' Law

C. Gay-Lussac's Law

Temperature (K)	Pressure (torr)	P/T (torr/K)
248	691.6	2.79
273	760.0	2.78
298	828.4	2.78
373	1,041.2	2.79

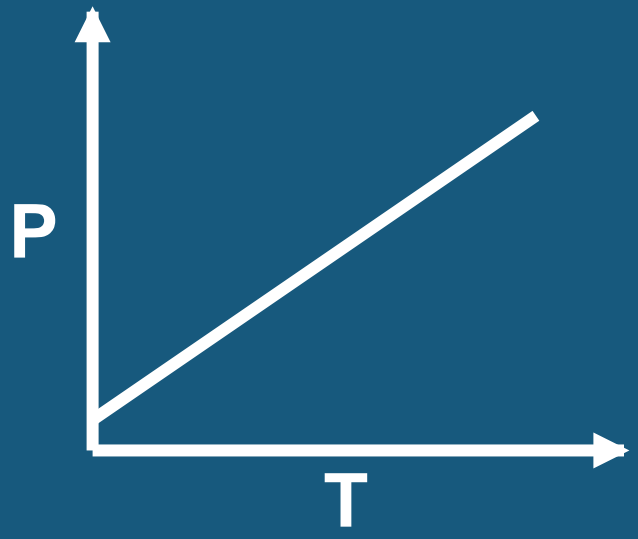


$$\frac{P}{T} = k$$

C. Gay-Lussac's Law

b The pressure and absolute temperature (K) of a gas are directly related

- at constant mass & volume



$$\frac{P}{T} = k$$

D. Combined Gas Law

$$\frac{PV}{T} = k$$

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

$$P_1V_1T_2 = P_2V_2T_1$$

E. Gas Law Problems

b A gas occupies 473 cm^3 at 36°C. Find its volume at 94°C.

CHARLES' LAW

GIVEN: T↑ V↑	WORK:
V_1 = 473 cm^3 T_1 = 36°C = 309K V_2 = ? T_2 = 94°C = 367K	~~P_1~~V_1T_2 = ~~P_2~~V_2T_1 (473 cm^3)(367 K)=V_2(309 K) **V_2 = 562 cm^3**

E. Gas Law Problems

b A gas occupies 100. mL at 150. kPa. Find its volume at 200. kPa.

BOYLE'S LAW

GIVEN: P↑ V↓	WORK:
V_1 = 100. mL P_1 = 150. kPa V_2 = ? P_2 = 200. kPa	$P_1V_1\cancel{T_2} = P_2V_2\cancel{T_1}$ (150.kPa)(100.mL)=(200.kPa)V_2 **V_2 = 75.0 mL**

E. Gas Law Problems

b A gas occupies 7.84 cm^3 at 71.8 kPa & 25°C. Find its volume at STP.

COMBINED GAS LAW

GIVEN: **P↑ T↓ V↓**	WORK:
$V_1 = 7.84\ cm^3$ $P_1 = 71.8\ kPa$ $T_1 = 25°C = 298\ K$ $V_2 = ?$ $P_2 = 101.325\ kPa$ $T_2 = 273\ K$	$P_1V_1T_2 = P_2V_2T_1$ $(71.8\ kPa)(7.84\ cm^3)(273\ K)$ $= (101.325\ kPa)\ V_2\ (298\ K)$ **$V_2 = 5.09\ cm^3$**

E. Gas Law Problems

b A gas' pressure is 765 torr at 23°C. At what temperature will the pressure be 560. torr?

GAY-LUSSAC'S LAW

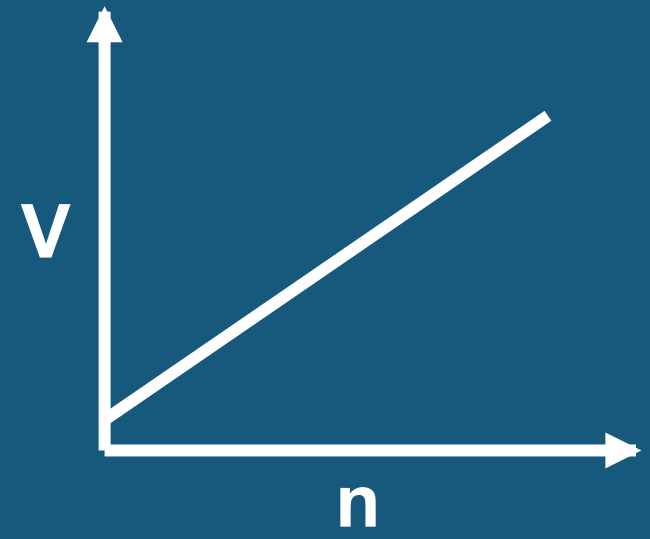
GIVEN: **P↓ T↓**	WORK:
P_1 = 765 torr T_1 = 23°C = 296K P_2 = 560. torr T_2 = ?	$P_1 \cancel{V_1} T_2 = P_2 \cancel{V_2} T_1$ (765 torr)T_2 = (560. torr)(309K) **T_2 = 226 K = -47°C**

Ch. 10 & 11 - Gases

III. Ideal Gas Law
(p. 334-335, 340-346)

A. Avogadro's Principle

b Equal volumes of gases contain equal numbers of moles
- at constant temp & pressure
- true for any gas



$$\frac{V}{n} = k$$

A. Ideal Gas Law

Merge the Combined Gas Law with Avogadro's Principle:

$$\frac{PV}{nT} = R$$

UNIVERSAL GAS CONSTANT

$R = 0.0821\ L \cdot atm/mol \cdot K$

$R = 8.315\ dm^3 \cdot kPa/mol \cdot K$

You don't need to memorize these values!

A. Ideal Gas Law

$$PV=nRT$$

UNIVERSAL GAS CONSTANT

$R=0.0821\ L\cdot atm/mol\cdot K$

$R=8.315\ dm^3\cdot kPa/mol\cdot K$

You don't need to memorize these values!

C. Ideal Gas Law Problems

b Calculate the pressure in atmospheres of 0.412 mol of He at 16°C & occupying 3.25 L.

GIVEN:	WORK:
P = ? atm n = 0.412 mol T = 16°C = 289 K V = 3.25 L R = 0.0821 L·atm/mol·K	PV = nRT P(3.25) = (0.412)(0.0821)(289) L mol L·atm/mol·K K P = 3.01 atm

C. Ideal Gas Law Problems

b Find the volume of 85 g of O_2 at 25°C and 104.5 kPa.

GIVEN:	WORK:
V = ?	$\frac{85\ g}{32.00\ g} \left\vert \frac{1\ mol}{} \right. = 2.7\ mol$
n = 85 g = 2.7 mol	PV = nRT
T = 25°C = 298 K	(104.5 kPa)V = (2.7 mol)(8.315 $dm^3 \cdot kPa/mol \cdot K$)(298 K)
P = 104.5 kPa	V = 64 dm^3
R = 8.315 $dm^3 \cdot kPa/mol \cdot K$	

Ch. 10 & 11 - Gases

IV. Gas Stoichiometry at Non-STP Conditions (p. 347-350)

A. Gas Stoichiometry

- **Moles ↔ Liters of a Gas:**
  - STP - use 22.4 L/mol
  - Non-STP - use ideal gas law

- **Non-STP**
  - Given liters of gas?
    - start with ideal gas law
  - Looking for liters of gas?
    - start with stoichiometry conv.

B. Gas Stoichiometry Problem

b What volume of CO_2 forms from 5.25 g of $CaCO_3$ at 103 kPa & 25ºC?

$$CaCO_3 \rightarrow CaO + CO_2$$

5.25 g ? L

non-STP

Looking for liters: Start with stoich and calculate moles of CO_2.

$$\frac{5.25\ g\ CaCO_3}{100.09\ g\ CaCO_3} \times \frac{1\ mol\ CaCO_3}{1\ mol\ CaCO_3} \times \frac{1\ mol\ CO_2}{1\ mol\ CaCO_3} = \mathbf{1.26\ mol\ CO_2}$$

Plug this into the Ideal Gas Law to find liters.

B. Gas Stoichiometry Problem

b What volume of CO_2 forms from 5.25 g of $CaCO_3$ at 103 kPa & 25ºC?

GIVEN:	WORK:
P = 103 kPa V = ? n = 1.26 mol T = 25°C = 298 K R = 8.315 $dm^3 \cdot kPa/mol \cdot K$	PV = nRT (103 kPa)V =(1mol)(8.315$dm^3 \cdot kPa/mol \cdot K$)(298K) **V = 1.26 dm^3 CO_2**

B. Gas Stoichiometry Problem

b How many grams of Al_2O_3 are formed from 15.0 L of O_2 at 97.3 kPa & 21°C?

$$4\ Al + 3\ O_2 \rightarrow 2\ Al_2O_3$$

15.0 L non-STP

? g

GIVEN:	WORK:
P = 97.3 kPa	PV = nRT
V = 15.0 L	(97.3 kPa) (15.0 L)
n = ?	= n (8.315 $dm^3 \cdot kPa/mol \cdot K$) (294K)
T = 21°C = 294 K	**n = 0.597 mol O_2**
R = 8.315 $dm^3 \cdot kPa/mol \cdot K$	

Given liters: Start with Ideal Gas Law and calculate moles of O_2.

NEXT →

B. Gas Stoichiometry Problem

b How many grams of Al_2O_3 are formed from 15.0 L of O_2 at 97.3 kPa & 21°C?

$$4\ Al + 3\ O_2 \rightarrow 2\ Al_2O_3$$

15.0L ? g

non-STP

Use stoich to convert moles of O_2 to grams Al_2O_3.

$$\frac{0.597\ \text{mol } O_2}{} \times \frac{2\ \text{mol } Al_2O_3}{3\ \text{mol } O_2} \times \frac{101.96\ \text{g } Al_2O_3}{1\ \text{mol } Al_2O_3} = \mathbf{40.6\ g\ Al_2O_3}$$

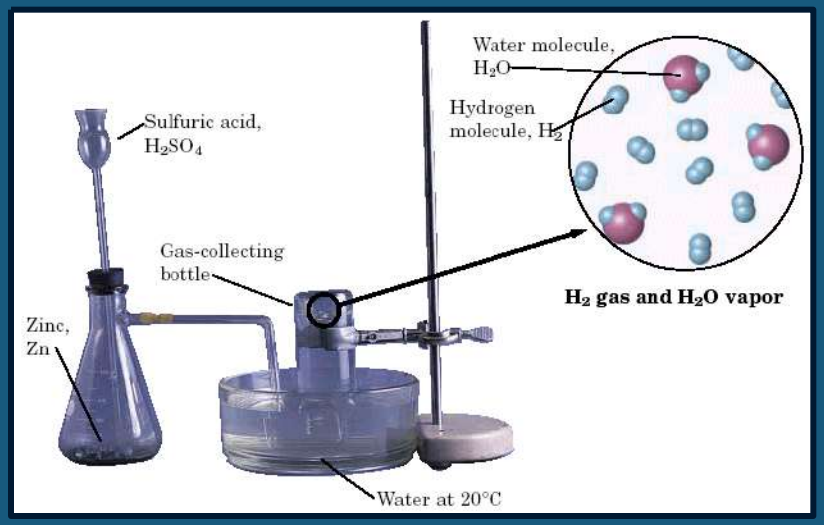
Ch. 10 & 11 - Gases

V. Two More Laws
(p. 322-325, 351-355)
Read these pages first!

B. Dalton's Law

b The total pressure of a mixture of gases equals the sum of the partial pressures of the individual gases.

$$P_{total} = P_1 + P_2 + \ldots$$



When a H_2 gas is collected by water displacement, the gas in the collection bottle is actually a mixture of H_2 and water vapor.

B. Dalton's Law

b Hydrogen gas is collected over water at 22.5°C. Find the pressure of the dry gas if the atmospheric pressure is 94.4 kPa.

The total pressure in the collection bottle is equal to atmospheric pressure and is a mixture of H_2 and water vapor.

GIVEN:	WORK:
$P_{H2} = ?$	$P_{total} = P_{H2} + P_{H2O}$
$P_{total} = 94.4$ kPa	$94.4 \text{ kPa} = P_{H2} + 2.72 \text{ kPa}$
$P_{H2O} = 2.72$ kPa	$P_{H2} = 91.7$ kPa

Look up water-vapor pressure on p.899 for 22.5°C.

Sig Figs: Round to least number of decimal places.

B. Dalton's Law

b A gas is collected over water at a temp of 35.0°C when the barometric pressure is 742.0 torr. What is the partial pressure of the dry gas?

The total pressure in the collection bottle is equal to barometric pressure and is a mixture of the "gas" and water vapor.

GIVEN:	WORK:
$P_{gas} = ?$	$P_{total} = P_{gas} + P_{H2O}$
$P_{total} = 742.0$ torr	$742.0 \text{ torr} = P_{H2} + 42.2 \text{ torr}$
$P_{H2O} = 42.2$ torr	$P_{gas} = 699.8$ torr

Look up water-vapor pressure on p.899 for 35.0°C.

Sig Figs: Round to least number of decimal places.

C. Graham's Law

- **Diffusion**
  - Spreading of gas molecules throughout a container until evenly distributed.
- **Effusion**
  - Passing of gas molecules through a tiny opening in a container

C. Graham's Law

b **Speed of diffusion/effusion**

- Kinetic energy is determined by the temperature of the gas.
- At the same temp & KE, heavier molecules move more slowly.
  - Larger $m \Rightarrow$ smaller v

$$KE = \tfrac{1}{2}mv^2$$

C. Graham's Law

b **Graham's Law**

- Rate of diffusion of a gas is inversely related to the square root of its molar mass.
- The equation shows the ratio of Gas A's speed to Gas B's speed.

$$\frac{v_A}{v_B} = \sqrt{\frac{m_B}{m_A}}$$

C. Graham's Law

b Determine the relative rate of diffusion for krypton and bromine.

The first gas is "Gas A" and the second gas is "Gas B". Relative rate mean find the ratio "v_A/v_B".

$$\frac{v_A}{v_B} = \sqrt{\frac{m_B}{m_A}}$$

$$\frac{v_{Kr}}{v_{Br_2}} = \sqrt{\frac{m_{Br_2}}{m_{Kr}}} = \sqrt{\frac{159.80\ g/mol}{83.80\ g/mol}} = 1.381$$

Kr diffuses 1.381 times faster than Br_2.

C. Graham's Law

b A molecule of oxygen gas has an average speed of 12.3 m/s at a given temp and pressure. What is the average speed of hydrogen molecules at the same conditions?

$$\frac{v_A}{v_B} = \sqrt{\frac{m_B}{m_A}}$$

$$\frac{v_{H_2}}{v_{O_2}} = \sqrt{\frac{m_{O_2}}{m_{H_2}}}$$

Put the gas with the unknown speed as "Gas A".

$$\frac{v_{H_2}}{12.3\ m/s} = \sqrt{\frac{32.00\ g/mol}{2.02\ g/mol}}$$

$$\frac{v_{H_2}}{12.3\ m/s} = 3.980$$

$$v_{H_2} = 49.0\ m/s$$

C. Graham's Law

b An unknown gas diffuses 4.0 times faster than O_2. Find its molar mass.

The first gas is "Gas A" and the second gas is "Gas B". The ratio "v_A/v_B" is 4.0.

$$\frac{v_A}{v_B} = \sqrt{\frac{m_B}{m_A}}$$

$$\frac{v_A}{v_{O_2}} = \sqrt{\frac{m_{O_2}}{m_A}}$$

Square both sides to get rid of the square root sign.

$$\left(4.0 = \sqrt{\frac{32.00\ g/mol}{m_A}}\right)^2$$

$$16 = \frac{32.00\ g/mol}{m_A}$$

$$m_A = \frac{32.00\ g/mol}{16} = 2.0\ g/mol$$

TEAM PRACTICE!

- Work the following problems in your book. Check your work using the answers provided in the margin.
  - p. 324
    - SAMPLE PROBLEM 10-6
    - PRACTICE 1 & 2
  - p. 355
    - SAMPLE PROBLEM 11-10
    - PRACTICE 1, 2, & 3

$P_1V_1T_2 = P_2V_2T_1$

Gas Laws Practice Problems

1) Work out each problem on scratch paper.

2) Click ANSWER to check your answer.

3) Click NEXT to go on to the next problem.

CLICK TO START

QUESTION #1

b Helium occupies 3.8 L at -45°C. What volume will it occupy at 45°C?

ANSWER

ANSWER #1

- $V_1 = 3.8$ L
- $T_1 = -45°C = 228$ K
- $V_2 = ?$
- $T_2 = 45°C = 318$ K

CHARLES' LAW

$\cancel{P_1} V_1 T_2 = \cancel{P_2} V_2 T_1$

$V_2 = 5.3$ L

BACK TO PROBLEM

NEXT

QUESTION #2

b Ammonia gas occupies a volume of 450. mL at 720. mm Hg. What volume will it occupy at standard pressure?

ANSWER

ANSWER #2

- V_1 = 450. mL
- P_1 = 720. mm Hg
- V_2 = ?
- P_2 = 760. mm Hg

BOYLE'S LAW

$$P_1 V_1 \cancel{T_2} = P_2 V_2 \cancel{T_1}$$

V_2 = 426 mL

BACK TO PROBLEM

NEXT

QUESTION #3

b A gas at STP is cooled to -185°C. What pressure in atmospheres will it have at this temperature (volume remains constant)?

ANSWER

ANSWER #3

- P_1 = 1 atm
- T_1 = 273 K
- P_2 = ?
- T_2 = -185°C = 88 K

GAY-LUSSAC'S LAW

$$P_1 \cancel{V_1} T_2 = P_2 \cancel{V_2} T_1$$

$P_2 = 0.32$ atm

BACK TO PROBLEM

NEXT

QUESTION #4

b A gas occupies 1.5 L at 850 mm Hg and 15°C. At what pressure will this gas occupy 2.5 L at 30.0°C?

ANSWER

ANSWER #4

- V_1 = 1.5 L
- P_1 = 850 mm Hg
- T_1 = 15°C = 288 K
- P_2 = ?
- V_2 = 2.5 L
- T_2 = 30.0°C = 303 K

COMBINED GAS LAW

$$P_1V_1T_2 = P_2V_2T_1$$

P_2 = 540 mm Hg

BACK TO PROBLEM

NEXT

QUESTION #5

b Chlorine gas has a pressure of 1.05 atm at 25°C. What pressure will it exert at 75°C?

ANSWER

ANSWER #5

- $P_1 = 1.05$ atm
- $T_1 = 25°C = 298$ K
- $P_2 = ?$
- $T_2 = 75°C = 348$ K

GAY-LUSSAC'S LAW

$$P_1 \cancel{V_1} T_2 = P_2 \cancel{V_2} T_1$$

$P_2 = 1.23$ atm

BACK TO PROBLEM

NEXT

QUESTION #6

b A gas occupies 256 mL at 720 torr and 25°C. What will its volume be at STP?

ANSWER

ANSWER #6

- V_1 = 256 mL
- P_1 = 720 torr
- T_1 = 25°C = 298 K
- V_2 = ?
- P_2 = 760. torr
- T_2 = 273 K

COMBINED GAS LAW

$P_1V_1T_2 = P_2V_2T_1$

V_2 = 220 mL

BACK TO PROBLEM

NEXT

QUESTION #7

b At 27°C, fluorine occupies a volume of 0.500 dm^3. To what temperature in degrees **Celsius** should it be lowered to bring the volume to 200. mL?

ANSWER

ANSWER #7

- $T_1 = 27^{\circ}C = 300.\ K$
- $V_1 = 0.500\ dm^3$
- $T_2 = ?^{\circ}C$
- $V_2 = 200.\ mL = 0.200\ dm^3$

CHARLES' LAW

$$\cancel{P_1} V_1 T_2 = \cancel{P_2} V_2 T_1$$

$$T_2 = -153^{\circ}C$$

$$(120\ K)$$

BACK TO PROBLEM

NEXT

QUESTION #8

b A gas occupies 125 mL at 125 kPa. After being heated to 75°C and depressurized to 100.0 kPa, it occupies 0.100 L. What was the original temperature of the gas?

ANSWER

ANSWER #8

- V_1 = 125 mL
- P_1 = 125 kPa
- T_2 = 75°C = 348 K
- P_2 = 100.0 kPa
- V_2 = 0.100 L = 100. mL
- T_1 = ?

COMBINED GAS LAW

$P_1V_1T_2 = P_2V_2T_1$

T_1 = 544 K

(271°C)

BACK TO PROBLEM

NEXT

QUESTION #9

b A 3.2-L sample of gas has a pressure of 102 kPa. If the volume is reduced to 0.65 L, what pressure will the gas exert?

ANSWER

ANSWER #9

- $V_1 = 3.2$ L
- $P_1 = 102$ kPa
- $V_2 = 0.65$ L
- $P_2 = ?$

BOYLE'S LAW

$$P_1 V_1 \cancel{T_2} = P_2 V_2 \cancel{T_1}$$

$P_2 = 502$ kPa

BACK TO PROBLEM

NEXT

QUESTION #10

b A gas at 2.5 atm and 25°C expands to 750 mL after being cooled to 0.0°C and depressurized to 122 kPa. What was the original volume of the gas?

ANSWER

ANSWER #10

- P_1 = 2.5 atm
- T_1 = 25°C = 298 K
- V_2 = 750 mL
- T_2 = 0.0°C = 273 K
- P_2 = 122 kPa = 1.20 atm
- V_1 = ?

COMBINED GAS LAW

$$P_1V_1T_2 = P_2V_2T_1$$

V_1 = 390 mL

BACK TO PROBLEM

EXIT

$PV = nRT$

$R = 0.0821\ L \cdot atm/mol \cdot K = 8.315\ dm^3 \cdot kPa/mol \cdot K$

Ideal Gas Law & Gas Stoichiometry

1) Work out each problem on scratch paper.

2) Click ANSWER to check your answer.

3) Click NEXT to go on to the next problem.

CLICK TO START

QUESTION #1

- How many grams of CO_2 are produced from 75 L of CO at 35°C and 96.2 kPa?
  - $2CO + O_2 \rightarrow 2CO_2$

ANSWER

ANSWER #1

- Find the new molar volume:
- n = 1 mol
- V = ?
- P = 96.2 kPa
- T = 35°C = 308 K
- R = 8.315 $dm^3 \cdot kPa/mol \cdot K$

$PV = nRT$

$V = 26.6\ dm^3/mol$

BACK TO PROBLEM

CONTINUE...

ANSWER #1 (con't)

$$2CO + O_2 \rightarrow 2CO_2$$

75 L ? g

$$\frac{75\ \text{L}\ CO}{} \times \frac{1\ \text{mol}\ CO}{} \times \frac{2\ \text{mol}\ CO_2}{} \times \frac{44.01\ \text{g}\ CO_2}{}$$

$$\frac{}{26.6\ \text{L}\ CO} \times \frac{2\ \text{mol}\ CO}{} \times \frac{1\ \text{mol}\ CO_2}{}$$

$$= \mathbf{120\ g\ CO_2}$$

BACK TO PROBLEM

NEXT

QUESTION #2

b How many moles of oxygen will occupy a volume of 2.5 L at 1.2 atm and 25°C?

ANSWER

ANSWER #2

- n = ?
- V = 2.5 L
- P = 1.2 atm
- T = 25°C = 298 K
- R = 0.0821 L·atm/mol·K

$PV = nRT$

n = 0.12 mol

BACK TO PROBLEM

NEXT

QUESTION #3

b What volume will 56.0 grams of nitrogen (N_2) occupy at 96.0 kPa and 21°C?

ANSWER

ANSWER #3

- V = ?
- n = 56.0 g = 2.00 mol
- P = 96.0 kPa
- T = 21°C = 294 K
- R = 8.315 $dm^3 \cdot kPa/mol \cdot K$

$PV = nRT$

$V = 50.9\ dm^3$

BACK TO PROBLEM

NEXT

QUESTION #4

- What volume of NH_3 at STP is produced if 25.0 g of N_2 is reacted with excess H_2?
  - $N_2 + 3H_2 \rightarrow 2NH_3$

ANSWER

ANSWER #4

$$N_2 + 3H_2 \rightarrow NH_3$$

25.0 g ? L

$$\frac{25.0\ \text{g } N_2}{} \times \frac{1\ \text{mol } N_2}{28.02\ \text{g } N_2} \times \frac{2\ \text{mol } NH_3}{1\ \text{mol } N_2} \times \frac{22.4\ \text{L } NH_3}{1\ \text{mol } NH_3} = \mathbf{40.0\ L\ NH_3}$$

BACK TO PROBLEM

NEXT

QUESTION #5

- What volume of hydrogen is produced from 25.0 g of water at 27°C and 1.16 atm?
  - $2H_2O \rightarrow 2H_2 + O_2$

ANSWER

ANSWER #5

- Find the new molar volume:
- n = 1 mol
- V = ?
- P = 1.16 atm
- T = 27°C = 300. K
- R = 0.0821 L·atm/mol·K

$$PV = nRT$$

V = 21.2 L/mol

BACK TO PROBLEM

CONTINUE...

ANSWER #5 (con't)

$$2H_2O \rightarrow 2H_2 + O_2$$

25.0 g ? L

$$\frac{25.0\ g\ H_2O}{} \times \frac{1\ mol\ H_2O}{} \times \frac{2\ mol\ H_2}{} \times \frac{21.2\ L\ H_2}{} = 29.4\ L\ H_2$$

$$\frac{}{} \times \frac{18.02\ g\ H_2O}{} \times \frac{2\ mol\ H_2O}{} \times \frac{1\ mol\ H_2}{}$$

BACK TO PROBLEM

NEXT

QUESTION #6

b How many atmospheres of pressure will be exerted by 25 g of CO_2 at 25°C and 0.500 L?

ANSWER

ANSWER #6

- P = ?
- n = 25 g = 0.57 mol
- T = 25°C = 298 K
- V = 0.500 L
- R = 0.0821 L·atm/mol·K

$$PV = nRT$$

P = 28 atm

BACK TO PROBLEM

NEXT

QUESTION #7

- How many grams of $CaCO_3$ are required to produce 45.0 dm^3 of CO_2 at 25°C and 2.3 atm?
  - $CaCO_3 + 2HCl \rightarrow CO_2 + H_2O + CaCl_2$

ANSWER

ANSWER #7

- Find the new molar volume:
- n = 1 mol
- V = ?
- P = 2.3 atm
- T = 25°C = 298 K
- R = 0.0821 L·atm/mol·K

$$PV = nRT$$

V = 11 L/mol

BACK TO PROBLEM

CONTINUE...

ANSWER #7

$$CaCO_3 + 2HCl \rightarrow CO_2 + H_2O + CaCl_2$$

? g — 45.0 dm^3

$$\frac{45.0\,dm^3\ CO_2 \quad | \quad 1\ mol\ CO_2 \quad | \quad 1\ mol\ CaCO_3 \quad | \quad 100.09\ g\ CaCO_3}{11\,dm^3\ CO_2 \quad | \quad 1\ mol\ CO_2 \quad | \quad 1\ mol\ CaCO_3} = \mathbf{410\ g\ CaCO_3}$$

BACK TO PROBLEM

NEXT

QUESTION #8

b Find the number of grams of CO_2 that exert a pressure of 785 torr at 32.5 L and 32°C.

ANSWER

ANSWER #8

- n = ?
- P = 785 torr = 1.03 atm
- V = 32.5 L
- T = 32°C = 305 K
- R = 0.0821 L·atm/mol·K

$PV = nRT$

$$n = 1.34 \text{ mol}$$

$$\Downarrow$$

$$59.0 \text{ g } CO_2$$

BACK TO PROBLEM

NEXT