Ideal Gas Laws

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Challenge Question

* Let's consider the gas law's so far . . .

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  - Boyles: $P_1V_1=P_2V_2$

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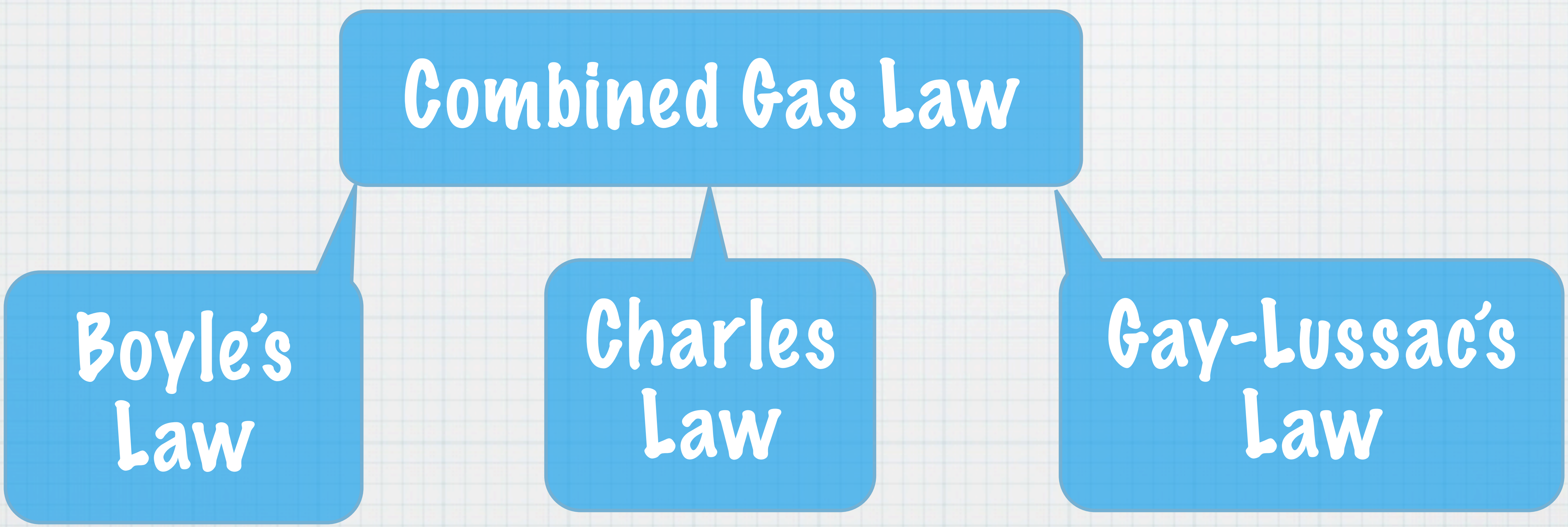
  * Boyles: $P_1V_1=P_2V_2$
  * Charles: $T_1V_2=T_2V_1$
  * Gay-Lussac's Law: $T_1P_2=T_2P_1$

Combined Gas Law

* We have just created the combined gas law:
  * $P_1V_1T_2=P_2V_2T_1$



Avagadro's Law

$$V_1 n_2 = V_2 n_1$$

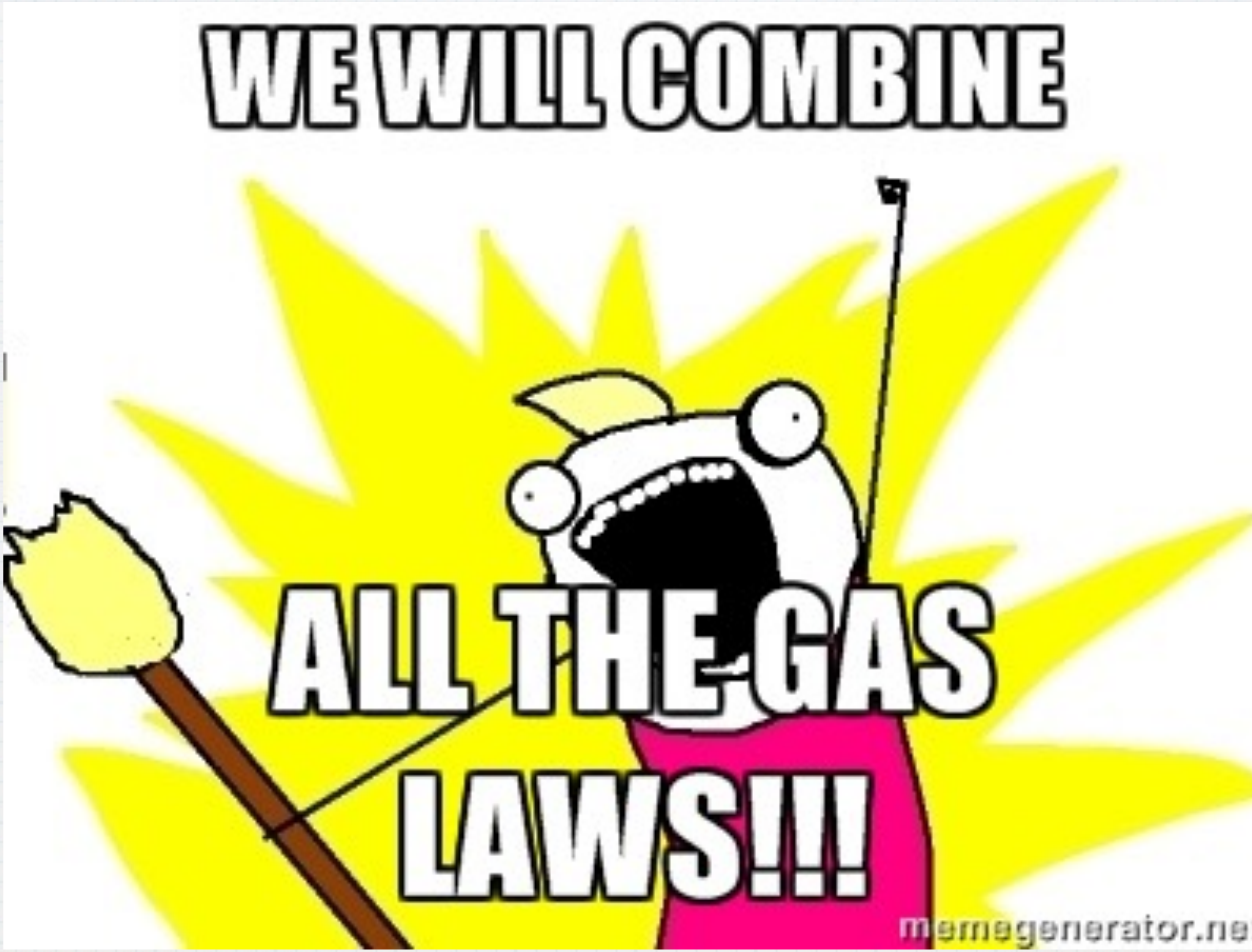
* Equal volume of gas under equal temperature and pressure will have the same number of moles.

Homework

* p. 542 #1 - 4
* p. 545 #1, 2, 6

Gas Law Summary

Gas Law	Equation
Boyle's Law	$P_1V_1=P_2V_2$
Charles Law	$T_1V_2=T_2V_1$
Gay-Lussac's Law	$T_1P_2=T_2P_1$
Combined Gas Law	$P_1V_1T_2=P_2V_2T_1$
Avagadro's Law	$V_1n_2=V_2n_1$


WE WILL COMBINE
ALL THE GAS
LAWS!!!
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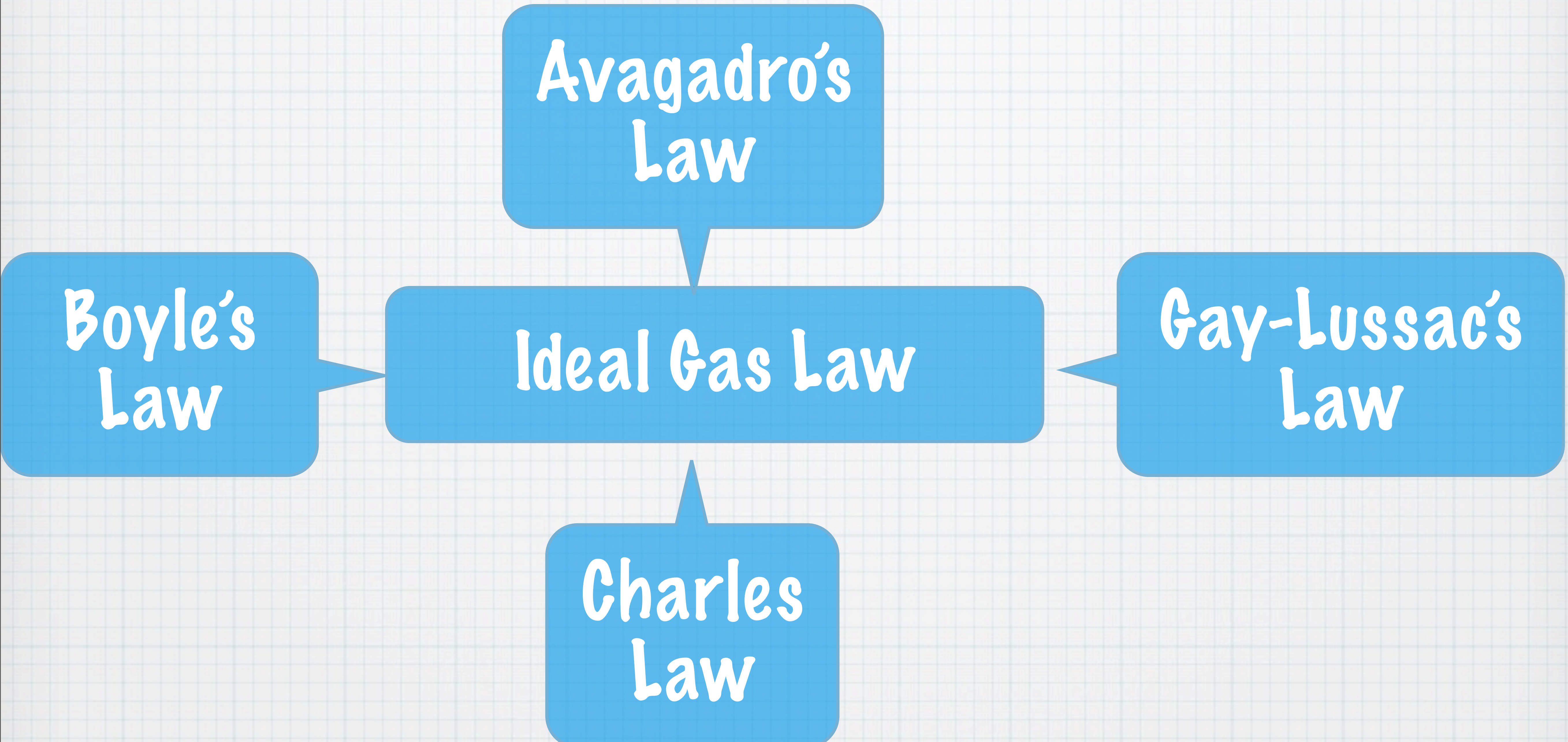
Avagadro's Law
Boyle's Law
Ideal Gas Law
Gay-Lussac's Law
Charles Law

Ideal Gas Law

* A hypothetical gas that obeys all the gas laws perfectly under all conditions
  * It does not condense into a liquid when cooled.
  * Graphs of its volume + temperature and its pressure + temperature relationships are perfectly straight lines.

PV=nRT

* P - pressure in kPa
* V - volume in L
* n - moles
* T - temperature in K
* R - the universal gas constant
    * R = 8.314 kPa•L / mol•K

Example

* How many moles of oxygen will be trapped in a 6.0 L vessel at 1.2 atm and 28.4^0 C?

Solution

* Given
  * V= 6.0 L
  * P=1.2 atm
  * T= 28.4 ^{0}C
  * R= 8.314 kPa•L / mol•K

Solution

* Given
  * V= 6.0 L
  * P=1.2 atm
  * T= 28.4 ^{0}C
  * R= 8.314 kPa•L / mol•K

$T_k = T_c + 273$

Temperature must be in K!

Solution

* Given
  * V= 6.0 L
  * P=1.2 atm
  * T= 28.4^{0}C
  * R= 8.314 kPa•L / mol•K

T_k= 28.4 + 273

Solution

* Given
  * V= 6.0 L
  * P=1.2 atm
  * T= 28.4⁰C
  * R= 8.314 kPa•L / mol•K

T_k= 301.4

Solution

* Given
  * V= 6.0 L
  * P=1.2 atm
  * T= 301.4
  * R= 8.314 kPa•L / mol•K

$P_{kPa} = P_{atm} \times 101.325$

↑ Pressure must be in kPa!

Solution

* Given
  * V= 6.0 L
  * P=1.2 atm
  * T= 301.4
  * R= 8.314 kPa•L / mol•K

P_{kPa}= 1.2 x 101.325

Solution

* Given
  * V= 6.0 L
  * P=1.2 atm
  * T= 301.4
  * R= 8.314 kPa•L / mol•K

P_{kPa}= 121.59

Solution

* Given
  * V= 6.0 L
  * P=121.59 kPa
  * T= 301.4 K
  * R= 8.314 kPa•L / mol•K

Solution

PV=nRT

(121.59 kPa) (6.0 L) = n (8.314 kPa•L / mol•K) (301.4 K)

$$n = \frac{(121.59\ \text{kPa})(6.0\ \text{L})}{(8.314\ \text{kPa}\cdot\text{L / mol}\cdot\text{K})(301.4\ \text{K})}$$

n= 0.29 mol

There are 0.29 moles of oxygen trapped in the vessel.

Extension Question

* <u>What mass</u> of oxygen will be trapped in a 6.0 L vessel at 1.2 atm and 28.4^{0} C?

Solution

* Given
  * n_{O2}=0.29 moles
  * M_{O2} = 32.00 g/mol
* m= n x M
  * (0.29 moles x 32.00 g/mol)
  * 9.28 g

There are 9.28 moles of oxygen trapped in the vessel.

Homework

* p. 556 # 1, 22, 24
* Challenge (for bragging rights . . . and prizes) - p. 556 #30