N-32
Ideal Gas Law Equation

N-32
Ideal Gas Law Equation

Target: I can use the Ideal Gas law to solve for various conditions of a gas.

Link to YouTube Presentation: https://youtu.be/Bksd_GhLpt8

Remember!
Use Kelvins!

$$K = °C + 273$$

Ideal Gas Law

$$PV = nRT$$

"Piv-nert"

Ideal Gas Law

$$PV = nRT$$

- P = pressure
- V = volume
- n = number of moles
- R = ideal gas constant
- T = temperature

But what the heck is R ???

Ideal Gas Constant

- It is a "proportionality constant"
- Allows us to use various units and relate them together – if we had the perfect set of units we wouldn't need this constant to adjust them!
- The specific R number you choose to use varies based on which units you are using.
- If we were dealing with a "real gas" then we would need to use a "specific gas constant." – We wont be!

Ideal Gas Constant

Common R values can be found on your reference sheet R-35

(kPa, atm, mmHg on equation sheet on the back of the quiz periodic table)

Two choices:

1) **Memorize the common ones**
2) **Memorize JUST ONE of them, and then convert all pressure units to that R value!**

You decide which you would rather do!

Ideal Gas Constant

Values of the Universal Gas Constant R				
Values of R	**Units**		**Values of R**	**Units**
8.314472	$J \cdot K^{-1} \cdot mol^{-1}$		83.14472	$L \cdot mbar \cdot K^{-1} \cdot mol^{-1}$
0.082057	$L \cdot atm \cdot K^{-1} \cdot mol^{-1}$		8.314472×10^{-5}	$m^3 \cdot bar \cdot K^{-1} \cdot mol^{-1}$
8.205745×10^{-5}	$m^3 \cdot atm \cdot K^{-1} \cdot mol^{-1}$		10.73159	$ft^3 \cdot psi \cdot °R^{-1} \cdot lb\text{-}mol^{-1}$
8.314472	$L \cdot kPa \cdot K^{-1} \cdot mol^{-1}$		0.73024	$ft^3 \cdot atm \cdot °R^{-1} \cdot lb\text{-}mol^{-1}$
8.314472	$m^3 \cdot Pa \cdot K^{-1} \cdot mol^{-1}$		1.98588	$Btu \cdot °R^{-1} \cdot lb\text{-}mol^{-1}$
82.05745	$cm^3 \cdot atm \cdot K^{-1} \cdot mol^{-1}$		62.36367	$L \cdot torr \cdot K^{-1} \cdot mol^{-1}$

Ideal Gas Constant

Values of the Universal Gas Constant R			
Values of R	**Units**	**Values of R**	**Units**
8.314472	$J \cdot K^{-1} \cdot mol^{-1}$	83.14472	$L \cdot mbar \cdot K^{-1} \cdot mol^{-1}$
0.082057	$L \cdot atm \cdot K^{-1} \cdot mol^{-1}$	8.314472×10^{-5}	$m^3 \cdot bar \cdot K^{-1} \cdot mol^{-1}$
8.205745×10^{-5}	$m^3 \cdot atm \cdot K^{-1} \cdot mol^{-1}$	10.73159	$ft^3 \cdot psi \cdot °R^{-1} \cdot lb\text{-}mol^{-1}$
8.314472	$L \cdot kPa \cdot K^{-1} \cdot mol^{-1}$	0.73024	$ft^3 \cdot atm \cdot °R^{-1} \cdot lb\text{-}mol^{-1}$
8.314472	$m^3 \cdot Pa \cdot K^{-1} \cdot mol^{-1}$	1.98588	$Btu \cdot °R^{-1} \cdot lb\text{-}mol^{-1}$
82.05745	$cm^3 \cdot atm \cdot K^{-1} \cdot mol^{-1}$	62.36367	$L \cdot torr \cdot K^{-1} \cdot mol^{-1}$

In this class…

Most answer keys will be done with the R value for atmospheres:

$$0.0821 \ \frac{L \bullet atm}{K \bullet mol}$$

Tip! If you keep track of your units, everything should cancel correctly thanks to the R value's crazy units!

Is the Ideal Gas Law perfect? No!

Its's only going to work for "ideal gases"

- **Imaginary perfect gases with no volume and no attractive or repulsive forces**
- **Can use "correction values" to account for the real behaviors of gases – beyond what we do here!**

$$PV = nRT \longrightarrow \left(P + \frac{an^2}{V^2}\right)(V - nb) = nRT$$

Correction for molecular attraction

Correction for volume of molecules

Density and Molar Mass of a Gas Calculations

Equations on your reference sheet! Memorize them! We don't use them often and people forget to study them. They are still important!

Or…
You can Rearrange Ideal Gas Law to Solve for Them!

Whatever works!

Future AP Chem students…you will want to be comfortable rearranging not just memorizing!

Abbreviations to Know

P = *pressure*

V = *volume*

n = *number of moles*

R = *ideal gas constant*

T = *temperature*

M = *molar mass*

m = *sample mass*

D = *density*

Molar Mass

$$PV = nRT$$

substitute

$$PV = \frac{m}{M}RT$$

rearrange

$$M = \frac{mRT}{PV}$$

$$Molar\ mass = \frac{grams}{moles}$$

$$M = \frac{m}{n}$$

$$n = \frac{m}{M}$$

Density

$$PV = nRT$$

substitute

$$n = \frac{m}{M}$$

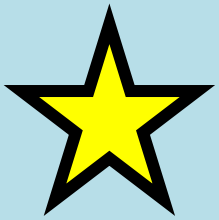
$$PV = \frac{m}{M}RT$$

$$D = \frac{m}{V}$$

rearrange

$$\frac{m}{V} = \frac{MP}{RT}$$

$$D = \frac{MP}{RT}$$



Molar Mass

$$D = \frac{MP}{RT}$$

Or...

$$M = \frac{mRT}{PV}$$

substitute

$$D = \frac{m}{V}$$

rearrange

substitute

$$M = \frac{DRT}{P}$$

Molar Mass Kitty always puts DIRT over its PEE

WS #3, Q#5

Determine the volume occupied by 2.34 g of carbon dioxide gas, at 1.09atm and 68°C

P = 1.09 atm **V** = ? **T =** 68°C + 273 = 341 K

$$\mathbf{n} = \frac{2.34\ \text{g} \mid 1\ \text{mol}}{\mid 44.01\ \text{g}} = 0.0532\ \text{mol}$$

R = *Get from R-35! Use # with atm!* = $0.0821\ \frac{L \cdot atm}{k \cdot mol}$

$$(1.09\text{atm})(V) = (0.0532\ \text{mol})\left(0.0821\ \frac{L \cdot atm}{K \cdot mol}\right)(341\ \text{K})$$

WS #3, Q#5

Determine the volume occupied by 2.34 g of carbon dioxide gas, at 1.09atm and 68°C

$$\frac{(1.09\text{atm})(V)}{(1.09\text{atm})} = \frac{(0.0532\ \text{mol})\left(0.0821\ \frac{L \cdot atm}{K \cdot mol}\right)(341\ K)}{(1.09\text{atm})}$$

$$= 1.366\ \mathbf{L}$$

YouTube Link to Presentation

- https://youtu.be/Bksd_GhLpt8