Ideal Gas Law

Ideal Gas Law

- For every problem we have done, we also could have used the ideal gas law.
- On the test, you will have to do a couple of problems with the combined gas law, some with the ideal gas law and then you will be able to choose which law you want to use.

Ideal gas law can be derived from the combined gas law

- PV/T = PV/T (using kPa for pressure)
- n (22.4) = Volume of any gas at STP (n is the number of moles)
- plug this into combined gas law for initial state.
- PV/T = (101.2 kPa) (n • 22.414 L) / 273 K
- PV = n (8.31 kPa•L/K mol) T
- 8.31 kPa•L/K mol is the ideal gas constant for these units. It is abbreviated "R"

The equation

- PV = nRT
- *R can also be .0821 *atm* •L/K mol
- *R can also be 62.4 *torr* •L/K mol
- The units of R must match the other units in the problem.
- If you are using **8.31 kPa•L/K mol**, your units are:
- kPa(L) = mol (8.31 kPa•L/K mol) K

Converting pressures

- Use the standard pressures as a conversion factor
- 1.00 atm = 101 kPa = 760. torr
- convert 135 kPa to atm
- 135 kPa x 1 atm / 101 kPa = 1.34 atm
- convert 768 torr to kPa
- 768 torr x 101 kPa / 760 torr = 102 kPa

Using the ideal gas law

- What volume will .76 mol of a gas occupy at .82 atm and 264 K?
- PV = nRT
- 0.82 atm x 101kPa / 1.00 atm = 82.82 kPa
- 82.82kPa V = 0.76 mol (8.31 kPa•L/K mol)264 K
- V = 20. L

Ideal Gas Law Problem

- If a gas occupies 14 L at 135 kPa and 285 K, what volume will it occupy at STP?
- PV = nRT
- 135 kPa (14 L) = n 8.31 kPa•L/K mol (285 K)
- n = .798 mol
- .798 mol x 22.4 L / 1 mol
- = **18 L**

or you can also

- take the .798 mol and plug it back into
- PV = nRT (you would have to do this if you were not going to STP)
- 101 kPa V= (.798 mol) 8.31 (273 K)
- V = 18 L (still)

Ideal Gas Law Problems

Number 1

- 1.54 mol of helium will occupy what volume at 92 kPa and 315 K?
- PV = nRT

Number 1

- 1.54 mol of helium will occupy what volume at 92 kPa and 315 K?
- PV = nRT
- 92 KPa V = 1.54 mol (8.31) 315K
- V = **44 L**

Number 2

- 126 mL of nitrogen at 113 kPa and 39º C will occupy what volume at STP?
- PV= nRT

Number 2

- 126 mL of nitrogen at 113 kPa and 39º C will occupy what volume at STP?
- PV= nRT
- .126 L (113 kPa)= n(8.31)312K
- n = .00549 mol x 22.4L/1 mol
- V = **.123 L (123 mL)**

Number 3

- 2.14 g of NH_3, ammonia, will occupy what volume at 795 torr and 315 K?

Number 3

- 2.14 g of NH_3, ammonia, will occupy what volume at 795 torr and 315 K?
- 2.14 g x 1 mol/17.034 g = .125mol
- 795 torr x101 kPa/760 torr =105.65 kPa
- PV = nRT
- 105.65 V = .125 mol (8.31) 315K
- V = **3.10 L**

Number 4

- $CH_3OH + O_2 \rightarrow H_2O + CO_2$
- What volume of carbon dioxide will 5.2 g oxygen produce at 1.2 atm and 299 K?

Number 4

- $2\ CH_3OH + 3O_2 \rightarrow 4H_2O + 2\ CO_2$
- What volume of carbon dioxide will 5.2 g oxygen produce at 1.2 atm and 299 K?

5.2 g O_2	1 mol O_2	2 mol CO_2
	32.00 g O_2	3 mol O_2

- =.108… mol
- 1.2 atm x 101 kPa/1.00 atm = 121.2 kPa
- 121.2 kPa V = .108 (8.31) 299K
- V = **2.2 L**

Number 5

- $HCl + Co \rightarrow CoCl_3 + H_2$
- What volume of hydrogen gas will 5.2 g cobalt produce at 97 kPa and 285 K?

Number 5

- $6HCl + 2Co \rightarrow 2CoCl_3 + 3H_2$
- What volume of hydrogen gas will 5.2 g cobalt produce at 97 kPa and 285 K?

5.2 g Co	1 mol Co	3 mol H_2
	58.93 g Co	2 mol Co

- .132.. mol
- 97 V= .132mol(8.31)285K
- V = 3.2 L