Exam 1 Review

CH 301N

Today’s Agenda

- About the exam
- Content
  - Matter
  - Stoichiometry
  - Limiting reactant
  - Gases
  - Air
  - Stuff to memorize
- Q&A

The exam…

- Tomorrow
- 2:00 - 3:15 in classroom
- 20 multiple choice questions
- Paper exam
- QR code at the end
    - This is where you will submit your answers!!!

Things you will be given

- The exam (yay!)
- QR code for the bubble sheet
- Scratch paper if needed
- Periodic table and conversion sheet

Periodic Table of the Elements

1A 1	2A 2	3B 3	4B 4	5B 5	6B 6	7B 7	8B 8	8B 9	8B 10	1B 11	2B 12	3A 13	4A 14	5A 15	6A 16	7A 17	8A 18
1 H 1.008																	2 He 4.003
3 Li 6.941	4 Be 9.012											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
11 Na 22.99	12 Mg 24.31											13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.07	17 Cl 35.45	18 Ar 39.95
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.87	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.38	31 Ga 69.72	32 Ge 72.64	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc (98)	44 Ru 101.07	45 Rh 102.91	46 Pd 106.42	47 Ag 107.87	48 Cd 112.41	49 In 114.82	50 Sn 118.71	51 Sb 121.76	52 Te 127.60	53 I 126.90	54 Xe 131.29
55 Cs 132.91	56 Ba 137.33	57 La 138.91	72 Hf 178.49	73 Ta 180.95	74 W 183.84	75 Re 186.21	76 Os 190.23	77 Ir 192.22	78 Pt 195.08	79 Au 196.97	80 Hg 200.59	81 Tl 204.38	82 Pb 207.20	83 Bi 208.98	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra (226)	89 Ac (227)	104 Rf (261)	105 Db (262)	106 Sg (266)	107 Bh (264)	108 Hs (277)	109 Mt (268)	110 Ds (281)	111 Rg (281)	112 Cn (285)	113 Nh (286)	114 Fl (289)	115 Mc (289)	116 Lv (293)	117 Ts (293)	118 Og (294)

58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm (145)	62 Sm 150.36	63 Eu 151.96	64 Gd 157.25	65 Tb 158.93	66 Dy 162.50	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.04	71 Lu 174.97
90 Th 232.04	91 Pa 231.04	92 U 238.03	93 Np (237)	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (262)

constants

R	=	8.314 J/mol K
R	=	0.08206 L·atm/mol·K
N_A	=	6.022×10^{23} /mol
h	=	6.626×10^{-34} J·s
c	=	3.00×10^{8} m/s
F	=	96485 C/mol e^-
g	=	9.81 m/s^2

conversions

1 atm	=	760 torr
1 atm	=	101325 Pa
1 atm	=	1.01325 bar
1 atm	=	14.7 psi
1 bar	=	10^5 Pa
°F	=	°C(1.8)+32
K	=	°C + 273.15

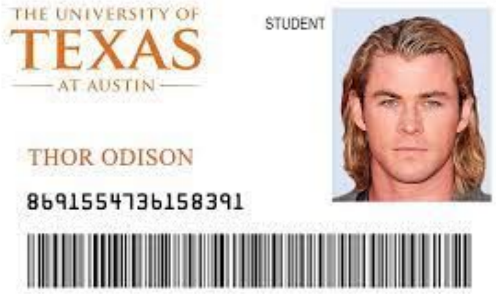
conversions

1 cal	=	4.184 J
1 L·atm	=	101.325 J
1 eV	=	1.602×10^{-19} J
1 in	=	2.54 cm
1 ft	=	12 in
1 yd	=	3 ft
1 mi	=	5280 ft
1 Å	=	10^{-10} m
1 lb	=	453.6 g
1 ton	=	2000 lbs
1 tonne	=	1000 kg
1 gal	=	3.785 L
1 gal	=	231 in^3
1 gal	=	128 fl oz
1 fl oz	=	29.57 mL

H_2O water data

$C_{s,ice}$	=	2.09 J/g K
$C_{s,water}$	=	4.184 J/g K
$C_{s,steam}$	=	2.03 J/g K
ρ_{water}	=	1.000 g/mL
$\rho_{saltwater}$	=	1.024 g/mL
ρ_{ice}	=	0.9167 g/mL
ΔH_{fus}	=	334 J/g
ΔH_{vap}	=	2260 J/g
K_w	=	1.0×10^{-14}

What to bring



ChemBook Chapters:
[Chapter 0: Stuff You Already Know]
[Chapter 1: Fundamentals of Chemistry]
[Chapter 2: Atmosphere, Air, and Gases]

What to study:
LO's, HW's, chembook, class notes

(Everything is fair game)

Learning Outcomes

Students will know...

1. how to count stuff
2. how to mathematically convert from one type of unit to another utilizing a set of conversion factors
3. the names, formulas, and physical state of the first 10 alkanes
4. Know which elements exist as diatomic molecules
5. the MAIN Metric Prefixes for Chemistry Class as listed in section 10.2 of chembook - it's the last table there
6. how to fully balance a chemical reaction and identify the coefficients
7. how to do composition stoichiometry calculations - figuring out the percent of a specific element in a given compound
8. how to do reaction stoichiometry calculations converting moles to moles and also moles to grams and grams to grams or anything else
9. how to predict product amounts when given arbitrary amounts of reactants - limiting reactant problems (like #20 on HW01)
10. the same outcomes as the two previous ones but with *gas moles* using the ideal gas law to get pressure or volume of the gas reactants.
11. the 3 primary components and their percentages of dry air
12. how those percentages change when humid air is used
13. the 6 primary pollutants in our air - know names and formulas and/or abbreviations for them
14. the primary sources/causes of those pollutants
15. what methods are in place to help curb the amounts of these pollutants in air
16. how to calculate various gas law values - P, V, T, and n according to the ideal gas law and associated laws
17. how to convert pressure of a gas into number (mole) density
18. what partial pressure is and how to calculate it.
19. how to get mole fraction from partial pressure and total pressure and vice versa
20. how to use the pressure and identity of a gas to calculate its mass density
21. how to convert mass density and pressure into the molecular weight of a gas
22. anything else we learned and did in class, on HW, that I forgot here

0 Stuff You Already Know

0.1 I Can Count

0.2 Big/Small - Hot/Cold

0.3 Looking Stuff Up

0.4 Using a Calculator

0.5 Basic Math/Algebra

0.6 The Art of Reasonableness

0.7 Which Pill? Red or Blue

0.42 Learning Outcomes

1 Fundamentals of Chemistry

1.1 Matter - Breakdown

1.2 Molecules

1.3 Measurements

1.4 Significant Figures

1.5 Periodic Table

1.6 Conversions

1.7 Solutions and their Concentrations

1.8 Definition of a Mole

1.9 Calculating Moles

1.10 Stoichiometry

1.11 Limiting Reactant

1.12 Common Diatomic Elements

1.13 Chemical Formulas

1.14 Nomenclature

1.42 Learning Outcomes

2 Atmosphere, Air, and Gases

2.1 Composition of Air

2.2 What Makes a Gas... different?

2.3 Our Atmosphere

2.4 What is Pressure?

2.5 Gas Laws

2.6 Partial Pressure

2.7 Reaction Stoichiometry and Gases

2.8 Air Pressure and Elevation

2.9 Pollutants in Air

2.10 Curbing Air Pollutants

2.11 Al Kane

2.12 Density of a Gas

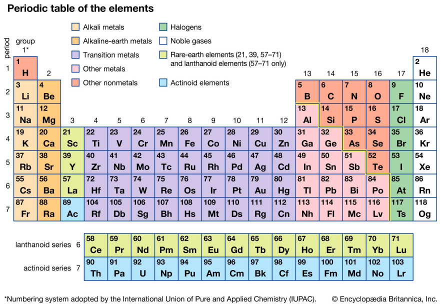
2.13 STP and more

Ready to get started???

Matter

Pure Substances

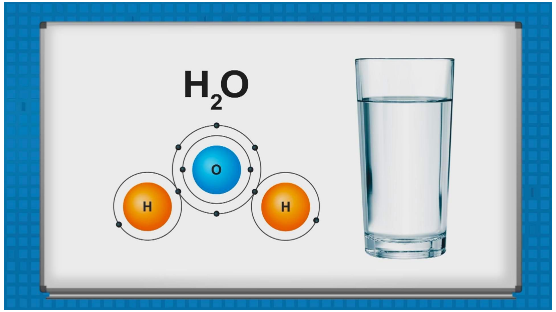
- Elements: on periodic table



- Compounds:

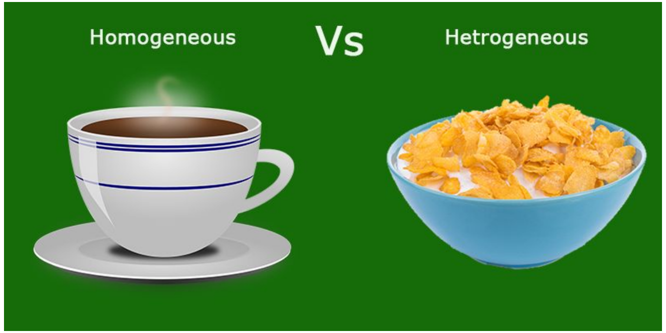
Chemically combined elements (chemical formulas)

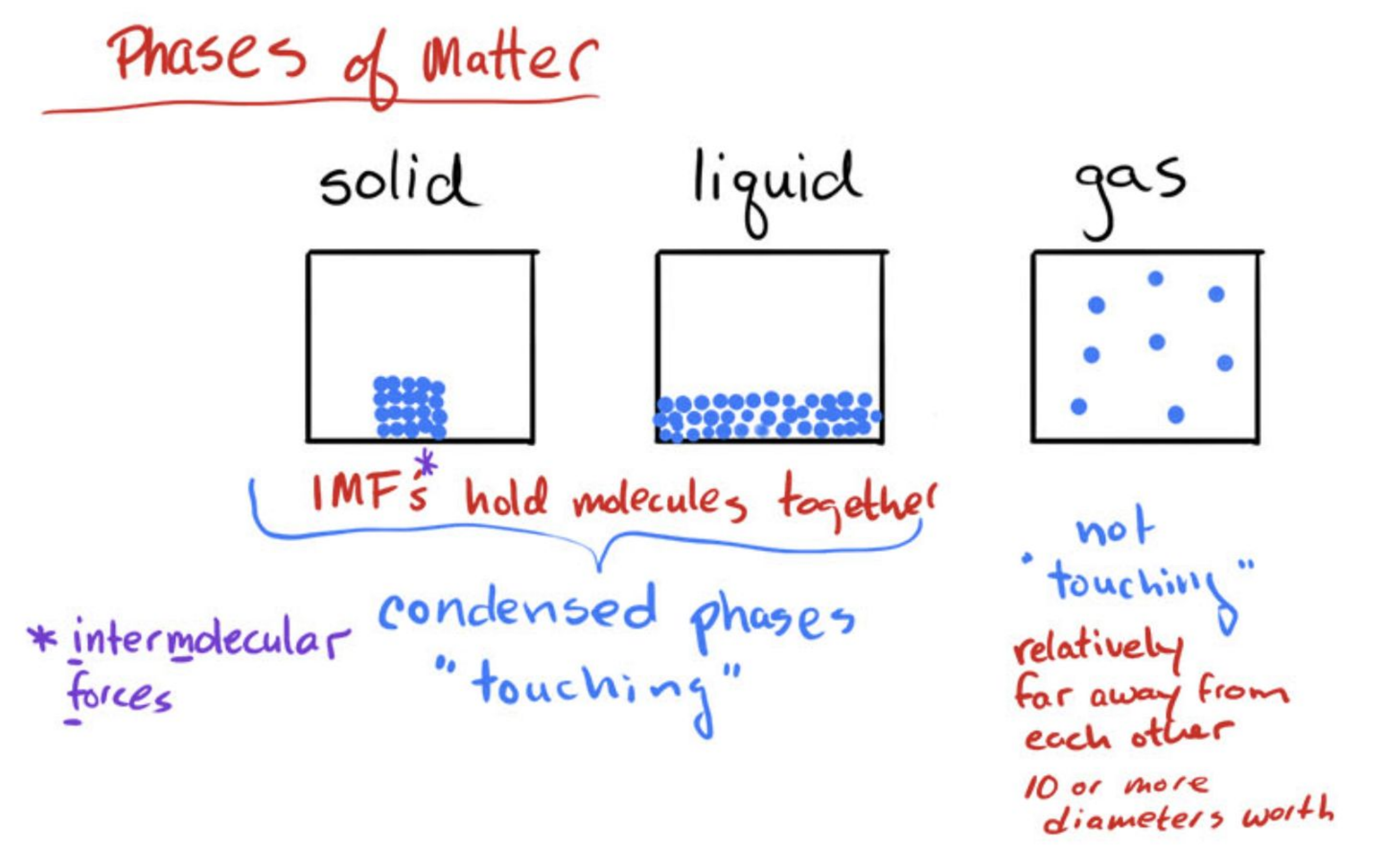
H_2O, NaCl, $C_6H_{12}O_6$



Mixtures

- Homogenous: same throughout (solutions)
- Heterogenous: obvious differences




Phases of Matter
solid
liquid
gas
* IMF's hold molecules together
condensed phases
"touching"
* intermolecular forces
not "touching"
relatively far away from each other
10 or more diameters worth

Stoichiometry (ratios)

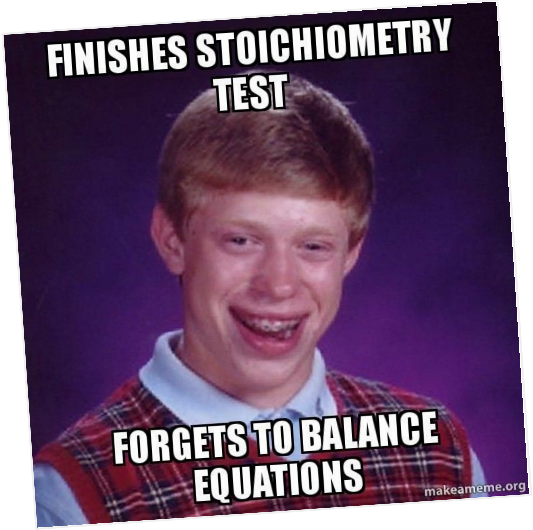
Example: Propane

Calculating molar mass

C_3H_8 → 3C: 3 x 12 = 36 g/mol
8H: 8 x 1 = 8 g/mol
——--–
~ 44 g/mol

Percent mass

36/44 = 82 % C
8/44 (or 100-82) = 18% H

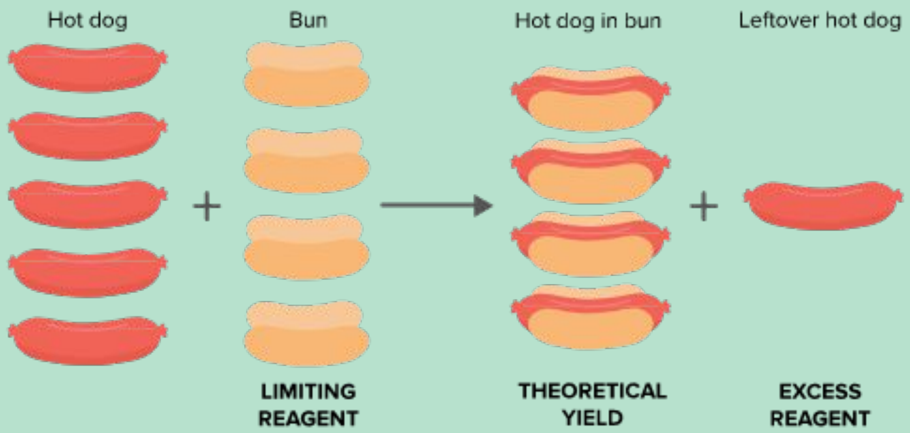


Don’t be like him

$$\_Al + \_H_2SO_4 \rightarrow \_Al_2(SO_4)_3 + \_H_2$$

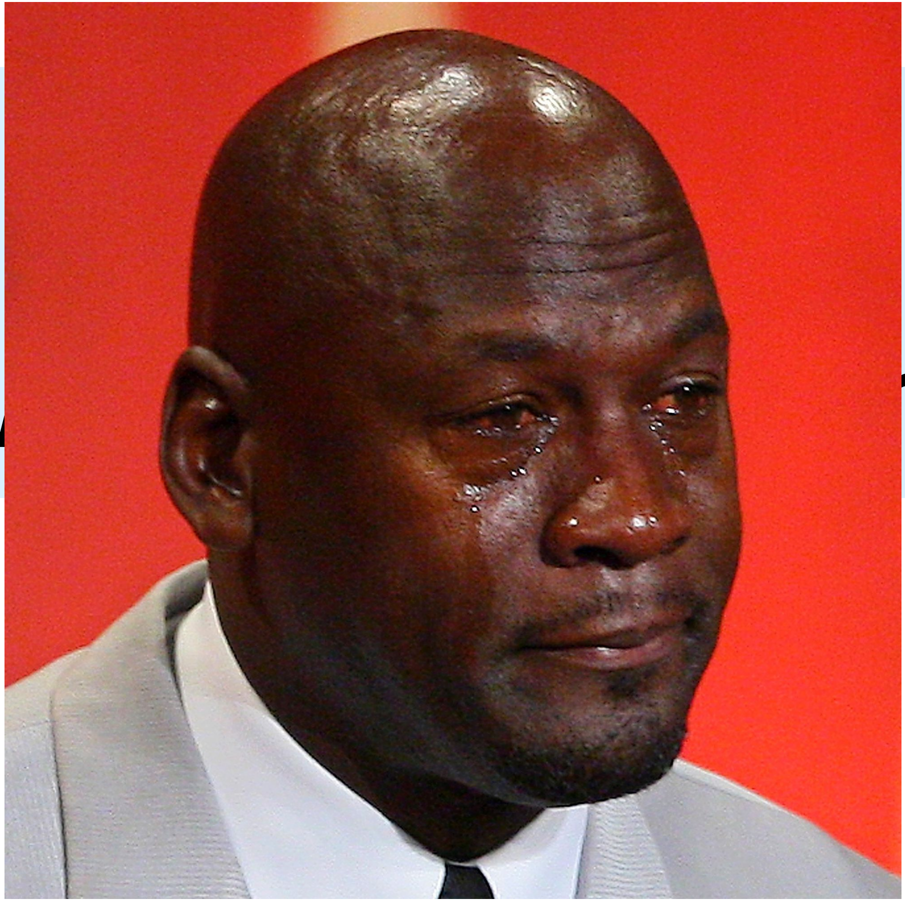
$$2Al + 3H_2SO_4 \rightarrow Al_2(SO_4)_3 + 3H_2$$

Limiting Reactant



Now with chemistry :)

Now ry :)



$$3\,H_2 + N_2 \rightarrow 2\,NH_3$$

I give you 2 moles of H_2 and 5 moles of N_2

What's the limiting reactant???

$$3\ H_2 + N_2 \rightarrow 2\ NH_3$$

Given: 2 moles H_2 and 5 moles N_2

Option 1: Convert one reactant to the other reactant to see which one is limiting

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Option 2: Convert both reactants to moles of product and see which makes less

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Option 2: Convert both reactants to moles of product and see which makes less

Some people prefer one way over another, but EITHER WAY IS FINE!!!

$$3\ H_2 + N_2 \rightarrow 2\ NH_3$$

Given: 2 moles H_2 and 5 moles N_2

Option 1: Convert one reactant to the other reactant to see which one is limiting

$5\ mol\ N_2 \times (3\ mol\ H_2 / 1\ mol\ N_2)$

$= 15\ mol\ H_2$ NEEDED for the reaction to run to completion

You only HAVE 2 moles. You do not have enough H_2, so it is your LR.

Option 2: Convert both reactants to moles of product and see which makes less

$$3\ H_2 + N_2 \rightarrow 2\ NH_3$$

Given: 2 moles H_2 and 5 moles N_2

Option 1: Convert one reactant to the other reactant to see which one is limiting

5 mol N_2 x (3 mol H_2 / 1 mol N_2)
= 15 mol H_2 NEEDED for the reaction to run to completion

You only HAVE 2 moles. You do not have enough H_2, so it is your LR.

Option 2: Convert both reactants to moles of product and see which makes less

2 mol H_2 x (2 mol NH_3 / 3 mol N_2)
= 1.33 mol NH_3 made

5 mol N_2 x (2 mol NH_3 / 1 mol N_2)
= 10 mol NH_3 made

Because you made less NH_3 with your H_2, that is your limiting reactant!

Be sure you can work these problems both ways!! (i.e. going from pdt → rct)

Questions so far?

Gases

Ideal Gas Law

PV = nRT

MEMORIZE THIS!!

(or put it on your notecard :))

Boyle's Law

$$P_1V_1 = P_2V_2$$

constant n, T

Charles' Law

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

constant n, P

Avogadro's Law

$$\frac{V_1}{n_1} = \frac{V_2}{n_2}$$

constant P, T

Gay-Lussac's Law

$$\frac{P_1}{T_1} = \frac{P_2}{T_2}$$

constant n, V

Combined Gas Law

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

constant n

Ideal Gas Law (rearranged)

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

*equation of state

Inflate a Tire* Law

$$\frac{P_1}{n_1} = \frac{P_2}{n_2}$$

* constant V, T named by dr mccord

Nobody Does This* Law

$$n_1T_1 = n_2T_2$$

*constant P, V named by dr mccord

DO NOT MEMORIZE THESE!!

Units matter!

P: atm, kPa, bar, torr, psi, …

V: L, mL, …

N: MOLES (don't accidentally plug in grams when you need moles!)

T: KELVIN! (don't use ºC or ºF in calculations)

Common R Values

$R = 0.08206 \text{ L atm/mol K}$
$R = 0.08314 \text{ L bar/mol K}$
$R = 62.36 \text{ L torr/mol K}$
$R = 8.314 \text{ m}^3 \text{ Pa/mol K}$

*all these values will be given on exams

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We could say these in a problem…

STP	SATP
1 atm	1 bar
273.15 K	298.15 K

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Like…

You have 2L of an ideal gas at STP. How many moles?

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STP	**SATP**
1 atm	1 bar
273.15 K	298.15 K

Like…

You have 2L of an ideal gas at STP. How many moles?

$PV = nRT$

n = PV/RT = (1 atm)(2 L) / (0.08206 L atm / mol K)(273.15 K)
= 0.089 moles

Dalton's Law of Partial Pressures

$P_{total} = P_A + P_B + P_C \ldots$

Each gas in your container contributes to the overall pressure

Mole Fraction

$$X_A = \frac{P_A}{P_{total}} \qquad X_A = \frac{\text{moles of A}}{\text{total moles}} \qquad P_A = X_A \cdot P_{total}$$

Questions?

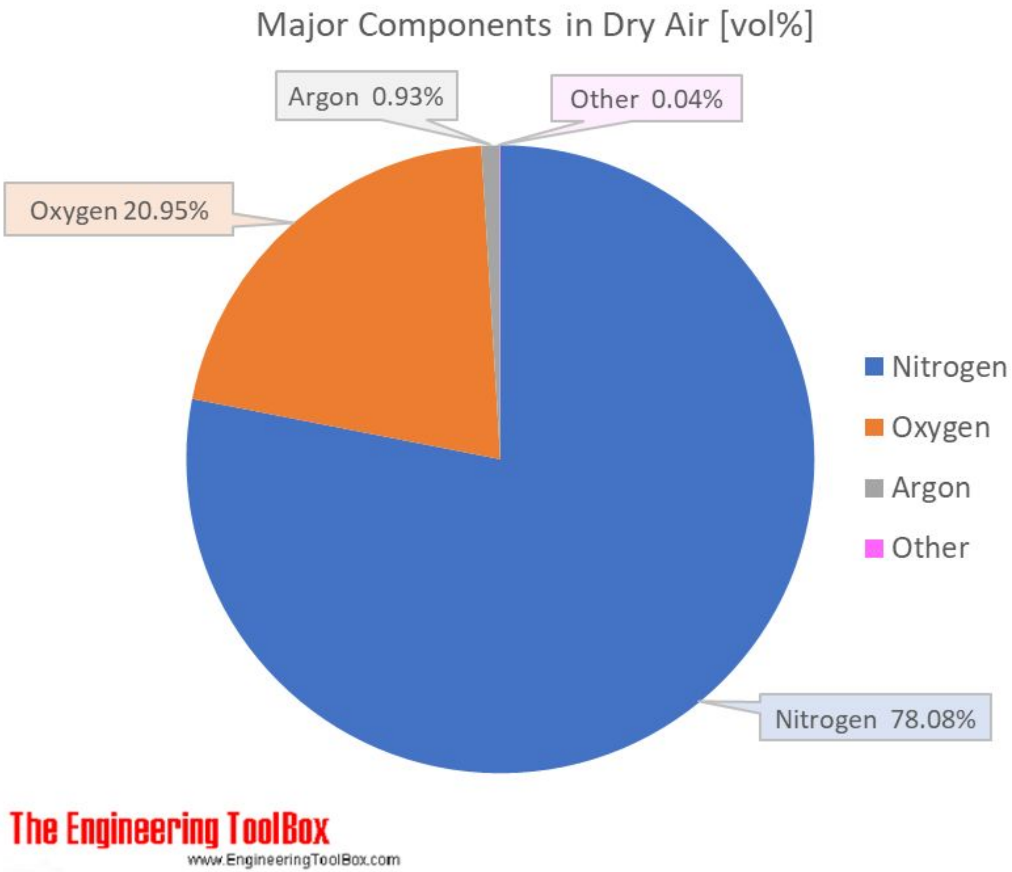
Air

… and other stuff to basically memorize

Components of Dry Air

78% N_2
21% O_2
1% Ar

Humid air has water vapor – H_2O (g)



Pollutants – Chembook 2.9 & 2.10

CO, NO_x, SO_x, VOCs, PM, O_3

Know:

- Names
- Formulas / abbreviations
- Sources / causes
- A little about them – chembook
- Methods in place to curb these pollutants
    - Catalytic converters remove VOCs, CO, NOx & requires O_2 → N_2, CO_2, H_2O
    - Scrubbers remove SO_x → gypsum, $CaSO_4$*$2H_2O$

Alkanes

name	formula	state (25°C)
methane	CH_4	gas
ethane	C_2H_6	gas
propane	C_3H_8	gas
butane	C_4H_{10}	gas
pentane	C_5H_{12}	liquid
hexane	C_6H_{14}	liquid
heptane	C_7H_{16}	liquid
octane	C_8H_{18}	liquid
nonane	C_9H_{20}	liquid
decane	$C_{10}H_{22}$	liquid

We made it!

Questions??

You’ve got this!

- Get some sleep!
- Hydrate & eat a good meal!
- Don’t overthink!
- Use your resources!