

1.5 Factor-Label Method – Dimensional Analysis – The Mathematics of Chemistry

What is a Handy Way to Convert from One Unit to Another?

1.5 Example_3

The density of whole blood at 37°C is 1.06 g.cm⁻³. What is the mass, in grams of a 15.0 cm³ sample of blood?



- A) 15.9g ✓
- B) 14.2g
- C) Neither a or b
- D) Tom I am clueless!

Would it help if I told you that :- $1.06 \text{ g.cm}^{-3} = \frac{1.06 \text{ g}}{1 \text{ cm}^3}$

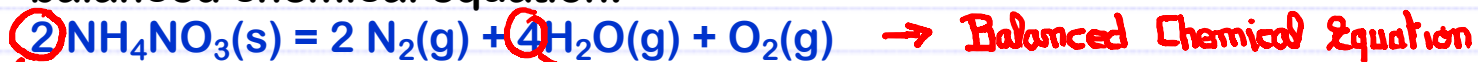
$$15.0 \text{ cm}^3 \left| \frac{1.06 \text{ g}}{1 \text{ cm}^3} \right. = 15.9 \text{ g}$$

1.5 Factor-Label Method – Dimensional Analysis – The Mathematics of Chemistry

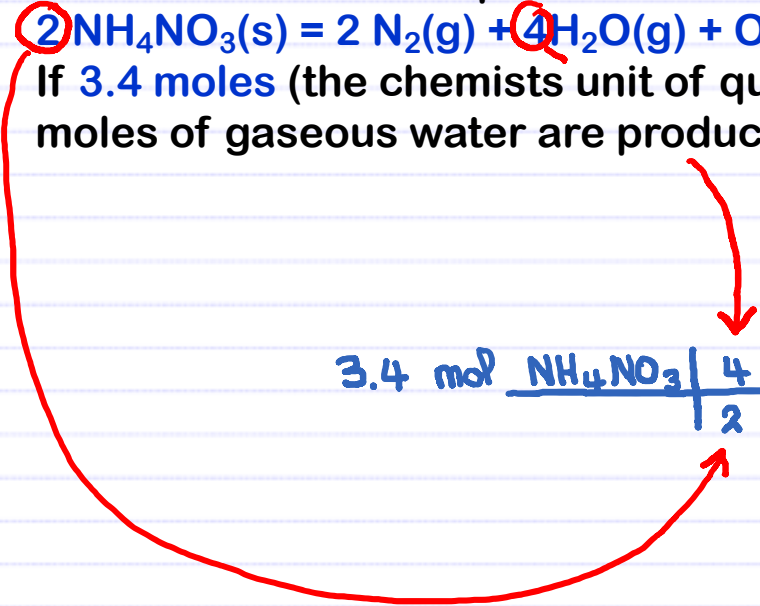
What is a Handy Way to Convert from One Unit to Another?

1.5 Example_4

Ammonium Nitrate decomposes explosively according to the following balanced chemical equation:



If 3.4 moles (the chemists unit of quantity) decomposes, how many moles of gaseous water are produced.


$$3.4 \text{ mol } \frac{\text{NH}_4\text{NO}_3}{2 \text{ NH}_4\text{NO}_3} \times \frac{4 \text{ H}_2\text{O}}{4 \text{ H}_2\text{O}}$$

3.5 How Do We Name Ionic Compounds – An Early First Visit

+1												+3				-3		-2		-1	
1A	2A											3A	4A	5A	6A	7A	8				
H ⁺														N ³⁻	O ²⁻	H ⁻					
Li ⁺												Al ³⁺		P ³⁻	S ²⁻	F ⁻					
Na ⁺	Mg ²⁺	3B	4B	5B	6B	7B	8B	8B	8B	1B	2B			Se ²⁻	Cl ⁻						
K ⁺	Ca ²⁺													Te ²⁻	Br ⁻						
Rb ⁺	Sr ²⁺														I ⁻						
Cs ⁺	Ba ²⁺																				

Monoatomic cations retain the parent name
 ↳ single atom

Na = Sodium

Na⁺ = Sodium

Monoatomic anions end in 'ide'

O = Oxygen

O²⁻ = Oxide

Convention dictates that the name of the cation comes first, followed by the name of the anion.

2.4

What Are Atoms Made Of?

2.4 What Are Atoms Made Of? – The Three Subatomic Particles

Name	Symbol	Mass (g)	Charge	Mass*1 (amu)*2
PROTON	${}^1_1\text{p}$	1.673×10^{-24}	+1	1
NEUTRON	${}^1_0\text{n}$	1.675×10^{-24}	0	1
ELECTRON	${}^{-1}_0\text{e}$	9.109×10^{-28}	-1	0.0005

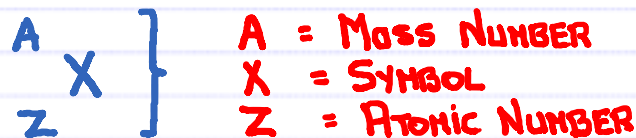
a) Chemists tend to ignore the mass of the electron.

b) # PROTONS ... the atom determinant ... $\#p = \text{Atomic Number (Z)}$

c) # NEUTRONS ... the other mass contributor ... $\#n + \#p = \text{Mass Number (A)}$

d) # ELECTRONS ... determines the charge on the atom.

$\#e = \#p$, neutral : $\#e > \#p$, anion : $\#e < \#p$, cation



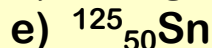
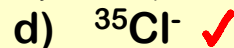
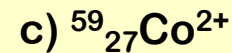
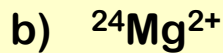
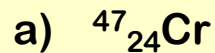
*1: Rounded to one significant figure

*2: $1 \text{ amu} = 1.6605 \times 10^{-24} \text{ g}$

2.4 What Are Atoms Made Of? – The Three Subatomic Particles

2.4 Example_1

Which if any of the following species has the same number of Neutrons as it does Electrons?



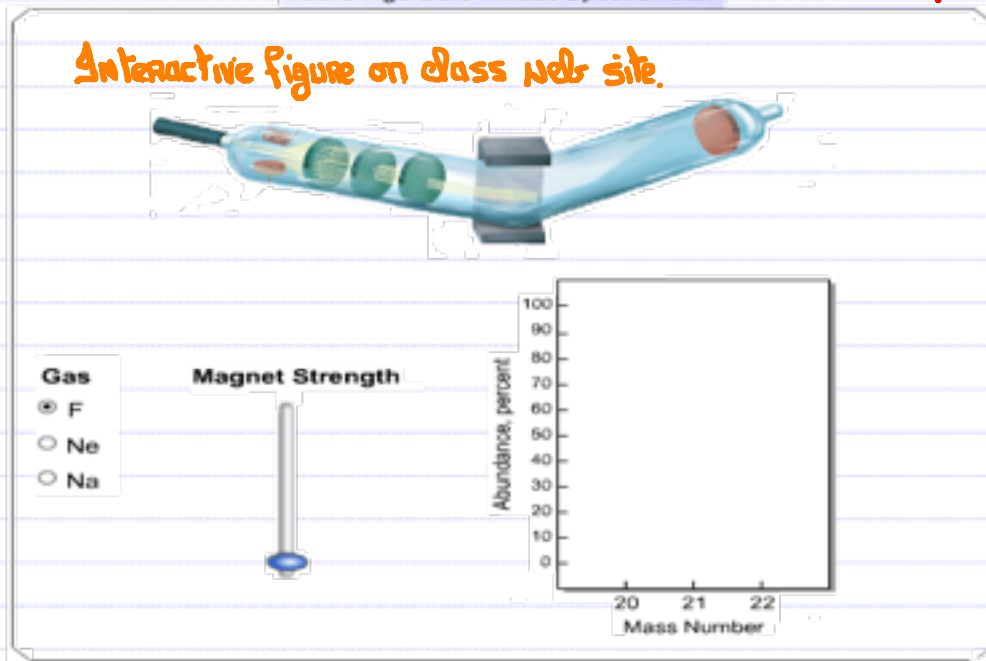
	<u># Protons</u>	<u># Neutrons</u>	<u># Electrons</u>	
${}^{47}_{24}\text{Cr}$	24	23	24	
${}^{24}\text{Mg}$	12	12	10	
${}^{59}_{27}\text{Co}^{2+}$	27	32	25	
${}^{35}\text{Cl}^-$	17	18	18	✓
${}^{125}_{50}\text{Sn}$	50	75	50	

2.4 What Are Atoms Made Of? – *Isotopes*

ISOTOPE: Atoms with the same number of protons but different number of neutrons.

Active Figure 2.04: Mass Spectrometer

Interactive figure on class web site.



	#p	#n	#e
^{12}C	6	6	6
^{14}C	6	8	6

^{14}C : Natural radioactive isotope used in dating artifacts
↳ More on this towards the end of the course.

2.4 What Are Atoms Made Of? — Atomic Weight

2.4 Example_2

Chlorine has two naturally occurring isotopes:

^{35}Cl , 75.77% Abundant, Exact Mass 34.96885 amu

^{37}Cl , 24.23% Abundant, Exact Mass 36.96590 amu

What is the Atomic Weight of Chlorine?

Atomic Weight: the weighted average of the naturally occurring isotopes.

$$0.7577(34.96885) + 0.2423(36.96590) = 35.45271 \text{ amu}$$

Note: When doing these treat all numbers as exact.
Which means no number limits the significant figures in the answer.

2.4 What Are Atoms Made Of? — Atomic Weight

2.4 Example_3

Neon has 3 naturally occurring isotopes:

^{20}Ne , 90.92% Abundant, Exact Mass 19.9989 amu

^{21}Ne , 0.26% Abundant, Exact Mass 20.9975 amu

^{22}Ne , 8.82% Abundant, Exact Mass 21.9979 amu

What is the Atomic Weight of Neon?



The 4th decimal place in the answer is

- a) 5 b) 6 c) 7 d) 8 ✓ e) 9

$$0.9092(19.9989) + 0.0026(20.9975) + 0.0882(21.9979) = 20.1778$$