Ch 3   Stoichiometry

$1 \text{ amu} = \frac{1}{12} \times \text{mass of } {}^{12}_{6}\text{C}$.

$1 \text{ amu} = 1u$
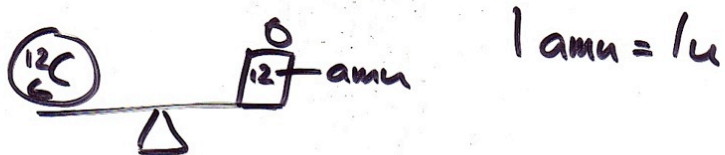
Average Atomic Mass

Carbon ~ isotopes

98.900% ${}^{12}_{6}\text{C}$ exactly 12u
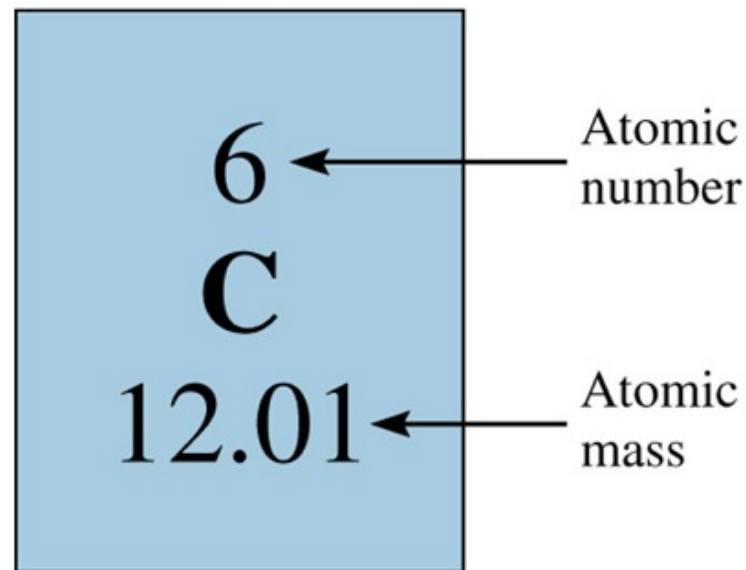
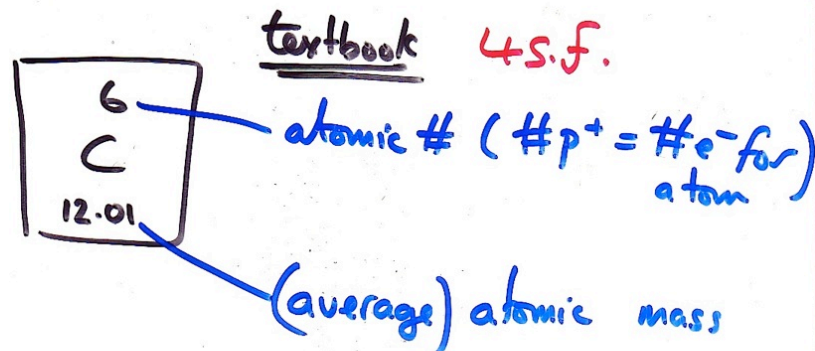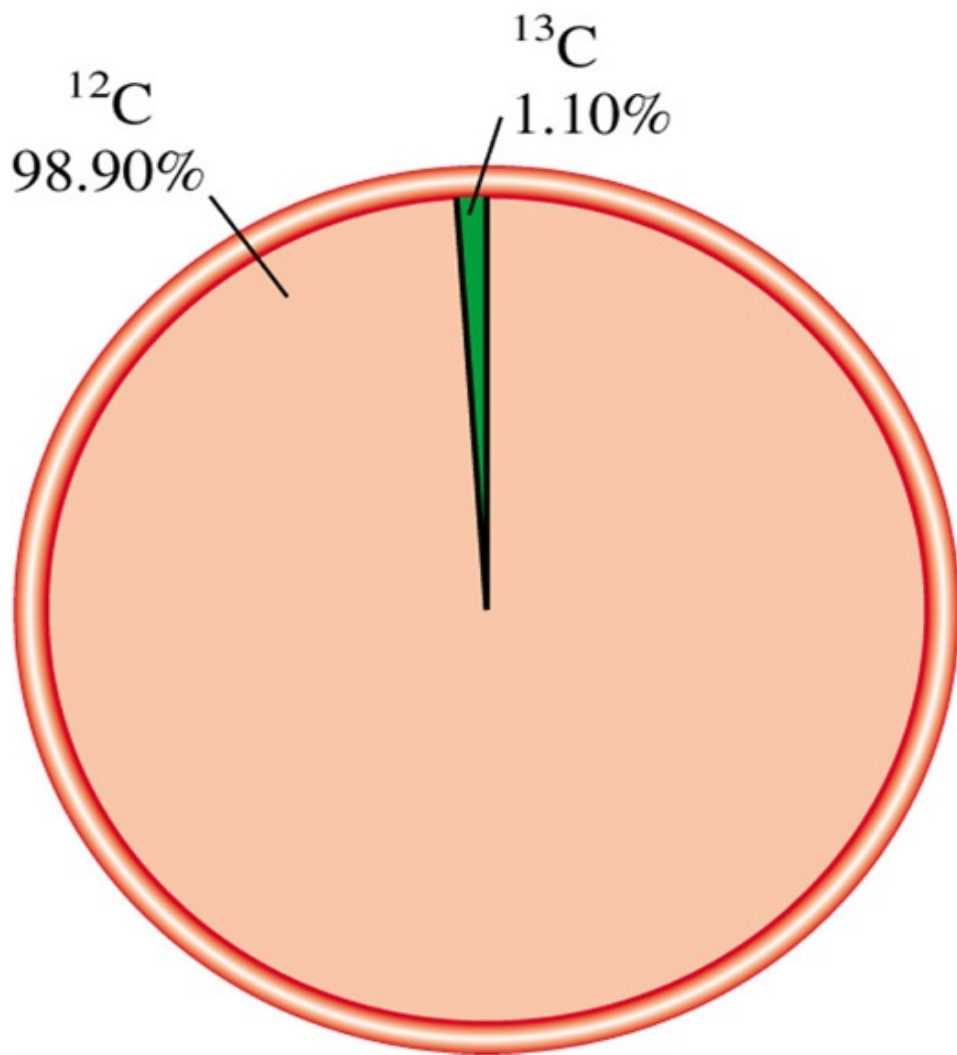1.100% ${}^{13}_{6}\text{C}$ mass = 13.0335u

mass# ≈ mass in amu

to find the average mass...

exact!

$= \frac{98.900}{100} \times 12u + \frac{1.100}{100} \times 13.0335u$

$= 12.011u$

6 ← Atomic number

C

12.01 ← Atomic mass

^{12}C
98.90%

^{13}C
1.10%

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textbook   4 s.f.

$^6_{}C$ ← atomic # ($\#p^+ = \#e^-$ for atom)

12.01 ← (average) atomic mass

Avogadro's # + Molar Mass

Atoms ~ tiny
  ~ hard to count out
     by counting
  ~ easy to count out
     by weighing!

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pair = 2   gross = 144   Avogadro's #
dozen = 12
score = 20   mole = 6.022 × 10²³
            abbreviated: mol

atomic # = #p⁺ → atomic $\# = \#p^+$

82
Pb
207.2 → (average) atomic mass.

− On average, an atom of Pb has a mass of 207.2u.

If we take 6.022×10^{23} atoms of Pb, it will have a mass of 207.2g.

1 mol of Pb = 207.2g Pb.

17
Cl
35.45 → avg atomic mass.

− on avg, 1 atom Cl = 35.45u

6.022×10^{23} atoms of Cl = 35.45g Cl

1 mol Cl = 35.45g Cl

Gold

79
Au
197.0

1 mol Au = 197.0g Au

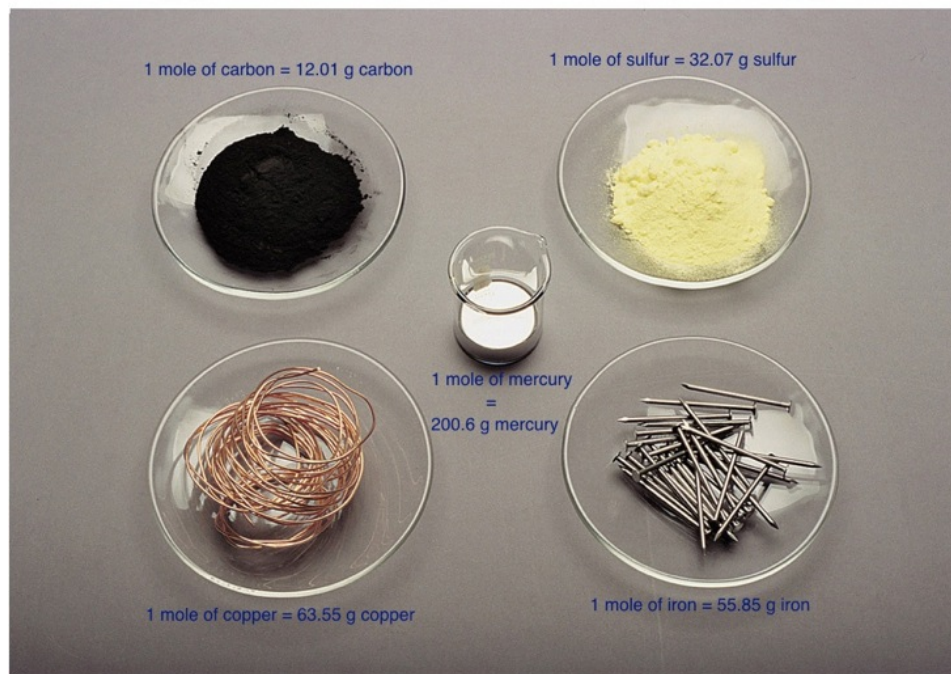6.022×10^{23} Au = 197.0g Au

Well, how many atoms of Au are there in 15.2g Au?

3sf

$\dfrac{15.2g \ Au}{} \left| \dfrac{6.022 \times 10^{23} \ Au \ \text{(4 sf.)}}{197.0g \ Au \ \text{(4sf.)}} \right| = 4.65 \times 10^{22}$ atoms Au

How many moles of Au is this? ③sf

$\dfrac{15.2g \ Au}{3sf.} \left| \dfrac{1 \ mol \ Au \ \text{(exact)}}{197.0g \ Au \ \text{(4sf)}} \right| = 0.0772$ mol Au ③sf

1 mole of carbon = 12.01 g carbon

1 mole of sulfur = 32.07 g sulfur

1 mole of mercury = 200.6 g mercury

1 mole of copper = 63.55 g copper

1 mole of iron = 55.85 g iron

How many grams of Uranium would 0.18 moles weigh?

$$238.0 \text{ g U} = 1 \text{ mol U}$$

$$\boxed{\begin{array}{c} 92 \\ U \\ 238.0 \end{array}}$$
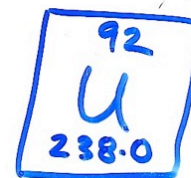
$$\frac{0.18 \text{ mol U}}{\text{(2sf)}} \bigg| \frac{238.0 \text{ g U} \text{ (4sf)}}{1 \text{ mol U} \text{ (exact)}} = 43 \text{ g U} \text{ (2sf)}$$

Molar Masses / Molecular Mass / Formula Mass

for molecules   for ionic cpds

- Mass in g of 1 mol of something

ex: H_2O H_2O

$$\boxed{\begin{array}{c} 1 \\ H \\ 1.008 \end{array}}$$ $$\boxed{\begin{array}{c} 8 \\ O \\ 16.00 \end{array}}$$
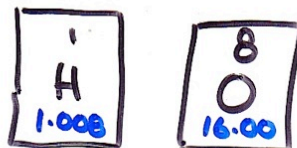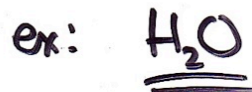
$$2 \times H = 2 \times 1.008$$
$$1 \times O = 1 \times 16.00$$
$$\underline{18.02}$$

(1) 1 molecule H_2O = 18.02u H_2O

(2) 6.022×10^{23} H_2O = $18.02g$ H_2O

(3) 1 mol H_2O = $18.02g$ H_2O

er: How many moles of H_2O are in $5.10g$ of H_2O?

3s.f.

$$\frac{5.10g \; H_2O}{} \left| \frac{1 \; mol \; H_2O}{18.02g \; H_2O} \right| = 0.283 \; mol \; H_2O$$

exact

4s.f.

3sf

Ethyl alcohol

C_2H_6O.

$g \Longleftrightarrow mol$

(1) How many grams is equivalent to 3.80 moles?

(2) How many moles are equivalent to 184g?

C_2H_6O

$2 \times C = 2 \times 12.01 = 24.02$ 2dp
$6 \times H = 6 \times 1.008 = 6.042$ 3dp
$1 \times O = 1 \times 16.00 = 16.00$ 2dp

$\underline{46.06}$

$\Rightarrow$ 1 mol C_2H_6O = $46.06g$ C_2H_6O

(1) $\dfrac{3.80 \; mol \; C_2H_6O}{} \left| \dfrac{46.06g \; C_2H_6O}{1 \; mol \; C_2H_6O} \right| = 175g \; C_2H_6$

(2) $\dfrac{184g \; C_2H_6O}{} \left| \dfrac{1 \; mol \; C_2H_6O}{46.06g \; C_2H_6O} \right| = 3.99 \, mol \; C_2H_6O$