11) Write the symbol for each of the following ions:

we didn't talk about ions just yet, but this isn't hard. An ion is a charge resulting from a difference between p^+ (positive) and e^- (negative).

Ex

Oxygen w/ $8p^+ + 10e^-$ = $+8$ (8 positives)

-10 (10 negatives)

-2

The ion is written O^{2-}

So.... neuclide Symbol becomes

$$\text{mass \#} = p^+ + n^0 \quad \text{difference } p^+ + e^- = \text{charge}$$

$$\text{atomic \#} = p^+ \quad X$$

a) 1+ Charge, atomic # 55, mass # 133 $\quad {}^{133}_{55}Cs^{+}$

b) $54e^-$, $53p^+$, 74 neutrons $\quad {}^{53+74}_{53}I^{53-54} \Rightarrow {}^{127}_{53}I^{-}$

c) atomic # 15, mass number 31, 3- charge $\quad {}^{31}_{15}P^{3-}$

d) $24e^-$, 30 neutrons, 3^+ charge $\quad {}^{30+27}_{27}X^{3+} \Rightarrow {}^{57}_{27}Co^{3+}$

$-24 + p = 3$

$p = 3 + 24$

$p = 27$

12) Write the Symbol for each of the following ions:

a) 3+ Charge, 28 e^-, mass # 71 $\quad {}^{71}_{31}X^{3+} \Rightarrow {}^{71}_{31}Ga^{3+}$

$p - 28 = 3$

$p = 3 + 28 = 31$

b) 36 e^-, 35 p, 45 neutrons $\quad {}^{35+45}_{35}X^{35-36} \Rightarrow {}^{80}_{35}Br^{-}$

c) 86 e^-, 142 neutrons, 4+ charge $\quad {}^{142+90}_{90}X^{4+} \Rightarrow {}^{232}_{90}Th^{4+}$

$p - 86 = 4$

$p = 86 + 4 = 90$

d) 2+ charge, atomic # 38, mass # 87 $\quad {}^{87}_{38}X^{2+} \Rightarrow {}^{87}_{38}Sr^{2+}$

16) Determine the number of protons, neutrons, and electrons in the following isotopes used in medical diagnosis:

a) atomic number 9, mass # 18, 1- charge $\quad {}^{18}_{9}X^{-} \Rightarrow {}^{18}_{9}F^{-}$

b) atomic number 43, mass # 99, 7+ charge $\quad {}^{99}_{43}X^{7+} \Rightarrow {}^{99}_{43}Tc^{7+}$

c) atomic # 53, mass # 131, charge 1- $\quad {}^{131}_{53}X^{-} \Rightarrow {}^{131}_{53}I^{-}$

d) atomic # 81, mass # 201, charge 1+ $\quad {}^{201}_{81}X^{+} \Rightarrow {}^{201}_{81}Tl^{+}$

e) name elements in a, b, c & d.

	${}^{18}_{9}F^{-}$	${}^{99}_{43}Tc^{7+}$	${}^{131}_{53}I^{-}$	${}^{201}_{81}Tl^{+}$
Element	Fluorine	Technetium	Iodine	Thallium
Ion name	Fluoride	Technetium ion	Iodide	Thallium ion

17) The following are propertries of isotopes of two elements that are essential to our diet. Determine the number of protons, neutrons, and electrons in each and name them.

a) atomic # 26, mass # 58, Charge 2+

$^{58}_{26}X^{2+} \Rightarrow {}^{58}_{26}Fe^{2+}$

$\#p = \text{atomic } \# = 26p^+$

$\#n = \text{mass } \# - p = 58 - 26 = 32n$

$\#e^- = \#p - \text{charge} = 26 - 2 = 24e^-$

name Element = Iron name Ion = Iron Ion

b) atomic # 53, mass # 127, Charge 1-

$^{127}_{53}X^{-} \Rightarrow {}^{127}_{53}I^{-}$

$\#p = \text{atomic } \# = 53p$

$\#n = \text{mass}\# - p = 127 - 53 = 74n$

$\#e^- = \#p - \text{charge} = 53 - (-1) = 54e^-$

Element name = Iodine Ion name = Iodide

19) Give the number of protons, electrons, and neutrons in each of these neutral isotopes.

	#p	#n	#e⁻
a) $^{7}_{3}Li$	3	7-3 = 4	3
b) $^{125}_{52}Te$	52	125-52 = 73	52
c) $^{100}_{47}Ag$	47	100-47 = 53	47
d) $^{15}_{7}N$	7	15-7 = 8	7
e) $^{31}_{15}P$	15	31-15 = 16	15

22) An element has the following natural isotopic abundances and masses:

90.92%	0.26%	8.82%
19.99 amu	20.99 amu	21.99 amu

Calculate the average atomic mass of this element.

$\overset{4}{19.99}\text{ amu} \times \dfrac{\overset{4}{90.92\%}}{100} = 18.1\underline{7}4908 \quad \pm 0.01$

$\overset{4}{20.99}\text{ amu} \times \dfrac{\overset{2}{0.26\%}}{100} = 0.05\underline{4}574 \quad \pm 0.001$

$\overset{4}{21.99}\text{ amu} \times \dfrac{\overset{3}{8.82\%}}{100} = + 1.9\underline{3}9518 \quad \pm 0.01$

$20.16|9000$ amu

$\boxed{= 20.17\text{ amu}} \quad \pm 0.01$

23) Average atomic masses listed by IUPAC are based on a study of experimental results. Bromine has two isotopes ^{79}Br & ^{81}Br, whose masses (78.9183 and 80.9163 amu respectively) and abundances (50.69 % and 49.31% respectively) were determined in earlier experiments. Calculate the average atomic mass.

^{79}Br	^{81}Br
78.9183 amu	80.9163 amu
50.69%	49.31%

$$\overset{6}{78.9183\text{ amu}} \times \frac{\overset{4}{50.69\%}}{100} = 40.00368627\text{ amu}$$

$$\overset{6}{80.9163\text{ amu}} \times \frac{\overset{4}{49.31\%}}{100} = + \; 39.89982753\text{ amu}$$

$$79.9035138\text{ amu}$$

$$\boxed{= 79.90\text{ amu}}$$

25) This one was a mistake to assign, but is actually a great problem and demonstrates some great problem solving skills

The average atomic mass of some elements may vary depending upon the source of their ores. Naturally occuring Boron consists of two isotopes with accurately known masses (^{10}B, 10.0129 amu and ^{11}B, 11.00931 amu) The actual atomic mass of boron can vary from 10.807 to 10.819 depending on whether the mineral source is from Turkey or The United States. Calculate the % abundance leading to the two values of the average atomic masses of boron from these two countries.

Translation ⇒ work the problem in reverse, twice.

okay, not an easy problem ⇒ but very satisfying

Here's what it looks like:

Turkey Ave B mass = 10.807 amu

$$\underbrace{(m_{^{10}B})}_{\text{known}}\left(\frac{\%^{10}B}{100}\right) + \underbrace{(m_{^{11}B})}_{\text{known}}\left(\frac{\%^{11}B}{100}\right) = 10.807$$

two unknowns

$$(10.0129\text{ amu})\left(\frac{\%^{10}B}{100}\right) + (11.00931\text{ amu})\left(\frac{\%^{11}B}{100}\right) = 10.807$$

to solve an equation with 2 unknowns you need 2 equations. $\%^{10}B + \%^{11}B = 100\%$

$$\%^{10}B = 100\% - \%^{11}B$$

Now Substitute and Solve

$$(10.0129\text{ amu})\left(\frac{100\% - \%^{11}B}{100}\right) + (11.00931\text{ amu})\left(\frac{\%^{11}B}{100}\right) = 10.807\text{ amu}$$

$$(10.0129\text{ amu})\left(1 - \frac{\%^{11}B}{100}\right) + (11.00931\text{ amu})\left(\frac{\%^{11}B}{100}\right) = 10.807\text{ amu}$$

$$10.0129\text{ amu} - (10.0129)\left(\frac{\%^{11}B}{100}\right) + (11.00931\text{ amu})\left(\frac{\%^{11}B}{100}\right) = 10.807\text{ amu}$$

$$\underbrace{-(10.0129\text{ amu})\left(\frac{\%^{11}B}{100}\right)}_{\text{move to right}} + (11.00931\text{ amu})\left(\frac{\%^{11}B}{100}\right) = \underbrace{10.807\text{ amu} - 10.0129\text{ amu}}_{\text{Simplify}}$$

$$(11.00931\text{ amu})\left(\frac{\%^{11}B}{100}\right) - (10.0129\text{ amu})\left(\frac{\%^{11}B}{100}\right) = 0.7941\text{ amu}$$

Factor out $\left(\frac{\%^{11}B}{100}\right)$

$$\left(\frac{\%^{11}B}{100}\right)(11.00931\text{ amu} - 10.0129\text{ amu}) = 0.7941\text{ amu}$$

$$\left(\frac{\%^{11}B}{100}\right)(0.99641\text{ amu}) = 0.7941\text{ amu}$$

$$\frac{\%^{11}B}{100} = \frac{0.7941\text{ amu}}{0.99641\text{ amu}}$$

3

4

$$\frac{\%^{11}B}{100} = 0.7969610903$$

$$\%^{11}B = 79.69610903$$

3

$$\%^{11}B = 79.7\%$$

$$\%^{11}B + \%^{10}B = 100$$

Now use the 2nd Eq to Solve for ^{10}B

$$\%^{10}B = 100 - \%^{11}B$$

$$\%^{10}B = 100 - 79.7\%$$

$$\%^{10}B = 20.3\%$$

$$\Rightarrow \boxed{\text{Turkey } {}^{10}B = 20.3\% \quad {}^{11}B = 79.7\%}$$

Now we do it all again to Solve for the US values :)

United States $B = 10.819$ amu

I'm going to short cut it a bit by jumping to the step where the Substitution has already been done.

$$(10.0129\text{ amu})\left(\frac{100\% - \%^{11}B}{100}\right) + (11.00931\text{ amu})\left(\frac{\%^{11}B}{100}\right) = 10.819\text{ amu}$$

$$(10.0129\text{ amu})\left(1 - \frac{\%^{11}B}{100}\right) + (11.00931\text{ amu})\left(\frac{\%^{11}B}{100}\right) = 10.819\text{ amu}$$

$$10.0129\text{ amu} - (10.0129\text{ amu})\left(\frac{\%^{11}B}{100}\right) + (11.00931\text{ amu})\left(\frac{\%^{11}B}{100}\right) = 10.819\text{ amu}$$

$$(11.00931\text{ amu})\left(\frac{\%^{11}B}{100}\right) - (10.0129)\left(\frac{\%^{11}B}{100}\right) = 10.819 - 10.0129\text{ amu}$$

$$\left(\frac{\%^{11}B}{100}\right)\left(11.00931 - 10.0129\text{ amu}\right) = 0.8061\text{ amu}$$

$$\left(\frac{\%^{11}B}{100}\right)\left(0.99641\text{ amu}\right) = 0.8061\text{ amu}$$

$$\frac{\%^{11}B}{100} = \frac{0.8061\text{ amu}}{0.99641\text{ amu}}$$

$$\frac{\%^{11}B}{100} = 0.8090043255$$

$$\%^{11}B = 80.90043255 = 80.9\%$$

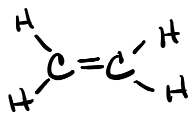
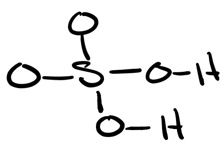
$$\%^{10}B = 100 - 80.9\% = 19.1\%$$

$$\boxed{\text{United States} \quad \%^{10}B = 19.1\% \quad \%^{11}B = 80.9\%}$$

Now that was a good problem.

2 equations & 2 variables to Solve the problem backwards!

29) write the molecular and empirical formulas for the following compounds.

		Molecular	Empirical
a)	O=C=O	CO_2	CO_2
b)	H−C≡C−H	C_2H_2	CH
c)		C_2H_4	CH_2
d)		H_2SO_4	H_2SO_4

31) Determine the empirical formula for the following compounds:

a) Caffeine $C_8H_{10}N_4O_2$ ÷2 $C_4H_5N_2O$

b) Sucrose $C_{12}H_{22}O_{11}$ can't reduce $C_{12}H_{22}O_{11}$

c) Hydrogen peroxide H_2O_2 ÷2 HO

d) glucose $C_6H_{12}O_6$ ÷6 CH_2O

e) ascorbic acid (vitamin C) $C_6H_8O_6$ ÷2 $C_3H_4O_3$

38) Compare 1 mole O_2, 1 mole H_2, 1 mole F_2

a) Which has the most molecules? Explain why.

H_2) $1 \text{ mole } H_2 \times \frac{6.022 \times 10^{23} \text{ molecules } H_2}{1 \text{ mole } H_2} = 6.022 \times 10^{23}$ molecules

O_2) $1 \text{ mole } O_2 \times \frac{6.022 \times 10^{23} \text{ molecules } O_2}{1 \text{ mole } O_2} = 6.022 \times 10^{23}$ molecules

F_2) $1 \text{ mole } F_2 \times \frac{6.022 \times 10^{23} \text{ molecules } F_2}{1 \text{ mole } F_2} = 6.022 \times 10^{23}$ molecules

All equal because all 1 mole!
⇒ These are counted values and its the same as asking if you have 100 apples & 100 oranges which do you have more of?

b) Which has the greatest mass? Explain

H_2) $1 \text{ mole } H_2 \times \frac{2.016 g\ H_2}{1 \text{ mole } H_2} = 2.016 g\ H_2$

O_2) $1 \text{ mole } O_2 \times \frac{32.00 g}{1 \text{ mole } O_2} = 32.00 g\ O_2$

F_2) $1 \text{ mole } F_2 \times \frac{38.00 g}{1 \text{ mole } F_2} = 38.00 g\ F_2$

Fluorine weighs the most as F_2 has the highest atomic mass.

39) Which contains the greatest mass of oxygen: 0.75 mol C_2H_5OH, 0.60 mol HCO_2H or 1.0 mol H_2O

Road Map

mol A $\longrightarrow$ mol Oxygen $\longrightarrow$ g Oxygen

* You could stop here as more moles = more grams

$$0.75 \text{ mol } C_2H_5OH \times \frac{1 \text{ mole } O}{1 \text{ mole } C_2H_5OH} \times \frac{16.00 g}{1 \text{ mole } O} = 12 g\ O$$

$$\Rightarrow 0.60 \text{ mol } HCO_2H \times \frac{2 \text{ mole } O}{1 \text{ mol } HCO_2H} \times \frac{16.00 g}{1 \text{ mol } O} = \underline{19 g\ O}$$

$$1.0 \text{ mol } H_2O \times \frac{1 \text{ mol } O}{1 \text{ mol } H_2O} \times \frac{16.00 g}{1 \text{ mol } O} = 16 g$$

The formic acid (HCO_2H) has the highest mass of oxygen

42) Calculate the molar mass of each of the following compounds

a) HF $\quad 1.008 + 19.00 = 20.02$ g/mole

b) NH_3 $\quad 14.01 + 3(1.008) = 17.03$ g/mole

c) HNO_3 $\quad 1.008 + 14.01 + 3(16.00) = 63.02$ g/mole

d) Ag_2SO_4 $\quad 2(107.9) + 32.07 + 4(16.00) = 311.9$ g/mole

e) $B(OH)_3$ $\quad 10.81 + 3(16.00) + 3(1.008) = 61.83$ g/mole

43) Calculate the molar mass of each:

a) S_8 $\quad 8(32.07) = 256.6\ g/mole$

b) C_5H_{12} $\quad 5(12.01) + 12(1.008) = 72.15\ g/mole$

c) $Sc_2(SO_4)_3$ $\quad 2(44.96) + 3(32.07) + 12(16.00) = 378.13\ g/mole$

d) CH_3COCH_3 $\quad 3(12.01) + 6(1.008) + 16.00 = 58.08\ g/mole$

e) $C_6H_{12}O_6$ $\quad 6(12.01) + 12(1.008) + 6(16.00) = 180.16\ g/mole$

46) Determine the number of moles and the number of moles of each type of atom in each of the following:

Long problem!

Road Map

$$g\ A \rightarrow mole\ A \left\{\begin{array}{l} \rightarrow mole\ B_1 \\ \rightarrow mole\ B_2 \\ \rightarrow mole\ B_3 \end{array}\right\} \text{mole each element}$$

* we will also need the molar mass of each compound.

a) $25.0g\ C_3H_6$ $\quad$ molar mass $= 3(12.01) + 6(1.008) = 42.08 g/mole$

$$25.0g\ C_3H_6 \times \frac{1\ mole\ C_3H_6}{42.08\ g\ C_3H_6} = \boxed{0.594\ mole\ C_3H_8}$$

$$25.0g\ C_3H_6 \times \frac{1\ mole\ C_3H_6}{42.08\ g\ C_3H_6} \times \frac{3\ mole\ C}{1\ mole\ C_3H_6} = \boxed{1.78\ mole\ C}$$

$$25.0g\ C_3H_6 \times \frac{1\ mole\ C_3H_6}{42.08\ g\ C_3H_6} \times \frac{6\ mole\ H}{1\ mole\ C_3H_6} = \boxed{3.56\ mole\ H}$$

b) $3.06 \times 10^{-3}\,g\ C_2H_5NO_2$ $\quad 2(12.01) + 5(1.008) + 14.01 + 2(16.00)$

$= 75.07\ g/mole$

$$3.06 \times 10^{-3}\,g\ C_2H_5NO_2 \times \frac{1\ mole\ C_2H_5NO_2}{75.07\,g\ C_2H_5NO_2} = \boxed{4.08 \times 10^{-5}\ mole\ C_2H_5NO_2}$$

$$3.06 \times 10^{-3}\,g\ C_2H_5NO_2 \times \frac{1\ mole\ C_2H_5NO_2}{75.07\,g\ C_2H_5NO_2} \times \frac{2\ mole\ C}{1\ mole\ C_2H_5NO_2} = \boxed{8.16 \times 10^{-5}\ mole\ C}$$

$$3.06 \times 10^{-3}\,g\ C_2H_5NO_2 \times \frac{1\ mole\ C_2H_5NO_2}{75.07\,g\ C_2H_5NO_2} \times \frac{5\ mole\ H}{1\ mole\ C_2H_5NO_2} = \boxed{2.04 \times 10^{-4}\ mole\ H}$$

$$3.06 \times 10^{-3}\,g\ C_2H_5NO_2 \times \frac{1\ mole\ C_2H_5NO_2}{75.07\,g\ C_2H_5NO_2} \times \frac{1\ mole\ N}{1\ mole\ C_2H_5NO_2} = \boxed{4.08 \times 10^{-5}\ mole\ N}$$

$$3.06 \times 10^{-3}\,g\ C_2H_5NO_2 \times \frac{1\ mole\ C_2H_5NO_2}{75.07\,g\ C_2H_5NO_2} \times \frac{2\ mole\ O}{1\ mole\ C_2H_5NO_2} = \boxed{8.16 \times 10^{-5}\ mole\ O}$$

c) $25\ lbs\ C_{13}H_{16}N_2O_4F$

$13(12.01) + 16(1.008) + 2(14.01) + 4(16.00) + 19.00 = 283.28\ g/mole$

$$25\ lbs\ C_{13}H_{16}N_2O_4F \times \frac{453.6\,g\ C_{13}H_{16}N_2O_4F}{1\ lb\ C_{13}H_{16}N_2O_4F} \times \frac{1\ mole\ C_{13}H_{16}N_2O_4F}{283.28\,g\ C_{13}H_{16}N_2O_4F}$$

$$= \boxed{40.\ mole\ C_{13}H_{16}N_2O_4F}$$

$$25\ lbs\ C_{13}H_{16}N_2O_4F \times \frac{453.6\,g\ C_{13}H_{16}N_2O_4F}{1\ lb\ C_{13}H_{16}N_2O_4F} \times \frac{1\ mole\ C_{13}H_{16}N_2O_4F}{283.28\,g\ C_{13}H_{16}N_2O_4F} \times \frac{13\ mole\ C}{1\ mole\ C_{13}H_{16}N_2O_4F}$$

$$= \boxed{520\ mole\ C}$$

$$25\ lbs\ C_{13}H_{16}N_2O_4F \times \frac{453.6\,g\ C_{13}H_{16}N_2O_4F}{1\ lb\ C_{13}H_{16}N_2O_4F} \times \frac{1\ mole\ C_{13}H_{16}N_2O_4F}{283.28\,g\ C_{13}H_{16}N_2O_4F} \times \frac{16\ mole\ H}{1\ mole\ C_{13}H_{16}N_2O_4F}$$

$$= \boxed{640\ mole\ H}$$

$$25\,lbs\ C_{13}H_{16}N_2O_4F \times \frac{453.6\,g\ C_{13}H_{16}N_2O_4F}{1\,lb\ C_{13}H_{16}N_2O_4F} \times \frac{1\,mole\ C_{13}H_{16}N_2O_4F}{283.28\,g\ C_{13}H_{16}N_2O_4F} \times \frac{2\ mole\ N}{1\,mole\ C_{13}H_{16}N_2O_4F}$$

$$= \boxed{80.\ mole\ N}$$

$$25\,lbs\ C_{13}H_{16}N_2O_4F \times \frac{453.6\,g\ C_{13}H_{16}N_2O_4F}{1\,lb\ C_{13}H_{16}N_2O_4F} \times \frac{1\,mole\ C_{13}H_{16}N_2O_4F}{283.28\,g\ C_{13}H_{16}N_2O_4F} \times \frac{4\ mole\ O}{1\,mole\ C_{13}H_{16}N_2O_4F}$$

$$= \boxed{160\ mole\ O}$$

$$25\,lbs\ C_{13}H_{16}N_2O_4F \times \frac{453.6\,g\ C_{13}H_{16}N_2O_4F}{1\,lb\ C_{13}H_{16}N_2O_4F} \times \frac{1\,mole\ C_{13}H_{16}N_2O_4F}{283.28\,g\ C_{13}H_{16}N_2O_4F} \times \frac{1\ mole\ F}{1\,mole\ C_{13}H_{16}N_2O_4F}$$

$$= \boxed{40.\ mole\ F}$$

d) 0.125 kg $Cu_4(AsO_3)_2(CH_3CO_2)_2$

$= Cu_4As_2C_4H_6O_{10}$ easier to count

$$4(63.55) + 2(74.92) + 4(12.01) + 6(1.008) + 10(16.00) = 618.13\ g/mole$$

$$0.125\,kg\ Cu_4(AsO_3)_2(C_2H_3O_2)_2 \times \frac{1000\,g\ Cu_4(AsO_3)_2(C_2H_3O_2)_2}{1\,kg\ Cu_4(AsO_3)_2(C_2H_3O_2)_2} \times \frac{1\ mole\ Cu_4(AsO_3)_2(C_2H_3O_2)_2}{618.13\,g\ Cu_4(AsO_3)_2(C_2H_3O_2)_2}$$

$$= \boxed{0.202\ mole\ Cu_4(AsO_3)_2(C_2H_3O_2)_2}$$

$$0.125\ kg\ Cu_4(AsO_3)_2(C_2H_3O_2)_2 \times \frac{1000\ g\ Cu_4(AsO_3)_2(C_2H_3O_2)_2}{1\ kg\ Cu_4(AsO_3)_2(C_2H_3O_2)_2} \times \frac{1\ mole\ Cu_4(AsO_3)_2(C_2H_3O_2)_2}{618.13\ g\ Cu_4(AsO_3)_2(C_2H_3O_2)_2}$$

$$\times \frac{4\ mole\ Cu}{1\ mole\ Cu_4(AsO_3)_2(C_2H_3O_2)_2} = \boxed{0.809\ mole\ Cu}$$

$$0.125\ kg\ Cu_4(AsO_3)_2(C_2H_3O_2)_2 \times \frac{1000\ g\ Cu_4(AsO_3)_2(C_2H_3O_2)_2}{1\ kg\ Cu_4(AsO_3)_2(C_2H_3O_2)_2} \times \frac{1\ mole\ Cu_4(AsO_3)_2(C_2H_3O_2)_2}{618.13\ g\ Cu_4(AsO_3)_2(C_2H_3O_2)_2}$$

$$\times \frac{2\ mole\ As}{1\ mole\ Cu_4(AsO_3)_2(C_2H_3O_2)_2} = \boxed{0.404\ mole\ As}$$

$$0.125\ kg\ Cu_4(AsO_3)_2(C_2H_3O_2)_2 \times \frac{1000\ g\ Cu_4(AsO_3)_2(C_2H_3O_2)_2}{1\ kg\ Cu_4(AsO_3)_2(C_2H_3O_2)_2} \times \frac{1\ mole\ Cu_4(AsO_3)_2(C_2H_3O_2)_2}{618.13\ g\ Cu_4(AsO_3)_2(C_2H_3O_2)_2}$$

$$\times \frac{4\ mole\ C}{1\ mole\ Cu_4(AsO_3)_2(C_2H_3O_2)_2} = \boxed{0.809\ mole\ C}$$

$$0.125\ kg\ Cu_4(AsO_3)_2(C_2H_3O_2)_2 \times \frac{1000\ g\ Cu_4(AsO_3)_2(C_2H_3O_2)_2}{1\ kg\ Cu_4(AsO_3)_2(C_2H_3O_2)_2} \times \frac{1\ mole\ Cu_4(AsO_3)_2(C_2H_3O_2)_2}{618.13\ g\ Cu_4(AsO_3)_2(C_2H_3O_2)_2}$$

$$\times \frac{6\ mole\ H}{1\ mole\ Cu_4(AsO_3)_2(C_2H_3O_2)_2} = \boxed{1.21\ mole\ H}$$

$$0.125\ kg\ Cu_4(AsO_3)_2(C_2H_3O_2)_2 \times \frac{1000\ g\ Cu_4(AsO_3)_2(C_2H_3O_2)_2}{1\ kg\ Cu_4(AsO_3)_2(C_2H_3O_2)_2} \times \frac{1\ mole\ Cu_4(AsO_3)_2(C_2H_3O_2)_2}{618.13\ g\ Cu_4(AsO_3)_2(C_2H_3O_2)_2}$$

$$\times \frac{10\ mole\ O}{1\ mole\ Cu_4(AsO_3)_2(C_2H_3O_2)_2} = \boxed{2.02\ mole\ O}$$

e) 325 mg $C_6H_5(CO_2H)(CO_2CH_3) \Rightarrow C_9H_9O_4$ So much easier

$9(12.01) + 9(1.008) + 4(16.00) = 181.16$ g/mole

$$325\,mg\ C_9H_9O_4 \times \frac{1\,g\ C_9H_9O_4}{1000\,mg\ C_9H_9O_4} \times \frac{1\ mole\ C_9H_9O_4}{181.16\,g\ C_9H_9O_4} = 0.00179\ mole\ C_9H_9O_4$$

$$325\,mg\ C_9H_9O_4 \times \frac{1\,g\ C_9H_9O_4}{1000\,mg\ C_9H_9O_4} \times \frac{1\ mole\ C_9H_9O_4}{181.16\,g\ C_9H_9O_4} \times \frac{9\ mole\ C}{1\ mole\ C_9H_9O_4} =$$

$$\boxed{0.0161\ mole\ C}$$

$$325\,mg\ C_9H_9O_4 \times \frac{1\,g\ C_9H_9O_4}{1000\,mg\ C_9H_9O_4} \times \frac{1\ mole\ C_9H_9O_4}{181.16\,g\ C_9H_9O_4} \times \frac{9\ mole\ H}{1\ mole\ C_9H_9O_4} =$$

$$\boxed{0.0161\ mole\ H}$$

$$325\,mg\ C_9H_9O_4 \times \frac{1\,g\ C_9H_9O_4}{1000\,mg\ C_9H_9O_4} \times \frac{1\ mole\ C_9H_9O_4}{181.16\,g\ C_9H_9O_4} \times \frac{4\ mole\ O}{1\ mole\ C_9H_9O_4} =$$

$$\boxed{0.00718\ mole\ O}$$

57) Determine the mass in grams of each of the following

a) 0.600 mole of oxygen atoms

$$0.600 \text{ mole O} \times \frac{16.00 \text{ g O}}{1 \text{ mol O}} = \boxed{9.60 \text{ g O}}$$

b) 0.600 mole of oxygen molecules O_2

2 x oxygen

$$0.600 \text{ mole } O_2 \times \frac{32.00 \text{ g } O_2}{1 \text{ mole } O_2} = \boxed{19.2 \text{ g } O_2}$$

c) 0.600 mole of ozone molecule, O_3

$$0.600 \text{ mole } O_3 \times \frac{48.00 \text{ g } O_3}{1 \text{ mole } O_3} = \boxed{28.8 \text{ g } O_3}$$

57) The Cullinan diamond was the largest natural diamond ever found (Jan 25, 1905). It weighed 3104 carats (1 carat = 200 mg). How many C atoms were present in the stone?

Diamonds are 100% Carbon

Road map

Carats → mg → g → mole → atom

$$3104 \text{ carats C} \times \frac{200 \text{ mg C}}{1 \text{ Carat C}} \times \frac{1 \text{ g C}}{1000 \text{ mg C}} \times \frac{1 \text{ mole C}}{12.01 \text{ g C}} \times \frac{6.022 \times 10^{23} \text{ C atoms}}{1 \text{ mole C}} =$$

$$= \boxed{3.113 \times 10^{25} \text{ C atoms}}$$