Chapter 1: Stoichiometry

1. The atomic mass of C is 12.011 u. How many moles of C are there in a 3.50 g sample of carbon?

* a. 0.291 moles
b. 0.374 moles
c. 1.00 moles
d. 3.43 moles
e. 3.50 moles

$$n = \frac{m}{MM} = \frac{3.50}{12} = 0.291$$

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2. The formula mass of $Ni(H_2O)_6Cl_2$ is

a. 157.69 u
b. 193.00 u
c. 227.61 u
* d. 237.69 u
e. 296.83 u

1Ni=58.7, 12H=12, 6O=6x16=96, 2Cl=2x35.5=71 MM = 58.7 + 12 + 96 + 71 =237.69 u

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3. If the atomic mass of gold is 196.9665 **u**, how many grams of gold are in 0.150 mol Au?

a. 7.62×10^{-4} g
* b. 29.5 g
c. 29.54498 g
d. 7.61551×10^{-4} g
e. 0.903 g

m = n x MM = 0.150 x 196.9665 = 29.5 g

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4. How many molecules of carbon dioxide (CO_2) are in 154.0 grams of carbon dioxide?

a. 3.499
* b. 2.107×10^{24}
c. 4.214×10^{24}
d. 9.274×10^{25}
e. 4.081×10^{27}

$$n = \frac{m}{MM} = \frac{154}{44}$$

$n \times N_A = 154 \times 6.02 \times 10^{23} / 44 = 2.107 \times 10^{24}$

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5. A sample of $Ca_3(PO_4)_2$ contains 3.51 moles of calcium ions. How many moles of $Ca_3(PO_4)_2$ are in that sample?

a. 3.55 moles
b. 0.491 moles
c. 10.5 moles
* d. 1.17 moles

e. 3.51×10^{21} moles

1 mol $Ca_3(PO_4)_2$ contains 3 mol Ca
? mol 3.51 mol Ca
N=3.51 x 1 / 3 =1.17 mol

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6. What is the percent, by mass, of chromium in K_2CrO_4? Use a periodic table to find the atomic masses.

* a. 26.776 %
b. 31.763 %
c. 40.268 %
d. 42.241 %
e. 51.996 %

%Cr = (n x MM_{Cr} / MM_{K2CrO4}) x 100= [(1 x 52 / (2x39 + 1x52 + 4x16)] x100 =26.773%

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7. A sample of $Ni(CO)_4$, a toxic transition-metal complex, has 5.23×10^{24} atoms of carbon. How many atoms of Ni does it contain?

a. 6.02×10^{23} atoms
b. 1.50×10^{23} atoms
c. 1/4 atom
d. 20.9×10^{23} atoms
* e. 1.31×10^{24} atoms

1 mol $Ni(CO)_4$ contain 4 mol C and 1 mol Ni
4 x 6.02×10^{23} atoms 1 x 6.02×10^{23} atoms
5.23×10^{24} ??
? = 5.23×10^{24} / 4 = 1.31×10^{24} atoms

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8. A sample of sulfolane, $C_4H_8O_2S$, contains 5.00×10^{24} atoms. How many moles of sulfolane are in the sample?

a. 0.120 moles
* b. 0.554 moles
c. 1.81 moles
d. 8.30 moles
e. 3.33×10^{23} moles

1 mol $C_4H_8O_2S$ contains (4+8+2+1)moles of atoms =15 moles= 15 x 6.02×10^{23} atoms
?? mol 5.00×10^{24} atoms

??= 5.00×10^{24} / (15 x 6.02×10^{23}) =0.554 mol

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9. A sample of $C_7H_5N_3O_4$ has a mass of 7.81 g. What is the mass of oxygen in this sample?

a. 31.2 g
* b. 2.56 g

c. 3.20×10^{23} g
d. 64.0 g
e. 1.75 g

1 mol $C_7H_5N_3O_4$ = (7x12 + 5x1 + 3x14 + 4x16) =195 g contains 4 mol O = 4x16 g O
7.81 g ??g

?? = 7.81 x 4 x 16 / 195 = 2.56 g

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10. Which one of the following is definitely not an empirical formula?
    a. $C_{12}H_{16}O_3$
    b. $C_{12}H_{22}O_{11}$
    c. $C_3H_8O_2$
    d. $C_4H_{12}N_2O$
    * e. $C_6H_{12}O_4$

Because can be divided by whole number (by 2) $C_3H_6O_2$

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11. A compound has an empirical formula of CH_2Cl. An independent analysis gave a value of 99.0 for its molar mass. What is the molecular formula of the compound?
    a. CH_2Cl
    * b. $C_2H_4Cl_2$
    c. $C_2H_2Cl_4$
    d. $C_3H_6Cl_3$
    e. $C_3H_3Cl_6$

R.F = $MM_{compound}$ / MMempirical formula = 99/ (12x1 +2x1 + 1x35.5) = 2
$(CH_2Cl)_2$ = $C_2H_4Cl_2$

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12. Magnetite is a binary compound containing only iron and oxygen. The percent, by weight, of iron is 72.360 %. What is the empirical formula of magnetite?
    a. FeO
    b. FeO_2
    * c. Fe_3O_4
    d. Fe_2O_3
    e. Fe_2O_5

100 -72.36 =27.64% O

Fe	**O**
72.360g	**27.64g**
72.36/55.8	**27.64/16**

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13. Zinc metal reacts with aqueous hydrochloric acid to give an aqueous solution of zinc chloride and hydrogen gas. Select the correct balanced chemical equation for this reaction.
    a. $Zn(s) + HCl(aq) \rightarrow 3ZnCl(aq) + H_2(g)$
    b. $Zn(s) + HCl(g) \rightarrow ZnCl(aq) + H(g)$

* c. $Zn(s) + 2HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$

d. $2Zn(s) + 4HCl(aq) \rightarrow 2ZnCl_2(aq) + H_2(g)$

e. $2Zn(s) + HCl(aq) \rightarrow 2ZnCl_2(aq) + H_2(g)$

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14. Given: $3H_2(g) + N_2(g) \rightarrow 2NH_3(g)$

If the reaction starts with 0.500 mol of H_2, how many atoms of hydrogen in the compound NH_3 would you expect to make?

a. 3.01×10^{23} atoms

* b. 6.02×10^{23} atoms

c. 12.04×10^{23} atoms

d. 1 atom

e. 6 atoms

3 mol H_2 gives 2 mol NH_3
0.5 mol ??
n= 0.5 x 2 / 3 = 0.333 mol NH_3
1 mol NH_3 contains 3 mol H
0.333mol ??
n= 0.333 x 3 = 1 mol
N= n xN_A= 1 x 6.02 x 10^{23} = 6.02×10^{23} atoms of H

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15. In a chemical reaction, 3 C_2H_6O + 1 PCl_3 → 3 C_2H_5Cl + 1 H_3PO_3, when the equation is balanced the sum of the coefficients of the reactants and products should be

a. 4

b. 5

c. 6

d. 7

* e. 8

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16. You are given the balanced chemical equation:

$C_3H_8 + 5\ O_2 \rightarrow 3\ CO_2 + 4\ H_2O$.

If 0.3818 moles of C_3H_8 and 1.718 moles of O_2 are allowed to react, and this is the only reaction which occurs, theoretically how many moles of water should be produced?

a. 1.336 moles

* b. 1.374 moles

c. 1.527 moles

d. 1.718 moles

e. 3.426 moles

C_3H_8 + 5 O_2
1 mol 5 mol
0.3818 mol 1.718 moles
0.3818/1 1.718/5
0.3818 > 0.3436 **smaller no is L.R O_2 is limiting reactant**

$5\ O_2 \rightarrow 4\ H_2O$
5 mol 4 mol
1.718mol ??

?? = 1.718 x 4 / 5 =1.3744 mol

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17. You are given the balanced chemical equation:
$C_4H_4 + 5\ O_2 \rightarrow 4\ CO_2 + 2\ H_2O$.
If 0.3618 moles of C_4H_4 are allowed to react with 1.818 moles of O_2, and this is the only reaction which occurs, what is the maximum mass of water that could be produced?
a. 11.02 g
* b. 13.04 g
c. 13.20 g
d. 19.64 g
e. 65.50 g

C_4H_4 + 5 O_2
1 mol 5 mol
0.3618 mol 1.818 moles
0.3618/1 1.818/5
0.3618 < 0.3636 smaller no is L.R C_4H_4 is limiting reactant

$C_4H_4 \rightarrow 2\ H_2O$
1 mol 2 x 18 g
0.3618 mol ??g

?? = 0.3618 x 2 x 18 / 1 = 13.05 g H_2O

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18. The left side of a balanced chemical equation is: $K_2Cr_2O_7 + 4\ H_2SO_4 + 3\ SeO_2 \rightarrow$
If 0.600 moles of $K_2Cr_2O_7$, 2.800 moles of H_2SO_4 and 1.500 moles of SeO_2 are brought together and allowed to react, then
a. H_2SO_4 is the limiting reagent
b. $K_2Cr_2O_7$ is the limiting reagent
c. there are 1.300 moles of H_2SO_4 in excess
* d. there are 0.800 moles of H_2SO_4 in excess
e. there are 0.300 moles of SeO_2 in excess

1- find limiting reactant
$K_2Cr_2O_7 + 4\ H_2SO_4 + 3\ SeO_2 \rightarrow$
1 mol 4 mol 3 mol
0.600/1 2.800/4 1.5/3
0.6 0.7 0.5 smaller no is L.R SeO_2 is limiting reactant

2- Calculate the reacted

$K_2Cr_2O_7$ + 4 H_2SO_4 + 3 SeO_2 →
1 mol 4 mol 3 mol
? ?? 1.5 mol
? = 1.5/3 =0.5 mol $K_2Cr_2O_7$ reacted
?? = 1.5 x 4 /3 = 2 mol H_2SO_4 reacted

3- Calculate the unreacted (excess)

0.6 – 0.5 = 0.1 mol $K_2Cr_2O_7$ excess
2.8-2 = 0.8 mol H_2SO_4 excess

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19. In a chemical equation, AsF_3 + C_2Cl_6 → $AsCl_3$ + $C_2Cl_2F_4$, the theoretical yield of $C_2Cl_2F_4$ was calculated to be 1.86 moles. If the percent yield in the reaction was 77.2%, how many grams of $C_2Cl_2F_4$ were actually obtained?

a. 222 grams
b. 231 grams
* c. 245 grams
d. 318 grams
e. 412 grams

Percent yield% = (Actuall yield / theoretical yield) x100
Actuall yield = theoretical yield x Percent yield / 100
= 1.86 x 77.2 /100=1.44 mol
M= n x Mm = 1.44 x (2x12 + 2x35.5 + 4x19) = 245 g

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20. The density of an object is the ratio of its mass to its volume. What is the derived SI unit for density?

a. kg m/s^3
b. kg m/s
* c. kg/m^3
d. m/s^2
e. pounds per cubic inches

d=mass/volume =kg/m^3

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21. What is the number needed to complete the following: 1 dm = __ m?

a. 10
b. 20
c. 1
* d. 0.1
e. 0.01

1dm = $1x10^{-1}$ m = 0.1 m

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22. The SI base units of temperature and mass, respectively, are
    a. degree and gram.
    * b. kelvin and kilogram.
    c. Celsius and milligram.
    d. degree and kilogram.
    e. kelvin and gram.

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23. The SI prefixes giga and micro, indicate respectively:

    * a. 10^{9} and 10^{-6}
    b. 10^{-9} and 10^{-6}
    c. 10^{6} and 10^{-3}
    d. 10^{3} and 10^{-3}
    e. 10^{-9} and 10^{-3}

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24. A solution of sodium nitrite is prepared by mixing 3.25 g of $NaNO_2$ with 12.0 g of water. The percent, by mass, of $NaNO_2$ is:

    a. 28.0 %
    b. 23.3 %
    c. 27.0 %
    * d. 21.3 %
    e. 37.1 %

% w/w = mass of solute x 100 / mass of solution = 3.25 x100 / (3.25 + 12) = 21.3 %

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25. A solution of potassium nitrate is prepared by mixing 3.50 g of KNO_3 with 12.0 g of water. The percent, by mass, of KNO_3 is:
    * a. 22.6 %
    b. 23.3 %
    c. 28.0 %
    d. 29.2 %
    e. 41.8 %

% w/w = mass of solute x 100 / mass of solution = 3. 5 x100 / (3. 5 + 12) = 22.6 %

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26. A glucose solution is prepared by dissolving 5.10 g of glucose, $C_6H_{12}O_6$, in 110.5 g of water. What is the molality of the glucose solution?
    a. 0.283 *m*
    b. 0.000256 *m*
    c. 0.245 *m*
    * d. 0.256 *m*
    e. 0.351 *m*

***m*= n(solute) / Mass of solvent (kg) = m(solute) / MM(solute) x Mass of solvent (kg)**
m*= 5.1 / (6x12 + 12x1 + 6x16) x 110.5 x 10^{-3} = 0.256 *m

27. An aqueous solution of glycerol, $C_3H_8O_3$, is 48.0% glycerol by mass and has a density of 1.120 g mL^{-1}. Calculate the molality of the glycerol solution.

a. 11.2 *m*
b. 5.84 *m*
c. 0.584 *m*
d. 0.521 *m*
* e. 10.0 *m*

***m*= n(solute) / Mass of solvent (kg) = m(solute) / MM(solute) x Mass of solvent (kg)**

48.0% means 48 g solute in 100 g solution m(solvent) = 100 – 48 = 52 g
m*= 48 / (3x12 + 8x1 + 3x16) x 52 x 10^{-3} = 10.0 *m

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28. Consider a 0.900 M $Al(NO_3)_3$ solution. This solution has a nitrate ion concentration of:

a. 0.300 M
b. 0.900 M
* c. 2.70 M
d. 3.60 M
e. 8.10 M

1 mol $Al(NO_3)_3$ contains 3 mol NO_3 ions
0.900 mol ?? mol
3 x 0.900 = 2.7 mol

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29. Which is a concentration unit whose value changes if the temperature of an aqueous solution is changed?

a. mole fraction
* b. molarity
c. molality
d. mass fraction
e. percent by weight
