1. The two most abundant isotopes of chlorine are $^{35}Cl$ (34.99 amu) and $^{37}Cl$ (36.99 amu). What are their percent abundances? (Hint: Use value from periodic table)

a) $^{35}Cl$ is 37%; $^{37}Cl$ is 63%
b) $^{35}Cl$ is 23%; $^{37}Cl$ is 77%
c) $^{35}Cl$ is 77%; $^{37}Cl$ is 23%
d) $^{35}Cl$ is 63%; $^{37}Cl$ is 37%
e) $^{35}Cl$ is 50%; $^{37}Cl$ is 50%

$35.45 = 34.99x + 36.99y$

$x + y = 1$

$-x \quad -x$

$y = 1 - x$

$35.45 = 34.99x + 36.99(1-x)$

$\%\ Cl^{35} \rightarrow x$

$\%\ Cl^{37} \rightarrow y$

$35.45 = 34.99x + 36.99 - 36.99x$

$-36.99 \quad -36.99$

$\frac{-1.54}{-2} = \frac{-2x}{-2}$

$x = 0.77$

$0.77 \times 100 = 77\%$

$x + y = 1$

$0.77 + y = 1 \rightarrow y = 0.23$

$0.23 \times 100 = 23\%$

2. Given the name of the compound, write its molecular formula.

a) Vanadium (v) nitride: $V^{+5} N^{-3} \rightarrow V_3N_5$
b) Iron (i) nitrate: $Fe^{+1} NO_3^- = FeNO_3$
c) Tin (iv) fluoride: $Sn^{+4} F^- = SnF_4$
d) Copper (ii) phosphate: $Cu^{2+} (PO_4)^{3-} = Cu_3(PO_4)_2$
e) Ammonium dichromate: $NH_4^+ \quad Cr_2O_7^{2-} \rightarrow (NH_4)_2Cr_2O_7$

$ClO^-$ hypo-x-ite
$ClO_2^-$ -ite
$ClO_3^-$ -ate
$ClO_4^-$ per-x-ate

$SO_4^{2-}$

3. What are the moles of each ion and the number of each atom in 78.5 g of aluminum sulfate?

I. 0.241 mol $Al^{3+}$
II. 0.459 mol $Al^{3+}$
III. 0.987 mol $SO_4^{2-}$
IV. 0.688 mol $SO_4^{2-}$
V. $2.76*10^{23}$ atoms Al
VI. $5.47*10^{24}$ atoms Al
VII. $4.14*10^{23}$ atoms S
VIII. $6.3510^{25}$ atoms S
IX. $1.66*10^{24}$ atoms O
X. $9.32*10^{23}$ atoms O

$Al^{3+} \quad SO_4^{2-} = Al_2(SO_4)_3$

a) II, IV, V, VII, IX
b) I, III, VI, VIII, X
c) I, II, IV, VI, VIII, X
d) II, III, V, VII, IX
e) None of the above

mass $\leftrightarrows$ moles $\leftrightarrows$ atoms
molar mass
avogadro. $6.02 \times 10^{23}$

molar mass: $(2 \times Al) + (3 \times S) + (12 \times O)$

$mm = (2 \times 26.98) + (3 \times 32) + (12 \times 16)$

$mm = 342.15\ g/mol$

$78.5g\ Al_2(SO_4)_3 \times \frac{1\ mol\ Al_2(SO_4)_3}{342.15g\ Al_2(SO_4)_3} \times \frac{2\ mol\ Al^{3+}}{1\ mol\ Al_2(SO_4)_3} = 0.459\ mol\ Al^{3+}$

$78.5g\ Al_2(SO_4)_3 \frac{1\ mol\ molecule}{342.15g\ molecule} \frac{3\ mol\ SO_4^{2-}}{1\ mol\ Al_2(SO_4)_3} = 0.688\ mol\ SO_4^{2-}$

$0.459\ mol\ Al^{3+} \frac{6.02 \times 10^{23}\ atoms}{1\ mol\ Al^{3+}} = 2.76 \times 10^{23}\ atoms\ Al$

$0.688\ mol\ SO_4^{2-} \frac{1\ mol\ S}{1\ mol\ SO_4^{2-}} \frac{6.02 \times 10^{23}\ atoms\ S}{1\ mol\ S} = 4.14 \times 10^{23}\ atoms\ S$

$0.688\ mol\ SO_4^{2-} \frac{4\ mol\ O}{1\ mol\ SO_4^{2-}} \frac{6.02 \times 10^{23}\ atoms\ O}{4\ mol\ O} = 1.66 \times 10^{24}\ atoms\ O$

4. You have a concentrated stock solution of HCl. The concentration is 8.2 M and there is 1.5 L of stock solution. 752 mL of stock solution are taken and diluted to 1.2 L in a volumetric flask. 65 mL of this new solution are taken and diluted to 125 mL in another volumetric flask. What is the final concentration?

a) 2.7 M
b) 6.2 M
c) 8.2 M
d) 3.4 M
e) 4.5 M

$M_1V_1 = M_2V_2 \;..\; M_3V_3 = M_4V_4$

M = Molarity (M)
V = volume (L)


$8.2M = M_1$
$752mL = 0.752L = V_1$
$1.2L = V_2$
$M_2$

$\frac{8.2M \times 0.752L}{1.2} = \frac{1.2L \times M}{1.2}$

$M_2 = 5.13M$

$\frac{5.13M \times 0.065L}{0.125} = \frac{.125L \times M}{.125}$

$M_4 = 2.7M$

$M_3 = 5.13M$
$V_3 = 65mL = 0.065L$
$V_4 = 125mL = 0.125L$
$M_4 = ?$

5. In an experiment, 25.0 mL of a gas with a pressure of 1.00 atm is contained in a balloon at 25.00°C. The balloon's temperature is adjusted until the pressure is 0.75 atm at a volume of 31.1 mL. What is the final temperature of the gas under the new conditions?

$V_1$ $P_1$ $T_1$ $P_2$ $V_2$ $T_2 = ?$

a) 278°C
b) 5°C
c) 23°C
d) 273°C

$\frac{1 \times 0.025}{298.15} = \frac{0.75 \times 0.031}{T_2}$

$T_2 = 278K$
$278 - 273.15 \approx 5°C$

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

$P_1 = 1atm$
$V_1 = 0.025L$
$T_1 = 25 + 273.15 = 298.15K$
$P_2 = 0.75atm$
$V_2 = 0.031L$
$T_2 = ?K$

6. Write the balanced molecular and net ionic equations for the combination of silver nitrate and sodium chromate.

$Na^+ \; CrO_4^{2-}$
$Na_2CrO_4$

$Ag^+ \; NO_3^- \rightarrow AgNO_3$

$Na_2CrO_4(aq) + 2AgNO_3(aq) \rightarrow 2NaNO_{3(aq)} + Ag_2CrO_4(s)$

complete: $2Na^+_{(aq)} + CrO_4^{2-}{}_{(aq)} + 2Ag^+_{(aq)} + 2NO_3^-{}_{(aq)} \rightarrow 2Na^+_{(aq)} + 2NO_3^-{}_{(aq)} + Ag_2CrO_4(s)$

net: $2Ag^+ + CrO_4^{2-} \rightarrow Ag_2CrO_4(s)$

$PO_4^{3-}$

7. Given 2.68 M of strontium phosphate, what are the mols of phosphate ion in 689 mL?

$Sr^{2+}$

a) 9.81 mol
b) 3.69 mol
c) 7.78 mol
d) 2.43 mol
e) 6.75 mol

$M = \frac{mol}{L}$

$689\,mL\,Sr_3(PO_4)_2 \times \frac{1L\,Sr_3(PO_4)_2}{1000mL\,Sr_3(PO_4)_2} \times \frac{2.68\,mol\,Sr_3(PO_4)_2}{1L} \times \frac{2\,mol\,PO_4^{3-}}{1\,mol\,Sr_3(PO_4)_2} =$

$3.69\,mol\,PO_4^{3-}$

8. Gypsum is a common hydrate salt. It has the general formula $CaSO_4 \cdot xH_2O$. If the molar mass of gypsum is 172.17 g/mol, what is $x$?

a) 1
b) 2
c) 3
d) 4
e) 5

$172.17\ g/mol = 1Ca + 1SO_4 + x H_2O$

$H_2O = 2H + O = 18.02\ g/mol$

$Ca = 40.089\ g/mol$

$172.17\ g/mol = 136.15\ g/mol + x \cdot 18.02\ g/mol$

$SO_4 = S + (4 \times O) = 32.07 + 64\ g/mol$

$CaSO_4 = 136.15\ g/mol$

$x \approx 2$

What is the mass of $CO_2$ if 8.2g of nonene ($C_9H_{18}$) and 20g of $O_2$ are combusted? And which is the limiting reactant?

a) Nonene, 23g
b) $O_2$, 16g
c) Nonene, 25g
d) $O_2$, 18g
e) $O_2$, 27g

$2(C_9H_{18} + 13.5\,O_2 \rightarrow 9CO_2 + 9H_2O)$

$2C_9H_{18} + 27O_2 \rightarrow 18CO_2 + 18H_2O$

$C = 9$, $H = 18$, $O = 27$

$C = 9$, $H = 18$, $O = 18 + 9 = 27$

$C = 18$, $H = 36$, $O = 54$

$C = 18$, $H = 36$, $O = 54$

$8.2\ g\ C_9H_{18} \frac{1\ mol\ C_9H_{18}}{126\ g\ C_9H_{18}} \frac{18\ mol\ CO_2}{2\ mol\ C_9H_{18}} \frac{44.01\ g\ CO_2}{1\ mol\ CO_2} = 25.77\ g\ CO_2$

$20\ g\ O_2 \frac{1\ mol\ O_2}{32\ g\ O_2} \frac{18\ mol\ CO_2}{27\ mol\ O_2} \frac{44.01\ g\ CO_2}{1\ mol\ CO_2} = 18.3\ g\ CO_2$

10. Consider 2.00 moles of Argon, an ideal gas, at a density of 5.00 g/L and a pressure of 2.00 atm. What is the closest value to the temperature (in K) of this gas?

a. 172 K
b. 273 K
c. 304 K
d. 195 K

$PV = nRT$

$mm = \frac{mass}{mol}$ $\quad d = \frac{mass}{V}$ $\quad V = \frac{mass}{d}$

$mm \cdot mol = mass$ $\quad V = \frac{mm \times mol}{d}$

$d = \frac{mm \cdot P}{R \cdot T}$

$\frac{d \cdot RT}{d\ R} = \frac{mm \cdot mol \cdot P}{d\ R}$

$T = 39.9\ \frac{g}{mol} \times 2\ atm \times \frac{2\ mol}{5.00\ g} \times 0.08206 \frac{L \times atm}{mol \times K} = 195\ K$

$mm = 135.949\ g/mol$

11. What is the mass of $V(OH)_5$ formed when 624 mL of 0.389 M $VCl_5$ reacts with 893 mL of 0.651 M of $Ca(OH)_2$?

a. 30.6g
b. 98.2g
c. 33.0g
d. 74.6g
e. 31.6g

$2VCl_5 + 5Ca(OH)_2 \rightarrow 2V(OH)_5 + 5CaCl_2$

$624\ mL\ VCl_5 \frac{1\ L}{10^3\ mL} \frac{0.389\ mol\ VCl_5}{1\ L\ VCl_5} \frac{2\ mol\ V(OH)_5}{2\ mol\ VCl_5} \frac{135.949\ g}{1\ mol\ V(OH)_5} = 32.999\ g\ V(OH)_5$

$893\ mL\ Ca(OH)_2 \frac{1\ L}{10^3\ mL} \frac{0.651\ mol\ Ca(OH)_2}{1\ L\ Ca(OH)_2} \frac{2\ mol\ V(OH)_5}{5\ mol\ Ca(OH)_2} \frac{135.949\ g}{1\ mol\ V(OH)_5} = 31.6\ g\ V(OH)_5$

Limiting Reactant

12. Using the question 11's chemical reaction, how many mL are left over of the excess reactant?

a. 30mL
b. 90mL
c. 512mL
d. 26mL
e. 410mL

$31.6\ g\ V(OH)_5 \frac{1\ mol\ V(OH)_5}{135.949\ g} \frac{2\ VCl_5}{2\ mol\ V(OH)_5} \frac{1\ L\ VCl_5}{0.389\ mol\ VCl_5} \frac{1000\ mL}{1\ L} = 597\ mL\ VCl_5\ used$

$624\ mL - 597\ mL \approx 26\ mL$ leftover

13. Balance and identify the type of reaction, oxidizing agent, and reducing agent of each equation:

O = -2
H = +1

$2N_2O_5 \rightarrow 4NO_2 + O_2$ - decomposition

N = 4 N = 4
O = 10 O = 10

$N_2O_5$ = RA + OA

$2N_2O_5 \rightarrow 4NO_2 + O_2$
+5 -2 +4 -2 0
(+10)(-10) (-4)

N: +5 → +4 getting reduced = oxidizing agent
O: -2 → 0 getting oxidized = reducing agent

OIL RIG

$S_8 + 2F_2 \rightarrow 8SF_4$
S = 8 S = 8
F = 4 F = 4
combination rxn: 2 react → 1 prod
RA OA

$2CsI + Cl_2 \rightarrow 2CsCl + I_2$
Cs: 2 Cs: 2
I: 2 I: 2
Cl 2 Cl 2

$2CsI + Cl_2 \rightarrow 2CsCl + I_2$
+1 -1 0 +1 -1 0
Cs: +1 → +1
Cl: 0 → -1 gets reduced = ox agent
I: -1 → 0 gets oxidized = red agent

RA OA
$S_8 + 2F_2 \rightarrow 8SF_4$
ON: 0 0 +4 -1 (-4)
S: 0 → +4 loose e⁻ = oxidized = reducing agent
F: 0 → -1 gain e⁻ = reduced = ox. agent

14. Given the reaction $Fe_3O_4 + 4H_2 \rightarrow 3Fe + 4H_2O$, if 0.250g $H_2$ makes 1.49 g of $H_2O$, what is the percent yield? (actual yield)

a. 52.3%
b. 66.7%
c. 95.2%
d. 12.4%
e. 75.3%

$0.25g\ H_2 \frac{1mol\ H_2}{2g\ H_2} \frac{4mol\ H_2O}{4mol\ H_2} \frac{18.02g}{1mol} = 2.25g\ H_2O$ - theoretical

$\%\ yield = \frac{actual}{theoretical} = \frac{1.49}{2.25} \times 100 = 66.7\%$

15. Given $7.13*10^{19}$ Ca atoms, what is the mass of calcium in grams?

a. $5.23*10^{-3}$
b. $6.35*10^{-3}$
c. $4.74*10^{-3}$
d. $9.24*10^{-3}$
e. $4.93*10^{-3}$

$7.13 \times 10^{19}\ Ca\ atoms \frac{1mol\ Ca}{6.02 \times 10^{23}\ atoms} \frac{40.08g}{1mol\ Ca}$

$= 4.74 \times 10^{-3} g$

16. Given 1 mol, what is the mass percent of each element in $C_6H_{12}O_6$?

I. 60% C
II. 40% C
III. 6.7% H
IV. 8.4% H
V. 31.6 % O
VI. 53.3% O

a. I, IV, VI
b. II, IV, VI
c. I, IV, V
d. II, III, VI
e. II, IV, V

$C: \frac{6 \times 12g}{180.096} \times 100\% = 39.97\%$

$H: \frac{12 \times 1g}{180.096} \times 100\% = 6.7\%$

$O: \frac{6 \times 16}{180.096} \times 100\% = 53.3\%$

1 mol $C_6H_{12}O_6$ start w/ mm = 180.969

17. What volume of 0.6143 M of strontium hydroxide would neutralize 72.59 mL of a 0.8291 M solution of hydrochloric acid?

a. 62.43mL
b. 48.99mL
c. 75.12mL
d. 36.25mL
e. 95.13mL

HCl → $H^+$ $Cl^-$

$Sr^{2+}$ $OH^-$ → $Sr(OH)_2$

$Sr(OH)_2 + 2HCl \rightarrow SrCl_2 + 2H_2O$

| | |
|---|---|
| Sr | 1 |
| O | 2 |
| H | 4 |
| Cl | 2 |

| | |
|---|---|
| Sr | 1 |
| O | 2 |
| H | 4 |
| Cl | 2 |

$72.59mL\ HCl \frac{1L\ HCl}{1000mL\ HCl} \frac{0.8291\ mol\ HCl}{1L\ HCl} \frac{1\ mol\ Sr(OH)_2}{2\ mol\ HCl} \frac{1L}{0.6143\ mol\ Sr(OH)_2} \frac{1000mL\ Sr(OH)_2}{1L\ Sr(OH)_2}$

$= 48.99mL\ Sr(OH)_2$

18. An unknown metal M reacts with sulfur to make $M_2S_3$. If 1.62g of M reacts with 2.88g of sulfur, what is M and the name of $M_2S_3$?

a. V; vanadium (iii) sulfide
b. Fe; iron (iii) sulfide
c. Au; gold (iii) sulfide
d. Al; aluminum sulfide
e. Cr; chromium (iii) sulfide

$2M + 3S \rightarrow M_2S_3$

$2.88gS \frac{1mol\ S}{32.06gS} \cdot \frac{2\ mol\ M}{3\ mol\ S} = 0.0599mol\ M$

$mm = \frac{g}{mol} = \frac{1.62g}{0.0599\ mol} = 27.05 = Al^{3+}$

19. Balance the equation and identify the oxidation numbers, oxidizing agent, and reducing agent for the combustion of $C_7H_{14}$.

RA OA

$2C_7H_{14} + 21O_2 \rightarrow 14CO_2 + 14H_2O$

| | |
|---|---|
| C | 14 |
| H | 28 |
| O | 42 |

| | |
|---|---|
| C | 14 |
| H | 28 |
| O | 42 |

$C_7H_{14} + O_2 \rightarrow CO_2 + H_2O$

ON: $-2\ +1 \quad 0 \quad +4\ -2 \quad +1\ -2$

$-14\ +14 \quad (-4)$

C: $-2 \rightarrow +4 = 0x$ = red. agent

O: $0 \rightarrow -2$ = red = ox agent

20. What is the empirical formula of a compound that is 40% C, 6.71% H, and 53.3% O? What is the molecular formula given that the molar mass is 240.24 g/mol?

a. $CH_2O$; $C_9H_{18}O_9$
b. $C_2HO$; $C_{16}H_8O_8$
c. $CH_2O$; $C_8H_{16}O_8$
d. $CHO_2$; $C_9H_9O_{18}$
e. $CH_2O$; $C_6H_{12}O_6$

$40\,g\,C \frac{1\,mol}{12\,g} = \frac{3.33\,mol\,C}{3.33} \sim 1$

$6.71\,g\,H \frac{1\,mol}{1\,g} = \frac{6.71\,mol\,H}{3.33} \sim 2$

$53.3\,g\,O \frac{1\,mol}{16\,g} = \frac{3.33\,mol\,O}{3.33} \sim 1$

empirical: $CH_2O$

empirical m.m = $12+2+16 = 30\,g/mol$

$\frac{240\,g/mol}{30\,g/mol} \sim 8 \rightarrow CH_2O \times 8 = C_8H_{16}O_8$

21. Consider the following reaction in a closed reaction flask:

$$2\,A_{(g)} + 3\,B_{(g)} \rightarrow A_2B_{3\,(g)}$$

If 1.20 atm of gas A is allowed to react with 1.20 atm of gas B, and the reaction goes to completion at constant temperature and volume, what is the total pressure (in atm) in the reaction flask at the end of the reaction?

a. 0.4 atm
b. 0.8 atm
c. 1.2 atm
d. 2.4 atm

$1.20\,atm\,A \frac{1\,mol\,A_2B_3}{2\,mol\,A} = 0.6\,atm\,A_2B_3$

$1.20\,atm\,B \frac{1\,mol\,A_2B_3}{3\,mol\,B} = 0.4\,A_2B_3$ ← product formed

↑ limiting reactant

$0.4\,atm\,A_2B_3 \frac{2\,mol\,A}{1\,mol\,A_2B_3} = 0.8\,atm\,A_2$ used

$1.20 - 0.8 = 0.4\,mol\,A_2$ left over

| initial P | final P |
|---|---|
| 1.2 atm A | 0.4 atm A |
| 1.2 atm B | 0 atm B |
| 0 atm $A_2B_3$ | 0.4 atm $A_2B_3$ |

$0.4 + 0.4 = 0.8$ atm total