Chemistry 1250 - Sp22
Solutions for Practice Midterm 1

1) Mixtures must contain **two** or **more different** substances. These substances can be **elements** (atomic or molecular) or **compounds**. There are essentially two types of mixtures, homogeneous and heterogeneous. The substances in a mixture can be separated into pure substances by physical means. Solutions exist in all phases (states).

Homogeneous mixtures are **uniform** throughout and have the same physical and chemical properties throughout. These are often referred to as **solutions**. Gases dissolve in each other to form solutions and gases dissolve in liquids to form solutions.

Heterogeneous mixtures have physical and chemical **properties** that are **NOT uniform** throughout the sample. Heterogeneous mixtures may contain elements and compounds and must contain 2 or more substances.

Pure substances are not mixtures. They are **elements** or **compounds**. They can not be separated into simpler substances through **physical** means but can be chemically decomposed into simpler pure substances. A pure substance can contain more than one type of atom. Table salt (NaCl) is a pure compound. **Compounds** are always composed of **two** or **more different elements**, chemically combined, in fixed proportion by mass. If only one substance is present the material is a pure substance and the material must be uniform throughout (homogeneous). Both pure substances and solutions have properties that are uniform throughout.

D

2) Phosphorus (P), Krypton (Kr), and Selenium (Se) are **nonmetals**.
Calcium (Ca) and Indium (In) are representative metals.
Copper (Cu) and Chromium (Cr) are **transition metals**.
Germanium (Ge) and Tellurium (Te) are semimetals (metalloids).

C (3 nonmetals and 2 transition metals)

3) Do the calculations in parentheses first.

(14.9 × 0.049) = 0.**7**<u>3</u>01 (2 s.f.)
3 s.f. 2 s.f.

(3.53 ÷ 0.0840) = **42.**<u>0</u>238 (3 s.f.)
3 s.f. 3 s.f.

101.60<u>**0**</u> (6 s.f.)

$$\begin{array}{r} 0.7\underline{3}01 \\ -\ \mathbf{42.\underline{0}}238 \\ \underline{+\ \mathbf{101.600}} \\ \mathbf{60.\underline{3}}062 \end{array}$$

Multiplication and **division** rule: answer has same # s.f. as the number with the least # s.f.
Addition and **subtraction** rule: last place in answer is the same as the last significant place common to all numbers. Line up the decimals. You can gain or lose s.f. in addition and subtraction.

$$0.7\underline{3}01 \quad - \quad \mathbf{42.\underline{0}}238 \quad + \quad \mathbf{101.60\underline{0}} \quad = \quad 60.\underline{3}062 \quad = \quad \mathbf{60.3}$$

Can only know the final number to the tenths place since that is all **42.**<u>0</u>238 is known to.

<u>**E**</u>

4) Remember, **precision** means the **degree of reproducibility** (how close the measurements are to each other and how close each measurement is to the average). **Accuracy** is how close the **average** is to the **true value** of what is measured. To determine precision and accuracy, you should determine the averages of the five trials.

The crucible weighs 24.3162 grams

Student A's average 24.<u>8</u>2
Students B's average 24.<u>2</u>4
Student C's average 24.3

Student **C** has done the most **accurate** work because the average mass of 24.3 grams is closest to the true mass of (24.3162 grams).
Student **A** has done the most **precise** work because the repeated measurements are within 0.2 g of each other and 0.12 g of the average.

<u>**E**</u>

5)

$$? \text{ L} = 1\underline{6}0 \text{ in}^3 \times \frac{(2.54 \text{ cm})^3}{1 \text{ in}^3} \times \frac{1 \text{ mL}}{1 \text{ cm}^3} \times \frac{10^{-3} \text{ L}}{1 \text{ mL}} = 2.\underline{6}2193 \text{ L} = 2.6 \text{ L (2 s.f.)}$$

<u>**A**</u>

6)

$$? \text{ L} = 1.00 \text{ hr} \times \frac{60 \text{ min}}{1 \text{ hr}} \times \frac{62 \text{ beats}}{1 \text{ min}} \times \frac{55 \text{ mL}}{1 \text{ beat}} \times \frac{1 \text{ L}}{10^3 \text{ mL}} = 204.6 \text{ L}$$

$$= 205 \text{ L} \quad (3 \text{ s.f.})$$

A

7) (bld = blood)

$$? \text{ g Ca} = 1.00 \text{ dL bld} \times \frac{10^{-1} \text{ L bld}}{1 \text{ dL bld}} \times \frac{1 \text{ mL bld}}{10^{-3} \text{ L bld}} \times \frac{96 \ \mu\text{g Ca}}{1 \text{ mL bld}} \times \frac{10^{-6} \text{ g Ca}}{1 \ \mu\text{g Ca}} = 9.6 \times 10^{-3} \text{ g Ca} \quad (2 \text{ s.f.})$$

B

8)

When you place an object into a liquid the volume of the object displaces the same volume of the liquid. This can be used to determine the volume of an object. If you place piece of an insoluble object into water in a graduated cylinder the volume of the water in the cylinder will increase by a volume equal to the volume of the object.

In this problem you're asked which metal will give the greatest total volume when put in the cylinder containing CCl4. The liquid in the cylinder is immaterial as long as the metals don't react with it and are more dense than the liquid, which is the case for all the metals listed. You want to know which one will result in the greatest total volume for 1 g of each metal, meaning **which metal has the largest volume for the same mass**. Look at the eqn for density rearranged to give volume,

$$V = m/D$$

This means the **metal with the smallest density will have the greatest volume** and thus give the largest total volume in the cylinder. This would be Cr. You can see this by calculating the volume for two of the metals, Cr and Ni.

$$? \text{ mL} = 1 \text{ g} \times \frac{1 \text{ cm}^3}{7.90 \text{ g}} \times \frac{1 \text{ mL}}{1 \text{ cm}^3} = 0.127 \text{ mL} \ (3 \text{ s.f.}) \qquad \text{Cr}$$

$$? \text{ mL} = 1 \text{ g} \times \frac{1 \text{ cm}^3}{8.90 \text{ g}} \times \frac{1 \text{ mL}}{1 \text{ cm}^3} = 0.112 \text{ mL} \ (3 \text{ s.f.}) \qquad \text{Ni}$$

A

9)

$$°F = \frac{9°F}{5°C} (x\ °C) + 32\ °F \qquad °C = \frac{5°C}{9°F} (x°F - 32\ °F)$$

$$K = °C + 273.15$$

$$?°C = \frac{5°\ C}{9°F} (85\ °F - 32\ °F) = 2\underline{9}.44°C \qquad ?\ K = 2\underline{9}.44°C + 273.15$$

= **302.59** K

= **302.59** K

B

10) The correct statements are 4 and 5:

4) A proton and neutron have approximately the **same mass** (1.0073 amu & 1.0088 amu, respectively).
5) A **neutron** is **neutral**. (The **proton** has a **positive** charge and the **electron** has a **negative** charge.)

The corrected answers for 1, 2 & 3 would be:

1) The **mass number** of an atom is the **sum** of the number of **neutron**s and **protons** in the nucleus.
2) Atoms are divisible. (They can be "broken down" into **neutrons**, **protons** and **electrons**.)
3) **Isotopes** of an element **differ** in the number of **neutrons** but have the same number of protons and electrons.

C (4 & 5 are correct)

11) The atomic weight (amu) is the **weighted average** of the masses of the isotopes.

The abundance of the 2^{nd} isotope is 100.00% - 69.09% = 30.91%

At. wt. = (0.6909) (62.9298 amu) + (0.3091) (X) = 63.5460 amu

X = 64.9233 amu

E

12)

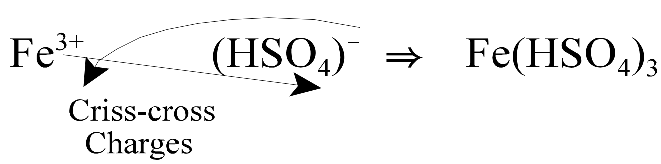
For ionic compounds you need to know the charge on both the cation and anion and the charges have to balance since ionic compounds are neutral (like NaCl). For group 1A and 2A metals the cations formed always have a +1 and +2 charges, respectively. Also, Al, Zn and Ag are always +3, +2 and +1, respectively. Other metals can have multiple charges depending on the compound and their charges are given as Roman Numerals in parentheses in the name. In ionic compounds groups 5A, 6A and 7A have charges of −3, −2 and −1 respectively. You have to memorize some polyatomic ions (names, formulas and charges).

For molecular compounds the less electronegative element is generally written first in the formula and is named first in the name. The second element (more electronegative element) in the formula is named by using the stem of the name and the suffix -ide. Numerical prefixes, indicating the numbers of each atom, precede the names of both elements. Common exceptions are for compounds containing H and an element from groups 3A, 4A and 5A (BH_3, CH_4, NH_3, etc.).

How can you tell if the compound is molecular and not ionic? Generally if the compound is composed of a metal and nonmetal it is ionic. Generally if the compound contains only nonmetals or nonmetal and semimetal it is molecular. The most common exceptions to this is when a compound contains ammonium ions, NH_4^+, such as NH_4Cl, $(NH_4)_2SO_4$, etc. All the elements in the compounds listed (and others with NH_4^+ ions) contain all nonmetals but are ionic because of the presence of the NH_4^+ ions.

The following are the correct formulas for the names given:

a) **iron(III) bisulfate** (Ionic)



Charge on iron is +3 (a Roman Numeral is needed since Fe can be +2 or +3 in compounds). You should know that SO_4^{2-} is sulfate with a −2 charge. Adding 1 H^+ to sulfate gives bisulfate (or hydrogen sulfate), HSO_4^-. Since there is a +3 charge on the Fe and the HSO_4^- has a −1 charge there has to be 3 HSO_4^- ions for every one Fe^{3+}. This gives a total positive charge of +3 and a total negative charge of −3.

b) **chlorous acid** (molecular acid since it as (aq))

$HClO_2$ (aq) from chlorite, ClO_2^-. When enough H^+ is added to an -ite anion to make it a neutral molecule it is named as an -ous acid (when it is in solution).

c) **trinitrogen pentoxide** (molecular)

$\mathbf{N_3O_5}$

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12) (cont.)

d) **zinc(II) dihydrogen phosphate** (Ionic)

$$Zn^{2+} \quad (H_2PO_4)^- \Rightarrow Zn(H_2PO_4)_2$$

Criss-cross
Charges

Charge on zinc is +2 (no Roman Numeral is needed since Zn is always +2 in compounds). You should know that PO_4^{3-} is sulfate with a −3 charge. Adding 1 H^+ to phosphate gives hydrogen phosphate, HPO_4^{2-}. Adding 1 H^+ to this gives dihydrogen phosphate, $H_2PO_4^-$. Since there is a +2 charge on the Zn and the $H_2PO_4^-$ has a −1 charge there has to be 2 $H_2PO_4^-$ ions for every one Zn^{2+}. This gives a total positive charge of +2 and a total negative charge of −2.

e) **zirconium(IV) hypobromite** (Ionic)

$$Zr^{4+} \quad (BrO)^- \Rightarrow Zr(BrO)_4$$

Criss-cross
Charges

Charge on zirconium is +4 (given as Roman Numeral IV in name). You should know that BrO_3^- is bromate with a −1 charge and one fewer oxygen is an -ite, BrO_3^- and one fewer than the -ite is hypo-ite, BrO^-. Criss-cross the charges and you get the correct subscripts in this case. The 1 zirconium provides a total positive charge of +4. The 4 hypobromites gives a total negative charge of −4.

<u>E</u>

13) **yttrium nitrate is $Y(NO_3)_3$**

Since the charge on nitrate, $\mathbf{NO_3^-}$, is −1, the charge on the Y must be +3

Carbonate: CO_3^{2-}
Arsenate: AsO_4^{3-}

yttrium carbonate: Y^{3+} CO_3^{2-} ⇒ $Y_2(CO_3)_3$

yttrium arsenate: Y^{3+} AsO_4^{3-} ⇒ $YAsO_4$

<u>C</u>

14) $(CH_3)_2N_2H_2$ + N_2O_4 → CO_2 + H_2O + N_2

A) Balance C (present in greatest number, other than H and O and in only 1 react. & prod. on each side)

$(CH_3)_2N_2H_2$ + N_2O_4 → 2 CO_2 + H_2O + N_2

B) Balance H (present in only one reactant and one product, leaving N_2 alone for now - elemental form)

$(CH_3)_2N_2H_2$ + N_2O_4 → 2 CO_2 + 4 H_2O + N_2

C) Balance O (8 O on the right; need 8 O on left from N_2O_4)

$(CH_3)_2N_2H_2$ + 2 N_2O_4 → 2 CO_2 + 4 H_2O + 3 N_2

D) Balance N (6 N on the left; need 6 N on right from 3 N_2)

1 $(CH_3)_2N_2H_2$ + **2** N_2O_4 → **2** CO_2 + **4** H_2O + **3** N_2
(↑ **1** here in front of $(CH_3)_2N_2H_2$, usually not shown)

The sum of the coefficients AND products = 1 + 2 + 2 + 4 + 3 = 12

D

15) $BiCl_3$ + NH_3 + H_2O → $Bi(OH)_3$ + NH_4Cl

A) Balance Cl (present in greatest number)

$BiCl_3$ + NH_3 + H_2O → $Bi(OH)_3$ + 3 NH_4Cl

B) Balance N - 3 now on right. Need 3 N on left.

$BiCl_3$ + 3 NH_3 + H_2O → $Bi(OH)_3$ + 3 NH_4Cl

C) Balance O - present in only 1 reactant and 1 product

$BiCl_3$ + 3 NH_3 + 3 H_2O → $Bi(OH)_3$ + 3 NH_4Cl

D) Balance H - this already is balanced
9 H + 6 H = 3 H + 12H

1 $BiCl_3$ + **3** NH_3 + **3** H_2O → **1** $Bi(OH)_3$ + **3** NH_4Cl
(Coefficients of **1** usually not shown)

The sum of the coefficients of the **reactants & products** = 1 + 3 + 3 + 1 + 3 = **11**

A

16) $C_{12}H_{22}O_6 \quad + \quad O_2 \quad \rightarrow \quad CO_2 \quad + \quad H_2O$

A) <u>Balance C</u>

$C_{12}H_{22}O_6 \quad + \quad O_2 \quad \rightarrow \quad 12\ CO_2 \quad + \quad H_2O$

(# C's in $C_{12}H_{22}O_6$)

B) <u>Balance H</u>

$C_{12}H_{22}O_6 \quad + \quad O_2 \quad \rightarrow \quad 12\ CO_2 \quad + \quad 11\ H_2O$

(½ # H's in $C_{12}H_{22}O_6$)

C) <u>Balance O</u> 6 – O + (Need 29 O atoms from O_2) → 24 – O + 11 – O = (35 – O on rt.)
Use 29/2 O_2 (½ of 29 O = O gives 29 O atoms)

$C_{12}H_{22}O_6 \quad + \quad (29/2)\ O_2 \quad \rightarrow \quad 12\ CO_2 \quad + \quad 11\ H_2O$

D) <u>Multiply by 2:</u>

2 $C_{12}H_{22}O_6 \quad + \quad$ **29** $O_2 \quad \rightarrow \quad$ **24** $CO_2 \quad + \quad$ **22** H_2O

D The sum of the coefficients of the **reactants** = 2 + 29 = 31

17) Need formula weight for $(NH_4)_2CO_3$ to determine weight % of N

$$
\begin{aligned}
MW &= 2(AW_N) + 8(AW_H) + 1(AW_C) + 3(AW_O) \\
&= 2(14.01) + 8(1.008) + 1(12.01) + 3(16.00) \\
&= 96.094 \text{ amu}
\end{aligned}
$$

$$\% N = \frac{\text{mass N}}{\text{mass } (NH_4)_2CO_3} \times 100\ \%$$

$$= \frac{2(14.01)}{96.094} \times 100\ \% = 29.1589\ \% = 29.2\ \%\ N$$

B

18

$$1 \text{ mol } NH_2CH_2CO_2H \;=\; 6.02 \times 10^{23} \text{ } NH_2CH_2CO_2H \text{ molec.} = \; 75.07 \text{ g } NH_2CH_2CO_2H$$

Also, $1 \text{ mol } NH_2CH_2CO_2H \;=\; 2 \text{ mol C atoms}$

$$? \text{ mol C atoms } = 0.0195 \text{ g } C_2H_5NO_2 \times \frac{1 \text{ mol } C_2H_5NO_2}{75.07 \text{ g } C_2H_5NO_2} \times \frac{2 \text{ mol C atoms}}{1 \text{ mol } C_2H_5NO_2}$$

$$= 5.1951 \times 10^{-4} \text{ moles C atoms}$$

$$= 5.20 \times 10^{-4} \text{ moles C atoms}$$

<u>B</u>

19)

$$1 \text{ mole } FeCl_3 \;=\; 6.02 \times 10^{23} \text{ } FeCl_3 \text{ f.u.} \;=\; 162.2 \text{ g } FeCl_3$$

Also, 1 mole of $FeCl_3$ f.u. $=$ 3 mol Cl^- ions & 1 $FeCl_3$ f.u. $=$ 3 Cl^- ions

$$? \text{ } Cl^- \text{ ions} = 1.63 \times 10^{-3} \text{ g } FeCl_3 \times \frac{1 \text{ mol } FeCl_3}{162.2 \text{ g } FeCl_3} \times \frac{6.02 \times 10^{23} \text{ } FeCl_3 \text{ f.u.}}{1 \text{ mol } FeCl_3} \times \frac{3 \text{ } Cl^- \text{ ions}}{1 \text{ } FeCl_3 \text{ f.u.}}$$

$$= 1.8149 \times 10^{19} \text{ } Cl^- \text{ ions}$$

$$= 1.81 \times 10^{19} \text{ } Cl^- \text{ ions}$$

or

$$? \text{ } Cl^- \text{ ions} = 1.63 \times 10^{-3} \text{ g } FeCl_3 \times \frac{1 \text{ mol } FeCl_3}{162.2 \text{ g } FeCl_3} \times \frac{3 \text{ mol } Cl^- \text{ ions}}{1 \text{ mol } FeCl_3} \times \frac{6.02 \times 10^{23} \text{ } Cl^- \text{ ions}}{1 \text{ mol } Cl^- \text{ ions}}$$

$$= 1.81 \times 10^{19} \text{ } Cl^- \text{ ions}$$

<u>E</u>

20)

This is an empirical formula problem using combustion analysis. In CA the sample is combusted. All the Carbon winds up in the CO_2 and the Hydrogen winds up in the H_2O . If there is one other atom its mass can be determined by remembering the conservation of mass, in this case oxygen.

In this problem a 0.8946 g sample produces 2.0700 g of CO_2 & 0.4237 g H_2O.

Determine moles and mass of C and H in the sample:

$$? \text{ mol C} = 2.0700 \text{ g } CO_2 \times \frac{1 \text{ mol } CO_2}{44.01 \text{ g } CO_2} \times \frac{1 \text{ mol C}}{1 \text{ mol } CO_2} = 0.0470\underline{\mathbf{3}}4 \text{ mol C (4 s.f.)}$$

$$? \text{ mol H} = 0.4237 \text{ g } H_2O \times \frac{1 \text{ mol } H_2O}{18.016 \text{ g } H_2O} \times \frac{2 \text{ mol H}}{1 \text{ mol } H_2O} = 0.0470\underline{\mathbf{3}}5 \text{ mol H (4 s.f.)}$$

Need moles of oxygen but have to get mass first. Need to calculate mass of C and H and subtract from the total mass of sample.

$$? \text{ g C} = 0.0470\underline{\mathbf{3}}4 \text{ mol C} \times \frac{12.01 \text{ g C}}{1 \text{ mol C}} = 0.564\underline{\mathbf{8}}8 \text{ g C (4 s.f.)}$$

$$? \text{ g H} = 0.0470\underline{\mathbf{3}}5 \text{ mol H} \times \frac{1.008 \text{ g H}}{1 \text{ mol H}} = 0.0474\underline{\mathbf{1}}2 \text{ g H (4 s.f.)}$$

$$? \text{ g O} = 0.8946 \text{ g sample} - (0.564\underline{\mathbf{8}}8 \text{ g C} + 0.0474\underline{\mathbf{1}}2 \text{ g H}) = 0.282\underline{\mathbf{3}}0 \text{ g O}$$

Find moles of O:

$$? \text{ mol O} = 0.282\underline{\mathbf{3}}0 \text{ g O} \times \frac{1 \text{ mol O}}{16.00 \text{ g O}} = 0.0176\underline{\mathbf{4}}37 \text{ mol O (3 s.f.)}$$

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20) (cont.)

Empirical Formula calculations:

Divide each of the moles by the smallest number of moles (in this case N).

$$C: \frac{0.0470\underline{3}4 \text{ mol C}}{0.0176\underline{4}3 \text{ mol O}} = 2.6658$$

$$H: \frac{0.0470\underline{3}5 \text{ mol H}}{0.0176\underline{4}3 \text{ mol O}} = 2.6658$$

$$O: \frac{0.0176\underline{4}3 \text{ mol O}}{0.0176\underline{4}3 \text{ mol O}} = 1.000$$

$C_{2.6658}H_{2.6658}O$ Can't have a fractional subscript. Multiply by 3 in this case:

$C_8H_8O_3$

D

21)

All soluble ionic substances (salts) are strong electrolytes. All the substances are soluble and come apart to form ions in solution. Use the subscripts in the formulas for each element (stoichiometry) to determine the conc. of each ion in solution.

a) $CsBr \longrightarrow Cs^{+} + Br^{-}$
0.040 M → 0.040 M + 0.040 M
Total conc. of ions = 0.040 + 0.040 = 0.080 M

b) $Cu(BrO_3)_2 \longrightarrow Cu^{2+} + 2\ BrO_3^{-}$
0.030 M → 0.030 M + 2(0.030 M) = 0.060 M

Total conc. of ions = 0.030 + 0.060 = 0.090 M

c) $ScBr_3 \longrightarrow Sc^{3+} + 3\ Br^{-}$
0.020 M → 0.020 M + 3(0.020 M) = 0.060 M

Total conc. of ions = 0.030 + 0.060 = 0.090 M

d) $CaBr_2 \longrightarrow Ca^{2+} + 2\ Br^{-}$
0.050 M → 0.050 M + 2(0.050 M) = 0.015 M

Total conc. of ions = 0.050 + 0.100 = 0.150 M

e) $HBrO_2 \longrightarrow H^{+} + BrO_2^{-}$
0.070 M → 0.070 M + 0.070 M
Total conc. of ions = 0.070 + 0.070 = 0.140 M

D

22)

This is a limiting reactant problem. These are just stoichiometry problems. There is more than one way to do a LR problem. In this case since it's asking for the limiting reactant and the mass of excess reactant remaining after completion of the reaction.

$$3\ Ca(OH)_2\ (s)\ +\ 2\ H_3PO_4\ (aq)\ \rightarrow\ Ca_3(PO_4)_2\ (s)\ +\ 6\ H_2O\ (\ell)$$

1) Method 1: Calculate which reactant gives the smallest number of moles of product, and then use to determine how much of the excess reactant would be used (and remains).

Calculate mol $Ca_3(PO_4)_2$ from $Ca(OH)_2$ and H_3PO_4 :

$$?\ mol\ Ca_3(PO_4)_2 = 1.00\ mol\ Ca(OH)_2 \times \frac{1\ mol\ Ca_3(PO_4)_2}{3\ mol\ Ca(OH)_2} = 0.33\underline{3}3\ mol\ Ca_3(PO_4)_2\ \ (3\ s.f.)\ \ \textbf{LR}$$

$$?\ mol\ Ca_3(PO_4)_2 = 0.50\ mol\ H_3PO_4 \times \frac{1\ mol\ Ca_3(PO_4)_2}{2\ mol\ H_3PO_4} = 0.2\underline{5}00\ mol\ Ca_3(PO_4)_2\ \ (3\ s.f.)$$

Fewer moles of $Ca_3(PO_4)_2$ obtained from the H_3PO_4 so the H_3PO_4 is the **LR** and only $0.2\underline{5}00$ moles of $Ca_3(PO_4)_2$ are formed. Calculate the moles of $Ca(OH)_2$ required to produce $0.2\underline{5}00$ mol of $Ca_3(PO_4)_2$

$$\underset{used}{?\ mol\ Ca(OH)_2} = 0.2\underline{5}00\ mol\ Ca_3(PO_4)_2 \times \frac{3\ mol\ Ca(OH)_2}{1\ mol\ Ca_3(PO_4)_2} = 0.7\underline{5}0\ mol\ Ca(OH)_2\ \ \textbf{used}\ (2\ s.f.)$$

$$?\ mol\ Ca(OH)_2 = 1.00\ mol\ Ca(OH)_2 - 0.7\underline{5}0\ mol\ Ca(OH)_2 = 0.2\underline{5}0\ mol\ Ca(OH)_2\ remaining$$

H_3PO_4 is LR **0.25 mol $Ca(OH)_2$ remaining**

2) Method 2: Determine mole ratio of the two reactants & compare it to the mole ratio in the bal. eqn.

$$\frac{1.00\ mol\ Ca(OH)_2}{0.50\ mol\ H_3PO_4} > \frac{3\ mol\ Ca(OH)_2}{2\ mol\ H_3PO_4}$$

Since the actual ratio of $Ca(OH)_2$ to H_3PO_4 (ratio = 2) is greater than that from the bal. eqn. (ratio = 1.5) this means $Ca(OH)_2$ is in excess and H_3PO_4 is the LR. Can then calculate the moles of $Ca(OH)_2$ required to react with the H_3PO_4.

$$?\ mol\ Ca(OH)_2 = 0.50\ mol\ H_3PO_4 \times \frac{3\ mol\ Ca(OH)_2}{2\ mol\ H_3PO_4} = 0.7\underline{5}0\ mol\ Ca(OH)_2\ used\ \ (3\ s.f.)$$

<u>B</u>

23) 1 and 2 are **double** replacement

1) $Pb(NO_3)_2$ (aq) + 2 NaBr (aq) → $PbBr_2$ (s) + 2 $NaNO_3$ (aq) double replacement
ionic ionic ionic ionic w. ppt

2) 3 $CaSO_4$ (aq) + 2 $(NH_4)_3PO_4$ (aq) → $Ca_3(PO4)_2$(s) + 3 $(NH_4)_2SO_4$ (aq) double replacement
ionic ionic ionic ionic w. ppt

3) NaI (aq) + Br_2 (ℓ) → NaBr (aq) + I_2 (s) single replacement
ionic halide | element halogen | ionic halide | element halogen

4) Fe (s) + 2 HCl (aq) → $FeCl_2$ (aq) + H_2 (g) single replacement
element | acid (Acts like ionic in solution) | ionic | element

5) 2 Ba (s) + O_2 (g) → 2 BaO(s) combination
element | element | ionic cmpd | (2 reactants → 1 product)

D (1 & 2)

24)

See above answers in #23. **single-replacement** reactions are some examples of redox rxns.

3) NaI (aq) + Br_2 (ℓ) → NaBr (aq) + I_2 (s) single replacement
-1 0 -1 0
ionic halide | element halogen | ionic halide | element halogen

I oxidized (NaI reducing agent) Br reduced (Br_2 oxidizing agent)

4) Fe (s) + 2 HCl (aq) → $FeCl_2$ (aq) + H_2 (g) single replacement
0 +1 +2 0
element | acid (Acts like ionic in solution) | ionic | element

Fe oxidized (Fe reducing agent) H reduced (HCl oxidizing agent)

A (3 and 4)

25) This is a **double-replacement** reaction. Write the ionic equation and cancel out everything that appears the same way on both sides of the equation.

$AgNO_3$ (aq) + NaBr (aq) → $Ag^{1+}Br^{1-}$ (s) + $Na^{1+}(NO_3)^{1-}$ (aq)

$AgNO_3$ (aq) + NaBr (aq) → AgBr (s) + $NaNO_3$ (aq)

Ag^+ (aq) + NO_3^- (aq) + Na^+(aq) + Br^- (aq) → AgBr (s) + Na^+(aq) + NO_3^- (aq)

Ag^+ (aq) + Br^- (aq) → AgBr (s)

C

26)

A solution of oxalic acid ($C_2H_2O_4$) is prepared by dissolving 516.5 mg of the steroid in 100.0 mL of water. A 10.00 mL portion of this solution is diluted to a final volume of 250.0 mL. What is the resulting molarity?

Determine the initial molarity of the oxalic acid, get moles and divide by volume in liters.

$$? \text{ mol ox.} = 516.5 \text{ mg} \times \frac{1 \text{ g ox.}}{10^3 \text{ mg ox.}} \times \frac{1 \text{ mol ox.}}{90.04 \text{ g ox.}}$$

$= 5.73\underline{\mathbf{6}}3 \times 10^{-3}$ mole ox.

Molarity of ox. = $(5.73\underline{6}3 \times 10^{-3}$ mole ox.)/0.1000 L soln (dilute soln so vol soln = vol water)

$= 5.73\underline{6}3 \times 10^{-2}$ M ox.

Now do the dilution problem:

$M_2 * V_2 = M_1 * V_1$

$M_2 = M_1 * V_1 / V_2$

$M_2 = (5.73\mathbf{6}3 \times 10^{-2} \text{ M})(10.00 \text{ mL})/(250.0\text{mL})$

$= 2.29\underline{\mathbf{4}}53 \times 10^{-3} \text{ M} = 2.295 \times 10^{-3} \text{ M}$

C

27) This is a solution stoichiometry problem with an added twist.

$$16\ H^+ + 2\ Cr_2O_7^{2-} + C_2H_5OH \longrightarrow 4\ Cr^{3+} + 11\ H_2O + 2\ CO_2$$

This is like a mol-to-gram stoichiometry problem but have to get moles using volume and molarity. Can do this by first getting moles of $K_2Cr_2O_7$ used and then doing a mole-to-gram problem or do it in one long step. Remember, molarity (mol/L) is a conversion between moles of solute and volume of solution.

$$M = \frac{\text{mol solute}}{\text{L soln}}$$

1) method 1 (2 steps to get mass of C_2H_5OH):

Determine the moles of $K_2Cr_2O_7$ in 3.68 mL of a 0.05295 M $K_2Cr_2O_7$ solution and then do the mole-to-gram problem to determine the mass of C_2H_5OH and then get mass % in the 5.0 g of blood.

$$?\ \text{mol } K_2Cr_2O_7 = 3.68\ \text{mL } K_2Cr_2O_7\ \text{soln.} \times \frac{1\ \text{L soln}}{10^3\ \text{mL soln}} \times \frac{0.05295\ \text{mol } K_2Cr_2O_7}{1\ \text{L soln}} = 1.9\underline{\mathbf{4}}856 \times 10^{-4}\ \text{mol } K_2Cr_2O_7$$

$$?\ \text{g } C_2H_5OH = 1.9\underline{\mathbf{4}}856 \times 10^{-4}\ \text{mol } K_2Cr_2O_7 \times \frac{1\ \text{mol } Cr_2O_7^{2-}}{1\ \text{mol } K_2Cr_2O_7} \times \frac{1\ \text{mol } C_2H_5OH}{2\ \text{mol } Cr_2O_7^{2-}} \times \frac{46.068\ \text{g } C_2H_5OH}{1\ \text{mol } C_2H_5OH}$$

$$= 4.4\underline{\mathbf{8}}831 \times 10^{-3}\ \text{g } C_2H_5OH$$

Now get mass % of C_2H_5OH in 5.0 g of blood.

$$\%\ C_2H_5OH = \frac{4.4\underline{\mathbf{8}}831 \times 10^{-3}\ \text{g } C_2H_5OH}{5.0\ \text{g blood}} \times 100 = 0.089766\ \% = 0.090\ \%$$

2) method 2 (1 step to get mass of C_2H_5OH):

$$?\ \text{g } C_2H_5OH = 3.68\ \text{mL } K_2Cr_2O_7\ \text{soln.} \times \frac{1\ \text{L soln}}{10^3\ \text{mL soln}} \times \frac{0.05295\ \text{mol } K_2Cr_2O_7}{1\ \text{L soln}} \times \frac{1\ \text{mol } Cr_2O_7^{2-}}{1\ \text{mol } K_2Cr_2O_7}$$

$$\times \frac{1\ \text{mol } C_2H_5OH}{2\ \text{mol } Cr_2O_7^{2-}} \times \frac{46.068\ \text{g } C_2H_5OH}{1\ \text{mol } C_2H_5OH}$$

$$= 4.4\underline{\mathbf{8}}831 \times 10^{-3}\ \text{g } C_2H_5OH$$

Then proceed as above to get mass % of C_2H_5OH in 5.0 g of blood.

<u>**A**</u>

28)

a) P_4	b) PH_2^-	c) HPO_3^{2-}	d) P_2H_4	e) PO_4^{3-}
0	$X_P+2(+1)_H = -1$	$(+1)_H+X_P+3(-2)_O = -2$	$2X_P+4(+1)_H = 0$	$X_P+4(-2)_O = -3$
	$X_P = -3$	$X_P-5 = -2$	$2X_P = -4$	$X_P = +5$
		$X_P= +3$	$X_P = -2$	
0	**−3**	**+3**	**−2**	**+5**

−3,	**−2,**	**0,**	**+3,**	**+5**
PH_2^-,	P_2H_4,	P_4,	HPO_3^{2-},	PO_4^{3-}
b	d	**a**	c	e

A

29)

The reactions are redox (oxidation-reduction) reactions. To be a redox (oxidation-reduction) reaction the oxidation numbers must change. More specifically the reactions are all displacement (single replacement) reactions. You need to figure out what's being oxidized and reduced. Then you use the activity series. Remember, ease of oxidation increases from bottom to top in the series. The more easily oxidized substance is higher in the table.

Remember (OIL RIG):

oxidation: loss of e-, inc. in oxidation #

reduction: gain of e-, dec. in oxidation #

reaction (a):

$$\underset{0}{2\,Cr(s)} + \underset{+1}{6\,HBr(aq)} \rightarrow \underset{0}{3\,H_2(g)} + \underset{+3}{CrBr_3(aq)}$$ Cr oxidized H reduced

In the activity series table aluminum is higher than hydrogen meaning aluminum is more easily oxidized. Since Cr is being oxidized this reaction will occur as written going left to right. Thus the Cr replaces H^+ in solution.

Proceeding in this way you find reaction (**e**) can't occur as written:

$$\underset{0}{2\,Au(s)} + \underset{+2}{3\,Zn(NO_3)_2(aq)} \rightarrow \underset{0}{3\,Zn(s)} + \underset{+1}{2\,Au(NO_3)_3\,(aq)}$$ Au oxidized Zn reduced

However, from the table Zn is more easily oxidized than Au. This reaction won't occur spontaneously left to right but instead the reverse reaction would occur.

***** continued on next page *****

29) (cont.)

Reaction (d) is also a redox reaction. Aluminum is above Fe in the activity series meaning it will be oxidized more easily than Fe and that's what is occurring in the reaction as written.

$3\ Fe(NO_3)_2(aq) + 2\ Al(s) \rightarrow 3\ Fe(s) + 2\ Al(NO_3)_3\ (aq)$ Al oxidized Fe reduced

+2 0 0 +3

Reaction (c) is a redox reaction involving the replacement of one halogen in solution with another. The order of reactivity for halogens (ease of reduction) is I < Br < Cl < F. This reaction will occur as written and F will replace Br- in solution.

$F_2(aq) + 2\ NaBr\ (aq) \rightarrow Br_2\ (aq) + 2\ NaF(aq)$ Br oxidized F reduced

0 -1 0 -1

Reaction (b) is an acid-base neutralization reaction between a strong acid, HNO_3, and a hydroxide base. An acid-base neutralization involving a strong acid and/or a strong base go to completion.

<u>E</u>

30)

Ox # inc, lost e-, ox. (Te red. agt.)

(0) (+5) (+4) (+4)

$Te\ (s) + 4\ HNO_3\ (aq) \rightarrow TeO_2\ (s) + 2\ H_2O\ (l) + 4\ NO_2\ (g)$

Ox # dec, gain e-, red. (HNO_3 ox. agt.)

N: reduced Te: oxidized

HNO_3: oxidizing agent Te: reducing agent

<u>E</u> (1, 2 & 5 are Correct)