Name_____ _Key_____(print) Name _____(sign)
Please show work for partial credit and full credit on the Short Answer Questions. Multiple choice questions have no partial credit.
Please write anything you want graded legibly.   If you run out of space, continue on the empty back pages but clearly label where the
remaining answers can be found. (Please count your exam pages and make sure there are 4 pages)

MULTIPLE CHOICE. Choose the one best alternative.

MW= no work

1) Molarity is defined as *MA= not attempted*

   A) moles of solute per liter of solution.   B) moles of solute per liter of solvent.
   C) moles of solvent per liter of solvent.   D) moles of solvent per liter of solution.

1) __A__

2) What is the empirical formula for a compound if the compound contains 80.1 % carbon and 19.9
   % hydrogen by mass?
   A) CH_2 B) CH   C) CH_3 $\dfrac{80.1}{12} \approx 2$ D) C_2H

   $\dfrac{6.68}{6.68} = 1$

   $\dfrac{19.9}{1} = 19.9$

   $6.68 = 2.98$

2) __C__

3) Which statement about diluted solutions is **false**? When a solution is diluted
   A) the number of moles of solute remains unchanged.
   B) the concentration of the solution decreases.
   C) the number of moles of solvent remains unchanged.
   D) the molarity of the solution decreases.

3) __C__

4) What is the molar mass of $Al(OH)_3$? $27 + (16+1)3 =$
   A) 152 g/mol   B) 78 g/mol   C) 121 g/mol   D) 90 g/mol

4) __B__

5) Which of the following elements is **not** a diatomic molecule in its natural state   ?
   A) N_2 B) H_2 C) He_2 D) I_2

5) __C__

6) The sugar fructose has an empirical formula of CH_2O (FM = 30.03 g/mol) . The mass spectrum
   shows a molecular ion peak at a mass of 179.9. What is the molecular formula of fructose?
   A) $C_6H_{12}O_6$ B) $C_6H_{11}O_6$ C) $C_2H_4O_4$ D) CH_2O

   $(CH_2O)6 =$

6) __A__

7) Which of the following has the greatest mass?
   A) 0.500 mol of Cl_2 $\frac{1}{2}$ mol Cl_2 B) 6.02×10^{23} molecules of Cl_2 — 1 mol Cl_2
   C) 35.45 g of Cl_2 $\frac{1}{2}$ mol   D) All of these have the same mass.

7) __B__

8) Which one of the following statements about balanced equations is true? A reaction is balanced
   by
   A) multiplying by suitable coefficients.   B) rearranging atoms in a molecule.
   C) changing the charge on an ion.   D) changing the formula of the molecule.

8) __A__

9) Which one of the following is an empirical formula?
   A) C_2F_6 B) P_4O_{10} C) H_2SO_2 D) $C_2H_4O_2$

   No common denominator

9) __C__

10) When $Na_2CrO_4(aq)$ and $AgNO_3(aq)$ are mixed, a red colored precipitate forms which is

    A) Ag.   B) Ag_2CrO_4.   C) $NaNO_3$.   D) $AgNO_2$.

10) _B_

11) In the reaction $AgNO_3(aq) + HI(aq) \rightarrow AgI(s) + HNO_3(aq)$ the spectator ions are

    A) H^+ and NO_3^-.   B) Ag^+ and I^-.

    C) H^+ and I^-.   D) Ag^+ and NO_3^-.

11) _A_

12) Given the chemical equation: $N_2 + 3 H_2 \rightarrow 2 NH_3$. On a **molecular** level, what do the coefficients mean?

    A) 1 mole of nitrogen reacts with 3 moles of hydrogen to give 2 moles of ammonia.

    B) 1 molecule of nitrogen reacts with 3 molecules of hydrogen to give 2 molecules of ammonia.

    C) 28 g of nitrogen reacts with 6 grams of hydrogen to give 34 grams of ammonia.

    D) 1 atom of nitrogen reacts with 3 atoms of hydrogen to give 2 atoms of ammonia.

12) _B_

13) The reaction $2 HNO_3(aq) + Ba(OH)_2(aq) \rightarrow Ba(NO_3)_2(aq) + 2 H_2O(l)$ is best classified as a(n)

    A) precipitation reaction.   B) acid–base neutralization reaction.

   C) oxidation–reduction reaction.   D) single replacement reaction.

13) _B_

14) The reaction $Sr(NO_3)_2(aq) + Cs_2SO_4(aq) \rightarrow SrSO_4(s) + 2 CsNO_3(aq)$ is best classified as a(n)

    A) acid–base neutralization reaction.   B) precipitation reaction.

    C) single replacement reaction.   D) oxidation–reduction reaction.

14) _B_

15) If unshaded spheres represent nitrogen atoms and shaded spheres represent oxygen atoms, which box represents reactants and which represents products for the reaction $2 N_2O(g) \rightarrow 2 N_2(g) + O_2(g)$?

(a)   (b)   (c)   (d)
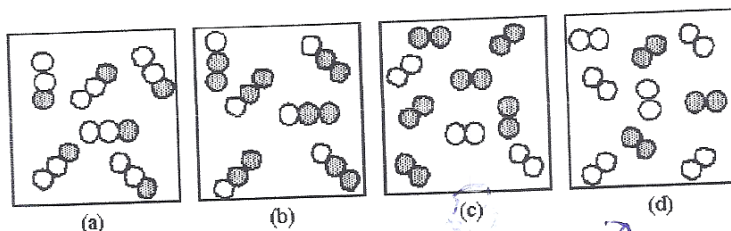
    A) box (a) reactants and box (c) products   B) box (b) reactants and box (d) products

    C) box (a) reactants and box (d) products   D) box (b) reactants and box (c) products

15) _C_

16) Identify the statement that is **true** about nonelectrolytes.

    A) Nonelectrolytes dissolve in water to produce ions.

    B) Nonelectrolytes do not dissociate in water.

    C) Nonelectrolytes conduct electricity.

    D) Most nonelectrolytes are ionic compounds.

16) _B_

Part II: Short Answers

Please show work on all questions for partial credit even on questions which do not specify. (40 total pts)

1   a.   Balance the following reaction by filling in the blanks (6 pts)

3 pt per blank

$B\ Cl_3 + 3\ H_2O \rightarrow$ __3__ $H\ Cl$ + __1__ $B(OH)_3$

b.   Give the number of each atom on both the reactant and   product side of the reaction. (4 pts)

Reactant atom count

$1\ B$
$3\ Cl$ $3\ \underline{O}$
$6\ H$

Product atom count

$3\ H,\ 3\ Cl,\ 1\ B,\ 3\ \underline{O}\ 3\ H$

2.   A substance has an empirical formula of C_6H_7N (empirical formula mass = 93.13)   What is the molecular formula of the substance if the molecular formula mass = 186.24 ? (5 pts)

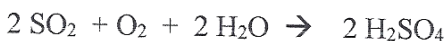$\dfrac{186.24}{93.13} = 1.999$

$(C_6 H_7 N)_2$

NW −½

up side down −½

$C_{12} H_{14} N_2$

3.   In the reaction shown below if you do the reaction with 2 moles SO_2 with 1 mole of H_2O what is the limiting reagent ?

by inspection or *NO NO pts off*

[(SO_2) or (H_2O)] (circle one) (5 pts)

$2\ SO_2 + O_2 + 2\ H_2O \rightarrow 2\ H_2SO_4$

$2\ mol\ SO_2 \times \dfrac{2\ mol\ H_2SO_4}{2\ mol\ SO_2} = 2\ mol\ SO_2$

$1\ mol\ H_2O \times \dfrac{2\ mol\ H_2SO_4}{2\ mol\ H_2O} = 1\ mol\ H_2O\ limiting$

4. For the reaction shown below if you have excess of all other reactants what is the theoretical yield of the H_2SO_4 in moles if you start with 45.2 grams of SO_2 (formula mass of $SO_2 = 64.06$ g/mol) ? show work. (10 pts)

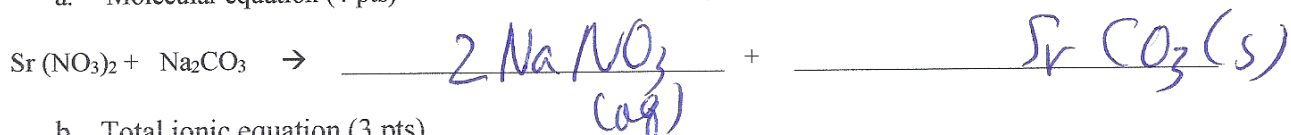$$2 SO_2 + O_2 + 2 H_2O \rightarrow 2 H_2SO_4$$
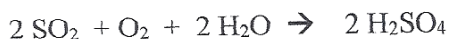
extra step to grams -2

$$45.2 g \; SO_2 \times \frac{1 \; mol \; SO_2}{64.06 g \; SO_2} \times \frac{2 \; mol \; H_2SO_4}{2 \; mol \; SO_2} = 0.706 \; mol \; H_2SO_4$$
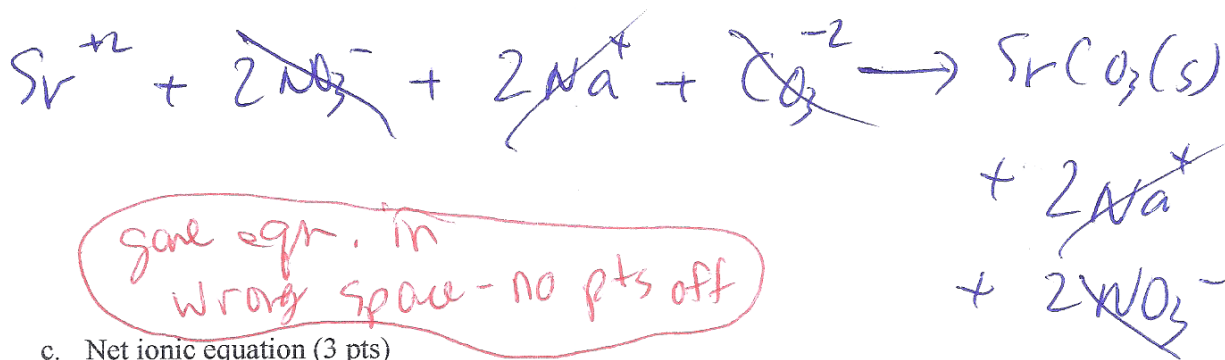
3 pt   *3 pt*   *2 pt*   *2 pt*

5. For the following write out the molecular equation, total ionic equation and net ionic equation (10 pts)
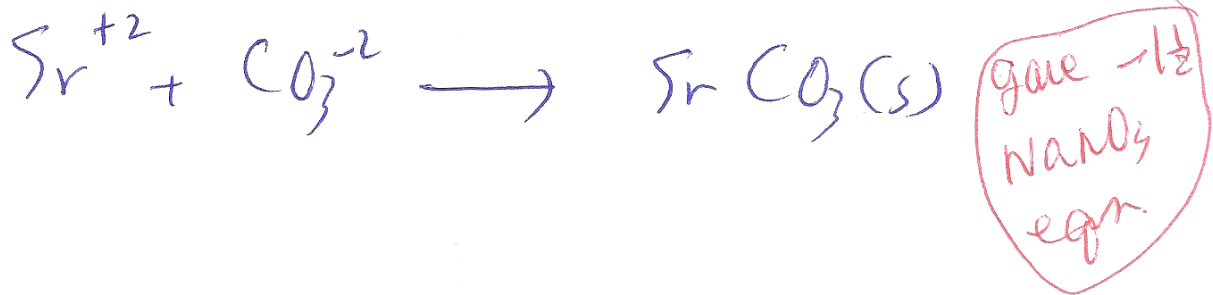
a. Molecular equation (4 pts)

$$Sr(NO_3)_2 + Na_2CO_3 \rightarrow \underline{\quad 2 NaNO_3 (aq) \quad} + \underline{\quad SrCO_3 (s) \quad}$$

b. Total ionic equation (3 pts)

$$Sr^{+2} + 2 NO_3^- + 2 Na^+ + CO_3^{-2} \rightarrow SrCO_3 (s) + 2 Na^+ + 2 NO_3^-$$

gave eqn. in wrong space - no pts off

c. Net ionic equation (3 pts)

$$Sr^{+2} + CO_3^{-2} \rightarrow SrCO_3 (s)$$

gave -1½ NaNO₃ eqn.

General Chemistry I Lecture   Fall 2019   Test 2   10/9/19 D   form B   section   Dr. Hahn Exam # _____

Name_____*Key*_____ (print) Name _____ (sign)
Please show work for partial credit and full credit on the Short Answer Questions.   Multiple choice questions have no partial credit.
Please write anything you want graded legibly.   If you run out of space, continue on the empty back pages but clearly label where the
remaining answers can be found.   (Please count your exam pages and make sure there are   4   pages)

MULTIPLE CHOICE. Choose the one best alternative.

NA = not attempt)   *NW = NO WORK*

1) Which statement about diluted solutions is **false**? When a solution is diluted   1) D
   A) the number of moles of solute remains unchanged.
   B) the concentration of the solution decreases.
   C) the molarity of the solution decreases.
   D) the number of moles of solvent remains unchanged.

2) What is the molar mass of $Al(OH)_3$?   2) C
   A) 121 g/mol   B) 152 g/mol   C) 78 g/mol   D) 90 g/mol

3) Which one of the following is an empirical formula?   3) A
   A) H_2SO_2 B) C_2F_6 C) P_4O_{10} D) $C_2H_4O_2$

4) Which of the following elements is **not** a diatomic molecule in its natural state   ?   4) D
   A) H_2 B) N_2 C) I_2 D) He_2

5) In the reaction $AgNO_3(aq) + HI(aq) \rightarrow AgI(s) + HNO_3(aq)$ the spectator ions are   5) B
   A) Ag^+ and I^-.   B) H^+ and NO_3^-.
   C) H^+ and I^-.   D) Ag^+ and NO_3^-.

6) The sugar fructose has an empirical formula of CH_2O (FM = 30.03 g/mol) . The mass spectrum   6) D
   shows a molecular ion peak at a mass of 179.9. What is the molecular formula of fructose?
   A) $C_2H_4O_4$ B) $C_6H_{11}O_6$ C) CH_2O D) $C_6H_{12}O_6$

7) The reaction $Sr(NO_3)_2(aq) + Cs_2SO_4(aq) \rightarrow SrSO_4(s) + 2\ CsNO_3(aq)$ is best classified as a(n)   7) B
   A) oxidation–reduction reaction.   B) precipitation reaction.
   C) single replacement reaction.   D) acid–base neutralization reaction.

8) The reaction $2\ HNO_3(aq) + Ba(OH)_2(aq) \rightarrow Ba(NO_3)_2(aq) + 2\ H_2O(l)$ is best classified as a(n)   8) C
   A) single replacement reaction.   B) precipitation reaction.
   C) acid–base neutralization reaction.   D) oxidation–reduction reaction.

9) Molarity is defined as   9) D
   A) moles of solvent per liter of solvent.   B) moles of solute per liter of solvent.
   C) moles of solvent per liter of solution.   D) moles of solute per liter of solution.

10) What is the empirical formula for a compound if the compound contains 80.1 % carbon and 19.9 % hydrogen by mass?

   A) CH_3 B) CH   C) C_2H D) CH_2

10) _A_

11) Which of the following has the greatest mass?

   A) 35.45 g of Cl_2 B) 0.500 mol of Cl_2
   C) 6.02×10^{23} molecules of Cl_2 D) All of these have the same mass.

11) _C_

12) Which one of the following statements about balanced equations is true? A reaction is balanced by

   A) changing the charge on an ion.   B) changing the formula of the molecule.
   C) multiplying by suitable coefficients.   D) rearranging atoms in a molecule.

12) _C_

13) If unshaded spheres represent nitrogen atoms and shaded spheres represent oxygen atoms, which box represents reactants and which represents products for the reaction $2 N_2O(g) \rightarrow 2 N_2(g) + O_2(g)$?

13) _C_
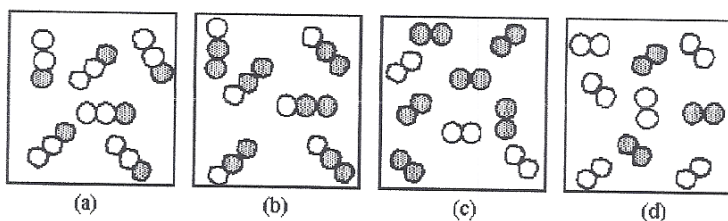
    (a)   (b)   (c)   (d)

   A) box (a) reactants and box (c) products   B) box (b) reactants and box (c) products
   C) box (a) reactants and box (d) products   D) box (b) reactants and box (d) products

14) When $Na_2CrO_4(aq)$ and $AgNO_3(aq)$ are mixed, a red colored precipitate forms which is

   A) $NaNO_3$.   B) Ag_2CrO_4.   C) $AgNO_2$.   D) Ag.

14) _B_

15) Given the chemical equation: $N_2 + 3 H_2 \rightarrow 2 NH_3$. On a **molecular** level, what do the coefficients mean?

   A) 1 molecule of nitrogen reacts with 3 molecules of hydrogen to give 2 molecules of ammonia.
   B) 28 g of nitrogen reacts with 6 grams of hydrogen to give 34 grams of ammonia.
   C) 1 mole of nitrogen reacts with 3 moles of hydrogen to give 2 moles of ammonia.
   D) 1 atom of nitrogen reacts with 3 atoms of hydrogen to give 2 atoms of ammonia.

15) _A_

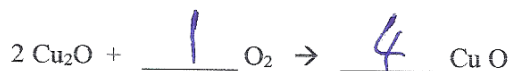16) Identify the statement that is **true** about nonelectrolytes.

   A) Nonelectrolytes conduct electricity.
   B) Nonelectrolytes do not dissociate in water.
   C) Most nonelectrolytes are ionic compounds.
   D) Nonelectrolytes dissolve in water to produce ions.

16) _B_

Part II: Short Answers

Please show work on all questions for partial credit even on questions which do not specify. (40 total pts)
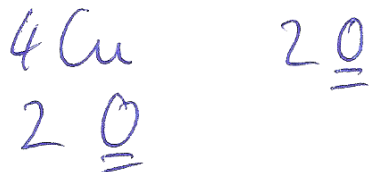
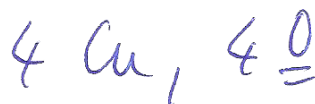1 a.   Balance the following reaction by filling in the blanks (6 pts)   *3pt per blank*

$2 Cu_2O$ + __1__ O_2 → __4__ $Cu O$

b.   Give the number of each atom on both the reactant and   product side of the reaction. (4 pts)

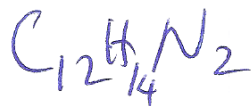Reactant atom count

4 Cu   2 O

2 O

Product atom count

4 Cu, 4 O

2.   A substance has an empirical formula of C_6H_7N (empirical formula mass = 93.13)   What is the molecular formula of the substance if the molecular formula mass = 186.24 ? (5 pts)

$\dfrac{186.24}{93.13} = 1.999$ $(C_6H_7N)_2$ *NW $-1\frac{1}{2}$*
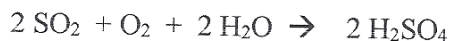
upside down $-1\frac{1}{2}$ $C_{12}H_{14}N_2$

3.   In the reaction shown below if you do the reaction with 1 mol SO_2 with 2 mole of H_2O what is the limiting reagent ?

[(SO₂) or (H₂O)] (circle one) (5 pts)

by inspection or

$2 SO_2 + O_2 + 2 H_2O$ → $2 H_2SO_4$

NW - no pts off

$1 mol\ SO_2 \times \dfrac{2\ mol\ H_2SO_4}{2\ mol\ SO_2} = 1\ mol\ H_2SO_4\ limiting$

$2\ mol\ H_2O \times \dfrac{2\ mol\ H_2SO_4}{2\ mol\ H_2O} = 2\ mol\ H_2SO_4$

4. For the reaction shown below if you have excess of all other reactants what is the theoretical yield of the H₂SO₄ in moles if you start with 45.2 grams of O₂ (formula mass of O₂ = 32.0 g/mol) ? show work. (10 pts)
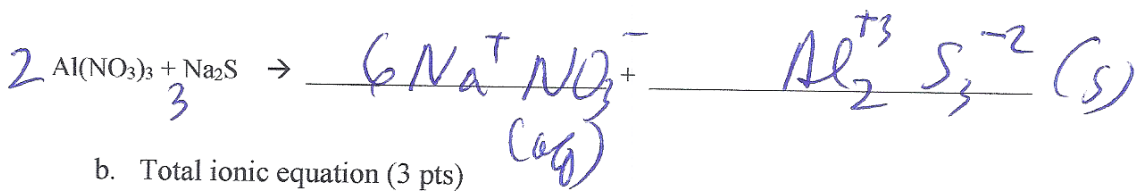
$$2\ SO_2 + O_2 + 2\ H_2O \rightarrow 2\ H_2SO_4$$
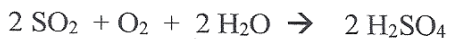
(handwritten in red: extra step to grams −2)

$$45.2\ g\ O_2 \times \frac{mol\ O_2}{32.0\ g\ O_2} \times \frac{2\ mol\ H_2SO_4}{1\ mol\ O_2} = 2.83\ mol\ H_2SO_4$$
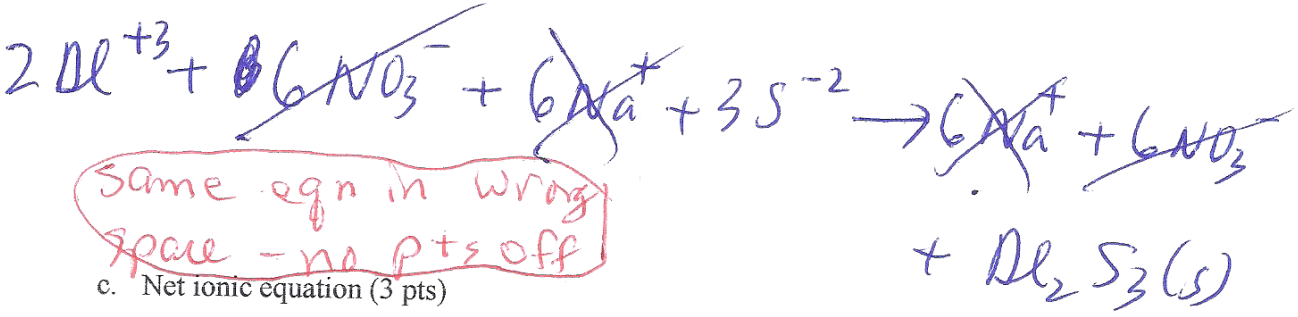
(red annotations: 3 pt, 3 pt, 2 pt, 2 pt)

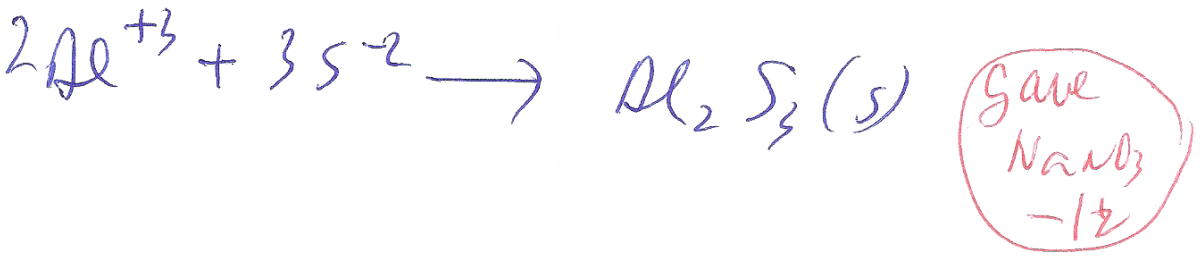5. For the following write out the molecular equation, total ionic equation and net ionic equation (10 pts)

a. Molecular equation (4 pts)

$$2\ Al(NO_3)_3 + 3\ Na_2S \rightarrow 6\ Na^+\ NO_3^-\ (aq) + Al_2^{+3}\ S_3^{-2}\ (s)$$

b. Total ionic equation (3 pts)

$$2\ Al^{+3} + 6\ NO_3^- + 6\ Na^+ + 3\ S^{-2} \rightarrow 6\ Na^+ + 6\ NO_3^- + Al_2S_3\ (s)$$

(red annotation: Same eqn in wrong space − no pts off)

c. Net ionic equation (3 pts)

$$2\ Al^{+3} + 3\ S^{-2} \rightarrow Al_2S_3\ (s)$$

(red annotation: Save NaNO₃ −1½)

Name_____*Key*_____(print) Name _____(sign)

Please show work for partial credit and full credit on the Short Answer Questions.   Multiple choice questions have no partial credit.
Please write anything you want graded legibly.   If you run out of space, continue on the empty back pages but clearly label where the remaining answers can be found.   (Please count your exam pages and make sure there are   5   pages)

MULTIPLE CHOICE. Choose the one best alternative.

NA = not attempt; NW = no work

$(0.350) \times 3 = 1.05$

1) What is the molar concentration of sodium ions in a 0.350 M Na_3PO_4 solution?

    A) 0.350 M   B) 1.05 M   C) 1.40 M   D) 0.117 M

1) __B__

2) What is the empirical formula for a compound if the compound contains 86.1 % carbon and 13.9 % hydrogen by mass?

    A) C_2H B) CH   C) CH_3 D) CH_2

2) __D__

$$\frac{86.1}{12} = 7.18 \quad / 7.18 = 1$$

$$\frac{13.9}{1} = 13.9 \quad / 7.18 = 1.9$$

$$CH_2$$

3) Identify the statement that is **true** about nonelectrolytes.

    A) Nonelectrolytes do not dissociate in water.
    B) Nonelectrolytes dissolve in water to produce ions.
    C) Nonelectrolytes conduct electricity.
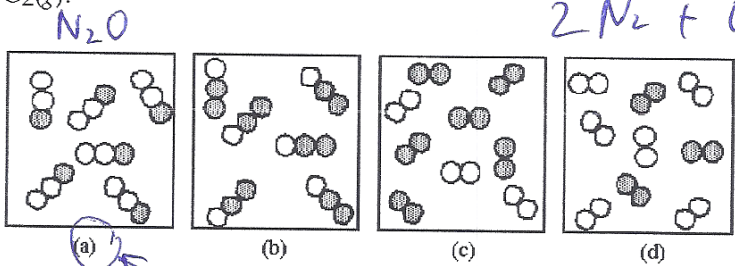   D) Most nonelectrolytes are ionic compounds.

3) __A__

4) In the reaction $AgNO_3(aq) + HI(aq) \rightarrow AgI(s) + HNO_3(aq)$ the spectator ions are

    A) Ag^+ and NO_3^-.
    B) H^+ and NO_3^-.
    C) H^+ and I^-.
   D) Ag^+ and I^-.

4) __B__

5) If unshaded spheres represent nitrogen atoms and shaded spheres represent oxygen atoms, which box represents reactants and which represents products for the reaction $2 N_2O(g) \rightarrow 2 N_2(g) + O_2(g)$?

N_2O $2 N_2 + O_2$

    A) box (b) reactants and box (d) products
    B) box (a) reactants and box (d) products
    C) box (b) reactants and box (c) products
    D) box (a) reactants and box (c) products

5) __B__

6) When 50.0 mL of a 1.00 M solution of $Fe(NO_3)_3$ are mixed with 50.0 mL of a 1.00 M solution of NaOH, a precipitate forms. What is the identity of the precipitate?

$$Fe(NO_3)_3(aq) + 3 NaOH(aq) \rightarrow Fe(OH)_3(s) + 3 NaNO_3(aq)$$
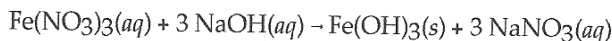
$Fe(OH)_3$ or $NaNO_3$

    A) $NaNO_3$ B) $Fe(OH)_3$ C) $Fe(NO_3)_3$ D) NaOH
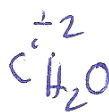
            (s)

6) __B__

$$137.3 + 2[14 + 3(16)] = 261.3$$

7) What is the molar mass of $Ba(NO_3)_2$?

    A) 261 g/mol   B) 121 g/mol   C) 152 g/mol   D) 90 g/mol

7) _A_

8) Which of the following elements is **not** a diatomic molecule in its natural state ? (i.e: which molecular formula is incorrect)

    A) H_2 B) He_2 C) I_2 D) N_2

8) _B_

9) Which statement about diluted solutions is **false**? When a solution is diluted

    A) the concentration of the solution decreases.
    B) the molarity of the solution decreases.
    C) the number of moles of solvent remains unchanged.
    D) the number of moles of solute remains unchanged.

9) _C_

10) Molarity is defined as

    A) moles of solvent per liter of solvent.   B) moles of solute per liter of solvent.
    C) moles of solute per liter of solution.   D) moles of solvent per liter of solution.

10) _C_

11) Predict the products of a reaction between $AgNO_3(aq)$ and $CsBr(aq)$. $\rightarrow$ $AgBr \downarrow$

    A) Ag(s) and NO(g)   B) $AgNO_3(aq)$ and $CsBr(aq)$
    C) Ag(s) and $Br_2(l)$ D) AgBr(s) and $CsNO_3(aq)$ $CsNO_3$

11) _D_

12) 1.00 mole of O_2 contains the same number of oxygen atoms as

    A) 1.00 mole of CH_3CO_2H.   B) 1.00 mole of CH_3CH_2OH.
    C) 16.0 grams of oxygen   D) All of the above

12) _A_

13) Write a balanced net ionic equation for the reaction of $Pb(NO_3)_2(aq)$ with $NaI(aq)$.

    A) $Pb^{2+}(aq) + 2\ NO_3^-(aq) + 2\ Na^+(aq) + 2\ I^-(aq) \rightarrow PbI_2(s) + 2\ Na^+(aq) + 2\ NO_3^-(aq)$
    B) $Pb^{2+}(aq) + 2\ I^-(aq) \rightarrow PbI_2(s)$
    C) $Pb(NO_3)_2(aq) + 2\ NaI(aq) \rightarrow PbI_2(s) + 2\ NaNO_3(aq)$
    D) $Pb^{2+}(aq) + 2\ NO_3^-(aq) + 2\ Na^+(aq) + 2\ I^-(aq) \rightarrow Pb^{2+}(aq) + 2\ I^-(aq) + 2\ Na^+(aq) + 2\ NO_3^-(aq)$

13) _B_

14) Given the chemical equation: $N_2 + 3\ H_2 \rightarrow 2\ NH_3$. On a **macroscopic** (lab scale) level, what do the coefficients mean?

    A) 1 atom of nitrogen reacts with 3 atoms of hydrogen to give 2 atoms of ammonia.
    B) 1 molecule of nitrogen reacts with 3 molecules of hydrogen to give 2 molecules of ammonia.
    C) 1 mole of nitrogen reacts with 3 moles of hydrogen to give 2 moles of ammonia.
    D) All of these are true.

14) _C_

15) The reaction $Na_3PO_4(aq) + 3\ AgNO_3(aq) \rightarrow Ag_3PO_4(s) + 3\ NaNO_3(aq)$ is best classified as a(n)

    A) oxidation–reduction reaction.   B) single replacement reaction.
    C) acid–base neutralization reaction.   D) precipitation reaction.

15) _D_

16) Which one of the following is an empirical formula?   16) _A_

(A) H_2SO_2 B) C_2F_6 C) $C_2H_4O_2$ D) P_4O_{10}
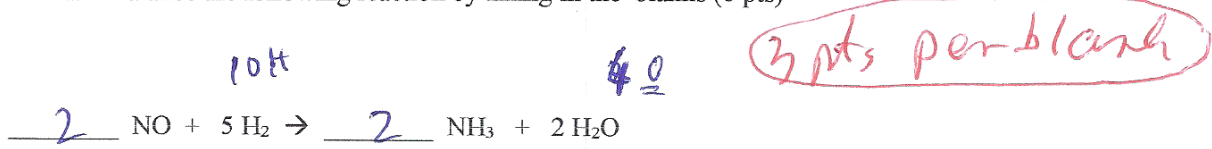
$\div 2$

CF_3

$\div 2$

CH_2O

$\div 2$

P_2O_5

no common denominator

Part II: Short Answers

Please show work on all questions for partial credit even on questions which do not specify. (40 total pts)

1   a.   Balance the following reaction by filling in the blanks (6 pts)

10H

4 O → *(3 pts per blank)*

__2__ NO + 5 H₂ → __2__ NH₃ + 2 H₂O

b.   Give the number of each atom on both the reactant and   product side of the reaction. (4 pts)

Reactant atom count

$2N, 2O$

$10H$

Product atom count

$2N$ $4H$

$6H$ $2O$

2.   A substance has an empirical formula of C₂HCl (empirical formula mass = 60.48).   What is the molecular formula of the substance if the molecular formula mass = 181.44   (5 pts)

$$\frac{181.44}{60.48} = 3$$

(MW −1½)

$(C_2HCl)3 = C_6H_3Cl_3$

upside down −1½

MW no pts off

3.   In the reaction shown below if you do the reaction with 4 moles of Fe and 4 moles O₂ what is the limiting reagent ?

by inspection! or

[(Fe) or (O₂)] (circle one) (5 pts)

limiting

4 Fe + 3 O₂ → 2 Fe₂O₃
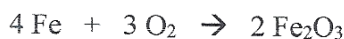
$4 mol Fe \times \dfrac{2 mol Fe_2O_3}{4 mol Fe} = 2 mol Fe_2O_3$

4 mol

4 mol

$4 mol\ O_2 \times \dfrac{2 mol Fe_2O_3}{3 mol O_2} = 2.67 mol Fe_2O_3$

4. For the reaction shown below if you have excess of all other reactants what is the theoretical yield of the Fe_2O_3 in moles if you start with 45.2 g Fe (atomic mass = 55.85 g/mol) ? show work. (10 pts)

$$4\ Fe\ +\ 3\ O_2\ \rightarrow\ 2\ Fe_2O_3$$
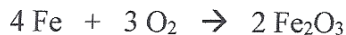
extra step to grams −2

$$45.2\ g\ Fe \times \frac{1\ mol\ Fe}{55.85\ g\ Fe} \times \frac{2\ mol\ Fe_2O_3}{4\ mol\ Fe} = 0.405\ mol\ Fe_2O_3$$

(3 pt) *(3 pt)* *(2 pt)* *(2 pt)*

5   For the following write out the molecular equation, total ionic equation and net ionic equation   (10 pts)

a. Molecular equation (4 pts)

$Pb(NO_3)_2 + Li_2\ SO_4 \rightarrow$ ___ $2\ Li^{+1}\ NO_3^-$ + ___ $Pb^{+2}\ SO_4^{-2}(s)$

b. Total ionic equation (3 pts)
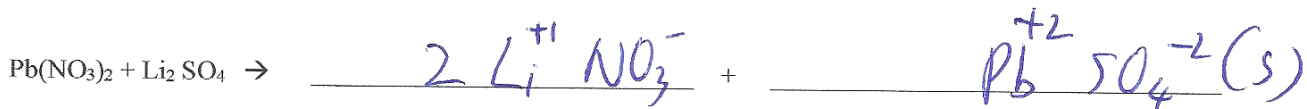
$$Pb^{+2} + 2\ NO_3^- + 2\ Li^+ + SO_4^{-2} \rightarrow 2\ Li^+ + 2\ NO_3^- + PbSO_4(s)$$
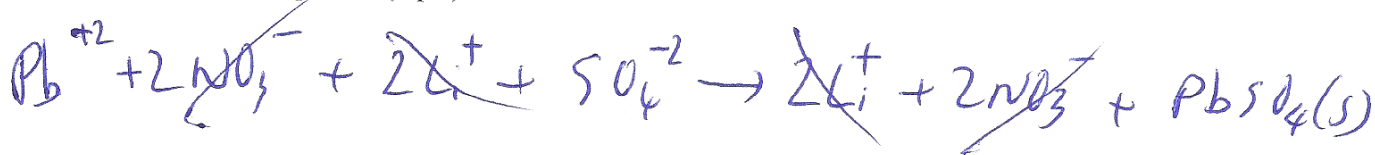
same eqn in wrong space — no pt off

c. Net ionic equation (3 pts)

$$Pb^{+2} + SO_4^{-2} \rightarrow PbSO_4(s)$$

gave $LiNO_3$ eqn. −1½

Name_____ Key _____(print) Name _____(sign)
Please show work for partial credit and full credit on the Short Answer Questions.   Multiple choice questions have no partial credit.
Please write anything you want graded legibly.   If you run out of space, continue on the empty back pages but clearly label where the remaining answers can be found.   (Please count your exam pages and make sure there are   5   pages)   pink

MULTIPLE CHOICE. Choose the one best alternative.

NA= not attempt   NW = no work

1) Identify the statement that is true about nonelectrolytes.   1) __C__

    A) Nonelectrolytes dissolve in water to produce ions.
    B) Nonelectrolytes conduct electricity.
    C) Nonelectrolytes do not dissociate in water.
    D) Most nonelectrolytes are ionic compounds.

2) The reaction $Na_3PO_4(aq)$ + 3 $AgNO_3(aq)$ → $Ag_3PO_4(s)$ + 3 $NaNO_3(aq)$ is best classified as a(n)   2) __B__

    A) acid–base neutralization reaction.   B) precipitation reaction.
    C) oxidation–reduction reaction.   D) single replacement reaction.

3) 1.00 mole of O_2 contains the same number of oxygen atoms as   3) __C__

    A) 16.0 grams of oxygen   B) 1.00 mole of CH_3CH_2OH.
    C) 1.00 mole of CH_3CO_2H.   D) All of the above

4) Predict the products of a reaction between $AgNO_3(aq)$ and $CsBr(aq)$.   4) __A__

    A) $AgBr(s)$ and $CsNO_3(aq)$ B) $Ag(s)$ and $Br_2(l)$
    C) $AgNO_3(aq)$ and $CsBr(aq)$ D) $Ag(s)$ and $NO(g)$

5) Which statement about diluted solutions is **false**? When a solution is diluted   5) __C__

    A) the molarity of the solution decreases.
    B) the number of moles of solute remains unchanged.
    C) the number of moles of solvent remains unchanged.
    D) the concentration of the solution decreases.

6) If unshaded spheres represent nitrogen atoms and shaded spheres represent oxygen atoms, which   6) __C__
box represents reactants and which represents products for the reaction 2 $N_2O(g)$ → 2 $N_2(g)$ + $O_2(g)$?

       (a)   (b)   (c)   (d)
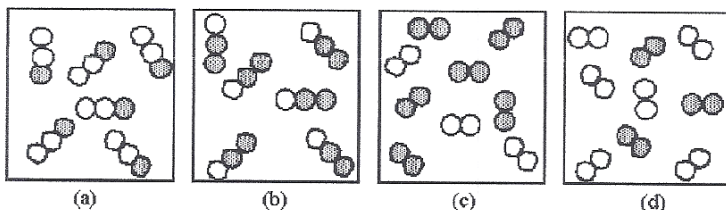
    A) box (b) reactants and box (d) products   B) box (b) reactants and box (c) products
    C) box (a) reactants and box (d) products   D) box (a) reactants and box (c) products

7) What is the molar mass of $Ba(NO_3)_2$?   7) **C**

    A) 90 g/mol   B) 121 g/mol   C) 261 g/mol   D) 152 g/mol

8) Write a balanced net ionic equation for the reaction of $Pb(NO3)2(aq)$ with $NaI(aq)$.   8) **A**

    A) $Pb^{2+}(aq) + 2\ I^-(aq) \rightarrow PbI_2(s)$

    B) $Pb^{2+}(aq) + 2\ NO_3^-(aq) + 2\ Na^+(aq) + 2\ I^-(aq) \rightarrow PbI_2(s) + 2\ Na^+(aq) + 2\ NO_3^-(aq)$

    C) $Pb^{2+}(aq) + 2\ NO_3^-(aq) + 2\ Na^+(aq) + 2\ I^-(aq) \rightarrow Pb^{2+}(aq) + 2\ I^-(aq) + 2\ Na^+(aq) + 2\ NO_3^-(aq)$

    D) $Pb(NO3)2(aq) + 2\ NaI(aq) \rightarrow PbI_2(s) + 2\ NaNO3(aq)$

9) Which one of the following is an empirical formula?   9) **D**

    A) $C_2H_4O_2$ B) P_4O_{10} C) C_2F_6 D) H_2SO_2

10) What is the empirical formula for a compound if the compound contains 86.1 % carbon and 13.9   10) **B**
    % hydrogen by mass?

    A) CH   B) CH_2 C) C_2H D) CH_3

11) Which of the following elements is **not** a diatomic molecule in its natural state ? (i.e: 11) **A**
    which molecular formula is incorrect)

    A) He_2 B) N_2 C) H_2 D) I_2

12) What is the molar concentration of sodium ions in a 0.350 M Na_3PO_4 solution?   12) **A**

    A) 1.05 M   B) 1.40 M   C) 0.350 M   D) 0.117 M

13) Given the chemical equation: $N_2 + 3\ H_2 \rightarrow 2\ NH_3$. On a **macroscopic** (lab scale) level, what do the   13) **C**
    coefficients mean?

    A) 1 atom of nitrogen reacts with 3 atoms of hydrogen to give 2 atoms of ammonia.

    B) 1 molecule of nitrogen reacts with 3 molecules of hydrogen to give 2 molecules of ammonia.

    C) 1 mole of nitrogen reacts with 3 moles of hydrogen to give 2 moles of ammonia.

    D) All of these are true.

14) Molarity is defined as   14) **D**

    A) moles of solute per liter of solvent.   B) moles of solvent per liter of solution.

    C) moles of solvent per liter of solvent.   D) moles of solute per liter of solution.

15) When 50.0 mL of a 1.00 M solution of $Fe(NO3)3$ are mixed with 50.0 mL of a 1.00 M solution of   15) **B**
    NaOH, a precipitate forms. What is the identity of the precipitate?

$$Fe(NO3)3(aq) + 3\ NaOH(aq) \rightarrow Fe(OH)3(s) + 3\ NaNO3(aq)$$
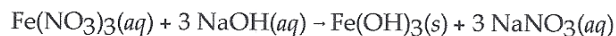
    A) $Fe(NO3)3$ B) $Fe(OH)3$ C) $NaNO3$ D) NaOH

16) In the reaction $AgNO_3(aq) + HI(aq) \rightarrow AgI(s) + HNO_3(aq)$ the spectator ions are

    A) H^+ and I^-.
                      B) Ag^+ and NO_3^-.
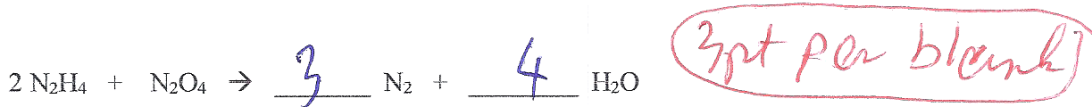
    C) H^+ and NO_3^-.
                    D) Ag^+ and I^-.

16)   C

Part II: Short Answers

Please show work on all questions for partial credit even on questions which do not specify. (40 total pts)

1   a.   Balance the following reaction by filling in the blanks (6 pts)

$2 N_2H_4 + N_2O_4 \rightarrow$ __3__ $N_2 +$ __4__ H_2O *(3pt per blank)*

b.   Give the number of each atom on both the reactant and   product side of the reaction. (4 pts)

Reactant atom count   Product atom count

4 N, 8 H, 2 N, 4 O   6 N, 8 H, 4 O

2.   A substance has an empirical formula of C_2HCl (empirical formula mass = 60.48)   What is the
molecular formula of the substance if the molecular formula mass = 181.44 ? (5 pts)
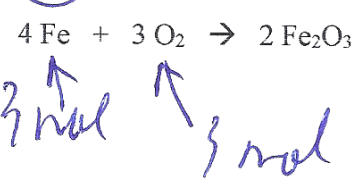
$\dfrac{181.44}{60.48} = 3$

$(C_2HCl)_3$ *(MW -1½)*

$C_6H_3Cl_3$

upside down, -1½

3.   In the reaction shown below if you do the reaction with 3 moles of Fe and 3 moles O_2 what is the limiting
reagent ?

by inspection or *(limiting)*

[(Fe) or (O_2)] (circle one) (5 pts)

$4 Fe + 3 O_2 \rightarrow 2 Fe_2O_3$

3 mol   3 mol

$3\ mol\ Fe \times \dfrac{2\ mol\ Fe_2O_3}{4\ mol\ Fe} = 1.5\ mol\ Fe_2O_3$

MW no pts off

$3\ mol\ O_2 \times \dfrac{2\ mol\ Fe_2O_3}{3\ mol\ O_2} = 2\ mol\ Fe_2O_3$

4. For the reaction shown below if you have excess of all other reactants what is the theoretical yield of the Fe₂O₃ in moles if you start with 45.2 g O₂ (atomic mass = 32.0 g/mol) ? show work. (10 pts)
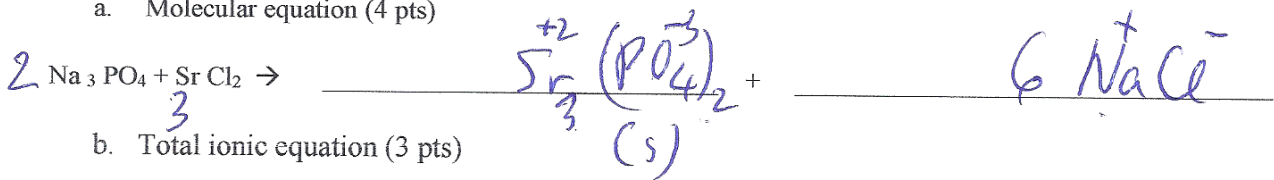
$$4\,Fe + 3\,O_2 \rightarrow 2\,Fe_2O_3$$
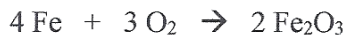
$$45.2\,g\,O_2 \times \frac{1\,mol\,O_2}{32.0\,g\,O_2} \times \frac{2\,mol\,Fe_2O_3}{3\,mol\,O_2} = 0.942\,mol\,Fe_2O_3$$

(3pt) (3pt) (2pt) (2pt)

extra step to grams −2 (in red)

5. For the following write out the molecular equation, total ionic equation and net ionic equation (10 pts)

a. Molecular equation (4 pts)

$$2\,Na_3PO_4 + 3\,SrCl_2 \rightarrow Sr_3(PO_4)_2\,(s) + 6\,NaCl$$

b. Total ionic equation (3 pts)

$$6\,Na^+{}_{(aq)} + 2\,PO_4^{-3}{}_{(aq)} + 3\,Sr^{+2}{}_{(aq)} + 6\,Cl^-{}_{(aq)} \rightarrow Sr_3(PO_4)_2\,(s) + 6\,Na^+{}_{(aq)} + 6\,Cl^-{}_{(aq)}$$

Save eqn in wrong space – no pts off (in red)

c. Net ionic equation (3 pts)

$$3\,Sr^{+2}{}_{(aq)} + 2\,PO_4^{-3}{}_{(aq)} \rightarrow Sr_3(PO_4)_2\,(s)$$

Save NaCl eqn −1 (in red)

Dr. Hahn   General Chemistry I Lecture   Test 2   sect F   form B   Page 5

General Chemistry I Lecture   Fall 2019   Test 2   10/9/19 G   section   Dr. Hahn Exam # _____

Name_____*Key*_____(print) Name _____(sign)
Please show work for partial credit and full credit on the Short Answer Questions.   Multiple choice questions have no partial credit.
Please write anything you want graded legibly.   If you run out of space, continue on the empty back pages but clearly label where the
remaining answers can be found. (Please count your exam pages and make sure there are 4   pages)

MULTIPLE CHOICE. Choose the one best alternative.

NA = not attempted   *NW = no work*

1) Molecular mass can be determined by   1) __C__

    A) weighing with an analytical balance.   B) titration.
    C) mass spectrometry.   D) combustion analysis.

2) Which statement about diluted solutions is **false**? When a solution is diluted   2) __D__

    A) the molarity of the solution decreases.
    B) the concentration of the solution decreases.
    C) the number of moles of solute remains unchanged.
    D) the number of moles of solvent remains unchanged.

3) Which of the following elements is **not** a diatomic molecule in its natural state ? (i.e: 3) __C__
    which molecular formula is incorrect)
    A) N_2 B) I_2 C) He_2 D) H_2

4) If unshaded spheres represent nitrogen atoms and shaded spheres represent oxygen atoms, which   4) __B__
    box represents reactants and which represents products for the reaction $2 N_2O(g) \rightarrow 2 N_2(g) +$
    $O_2(g)$?

      (a)   (b)   (c)   (d)
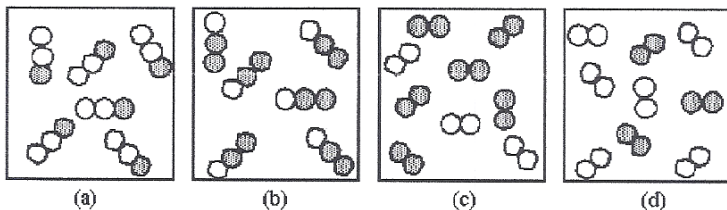
    A) box (b) reactants and box (c) products   B) box (a) reactants and box (d) products
    C) box (a) reactants and box (c) products   D) box (b) reactants and box (d) products

5) Which contains Avogadro's number of formula units?   5) __D__
   A) 36.5 g of HCl   B) 71.0 g of Cl_2 C) 35.5 g of Cl   D) All of these

6) In the reaction $AgNO_3(aq) + HI(aq) \rightarrow AgI(s) + HNO_3(aq)$ the spectator ions are   6) __D__
    A) Ag^+ and I^-.   B) Ag^+ and NO_3^-.
    C) H^+ and I^-.   D) H^+ and NO_3^-.

7) Chemical equations are balanced in order to obey the law of   7) __A__

   A) mass conservation.   B) mass action.

   C) definite proportions.   D) multiple proportions.

8) The reaction $HNO_3(aq) + KOH(aq) \rightarrow KNO_3(aq) + H_2O(l)$ is best classified as a(n)   8) __B__

   A) precipitation reaction.   B) acid–base neutralization reaction.

   C) oxidation–reduction reaction.   D) single replacement reaction.

9) What is the empirical formula for a compound if the compound contains 92.3 % carbon and 7.7 %   9) __C__
hydrogen by mass?

   A) C_2H B) CH_3 C) CH   D) CH_2

$$\frac{92.3}{12} = 7.7$$

$$\frac{7.7}{1} = 7.7$$

10) Identify the statement that is __false__ about strong electrolytes.   10) __B__

   A) Strong electrolytes are ionic compounds.

   B) Strong electrolytes do __not__ dissociate in water.

   C) Strong eelectrolytes conduct electricity.

   D) Strong electrolytes dissolve in water to produce ions.

11) What is the molar mass of $(NH_4)_2S$? $2(14 + 4) + 32$ 11) __C__

   A) 90 g/mol   B) 152 g/mol   C) 68 g/mol   D) 121 g/mol

12) What is the molar concentration of the phosphate ions in a 0.750 M Na_3PO_4 solution?   12) __C__

   A) 3.00 M   B) 0.250 M   C) 0.750 M   D) 2.25 M

13) Molarity is defined as   13) __A__

   A) moles of solute per liter of solution.   B) moles of solvent per liter of solution.

   C) moles of solvent per liter of solvent.   D) moles of solute per liter of solvent.

14) Write a balanced net ionic equation for the reaction of $AgNO_3(aq)$ with $LiCl(aq)$.   14) __A__

   A) $Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$

   B) $AgNO_3(aq) + LiCl(aq) \rightarrow AgCl(aq) + LiNO_3(s)$

   C) $Ag^+(aq) + NO_3^-(aq) + Li^+(aq) + Cl^-(aq) \rightarrow Ag^+(aq) + Cl^-(aq) + LiNO_3(s)$

   D) $Ag^+(aq) + NO_3^-(aq) + Li^+(aq) + Cl^-(aq) \rightarrow AgBr(s) + Li^+(aq) + NO_3^-(aq)$

15) Which one of the following is not a molecular formula?   (covalent)   15) __D__

   A) $C_2H_4O_2$ B) P_4O_{10} C) C_2F_6 D) All of these

16) Predict the products of a reaction between $Sr(NO_3)_2(aq)$ and $Rb_2SO_4(aq)$.   16) __D__

   A) SrRb (s) and $SO_4NO_3(aq)$ B) Sr(s), $RbNO_3(aq)$ and $Rb_2SO_3(aq)$

   C) $SrSO_3(s)$ and $RbNO_3(aq)$ D) $SrSO_4(s)$ and $RbNO_3(aq)$

Part II: Short Answers

Please show work on all questions for partial credit even on questions which do not specify. (40 total pts)

1   a.   Balance the following reaction by filling in the blanks (6 pts)

3 pts per blank

$4 KO_2 +$ __2__ $CO_2 \rightarrow$ __2__ $K_2CO_3 + 3 O_2$
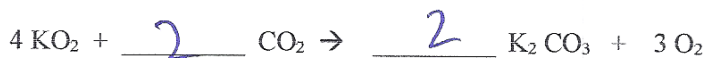
b.   Give the number of each atom on both the reactant and   product side of the reaction. (4 pts)

Reactant atom count

4 K, 8 O 2 C, 4 O

Product atom count

4 K, 2 C, 6 O, 6 O

2.   A substance has an empirical formula of   C Cl (empirical formula mass = 47.46) What is the molecular formula of the substance if the molecular formula mass = 284.77 ? (5 pts)
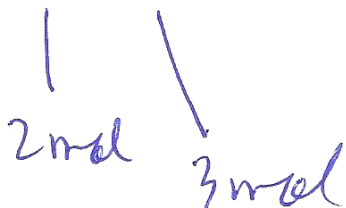
$\dfrac{284.77}{47.46} = 6$

$(C Cl)_6$

$C_6 Cl_6$

NW - 1½

upside down -1½

NW - no pts off

3.   In the reaction shown below if you do the reaction with   2 moles CO and 3 moles of H_2 which is the limiting reagent ?

by inspection or

[(CO) or (H₂)] (circle one) (5 pts)

$CO + 3 H_2 \rightarrow CH_4 + H_2O$

2 mol   3 mol

limiting

$2 \, mol \times \dfrac{1 \, mol \, CH_4}{1 \, mol \, CO} = 2 \, mol \, CH_4$

$3 \, mol \, H_2 \times \dfrac{1 \, mol \, CH_4}{3 \, mol \, H_2} = 1 \, mol \, CH_4$

4. For the reaction shown below if you have excess of all other reactants what is the theoretical yield of the CH_4 in moles if you start with 45.2 grams of CO (formula mass = 28.01 /mol) ? show work. (10 pts)
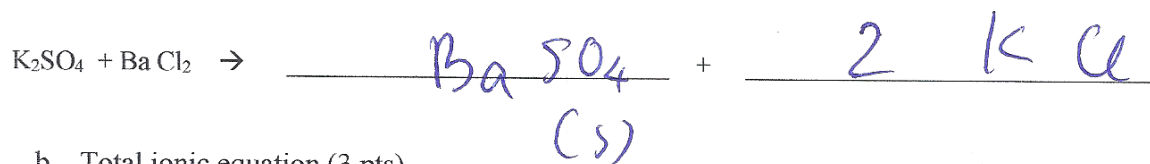
$CO + 3H_2 \rightarrow CH_4 + H_2O$

extra step to grams -2

$$45.2\,g\,CO \times \frac{1\,mol\,CO}{28.01\,g\,CO} \times \frac{1\,mol\,CH_4}{1\,mol\,CO} = 1.6\,mol\,CH_4$$
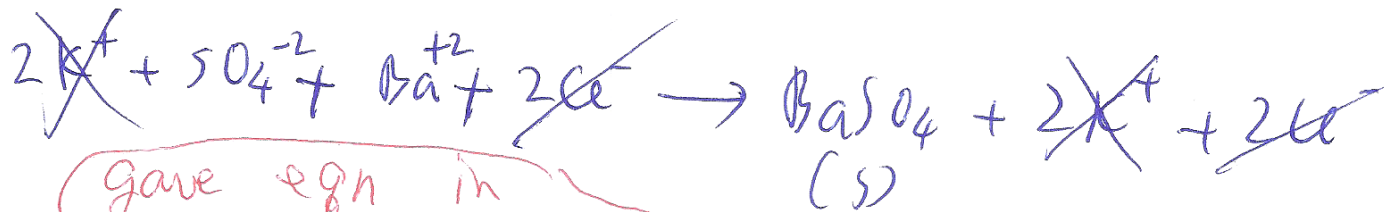
3pt   *3pt*   *2pt*   *2pt*

5. For the following write out the molecular equation, total ionic equation and net ionic equation (10 pts)
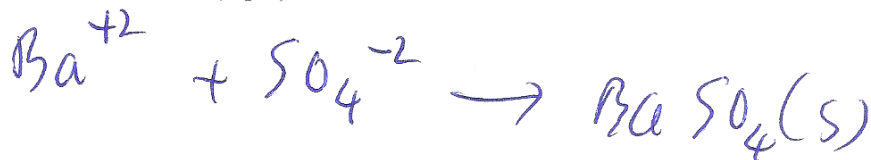
a. Molecular equation (4 pts)

$K_2SO_4 + BaCl_2 \rightarrow$ ___ $BaSO_4$ $+$ ___ $2\,KCl$
(s)

b. Total ionic equation (3 pts)

$2K^+ + SO_4^{-2} + Ba^{+2} + 2Cl^- \rightarrow BaSO_4 + 2K^+ + 2Cl^-$
(s)

gave eqn in wrong space – no pts off

c. Net ionic equation (3 pts)

$Ba^{+2} + SO_4^{-2} \rightarrow BaSO_4(s)$

Save K Cl eqn. -1½