Name _____   KEY

5/23/13

Please read all the questions VERY carefully before answering. If you do not understand any question, please ask. Use the reverse side of the question paper as scratch. Use the periodic table and constant chart in the last page. No outside paper is allowed. Total points = 71+(28x3=)84=155

SHORT ANSWER. Please write the set–up equation first, then insert the raw data with units in the equation before doing your calculations. Points will be deducted if your answer is not clear.

1) Calculate the number of atoms in 15.6 grams of silicon. (6 pts.)

$$\frac{15.6\,g\;Si}{} \left|\frac{1\;mol\;Si}{28.08\,g\,Si}\right|\frac{6.022\times10^{23}\,atom}{1\;mol\;Si}\right|$$

$$\frac{(15.6)(6.022\times10^{23})}{28.08}\;atom = 3.35\times10^{23}\;atom$$

1) $\underline{\dfrac{3.35\times10^{23}}{atom\;Si}}$ ✓

2) Calculate the number of atoms in 39.7 g oxygen gas (Note the the formula of Oxygen). (6 pts.)

$$\frac{39.7\,g\;O_2}{}\left|\frac{1\;mol\;O_2}{(16\times2)\,g\;O_2}\atop 32\right|\frac{6.022\times10^{23}\,molecules\;O_2}{1\;mol\;O_2}\right|\frac{2\;atoms\;O_2}{1\;molecule\;O_2}$$

$$\frac{(39.7)(1)(6.022\times10^{23})(2)}{(32)(1)(1)}\;atoms$$

$$1.49\times10^{24}\;atoms\;O_2$$

2) $\underline{1.49\times10^{24}}$ atoms O_2 ✓

3) Calculate the amount (in grams) of phosphorous in a 15.5 gram sample of diphosphorous pentoxide: (10 pts.)

$$molar\;mass\;P_2O_5 = 2(30.97)+5(16)$$
$$61.94+80 = 141.94\,g\;P_2O_5$$

$$\frac{15.5\,g\;P_2O_5}{}\left|\frac{141.94\,g\;P_2O_5}{1\;mol\;P_2O_5}\right|\frac{1\;mol\;P_2O_5}{141.94\,g\;P_2O_5}\right|\frac{2\;mol\;P}{1\;mol\;P_2O_5}\right|\frac{30.97\,g\;P}{1\;mol\;P}$$

$$\frac{(15.5)(2)(30.97)}{141.94}\;g\;P \qquad \frac{960.07}{141.94} = 6.76\,g\;P$$

3) $\underline{6.76\,g\;P}$ ✓

1

4) Calculate the mass percent of carbon in oxalic acid, $H_2C_2O_4$. (10 pts.)

mass % element $= \dfrac{mass\ x\ in\ 1\ mol\ Com}{molar\ mass}$

$H_2 = 2(1) = 2$
$C_2 = 2(12) = 24$
$\dfrac{O_4 = 4(16) = 64}{90g\ H_2C_2O_4}$

$\dfrac{2g\ H}{90g\ H_2C_2O_4} \times 100 = 2.22\%$

$\dfrac{24g\ C}{90g\ H_2C_2O_4} = 26.67\%$

$\dfrac{64g\ O}{90g\ H_2C_2O_4} = 71.11\%$

5) An acid has 40% C, 6.7% H, 53.3% O and its molar mass is 60.05 g/mol. Show your calculation to find the molecular formula of the acid? (10 pts.)

$40.0\ g\ C \times \dfrac{1\ mol}{12g\ C} = 3.33\ mol\ C$

$6.7g\ H \times \dfrac{1\ mol}{1g\ H} = 6.7\ mol\ H$

$53.30 \times \dfrac{1\ mol}{16g\ O} = 3.33\ mol\ O$

$C_{\frac{3.33}{3.33}} H_{\frac{6.7}{3.33}} O_{\frac{3.33}{3.33}}$

CH_2O
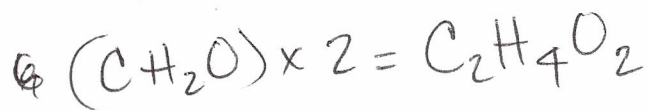
$C = 12$
$H_2 = 2$
$\dfrac{O = 16}{30g\ CH_2O}$

$\dfrac{60.05g/mol}{30g} = \dfrac{30g \times n}{30g}$

$2\ mol = n$

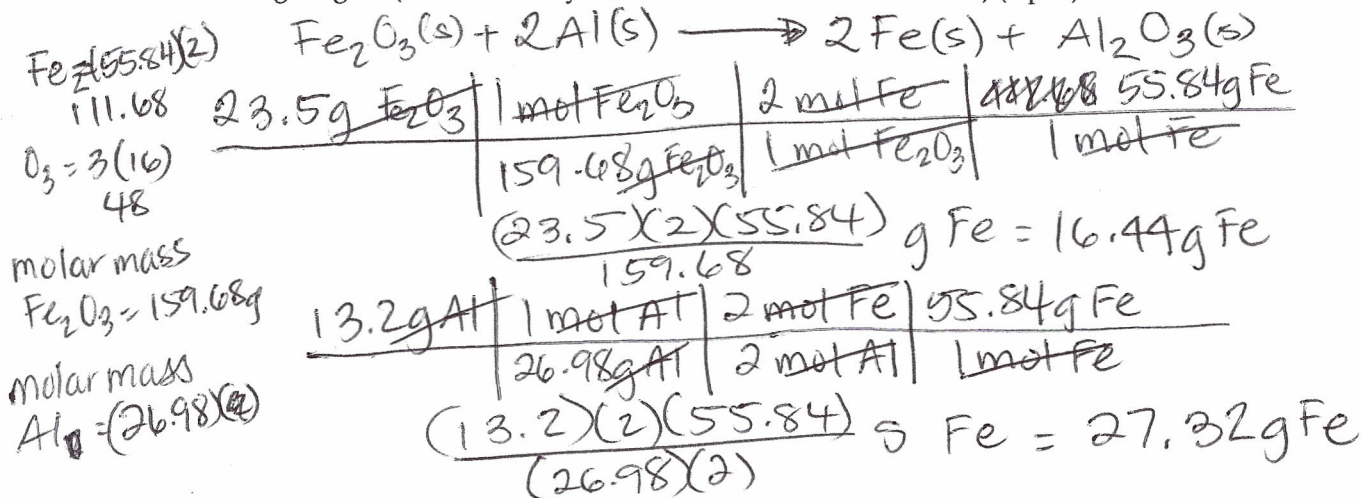$(CH_2O) \times 2 = C_2H_4O_2$
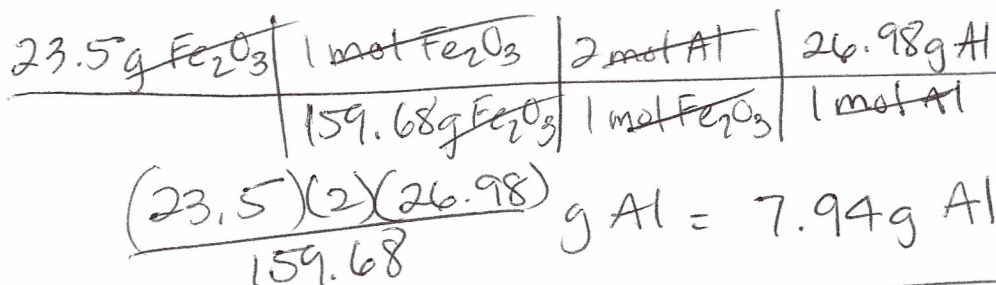
2

6) In the reaction between Fe2O3 (s) and Al (s) to produce Fe (s) and Al2O3 (s), 23.5 g of Fe2O3 was reacted with 13.2 g of Al. (a) Show all your calculations to find out the limiting reagent (Hint: You may want to balance the reaction first) (8 pts.)

6) $\underline{Fe_2O_3 \text{ is the}}$ $\underline{\text{Limiting Reagent}}$

$Fe \neq (55.84)(2)$
111.68

$O_3 = 3(16)$
48

molar mass
$Fe_2O_3 = 159.68 g$

molar mass
$Al_0 = (26.98)(2)$

$$Fe_2O_3(s) + 2Al(s) \longrightarrow 2Fe(s) + Al_2O_3(s)$$

$$\frac{23.5g\ Fe_2O_3}{} \left| \frac{1\ mol\ Fe_2O_3}{159.68g\ Fe_2O_3} \right| \frac{2\ mol\ Fe}{1\ mol\ Fe_2O_3} \right| \frac{111.68\ 55.84g\ Fe}{1\ mol\ Fe}$$

$$\frac{(23.5)(2)(55.84)}{159.68}\ g\ Fe = 16.44g\ Fe \qquad \checkmark$$

$$\frac{13.2g\ Al}{} \left| \frac{1\ mol\ Al}{26.98g\ Al} \right| \frac{2\ mol\ Fe}{2\ mol\ Al} \right| \frac{55.84g\ Fe}{1\ mol\ Fe}$$

$$\frac{(13.2)(2)(55.84)}{(26.98)(2)}\ g\ Fe = 27.32g\ Fe$$

(b) Calculate the amount (in grams) of the reagent that remained unreacted (6 pts.)

$$\frac{23.5g\ Fe_2O_3}{} \left| \frac{1\ mol\ Fe_2O_3}{159.68g\ Fe_2O_3} \right| \frac{2\ mol\ Al}{1\ mol\ Fe_2O_3} \right| \frac{26.98g\ Al}{1\ mol\ Al}$$

$$\frac{(23.5)(2)(26.98)}{159.68}\ g\ Al = 7.94g\ Al$$

$$13.2g\ of\ Al - 7.94g\ Al = \boxed{5.26g\ Al\ was\ unreacted}$$

$\checkmark$

3

7) In separating a mixture of sand and salt, a student had with following data:
   (a) 1.11 g salt
   (b) 1.11 g sand
   (c) The mass of an empty beaker where he would collect the salt sample = 71.60 g
   (d) The mass of the beaker with the dry salt residue = 72.61 g
   (e) The mass of a empty watch glass + clean filter paper = 43.45 g
   (f) The mass of a the watch glass + filter paper + dry sand = 44.55 g

Show all your calculations to find out the (1) the % recovery of salt (4 pts.) and
(2) the % recovery of sand (4 pts.).

7) <u>Recovery of Salt is</u>
   <u>90.99%</u>

2) Recovery of
   Sand is
   99.1%

% recovery salt = $\frac{\text{Salt recovered}}{\text{Salt starting}}$ × 100

d − c = 72.61 − 71.60 = 1.01 g Salt

$\frac{1.01 \text{ g Salt}}{1.11 \text{ g salt}}$ × 100

= 90.99%

% recovery sand = $\frac{\text{sand recovered}}{\text{Sand starting}}$ × 100

f − e = 44.55 − 43.45 = 1.1 g Sand

$\frac{1.1 \text{ g Sand}}{1.11 \text{ g Sand}}$ × 100

= 99.0% Sand

8) (a) Calculate how many grams of magnesium sulfate is in 31.8 grams of its hydrate
   salt . The hydrate salt contains 51.1% water by weight. (3 pts.)

8) <u>15.55 g Mg SO₄</u>

$MgSO_4$ 100 − 51.1 = 48.9%

mass of $MgSO_4$ = (.489)(31.8g)

= 15.55 g $MgSO_4$

9) Write the formula for (2 pts. each; Total 4 pts.):

−2 (a) Ammonium phosphate: PO_3 $(NH_4)_3 PO_4$

   (b) Calcium Sulfate: $Ca^{2+} SO_4^{2-}$

9) A) _____

   B) $CaSO_4$

4
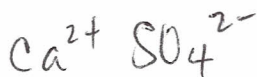
MULTIPLE CHOICE. On scantron, answer the questions starting from number 10. Choose the one alternative that best completes the statement or answers the question. (3 poins each)

10) The phosphorous–to–hydrogen mass ratio is 10.2 for a compound. This ratio could correspond   10) _B_
to the compound
   A) PH₂.
   B) PH₃.
   C) PH.
   D) PH₆.
   E) none of the above

$P^{3-} H^-$ $P (30.97g) \quad H (1 \, amu)$

PH_3 $\dfrac{31.97}{10.2} = 3.13$

11) How many of each type of atom are there in the formula (NH4)2HPO4?   11) _B_
   A) N = 2, H = 5, P = 1, O = 4
   B) N = 2, H = 9, P = 1, O = 4
   C) N = 1, H = 5, P = 1, O = 4
   D) N = 2, H = 8, P = 1, O = 4
   E) none of the above

$(N)_2 \, 2$
$2(H_4) + H = 8 + 1 = 9$
$P = 1 \qquad 2,9,1,4$
$O_4 = 4$

12) Which among the following elements does NOT exist as a diatomic molecule in nature?   12) _D_
   A) nitrogen
   B) fluorine
   C) hydrogen
   D) neon
   E) none of the above

13) Carbon monoxide is considered which of the following?   13) _B_
   A) atomic element
   B) molecular compound CO
   C) molecular element
   D) ionic compound
   E) none of the above

14) What is the formula for an ionic compound made of barium and nitrogen?   14) _C_
   A) Ba₂N₃
   B) BaN
   C) Ba₃N₂
   D) Ba₂N₄
   E) none of the above

$Ba^{2+} \, N^{3-}$

$Ba_3 N_2$

15) What is the name of the compound made from lithium and oxygen?   15) _D_
   A) lithium(I) oxide
   B) oxygen lithide
   C) lithium dioxide
   D) lithium oxide
   E) none of the above

$Li^+ O^{2-}$

$Li_2 O$

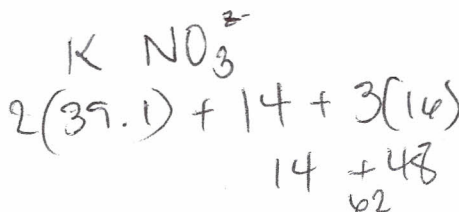16) What is the name of the compound whose formula is Na_2O?
   A) disodium oxide
   B) sodium oxide
   C) sodium monoxide
   D) disodium monoxide
   E) none of the above

16) __B__

17) What is the formula mass for potassium nitrate?
   A) 101.10 amu
   B) 92.99 amu
   C) 85.11 amu
   D) 117.11 amu
   E) none of the above
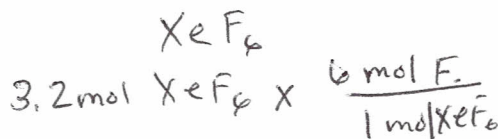
17) __A__

$$K \ NO_3^{2-}$$
$$2(39.1) + 14 + 3(16)$$
$$14 + 48$$
$$62$$

18) You have 10.0 g each of Na, C, Pb, Cu and Ne. Which contains the smallest number of moles?
   A) Ne .496   B) Na .435   C) Pb .048   D) C .826   E) Cu 0.157

18) __C__

$$10g \times \frac{1 \, mol}{20.18g} \quad 10 \, \frac{1 \, mol}{22.99} \quad 10 \times \frac{1 \, mol}{207.2} \quad 10 \times \frac{1 \, mol}{12.11} \quad 10 \times \frac{1 \, mol}{63.55}$$

19) How many moles of fluorine are in 3.2 moles of xenon hexafluoride?
   A) 19.2
   B) 12.8
   C) 16
   D) 22.4
   E) none of the above

19) __A__

$$XeF_6$$
$$3.2 \, mol \ XeF_6 \times \frac{6 \, mol \ F}{1 \, mol \ XeF_6}$$

20) Determine the empirical formula of a compound containing 60.3% magnesium and 39.7% oxygen.
   A) MgO_2
   B) MgO
   C) Mg_2O_3
   D) Mg_2O
   E) none of the above

20) __B__

$$60.3g \ Mg \qquad 39.7g \ O$$
$$60.3g \ Mg \times \frac{mol \ Mg}{24.305g \, Mg} = 2.48 \, mol$$
$$39.7g \ O \times \frac{mol}{16g \, O} = \frac{2.48}{}$$
$$Mg_{\frac{2.48}{2.48}} O_{\frac{2.48}{2.48}} = MgO$$
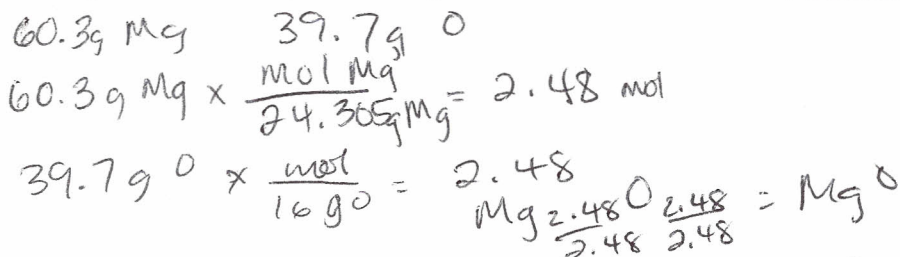
21) What is the value of n when the empirical formula is C_3H_5 and the molecular mass is 205.4 g/mol?
   A) 10
   B) 5
   C) 0.02
   D) 140
   E) none of the above

21) __B__

$$C_3H_4 = 3(12) + 5(1) =$$
$$36 + 5 = 41 g \ C_3H_4$$
$$\frac{205.4 \, g/mol}{41g} = \frac{41g \times n}{41}$$
$$5 = n$$

6
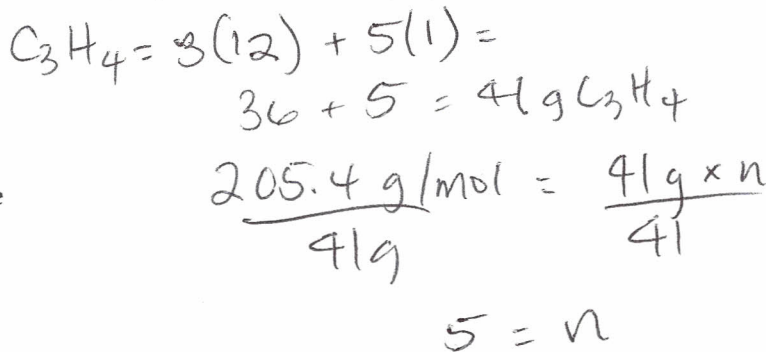
22) What are the coefficients for the following reaction when it is properly balanced?   22) __B__

___potassium iodide + ___lead (II) acetate → ___lead (II) iodide + ___potassium acetate

A) 2, 1, 1, 1
B) 2, 1, 1, 2
C) 1, 1, 2, 2
D) 3, 2, 2, 1
E) none of the above

$$2K^+I^- + Pb \longrightarrow PbI_2 + 2K$$
$$KI +$$

23) When the equation ___Ca_3N_2 + $\underline{6}$ H_2O → $\underline{3}$ $Ca(OH)_2$ + $\underline{2}$ NH_3 is balanced, the coefficient of   23) __B__
H_2O is:

$$H_E \quad 2 + 3 = 5$$

A) 3
B) 6
C) 12
D) 2
E) none of the above

24) All of the following compounds are soluble in water EXCEPT   24) __C__
   A) $FeCl_3$.   B) NH_4Cl.   C) $PbCl_2$.   D) $CaCl_2$.   E) NaCl.

25) If you had an aqueous mixture that contained Ag^+, K^+, and Pb^{+2} cations, how many different   25) __B__ A
solids could precipitate if a chloride solution was added?
   A) 2
   B) no solids will precipitate
   C) 4
   D) 1
   E) 3

26) What type of reaction is the generic equation AB → A + B?   26) __C__
   A) double–displacement
   B) single displacement
   C) decomposition
   D) synthesis/combination
   E) none of the above

27) How many moles of chlorine gas are needed to make 0.6 moles of sodium chloride?   27) __C__
   Given the reaction: $2Na + Cl_2 \rightarrow 2NaCl$
   A) 0.6
   B) 3.6
   C) 0.3
   D) 1.2
   E) not enough information

$$0.6 \; \text{moles NaCl} \times \frac{1 \text{mol } Cl_2}{2 \text{mol NaCl}}$$

$$0.3 \; \text{mol } Cl_2$$

7

28) Suppose two chemical reactions are linked together in a way that the O_2 produced in the first   28) <u>(D)</u> A

reaction goes on to react completely with Mg to form MgO in the second reaction.

Reaction one: $2 KClO_3 \rightarrow 3 O_2 + 2 KCl$

Reaction two: $2 Mg + O_2 \rightarrow 2 MgO$

If you start with 4 moles of $KClO_3$, how many moles of MgO could eventually form?

$4 KClO_3 \rightarrow 6 O_2 + 4 KCl$

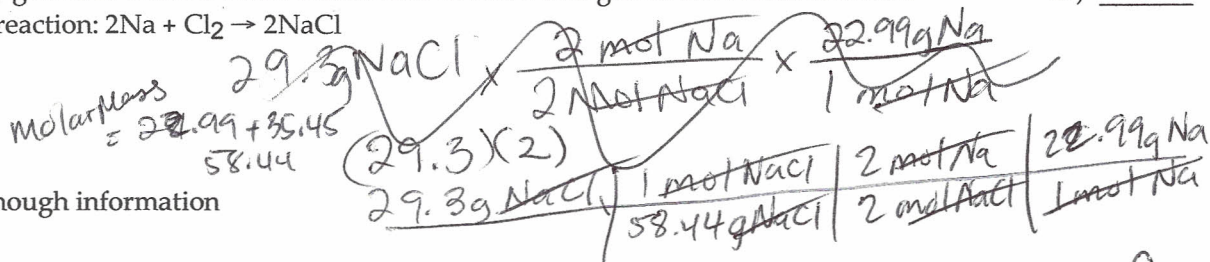A) 12 moles
B) 2 moles
C) 4 moles
D) 6 moles
E) none of the above
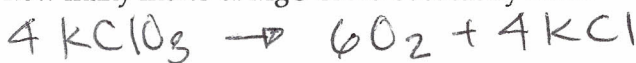
29) How many grams of sodium metal are needed to make 29.3 grams of sodium chloride?   29) <u>B</u>
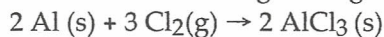
Given the reaction: $2Na + Cl_2 \rightarrow 2NaCl$

A) 5.75
B) 11.5
C) 46.0
D) 23.0
E) not enough information

$$29.3 \, NaCl \times \frac{2 \, mol \, Na}{2 \, mol \, NaCl} \times \frac{22.99 \, g \, Na}{1 \, mol \, Na}$$

molar mass $= 22.99 + 35.45$
$= 58.44$

$(29.3)(2)$

$$29.3 \, g \, NaCl \left| \frac{1 \, mol \, NaCl}{58.44 \, g \, NaCl} \right| \frac{2 \, mol \, Na}{2 \, mol \, NaCl} \left| \frac{22.99 \, g \, Na}{1 \, mol \, Na} \right.$$

30) Many metals react with halogens to give metal halides. For example,   30) <u>C</u>

$$2 Al (s) + 3 Cl_2(g) \rightarrow 2 AlCl_3 (s)$$

If you begin with 13.5 g of aluminum,

A) you will need 11.8 g Cl_2 for complete reaction and will produce 49.0 g of $AlCl_3$.
B) you will need 23.6 g Cl_2 for complete reaction and will produce 66.7 g of $AlCl_3$.
C) you will need 53.2 g Cl_2 for complete reaction and will produce 66.7 g of $AlCl_3$.
D) you will need 26.6 g Cl_2 for complete reaction and will produce 49.0 g of $AlCl_3$.
E) none of the above

31) What is the theoretical yield of waffles if you have 6 cups of flour, 9 eggs and 2 tbs of oil?   31) <u>A</u>

Given: 2 cups flour + 3 eggs + 1 tbs oil → 4 waffles

A) 8
B) 10
C) 12
D) 4
E) not enough information

32) What is the theoretical yield of a reaction if 25.0 grams of product were actually produced   32) <u>B</u>

from a reaction that has a 88% yield?

A) 352
B) 28.4
C) 22.0
D) 3.52
E) none of the above

$88\% = 88\%$

$$.88 = \frac{25.0g}{}$$

% yield $= \frac{actual \, yield}{theoretical \, yield} \times 100$

$$.88 \times \frac{25.0g}{X}$$

$$\frac{.88x}{.88} = \frac{25.0g}{.88}$$

$$x = 28.4$$

8

TRUE/FALSE. On scantron, choose "A" for a true answer and "B" for wrong answer. (3 points each)

33) The correct formula for calcium fluoride is CaF_3. $Ca^{2+}\ F^-$

33) _B_

34) One mole of I_2 has more atoms in it than one mole of Na.

34) _A_

35) The theoretical yield is the amount of each reactant needed in order to make the maximum amount of product.

35) _B_

36) The actual yield is the same as the theoretical yield if the reaction goes to completion and there is no loss of product.

36) _B A_

37) The limiting reactant determines what the actual yield is.

37) _B_