section

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 = 75+(27x3=)81=156

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 mass (in grams) of 1.56×10^{21} atoms of magnesium. (6 pts.)

1) $\underline{0.0629 g\ Mg}$

$$1.56 \times 10^{21}\ Mg\ atoms \times \frac{1\ mol\ Mg}{6.022 \times 10^{23}\ Mg\ atoms} \times \frac{24.30\ g\ Mg}{1\ mol\ Mg}$$

$$\frac{1.56 \times 10^{21} \times 1 \times 24.30\ g\ Mg}{6.022 \times 10^{23} \times 1} = 6.2949 \times 10^{-2}\ g\ Mg$$

$$= 0.0629\ g\ Mg$$

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

2) $\underline{6.74 \times 10^{23}\ atoms\ of\ Cl}$

$$39.7\ g\ Cl_2 \times \frac{1\ mol\ Cl_2}{2(35.45)\ g\ Cl_2} \times \frac{6.022 \times 10^{23}\ Cl_2\ molecules}{1\ mol\ Cl_2} \times \frac{2\ atoms\ Cl\ atoms}{1\ Cl_2\ molecules}$$

$$70.9$$

$$\frac{39.7 \times 1 \times 6.022 \times 10^{23} \times 2}{70.9 \times 1 \times 1} = 6.74 \times 10^{23}\ atoms\ of\ Cl$$

3) Show your calculation to determine the number of molecules in 78.0 grams of sulfur trioxide. (8 pts.)

3) $\underline{5.87 \times 10^{23}\ SO_3\ molecules}$

Molecular Mass of SO_3 = 1(molar mass of $\underline{S}$) + 3(molar mass of O)

$$= 1(32\ g) + 3(16\ g)$$

$$= 80\ g/mol$$

$$78.0\ g\ SO_3 \times \frac{1\ mol\ SO_3}{80\ g\ SO_3} \times \frac{6.022 \times 10^{23}\ SO_3\ molecules}{1\ mol\ SO_3}$$

$$\frac{78.0 \times 6.022 \times 10^{23}\ SO_3\ molecules}{80} = 5.87 \times 10^{23}\ SO_3\ molecules$$

1

4) Calculate the amount (in grams) of potassium in a 42.7 gram sample of potassium nitrate. (10 pts.) ~~Given~~   4) __16.5 g K__

Molecular Mass of $KNO_3 = 1(39.1 g) + 1(14 g) + 3(16 g)$
$$= 101.1 \text{ g/mol}$$

1 mol K to 1 mol KNO_3

$42.7 g \, KNO_3 \times \dfrac{1 \, mol \, KNO_3}{101.1 g \, KNO_3} \times \dfrac{1 \, mol \, K}{1 \, mol \, KNO_3} \times \dfrac{39.1 g \, K}{1 \, mol \, K}$

$$\dfrac{42.7 \times 1 \times 1 \times 39.1 \, g \, K}{101.1} = 16.5 g \, K$$

5) Calculate the mass percent of carbon in oxalic acid, $H_2C_2O_4$. (10 pts.)   5) __26.67%__

Molecular Mass of $H_2C_2O_4 = 2(1) + 2(12) + 4(16)$
$$= 90 \text{ g/mol}$$

~~Mol~~ 2 mol C to 1 mol $H_2C_2O_4$

Molecular Mass of Carbon $= 2(12g)$
$$= 24 g$$

Mass % of carbon in $H_2C_2O_4 = \dfrac{Mass \, of \, Carbon}{Mass \, of \, H_2C_2O_4} \times 100$ $\dfrac{24 g/mol}{90 g/mol} \times 100 = 26.67\%$

6) 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.)   6) __$C_2H_4O_2$__

In a 100 g. sample
C = 40.0 g
H = 6.70 g
O = 53.3 g

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

$6.70 g \, H \times \dfrac{1 \, mol \, H}{1 g \, H} = 6.70 \, mol \, H$

$53.3 g \, O \times \dfrac{1 \, mol \, O}{16 g \, O} = 3.33 \, mol \, O$

Empirical formula $= C_{\frac{3.33}{3.33}} H_{\frac{6.70}{3.33}} O_{\frac{3.33}{3.33}}$

$$= C_1 H_2 O_1$$

Empirical Mass $CH_2O = 1(12) + 2(1) + 1(16 g)$
$$= 30 \text{ g/mol}$$

$60.05 g/mol = 30 g/mol \times n$
$$2 = n$$

molecular formula $= CH_2O \times 2$
$$= C_2H_4O_2$$

Molecular formula ~~mass~~ mass $=$ empirical formula mass $\times n$
Molecular formula $=$ empirical formula $\times n$

7) In the reaction between Fe_2O_3 (s) and Al (s) to produce Fe (s) and Al_2O_3 (s), 23.5 g of Fe_2O_3 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.)

7) Fe_2O_3 is the limiting reagent

$$Fe_2O_3 (s) + 2Al(s) \longrightarrow 2Fe(s) + Al_2O_3 (s)$$
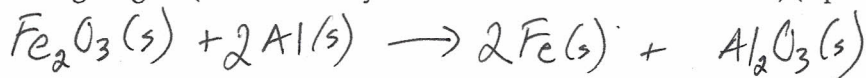
Molecular Mass of $Fe_2O_3 = 2(55.85g) + 3(16g)$
$$= 159.7 g/mol$$

1 mol Fe_2O_3 : 2 mol Al : 2 mol Fe

$23.5g \ Fe_2O_3 \times \dfrac{1 \ mol \ Fe_2O_3}{159.7g} \times \dfrac{2 \ mol \ Fe}{1 \ mol \ Fe_2O_3} \times \dfrac{55.85g \ Fe}{1 \ mol \ Fe} = 16.4 \ g \ Fe \ produced$ ↳limiting reagent produce least amount

$13.2g \ Al \times \dfrac{1 \ mol \ Al}{26.98g} \times \dfrac{2 \ mol \ Fe}{2 \ mol \ Al} \times \dfrac{55.85g \ Fe}{1 \ mol \ Fe} = 27.3 \ g \ Fe \ produced$

53.96

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

Since Al is not the limiting reagent, there will be Al left over. Need to find out how much Al is used in reaction first.

$23.5g \ Fe_2O_3 \times \dfrac{1 \ mol \ Fe_2O_3}{159.7g \ Fe_2O_3} \times \dfrac{2 \ mol \ Al}{1 \ mol \ Fe_2O_3} \times \dfrac{26.98g \ Al}{1 \ mol \ Al} = 7.94 \ g \ of \ Al \ used$

$13.2 \ g \ Al (starting) - 7.94g \ Al \ (used) = 5.26 \ g \ Al \ (left \ over / unreacted)$

3

8) 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

8) ~~% Recovery of salt~~
~~=90.99~~

% Recovery of Salt = 90.99 %

% Recovery of Sand = 99.10%

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

Salt recovered = 72.61 g - 71.60 g
= 1.01 g

$$\% \text{ Recovery of salt} = \frac{\text{Salt recovered}}{\text{salt starting}} \times 100$$

$$= \frac{1.01 g}{1.11 g} \times 100$$

$$= 90.99 \%$$

Sand recovered = 44.55 g - 43.45 g
= 1.1

$$\% \text{ Recovery of Sand} = \frac{\text{Sand recovered}}{\text{Sand starting}} \times 100$$

$$= \frac{1.1}{1.11} \times 100$$

$$= 99.10 \%$$

9) (a) Calculate how many grams of magnesium sulfate is in 63.6 grams of its hydrate
salt . The hydrate salt contains 51.1% water by weight. (3 pts.)

9) $31.1 g \, MgSO_4$

$MgSO_4$ weight is $100\% - 51.1\% = 48.9\%$

Mass of $MgSO_4 = .489 \times (63.6 g)$
$= 31.1 g \, MgSO_4$

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) What is the oxygen–to–sulfur mass ratio of sulfur dioxide?　　　　　　　　　10) _B_
   A) 0.5
   B) 1.0
   C) 2.0
   D) 16
   E) none of the above

11) How many total atoms are in the formula $Al_2(CO_3)_3$?　　　　　　　　　11) _C_
   A) 9
   B) 12
   C) 14
   D) 8
   E) none of the above

(handwritten: Al_2 C_3 O_9)

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) Which of the following is a molecular compound?　　　　　　　　　13) _B_
   A) calcium acetate
   B) nitrogen monoxide
   C) potassium hydroxide
   D) barium sulfide
   E) none of the above

14) What is the formula for an ionic compound made of aluminum and oxygen?　　　14) _C_
   A) AlO
   B) AlO_2
   C) Al_2O_3
   D) Al_3O_2
   E) none of the above

(handwritten: Al^{+3} O^{-2} Al_2O_3)

15) What is the name of the ionic compound made of beryllium and chlorine?　　　15) _D_
   A) monoberyllium dichloride
   B) beryllium(II) chloride
   C) beryllium dichloride
   D) beryllium chloride
   E) none of the above

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 of copper(II) fluoride?
   A) 101.55
   B) 90.00
   C) 165.10
   D) 146.10
   E) none of the above

CuF_2

$63.55 + 2(19)$

17) _A_

18) You have 10.0 g each of Na, C, Pb, Cu and Ne. Which contains the largest number of moles?
   A) C   B) Pb   C) Cu   D) Na   E) Ne

18) _A_

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

XeF_6

$3.2 \, mole \, XeF_6 \times \dfrac{6 \, mo \, F}{1 \, m \, XeF}$

19) _A_

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

$60.3 g \, Mg \times \dfrac{1 \, mol \, Mg}{24.30} = 2.48 \, mol$

$39.7 g \, O \times \dfrac{1 \, mol \, O}{16 \, g \, O} = 2.48 \, mol$

MgO

20) _B_

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

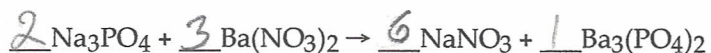$empirical = 3(12) + 5(1)$
$= 41$

$\dfrac{205.4}{41} = n$
$= n$
5

$C_3H_5 \times 5 = C_{15}H_{25}$

21) _B_

6

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

2 Na$_3$PO$_4$ + 3 Ba(NO$_3$)$_2$ → 6 NaNO$_3$ + 1 Ba$_3$(PO$_4$)$_2$

    A) 6, 1, 3, 2
    B) 2, 1, 1, 3
    C) 2, 3, 6, 1
    D) 2, 3, 1, 6
    E) none of the above

23) What are the coefficients for the following reaction when it is properly balanced?   23) __C__

    ___nitrogen monoxide + ___carbon monoxide → ___nitrogen + ___carbon dioxide

    A) 2, 1, 1, 2 $2NO + 2CO → N_2 + 2CO_2$
    B) 1, 1, 2, 2
    C) 2, 2, 1, 2
    D) 2, 2, 2, 1
    E) none of the above
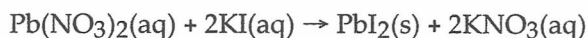
24) Which of the following compounds is INSOLUBLE?   24) __D__
    A) magnesium iodide sol
    B) magnesium nitrate
    C) magnesium sulfate
    D) magnesium phosphate
    E) none of the above

25) Considering the following precipitation reaction: 25) __C__

    Pb(NO$_3$)$_2$(aq) + 2KI(aq) → PbI$_2$(s) + 2KNO$_3$(aq)

    Which ion(s) would NOT be present in the net ionic equation?
    A) Pb^{2+}, NO$_3$$^-$
    B) K$^+$, I$^-$
    C) K$^+$, NO$_3$$^-$
    D) K$^+$, Pb^{2+}
    E) All the above ions are in the net ionic equation.

26) Identify the double displacement reactions among the following: 26) __D__
        1. KCl(aq) + AgNO$_3$(aq) → AgCl(s) + KNO$_3$(aq)
        2. Na$_2$SO$_4$(aq) + BaCl$_2$(aq) → BaSO$_4$(s) + 2NaCl(aq)
        3. H$_2$SO$_4$(aq) + 2NaOH(aq) → Na$_2$SO$_4$(aq) + 2H$_2$O(l)
    A) 1 and 3 only
    B) 2 and 3 only
    C) 1 and 2 only
    D) All of 1, 2, and 3
    E) None of 1, 2, and 3

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

1 mol Cl_2 : 2 mol NaCl

0.6 moles NaCl × $\dfrac{1\ mol\ Cl_2}{2\ mol\ NaCl}$

28) How many grams of sodium metal are needed to make 29.3 grams of sodium chloride?   28) __B__
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 g NaCl $\dfrac{1\ mol\ NaCl}{23+35.45}$ × $\dfrac{2\ mol\ Na}{2\ mol\ NaCl}$ × $\dfrac{23\ g}{1\ mol}$

58.45

116.9 = 11.5 g

29) Many metals react with halogens to give metal halides. For example,   29) __C__

       $2\ Al\ (s) + 3\ Cl_2(g) \rightarrow 2\ AlCl_3\ (s)$ *2 : 7 : 2*

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

13.5 g Al × $\dfrac{1\ mol\ Al}{26.98}$ × $\dfrac{2\ mol\ AlCl_3}{2\ mol\ Al}$ × $\dfrac{133.33}{53.96}$ = 66.7 g AlCl_3

30) What is the theoretical yield of waffles if you have 6 cups of flour, 9 eggs and 2 tbs of oil?   30) __A__
Given: 2 cups flour + 3 eggs + 1 tbs oil → 4 waffles

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

6 cup flour = 12 waf
9 eggs = 12 waf
= 8

31) What is the theoretical yield of a reaction if 25.0 grams of product were actually produced   31) __B__
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% = $\dfrac{25}{x}$ *$\dfrac{25}{x} = .88$*

$x \cdot .88 = 25$ *$25 = .88y$*

$= y$

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

32) The correct formula for calcium fluoride is CaF_3.   *CaF_2*   32) __B__

33) One mole of I_2 has more atoms in it than one mole of Na.   *T*   33) __A__

34) The theoretical yield is the amount of each reactant needed in order to make the maximum   34) __B__
amount of product.

8

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

35) _A_

36) The limiting reactant is not necessarily the reactant with the least mass.

36) _A_