

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 = $83 + (28 \times 3) = 84 + 84 = 167$

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 39.7 g liquid Bromine (Note the formula of Bromine). (8 pts.) 1) 2.99×10^{23}

Liquid Bromine Br_2 , Molar Mass 159.8 g/mol

$$\# \text{ of atoms} = \frac{39.7 \text{ g}}{159.8 \text{ g/mol}} \times 2 \times N_A \quad \text{where } N_A = 6.022 \times 10^{23} \text{ (mol}^{-1}\text{)}$$

$$\# \text{ of atoms} = 2.99 \times 10^{23}$$

- 2) Calculate the amount (in grams) of oxygen in a 21.35 gram sample of lithium sulfate. (10 pts) 2) 12.43g

Li_2SO_4

$$\text{Mass of oxygen} = \frac{21.35 \text{ g}}{\text{Molar Mass of } \text{Li}_2\text{SO}_4} \times 4 \times 16 \text{ g/mol}$$

$$= \frac{21.35 \text{ g}}{109.94 \text{ g/mol}} \times 4 \times 16 \text{ g/mol}$$

$$= 12.43 \text{ g}$$

- 3) An acid has 40% C, 6.7% H, 53.3% O and its molar mass is 120.10 g/mol. Show your calculation to find the molecular formula of the acid? (10 pts.)

3) $\text{C}_4\text{H}_8\text{O}_4$

take 1 mol of this acid, so it has 120.10 g then for mass of C = $120.10 \text{ g} \times 40\%$
= 48.04g

$$\text{mol of C} = \frac{48.04 \text{ g}}{12.011 \text{ g/mol}} \approx 4 \text{ mol}$$

$$\text{mass of H} = 120.10 \text{ g} \times 6.7\% = 8.047 \text{ g}, \quad \text{mol of H} = \frac{8.047 \text{ g}}{1.0079 \text{ g/mol}} \approx 8 \text{ mol}$$

$$\text{mass of O} = 120.10 \text{ g} \times 53.3\% = 64.01 \text{ g}, \quad \text{mol of O} = \frac{64.01 \text{ g}}{15.999 \text{ g/mol}} \approx 4 \text{ mol}$$

So, the molecular formula is $\text{C}_4\text{H}_8\text{O}_4$

- 4) 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 . Show the balanced chemical equation (2 pts.) and all your calculations to find out the limiting reagent (6 pts.) (Tot. 8 pts.)

4) Fe_2O_3



$$\text{mol of Fe}_2\text{O}_3 = \frac{23.5 \text{ g}}{159.69 \text{ g/mol}} = 0.147 \text{ mol}$$

$$\text{mol of Al} = \frac{13.2 \text{ g}}{26.98 \text{ g/mol}} = 0.489 \text{ mol}$$

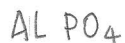
if consume all Fe_2O_3 (s), we need $0.147 \text{ mol} \times 2 = 0.294 \text{ mol}$ of Al .
but we are given 0.489 mol of Al which is more than 0.294 mol.

so, the limiting reagent is Fe_2O_3 (s)

- 5) Write the formula for (3 pts. each; Total 9 pts.):

5) _____

(a) Aluminum phosphate:



(b) Titanium(IV) sulfide:



(c) Diphosphorus tetranitride



- 6) Write the name for (3 pts. each; Total 9 pts.):

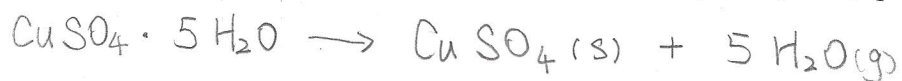
6) _____

(a) $\text{Ba}(\text{HCO}_3)_2$: Barium Hydrogen Carbonate

(b) $\text{Al}_2(\text{CrO}_4)_3$: Aluminium Chromate

(c) $\text{Cr}(\text{PO}_4)_2$: Chromium (VI) Phosphate

7) (a) Write the balanced equation for dehydration of copper (II) sulfate pentahydrate (5 pts.) 7) _____



(b) Calculate the grams of water in 1.1877 grams of copper (II) sulfate pentahydrate (6 pts).

$$\text{Mass of Water} = \frac{1.1877 \text{ g}}{249.68 \text{ g/mol}} \times 5 \times 18 \text{ g/mol} = 0.4281 \text{ g}$$

(c) Calculate the grams of anhydrous salt that remains after you have completely removed the water from 1.1877 grams of copper (II) sulfate pentahydrate (2 pts.)

$$\text{remaining anhydrous salt mass} = 1.1877(\text{g}) - 0.4281 \text{ g} = 0.7596(\text{g})$$

8) To determine the empirical formula of a compound made of Fe and Cl, a student added 2.15 g Zinc to a solution containing 1.750 g of Fe_xCl_y . After the reaction was over, the student isolated 0.771 g of Fe. Use these data to answer the following questions (16 pts total): 8) _____

(a) Calculate the mass of Cl in the Fe_xCl_y solution (2 pt.):

$$\text{mass of Cl} = 1.750 \text{ g} - 0.771 \text{ g} = 0.979 \text{ g}$$

(b) Calculate the number of moles of Fe present in the Fe_xCl_y solution (4 pt.):

$$\text{mol of Fe} = \frac{0.771 \text{ g}}{55.85 \text{ g/mol}} = 0.0138 \text{ mol}$$

(c) Calculate the number of moles of Cl present in the Fe_xCl_y solution (4 pt.):

$$\text{mol of Cl} = \frac{0.979(\text{g})}{35.45 \text{ g/mol}} = 0.0276 \text{ mol}$$

(d) Determine the molar ratio of Fe to Cl in the compound (4pts.).

$$\text{molar ratio of } \frac{\text{Fe}}{\text{Cl}} = \frac{\text{mol of Fe}}{\text{mol of Cl}} = \frac{0.0138 \text{ mol}}{0.0276 \text{ mol}} = \frac{1}{2}$$

(e) Use the above ratio to write the empirical formula of the compound containing Fe and Cl (2 pt.)



MULTIPLE CHOICE. On scantron, fill in the same bubble number as with the M/C or T/F question number. Choose the one alternative that best completes the statement or answers the question. (3 points each)

- 9) How many moles of fluorine are in 3.2 moles of xenon hexafluoride? 9) C
A) 12.8
B) 16
C) 19.2
D) 22.4
E) none of the above
- 10) What is the mass ratio of Na to S in sodium sulfide? 10) D
A) 55.06
B) 0.717
C) 7.17
D) 1.43
E) none of the above
- 11) Which among the following elements does NOT exist as a diatomic molecule in nature? 11) D
A) nitrogen
B) fluorine
C) hydrogen
D) neon
E) none of the above
- 12) Ammonium fluoride is considered which of the following? 12) ~~B~~C
A) atomic element
B) molecular compound
C) ionic compound
D) molecular element
E) none of the above
- 13) What is the formula for an ionic compound made of aluminum and oxygen? 13) C
A) Al_3O_2
B) AlO
C) Al_2O_3
D) AlO_2
E) none of the above
- 14) What is the name of the molecular compound SF_5 ? 14) B
A) sulfur heptafluoride
B) sulfur pentafluoride
C) sulfur hexafluoride
D) monosulfur tetrafluoride
E) none of the above

- 15) Which formula shown is incorrect for the name given?
A) calcium nitrate: $\text{Ca}(\text{NO}_3)_2$
B) ammonium cyanide: NH_4CN
C) strontium carbonate: SrCO_3
D) lithium sulfate: LiSO_4
E) potassium acetate: $\text{KC}_2\text{H}_3\text{O}_2$ 15) D
- 16) What is the formula mass of copper(II) fluoride?
A) 101.55
B) 90.00
C) 146.10
D) 165.10
E) none of the above 16) A
- 17) You have 10.0 g each of Na, C, Pb, Cu and Ne. Which contains the smallest number of moles?
A) Ne B) Na C) Pb D) C E) Cu 17) C
- 18) If a sample of carbon dioxide contains 3.8 moles of oxygen atoms, how many moles of carbon dioxide are in the sample?
A) 11.4
B) 3.8
C) 1.9
D) 7.6
E) none of the above 18) C
- 19) Determine the empirical formula of a compound containing 83% potassium and 17.0% oxygen.
A) K_2O
B) KO
C) K_2O_3
D) KO_2
E) none of the above 19) A
- 20) What are the coefficients for the following reaction when it is properly balanced?
 $__\text{O}_2 + __\text{CH}_4 \rightarrow __\text{CO}_2 + __\text{H}_2\text{O}$
A) 2, 1, 1, 2
B) 2, 3, 2, 2
C) 2, 1, 3, 1
D) 1, 3, 2, 1
E) none of the above 20) A
- 21) Which of the following compounds is INSOLUBLE in water?
A) potassium acetate
B) lithium carbonate
C) aluminum sulfide
D) magnesium bromide
E) none of the above 21) C

- 22) The compound sodium sulfate is soluble in water. When this compound dissolves in water, which ion listed below would be present in solution? 22) C
- A) S^{2-}
 - B) Na_2^{2+}
 - C) SO_4^{2-}
 - D) O^{2-}
 - E) none of the above
- 23) A precipitate is expected to be formed when an aqueous solution of sodium sulfate is added to an aqueous solution of 23) C
- A) iron(III) chloride.
 - B) potassium chloride.
 - C) barium chloride.
 - D) magnesium chloride.
 - E) none of the above
- 24) What type of reaction is the generic equation $AB + CD \rightarrow AD + CB$? 24) A
- A) double-displacement
 - B) decomposition
 - C) synthesis/combination
 - D) single displacement
 - E) none of the above
- 25) In order to determine the limiting reactant in a particular reaction, one must know each of the following EXCEPT 25) B
- A) the mass of each reactant present.
 - B) the mass of each product formed.
 - C) the coefficient of each reactant in a balanced equation.
 - D) the molar mass of each reactant present.
- 26) How many moles of NH_3 can be produced by the reaction of 2.00 g of N_2 with 3.00 g H_2 ? 26) B
- Reaction: $N_2(g) + 3 H_2(g) \rightarrow 2 NH_3(g)$
- A) 1.00
 - B) 0.143
 - C) 0.235
 - D) 0.0567
 - E) none of the above
- 27) What is the limiting reactant for the reaction below given that you start with 10.0 grams of Al and 19.0 grams of O_2 ? 27) A
- Reaction: $4Al + 3O_2 \rightarrow 2Al_2O_3$
- A) Al
 - B) Al_2O_3
 - C) O_2
 - D) both Al and O_2
 - E) not enough information

28) Consider the reaction: $2 \text{Al} + 3\text{Br}_2 \rightarrow 2 \text{AlBr}_3$

Suppose a reaction vessel initially contains 5.0 mole Al and 6.0 mole Br_2 . What is in the reaction vessel once the reaction has occurred to the fullest extent possible?

- A) 1.0 mole Al; 0 mole Br_2 ; 4.0 mole AlBr_3
- B) 2.0 mole Al; 3.0 mole Br_2 ; 2.0 mole AlBr_3
- C) 0 mole Al; 0 mole Br_2 ; 11.0 mole AlBr_3
- D) 0 mole Al; 1.0 mole Br_2 ; 4.0 mole AlBr_3
- E) none of the above

28)

~~A~~

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

29) The correct formula for sodium permanganate is NaMgO_4 .

29) F (B)

30) The numerical value of the mole is defined as being equal to the number of atoms in exactly 12 grams of pure carbon-12.

30) T

31) One mole of nitrogen gas contains $(2) \times (6.022 \times 10^{23})$ nitrogen atoms.

31) T

32) There are 6 grams of carbon in 22 grams of carbon dioxide.

32) T

33) $\text{C}_2\text{H}_3\text{O}_2$ could be an empirical formula.

33) T

34) Bubbles in water that appear during boiling show that a chemical reaction is occurring.

34) F (B)

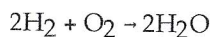
35) Given the chemical equation: $2 \text{Ca} + \text{O}_2 \rightarrow 2 \text{CaO}$,

if 2 moles of CaO are formed in this reaction, then 2 moles of O_2 must have reacted.

35) F

36) For the following reaction you have 8 grams of hydrogen and 2 grams of oxygen.

36) F



The excess reactant is the oxygen.