

## Test bank chapter (3)

## Choose the correct answer

1. What is the mass, in grams, of one copper atom?

- a)  $1.055 \times 10^{-22}$  g  
 b) 63.55 g  
 c) 1 amu  
 d)  $1.66 \times 10^{-24}$  g

$$\frac{m}{M} = \frac{1}{63.55} \times 10^{-23}$$

$$m = \frac{63.55}{6.022 \times 10^{23}} = 1.055 \times 10^{-22} \text{ g}$$

$$n = \frac{m}{M}, \quad n = \frac{N}{N_A}$$

2. Determine the number of moles of aluminum in 96.7 g of Al.

- a) 0.279 mol  
 b) 3.58 mol  
 c) 7.43 mol  
 d) 4.21 mol

$$n = \frac{m}{M} = \frac{96.7}{26.98} = 3.58 \text{ mol}$$

3. Which of the following samples contains the greatest number of atoms?

- a) 100 g of Pb  
 b) 2.0 mole of Ar  
 c) mole of Fe  
 d) 5 g of He

$$\text{a) } \frac{m}{M} = \frac{N}{N_A} \Rightarrow \frac{100}{207.2} = \frac{N}{6.022 \times 10^{23}} \Rightarrow N = \frac{6.022 \times 10^{23} \times 100}{207.2} = 2.906 \times 10^{23} \text{ atoms}$$

$$\text{b) } n = \frac{N}{N_A} \Rightarrow 2 = \frac{N}{6.022 \times 10^{23}} \Rightarrow N = 1.2044 \times 10^{24} \text{ atoms}$$

$$\text{c) } n = \frac{N}{N_A} \Rightarrow 1 = \frac{N}{6.022 \times 10^{23}} \Rightarrow N = 6.022 \times 10^{23} \text{ atoms}$$

$$\text{d) } \frac{m}{M} = \frac{N}{N_A} \Rightarrow \frac{5}{4.003} = \frac{N}{6.022 \times 10^{23}} \Rightarrow N = \frac{5 \times 6.022 \times 10^{23}}{4.003} = 7.522 \times 10^{23} \text{ atoms}$$

4. Formaldehyde has the formula  $\text{CH}_2\text{O}$ . How many molecules are there in 0.11 g of formaldehyde?

- a)  $6.1 \times 10^{-27}$   
 b)  $3.7 \times 10^{-3}$   
 c) 4  
 d)  $2.2 \times 10^{21}$

$$\frac{m}{M} = \frac{N}{N_A} \Rightarrow \frac{0.11}{30.027} = \frac{N}{6.022 \times 10^{23}}$$

$$N = \frac{0.11 \times 6.022 \times 10^{23}}{30.027} = 2.2 \times 10^{21}$$

5. How many sulfur atoms are present in 25.6 g of  $\text{Al}_2(\text{S}_2\text{O}_3)_3$ ?

- a) 0.393  
 b) 6  
 c)  $3.95 \times 10^{22}$   
 d)  $2.37 \times 10^{23}$

$$\begin{aligned} 1 \text{ molecule} &\rightarrow 6 \text{ S atoms} \\ 3.949 \times 10^{22} \text{ molecules} &\rightarrow 2.37 \times 10^{23} \text{ atoms} \end{aligned}$$

$$\frac{m}{M} = \frac{N}{N_A} \Rightarrow \frac{25.6}{390.399} = \frac{N}{6.022 \times 10^{23}} \Rightarrow N = 3.949 \times 10^{22} \text{ molecules}$$

6. The percent composition by mass of a compound is 76.0% C, 12.8% H, and 11.2% O. The molar mass of this compound is 284.5 g/mol. What is the molecular formula of the compound?

- a)  $\text{C}_{10}\text{H}_6\text{O}$   
 b)  $\text{C}_9\text{H}_{18}\text{O}$   
 c)  $\text{C}_{16}\text{H}_{28}\text{O}_4$   
 d)  $\text{C}_{18}\text{H}_{36}\text{O}_2$

	C	H	O
%	76.0	12.8	11.2
$n = \frac{\%}{12.011}$	$\frac{76}{12.011} = 6.327$	$\frac{12.8}{1.008} = 12.70$	$\frac{11.2}{16} = 0.7$
$\times 9$	$\approx 56.94$	$\approx 114.3$	$= 6.3$
$\approx$	57	114	6

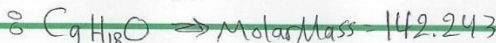
$$\begin{aligned} \text{1) } \% \text{ of each} \\ \text{2) } n = \frac{m}{M} \text{ عدد المولات} \\ \text{3) } n = \frac{\%}{\text{الوزن الجزيئي}} \\ \text{4) } \text{لا نأخذ في الحسبان عدد المولات} \end{aligned}$$

Chem.110

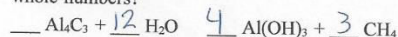
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$$\text{Ratio } \frac{284.5}{142.243} \approx 2$$

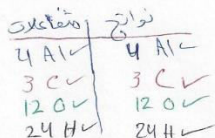
empirical formula



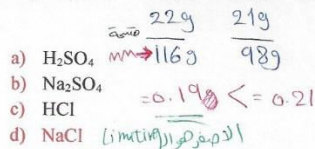
7. What is the coefficient of  $\text{H}_2\text{O}$  when the following equation is properly balanced with the smallest set of whole numbers?



- a) 3  
b) 4  
c) 6  
d) 12



8. When 22.0 g NaCl and 21.0 g  $\text{H}_2\text{SO}_4$  are mixed and react according to the equation below, which is the limiting reagent?  $2\text{NaCl} + \text{H}_2\text{SO}_4 \rightarrow \text{Na}_2\text{SO}_4 + 2\text{HCl}$



9. When the following equation is balanced, the coefficients are \_\_\_\_\_.

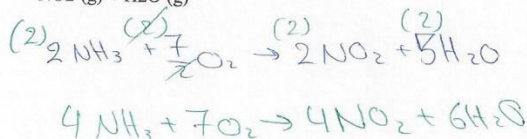


- (a). 1, 1, 1, 1

- (b). 2, 3, 2, 3

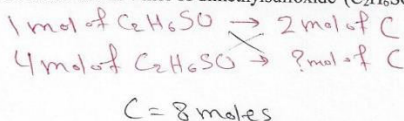
- (c). 4, 7, 4, 6

- (d). 1, 3, 1, 2



10. How many moles of carbon atoms are in 4 mol of dimethylsulfoxide ( $\text{C}_2\text{H}_6\text{SO}$ )?

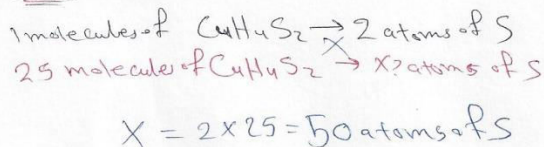
- a) 2  
b) 6  
c) 8  
d) 4



**Explanation:** This is based on reading the formula and correctly extracting information from it. The formula  $\text{C}_2\text{H}_6\text{SO}$  indicates that every mole of this compound has 2 moles of carbon atoms in it. Thus 4 moles of the compound would have  $4 \times 2 = 8$  moles of C atoms.

11. There are \_\_\_\_\_ sulfur atoms in 25 molecules of  $\text{C}_4\text{H}_4\text{S}_2$ .

- a)  $1.5 \times 10^{25}$   
b)  $4.8 \times 10^{25}$   
c)  $3.0 \times 10^{23}$   
d) 50



**Explanation:** The molecular formula indicates that every molecule of  $C_4H_4S_2$  has 2 sulfur atoms per molecule and hence 25 molecules of this compound will have  $25 \times 2 = 50$  atoms of sulfur.

12. There are \_\_\_\_\_ hydrogen atoms in 25 molecules of  $C_4H_4S_2$ .

- a) 25
- b)  $3.8 \times 10^{24}$
- c)  $6.0 \times 10^{25}$
- d) **100**

$$\begin{aligned} 1 \text{ molecule of } C_4H_4S_2 &\rightarrow 4 \text{ atoms of H} \\ 25 \text{ molecules of } C_4H_4S_2 &\rightarrow x \text{ atoms of H} \\ H &= 4 \times 25 = 100 \text{ atoms} \end{aligned}$$

**Explanation:** The formula of  $C_4H_4S_2$  indicates that there are 4 hydrogen atoms per molecule and hence 100 hydrogen atoms in 25 molecules of  $C_4H_4S_2$ .

13. How many grams of oxygen are in 65.0 g of  $C_2H_2O_2$ ?

- a) 18
- b) 29
- c) 9.5
- d) **35.8**

$$\begin{aligned} \text{المطلوب} \{ 65 \text{ g of } C_2H_2O_2 &\Rightarrow x \text{ g of } O_2 \\ \text{الحقيق} \{ 58 \text{ g of } C_2H_2O_2 &\Rightarrow 32 \text{ g of } O_2 \\ x &= \frac{32 \times 65}{58} = 35.862 \text{ g} \end{aligned}$$

**Explanation:** This question uses the mole to mole ratio between oxygen and  $C_2H_2O_2$  and needs the following

$$\text{steps. } \frac{65.0 \text{ g } C_2H_2O_2}{58.0 \text{ g} \cdot \text{mol}^{-1}} \times \frac{2 \text{ moles O}}{1 \text{ mole } C_2H_2O_2} \times \frac{15.99 \text{ g O}}{1 \text{ mole of O}} = 35.8 \text{ g of O}$$

17. How many moles of carbon dioxide are there in 52.06 g of carbon dioxide?

- a) 0.8452
- b) **1.183**
- c)  $1.183 \times 10^{23}$
- d)  $8.648 \times 10^2$

$$\begin{aligned} n &= \frac{m}{MM} \\ n &= \frac{52.06}{44.01} = 1.183 \text{ mol} \end{aligned}$$

**Explanation:** This is a straight-forward conversion from grams to moles of  $CO_2$  which is done as follows:

$$52.06 \text{ g } CO_2 \times \frac{1 \text{ mole } CO_2}{43.99 \text{ g } CO_2} = 1.183 \text{ moles of } CO_2$$

18. How many moles of the compound magnesium nitrate,  $Mg(NO_3)_2$ , are in a 2.35 g sample of this compound?

- a) 38.4
- b) 65.8
- c) **0.0158**
- d) 0.0261

$$n = \frac{m}{MM} = \frac{2.35}{148.324} = 0.0158 \text{ moles}$$

**Explanation:** This is a straight-forward conversion from grams to moles of  $Mg(NO_3)_2$  which is done as

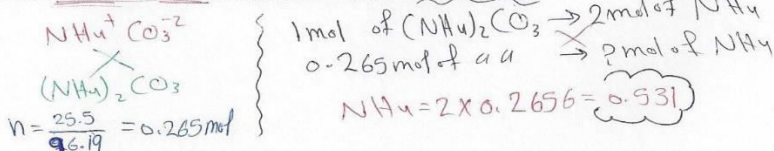


follows:

$$2.35 \text{ g Mg(NO}_3)_2 \times \frac{1 \text{ mole Mg(NO}_3)_2}{148.3148 \text{ g}} = 0.0158 \text{ moles} \quad \text{C } \checkmark$$

19. A 25.5-g sample of ammonium carbonate contains \_\_\_\_\_ mol of ammonium ions.

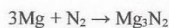
- a) 0.468
- b) 0.288
- c) 0.531
- d) 2.00



**Explanation:** Realize that the formula for ammonium carbonate is  $(\text{NH}_4)_2\text{CO}_3$  and calculate the molar mass (96.0856 g/mol). Convert grams to moles and then using the stoichiometric ratio find the # of moles of ammonium ions.

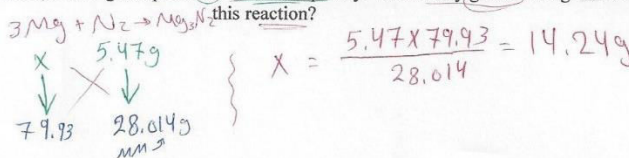
$$25.5 \text{ g } (\text{NH}_4)_2\text{CO}_3 \times \frac{1 \text{ mol } (\text{NH}_4)_2\text{CO}_3}{96.0856 \text{ g}} \times \frac{2 \text{ moles NH}_4^+}{1 \text{ mol } (\text{NH}_4)_2\text{CO}_3} = 0.531 \text{ moles} \quad \text{(C) } \checkmark$$

20. Magnesium and nitrogen react in a combination reaction to produce magnesium nitride:



In a particular experiment, a 5.47-g sample of  $\text{N}_2$  reacts completely. How many grams of Mg are needed for

- a) 14.2 g
- b) 24.1 g
- c) 16.1 g
- d) 0.92 g



**Explanation:** Ensure that the equation is balanced. The grams of  $\text{N}_2$  must be converted to moles of  $\text{N}_2$  and then using the stoichiometric ratio between the Mg and  $\text{N}_2$ , the grams of Mg can be calculated.

$$5.47 \text{ g N}_2 \times \frac{1 \text{ mole N}_2}{28.0134 \text{ g}} \times \frac{3 \text{ mole Mg}}{1 \text{ mole N}_2} \times \frac{24.3050 \text{ g Mg}}{1 \text{ mole Mg}} = 14.2 \text{ g Mg}$$

21. What information would you need to calculate the average atomic mass of an element?

- a) The number of neutrons in the element.
- b) The atomic number of the element.
- c) The mass and abundance of each isotope of the element.
- d) The position in the periodic table of the element.

22. The atomic masses of  $^{35}\text{Cl}$  (75.53 %) and  $^{37}\text{Cl}$  (24.47 %) are 34.968 amu and 36.956 amu, respectively. Calculate the average atomic mass of chlorine.

- a) 35.96 amu  
b) 35.45 amu  
c) 36.47 amu  
d) 71.92 amu

$$= \left( \frac{75.53}{100} \right) (34.968) + \left( \frac{24.47}{100} \right) (36.956) = 35.45 \text{ amu}$$

23. How many atoms are there in 5.10 moles of sulfur ( $16\text{S}=32$  amu)?

- a)  $3.07 \times 10^{24}$   
b)  $9.59 \times 10^{22}$   
c)  $6.02 \times 10^{23}$   
d)  $9.82 \times 10^{25}$

$$n = \frac{N}{N_A} \Rightarrow 5.10 \times \frac{N}{6.022 \times 10^{23}} \Rightarrow N = 3.07 \times 10^{24}$$

24. Iodine has two isotopes  $^{126}\text{I}$  and  $^{127}\text{I}$ , with the equal abundance. Calculate the average atomic mass of Iodine ( $53\text{I}$ ).

- a) 126.5 amu  
b) 35.45 amu  
c) 1.265 amu  
d) 71.92 amu

$$= \frac{50}{100} (126) + \frac{50}{100} (127) = 126.5 \text{ amu}$$

25. The atomic masses of  $^6\text{Li}$  and  $^7\text{Li}$  are 6.0151 amu and 7.0160 amu, respectively. Calculate the natural abundance of these two isotopes. The average atomic mass of Lithium ( $\text{Li}=6.941$  amu).

- a)  $^6\text{Li}=7.49\%$ ,  $^7\text{Li}=92.51\%$   
b)  $^7\text{Li}=7.49\%$ ,  $^6\text{Li}=92.51\%$   
c)  $^6\text{Li}=8.49\%$ ,  $^7\text{Li}=95.51\%$   
d)  $^7\text{Li}=7.22\%$ ,  $^6\text{Li}=82.51\%$

$$\text{Average Atomic Mass} = \frac{\text{abundance}_1 (\text{mass}_1)}{100} + \frac{\text{abundance}_2 (\text{mass}_2)}{100} + \dots$$

$$6.941 = \frac{6.0151 \times X_1 + (100 - X_1)(7.0160)}{100}$$

$$694.1 = 6.0151X_1 + 701.6 - 7.0160X_1$$

$$-7.5 = \frac{-1.0009X}{-1.0009} \Rightarrow X = 7.49\%$$

$$(100 - X) = (100 - 7.49) = 92.51\%$$

26. How many atoms are present in 3.14 g of copper ( $\text{Cu}$ )?

- a)  $2.98 \times 10^{22}$   
b)  $1.92 \times 10^{23}$   
c)  $1.89 \times 10^{24}$   
d)  $6.02 \times 10^{23}$

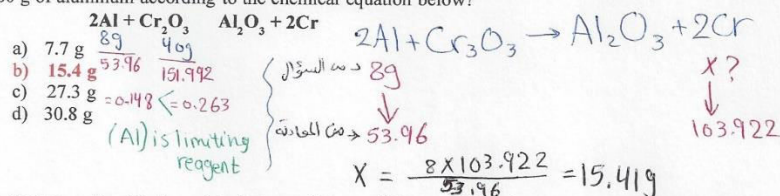
$$n = \frac{m}{M} = \frac{N}{N_A} \Rightarrow \frac{3.14}{63.546} = \frac{N}{6.022 \times 10^{23}}$$

$$N = \frac{3.14 \times 6.022 \times 10^{23}}{63.546} = 2.98 \times 10^{22} \text{ atoms}$$

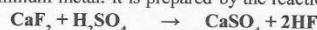




31. What is the theoretical yield of chromium that can be produced by the reaction of 40.0 g of  $\text{Cr}_2\text{O}_3$  with 8.00 g of aluminum according to the chemical equation below?



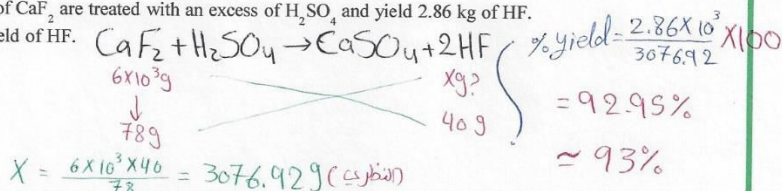
32. Hydrogen fluoride is used in the manufacture of Freons (which destroy ozone in the stratosphere) and in the production of aluminum metal. It is prepared by the reaction



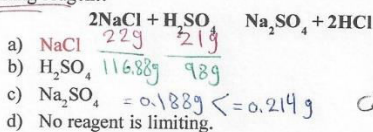
In one process 6.00 kg of  $\text{CaF}_2$  are treated with an excess of  $\text{H}_2\text{SO}_4$  and yield 2.86 kg of HF.

Calculate the percent yield of HF.

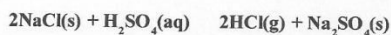
- a) 93.0 %  
 b) 95.3 %  
 c) 47.6 %  
 d) 62.5 %



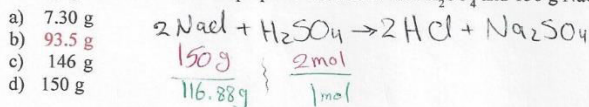
33. When 22.0 g NaCl and 21.0 g  $\text{H}_2\text{SO}_4$  are mixed and react according to the equation below, which is the limiting reagent?



34. Hydrochloric acid can be prepared by the following reaction:



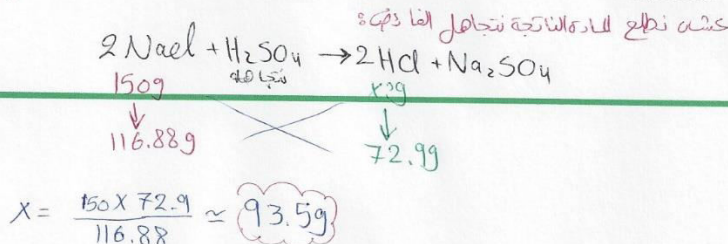
How many grams of HCl can be prepared from 2.00 mol  $\text{H}_2\text{SO}_4$  and 150 g NaCl?



Chem.110 Limiting reagent is  $1.28 < 2\text{mol}$

2012

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35. Calculate the molar mass of  $\text{Li}_2\text{CO}_3$ .

- a) 73.89 g  
b) 66.95 g  
c) 41.89 g  
d) 96.02 g

$$2(6.941) + 12.011 + 3(16)$$

$$M = 73.893 \text{ g/mol}$$

36. How many molecules of ethane ( $\text{C}_2\text{H}_6$ ) are present in 0.334 g of  $\text{C}_2\text{H}_6$ ?

- a)  $2.01 \times 10^{23}$   
b)  $6.69 \times 10^{21}$   
c)  $4.96 \times 10^{22}$   
d)  $8.89 \times 10^{20}$

$$n = \frac{m}{M} = \frac{N}{N_A}$$

$$\frac{0.334}{30.07} = \frac{N}{6.022 \times 10^{23}}$$

$$N = \frac{0.334 \times 6.022 \times 10^{23}}{30.07} = 6.689 \times 10^{21} \approx 6.69 \times 10^{21} \text{ molecules}$$

37. All of the substances listed below are fertilizers that contribute nitrogen to the soil. Which of these is the richest Source of nitrogen on a mass percentage basis?

- a) Urea,  $(\text{NH}_2)_2\text{CO}$   
b) Ammonium nitrate,  $\text{NH}_4\text{NO}_3$   
c) Guanidine,  $\text{HNC}(\text{NH}_2)_2$   
d) Ammonia,  $\text{NH}_3$

$$\text{(a)} \quad N\% = \frac{(2 \times 14)}{46} \times 100 = 70\%$$

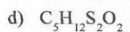
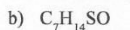
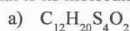
$$\text{(b)} \quad N\% = \frac{(2 \times 14)}{80} \times 100 = 35\%$$

$$\text{(c)} \quad N\% = \frac{(3 \times 14)}{59} \times 100 = 71\%$$

$$\text{(d)} \quad N\% = \frac{14}{17} \times 100 = 82\% \quad \checkmark$$

38. Allicin is the compound responsible for the characteristic smell of garlic. An analysis of the compound gives the following percent composition by mass: C: 44.4 percent; H: 6.21 percent; S: 39.5 percent; O: 9.86 percent.

What is its molecular formula given that its molar mass is about 162 g?

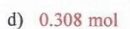
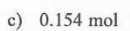


	C	H	S	O
	44.4	6.21	39.5	9.86
	12.011	1.008	32.066	16

$$n = \frac{3.6966}{0.61625} = 6.00 \approx 6$$

empirical formula  $\text{C}_6\text{H}_{10}\text{S}_2\text{O}$   
Ratio =  $\frac{162}{162.278} = 0.998 \approx 1$   
molecular formula

39. The formula for rust can be represented by  $\text{Fe}_2\text{O}_3$ . How many moles of Fe are present in 24.6 g of the compound?



$$n = \frac{m}{M}$$

$$n = \frac{24.6}{159.69}$$

$$n = 0.154 \text{ mol}$$

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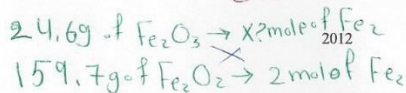
$$n = 0.154 \text{ mol}$$

$$n = 0.154 \text{ mol}$$

$$n = 0.154 \text{ mol}$$

$$n = 0.154 \text{ mol}$$

$$n = 0.154 \text{ mol}$$



$$x = 0.308 \text{ mol}$$



40. What is the mass, in grams, of one copper atom?

- a)  $1.055 \times 10^{-22}$  g  
 b) 63.55 g  
 c) 1 amu  
 d)  $1.66 \times 10^{-24}$  g

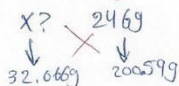
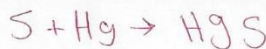
$$n = \frac{m}{M} = \frac{N}{N_A}$$

$$\frac{m}{63.546} \times \frac{1}{6.022 \times 10^{23}}$$

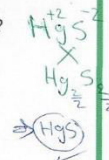
$$m = \frac{63.546}{6.022 \times 10^{23}} = 1.055 \times 10^{-22} \text{ g}$$

41. How many grams of sulfur (S) are needed to react completely with 246 g of mercury (Hg) to form HgS?

- a) 39.3 g  
 b) 24.6 g  
 c)  $9.66 \times 10^3$  g  
 d) 201 g

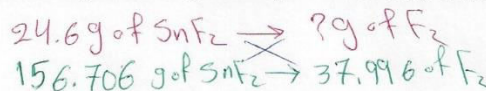


$$X = \frac{246 \times 32.066}{200.59} = 39.3\text{g}$$



42. Tin(II) fluoride ( $\text{SnF}_2$ ) is often added to toothpaste as an ingredient to prevent tooth decay. What is the mass of F in grams in 24.6 g of the compound?

- a) 18.6 g  
 b) 24.3 g  
 c) 5.97 g  
 d) 75.7 g

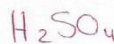


$$X = \frac{24.6 \times 37.996}{156.706} = 5.965 \approx 5.97\text{g}$$

43. What is the empirical formula of the compound with the following composition? 2.1 percent H, 65.3 percent O, 32.6 percent S.

- a)  $\text{H}_2\text{SO}_4$   
 b)  $\text{H}_2\text{SO}_3$   
 c)  $\text{H}_2\text{S}_2\text{O}_3$   
 d)  $\text{HSO}_3$

H	O	S
$n = \frac{2.1}{1.008}$	$= \frac{65.3}{16}$	$= \frac{32.6}{32.066}$
$= 2.083$	$= 4.081$	$= 1.017$
$\approx 2$	$\approx 4$	$\approx 1$



(1) نقيس النسب  
 (2) نطلع عدداً مشتركاً  
 (3) نقسم على أصغر عدد

44. Which of the following samples contains the greatest number of atoms?

- a) 100 g of Pb  
 b) 2.0 mole of Ar  
 c) mole of Fe  
 d) 5 g of He

45. Formaldehyde has the formula  $\text{CH}_2\text{O}$ . How many molecules are there in 0.11 g of formaldehyde?

- a)  $6.1 \times 10^{-27}$  molecule  
 b)  $3.7 \times 10^{-3}$  molecule  
 c)  $4 \times 10^{21}$  molecule  
 d)  $2.2 \times 10^{21}$  molecule

$$\textcircled{1} n = \frac{m}{M} = \frac{0.11}{30.027} = 3.66 \times 10^{-3} \text{ mol}$$

$$\textcircled{2} n = \frac{N}{N_A} \quad 3.66 \times 10^{-3} = \frac{N}{6.022 \times 10^{23}}$$

$$N = 2.2 \times 10^{21} \text{ molecules}$$

46. Determine the number of moles of aluminum in 96.7 g of Al.

- a) 0.279 mol
- b) 3.58 mol
- c) 7.43 mol
- d) 4.21 mol

47. How many sulfur atoms are present in 25.6 g of  $\text{Al}_2(\text{S}_2\text{O}_3)_3$ ?

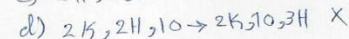
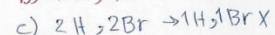
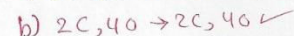
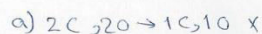
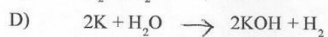
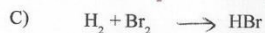
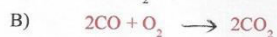
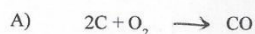
- a) 0.393
- b) 3.95  $10^{22}$
- c) 7.90  $10^{22}$
- d) 2.37  $10^{23}$

48. What is the coefficient of  $\text{H}_2\text{O}$  when the following equation is properly balanced with the smallest set of whole numbers?



- a) 3
- b) 4
- c) 6
- d) 12

50. Which of the following equations is balanced?



51. Determine the number of moles of aluminum in 96.7 g of Al

- a) 0.279 mol
- b) 3.58 mol
- c) 7.43 mol
- d) 4.21 mol