Mass relationships in chemical reactions

Test bank chapter (3)

Choose the correct answer

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

   a) 1.055×10^{-22} g
   b) 63.55 g
   c) 20 g
   d) 1.66×10^{-24} g

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

   a) 0.279 mol
   b) 3.58 mol
   c) 7.43mol
   d) 4.21 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) 0.1 mole of Fe
   d) 5 g of He

4. How many molecules are there in 0.11 g of formaldehyde (CH_2O)?

   a) 6.1×10^{-27}
   b) 3.7×10^{-3}
   c) 4×10^{22}
   d) 2.2×10^{21}

5. How many sulfur atoms are present in 25.6 g of $Al_2(S_2O_3)_3$?

   a) 0.393
   b) 6×10^{-5}
   c) 3.95×10^{22}
   d) 2.37×10^{23}

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) $C_{10}H_6O$
   b) $C_9H_{18}O$
   c) $C_{16}H_{28}O_4$
   d) $C_{18}H_{36}O_2$

7. What is the coefficient of H_2O when the following equation is properly balanced with the smallest set of whole numbers?

$$\_\_\_\_Al_4C_3 + \_\_\_\_H_2O \rightarrow \_\_\_\_\ Al(OH)_3 + \_\_\_\_CH_4$$

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

8. When 22.0 g NaCl and 21.0 g H_2SO_4 are mixed and react according to the equation below, which is the limiting reagent?

$$2NaCl + H_2SO_4 \rightarrow Na_2SO_4 + 2HCl$$

a) H_2SO_4
b) Na_2SO_4
c) HCl
d) NaCl

9. What are the coefficients, when the following equation is balanced?

$$NH_3(g) + O_2(g) \rightarrow NO_2(g) + H_2O(g)$$

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 moles of dimethyl sulfoxide (C_2H_6SO)?

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

Explanation: This is based on reading the formula and correctly extracting information from it. The formula C_2H_6SO 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. How many sulfur atoms are in 25 molecules of $C_4H_4S_2$?

a) 20
b) 4.8×10^{25}
c) 3.0×10^{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. Calculate hydrogen atoms in 25 molecules of $C_4H_4S_2$.

   a) 25
   b) 3.8×10^{24}
   c) 6.0×10^{25}
   d) 100

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

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

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

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

   a) 0.8452
   b) 1.183
   c) 1.183×10^{23}
   d) 8.648×10^{2}

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

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

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

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

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

$$2.35\text{ g } Mg(NO_3)_2 \times \frac{1\text{ mole } Mg(NO_3)_2}{148.3148\text{ g}} = 0.0158\text{moles}$$

16. How many moles of ammonium ions are there in 25.5 g of ammonium carbonate?

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

Explanation: Realize that the formula for ammonium carbonate is $(NH_4)_2CO_3$ 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.

$$25.5\text{ g }(NH_4)_2CO_3 \times \frac{1\text{ mol }(NH_4)_2CO_3}{96.0856\text{ g}} \times \frac{2\text{ moles }NH_4^+}{1\text{ mol }(NH_4)_2CO_3} = 0.531\text{ moles}$$

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

$$\mathbf{3Mg + N_2 \rightarrow Mg_3N_2}$$

In a particular experiment, 5.47 g sample of N_2 reacts completely. How many grams of Mg are needed for this reaction?

    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 N_2 must be converted to moles of N_2 and then using the stoichiometric ratio between the Mg and N_2, the grams of Mg can be calculated.

$$5.47\text{ g }N_2 \times \frac{1\text{ mole }N_2}{28.0134\text{ g}} \times \frac{3\text{ mole Mg}}{1\text{ mole }N_2} \times \frac{24.3050\text{ g Mg}}{1\text{mole Mg}} = 14.2\text{ g Mg}$$

18. 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.

19. The atomic masses of ^{35}Cl (75.53 %) and ^{37}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

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

    a) 3.07×10^{24}
    b) 9.59×10^{22}
    c) 6.02×10^{23}
    d) 9.82×10^{25}

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

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

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

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

23. How many atoms are present in 3.14 g of copper (Cu)?

    a) 2.98×10^{22}
    b) 1.92×10^{23}
    c) 1.89×10^{24}
    d) 6.02×10^{23}

24. How many moles of NO_2 can be produced by the reaction of 0.886 mole of NO with 0.503 mole of O_2 according to the following chemical equation? (Note: First determine which is the limiting reagent).

$$\mathbf{2NO(g) + O_2(g) \rightarrow 2NO_2(g)}$$

    a) 0.886 mol
    b) 0.503 mol
    c) 1.01 mol
    d) 1.77 mol

25. How many kilograms of NH_3 are needed to produce 1.00×10^5 kg of $(NH_4)_2SO_4$ according to the following chemical equation?

$$\mathbf{2NH_3(g) + H_2SO_4(aq) \rightarrow (NH_4)_2SO_4(aq)}$$

    a) 1.70×10^4 kg
    b) 3.22×10^3 kg
    c) 2.58×10^4 kg
    d) 7.42×10^4 kg

26. When 3.60 moles of CO mixed with excess oxygen gas and CO_2 is formed. Calculate no. of moles of CO_2 produced.

$$2CO(g) + O_2(g) \rightarrow 2CO_2(g)$$

a) 7.20 mol
b) 44.0 mol
c) 3.60 mol
d) 1.80 mol

27. How many grams of N_2O are formed if 0.46 mole of NH_4NO_3 is used in the following chemical reaction?

$$NH_4NO_3 \rightarrow N_2O + 2H_2O$$

a) 2.0 g
b) 3.7×10^1 g
c) 2.0×10^1 g
d) 4.6×10^{-1} g

28. What is the theoretical yield of chromium that can be produced by the reaction of 40.0 g of Cr_2O_3 with 8.00 g of aluminum according to the chemical equation below?

$$2Al + Cr_2O_3 \rightarrow Al_2O_3 + 2Cr$$

a) 7.7 g
b) 15.4 g
c) 27.3 g
d) 30.8 g

29. What is the percent yield of HF that can be produced by the reaction of 6.00 kg of CaF_2 with an excess of H_2SO_4 which yield 2.86 kg of HF according to the following chemical equation?

$$CaF_2 + H_2SO_4 \rightarrow CaSO_4 + 2HF$$

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

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

$$\mathbf{2NaCl(s) + H_2SO_4(aq) \rightarrow 2HCl(g) + Na_2SO_4(s)}$$

How many grams of HCl can be prepared from 2.00 moles of H_2SO_4 and 150 g of NaCl?

a) 7.30 g
b) 93.5 g
c) 146 g
d) 150 g

31. Calculate the molar mass of Li_2CO_3.

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

32. How many molecules of ethane (C_2H_6) are present in 0.334 g of C_2H_6?

a) 2.01×10^{23}
b) 6.69×10^{21}
c) 4.96×10^{22}
d) 8.89×10^{20}

33. Out of these, which is the richest source of nitrogen on a mass percentage basis?

a) Urea, $(NH_2)_2CO$
b) Ammonium nitrate, NH_4NO_3
c) Guanidine, $HNC(NH_2)_2$
d) Ammonia, NH_3

34. An analysis of Allicin (molar mass ≈ 162 g/mol) gives C: 44.4 percent; H: 6.21 percent; S: 39.5 percent; O: 9.86 percent. What is its molecular formula?

a) $C_{12}H_{20}S_4O_2$
b) $C_7H_{14}SO$
c) $C_6H_{10}S_2O$
d) $C_5H_{12}S_2O_2$

Mass relationships in chemical reactions

35. How many moles of Fe are present in 24.6 g of Fe_2O_3?

a) 2.13 mol
b) 0.456 mol
c) 0.154 mol
d) 0.308 mol

36. 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) 9.66×10^3 g
d) 201 g

37. What is the mass of F (fluoride) in 24.6 g of Tin (II) fluoride (SnF_2)?

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

38. 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) H_2SO_4
b) H_2SO_3
c) $H_2S_2O_3$
d) HSO_3

39. Which of the following equations is balanced?

a) $2C + O_2 \rightarrow CO$
b) $2CO + O_2 \rightarrow 2CO_2$
c) $H_2 + Br_2 \rightarrow HBr$
d) $2K + H_2O \rightarrow 2KOH + H_2$