Sample Problems

Answers

1. 0.50 bushel × (1 dozen/0.20 bushel) × (2.0 kg/1 dozen) = 5.0 kg

2. 14 kg × (1 dozen/2.0 kg) × (12 apples/1 dozen) × (8 seeds/1 apple) = 670 seeds

3. 2.80×10^{24} atoms Si × (1 mol/6.02×10^{23} atoms) = 4.65 mol Si

4. 2.17×10^{23} representative particles × (1 mol/6.02×10^{23} representative particles) = 0.360 mol Br_2

FIGURE 10.3 3.61×10^{24} atoms

5. 1.14 mol × (6.02×10^{23} molecules/mol) × (4 atoms/molecule) = 2.75×10^{24} atoms

6. 2.12 mol C_3H_6 × (6.02×10^{23} molecule/mol) × (3 atoms/molecule) = 3.83×10^{24} C atoms
2.12 mol C_3H_6 × (6.02×10^{23} molecule/mol) × (8 atoms/molecule) = 1.02×10^{25} H atoms

7. 1 mol P × (31.0 g P/1 mol P) = 31.0 g P
3 mol Cl × (35.5 g Cl/1 mol Cl)= 106.5 g Cl
31.0 g P + 106.5 g Cl = 138 g/mol

8. 1 mol Na × (23.0 g Na/1 mol Na) = 23.0 g Na
1 mol H × (1.0 g H/1 mol H) = 1.0 g H
1 mol C × (12.0 g C/1 mol C) = 12.0 g C
3 mol O ×(16.0 g O/1 mol O) = 48.0 g O
23.0 g Na + 1.0 g H + 12.0 g C + 48.0 g O = 84.0 g

Lesson Check Answers

9. You need a common unit.

10. Chemists use the mole to count the number of representative particles in a substance.

11. The molar mass of an element is the mass of a mole of the element. To calculate the molar mass of a compound, find the number of grams of each element in one mole of the compound. Then add the masses of the elements in the compound.

12. 0.10 bushel

13. 2.49×10^{-1} mol NH_3

14. 5.27×10^{24} atoms

15. 136.2 g/mol

12. 1 doz = 2.0 kg = 0.20 bushel → 1.0 kg x 0.20 bushel/2.0 kg = 0.1 bushel

13. 1.50 x 10^{23} molecules x 1 mol/6.02 x 10^{23} molecules = 2.49 x 10^{-1} mol NH_3

14. 1.75 mol x 6.02 x 10^{23} molecules/1 mol x 5 atoms/molecule [$CHCl_3$]

= 5.27 x 10^{24} atoms

15. Ca (40 g/mol) + S (32 g/mol) + 4 O (16 g/mol x 4) = 136 g/mol

Sample Problems

Answers

16. 4.52×10^{-3} mol $C_{20}H_{42}$ × (282.0 g $C_{20}H_{42}$/1 mol $C_{20}H_{42}$) = 1.27 g $C_{20}H_{42}$

17. 2.50 mol $Fe(OH)_2$ × (89.8 g $Fe(OH)_2$/1 mol $Fe(OH)_2$) = 225 g $Fe(OH)_2$

18. 3.70×10^{-1} g B × 0 (1 mol B/10.8 g B) = 3.43×10^{-2} mol B

19. 75.0 g N_2O_3 × (1 mol N_2O_3/76.0 g N_2O_3) = 0.987 mol N_2O_3

FIGURE 10.7 No; container (a) would be able to accommodate more molecules than container (b).

20. **a.** 3.20×10^{-3} mol CO_2 × (22.4 L CO_2/1 mol CO_2) = 7.17×10^{-2} L CO_2

b. 3.70 mol N_2 × (22.4 L N_2/1 mol N_2) = 82.9 L N_2

c. 0.960 mol CH_4 × (22.4 L CH_4/1 mol CH_4) = 21.5 L CH_4

21. **a.** 67.2 L SO_2 × (1 mol SO_2/22.4 L SO_2) = 3.00 mol SO_2

b. 0.880 L He × (1 mol He/22.4 L He) = 0.0393 mol He

c. 1.00×10^3 L C_2H_6 × (1 mol C_2H_6/22.4 L C_2H_6) = 44.6 mol C_2H_6

SAMPLE PROBLEM 10.8

22. 3.58 g/1 L × (22.4 L/1 mol) = 80.2 g/mol

23. 83.8 g/1 mol × (1 mol/22.4 L) = 3.74 g/L

FIGURE 10.8 You need to convert the mass of the gas to the moles of gas. Then convert moles to volume, so you need to use two conversion factors.

Lesson Check Answers

24. To convert mass to moles, multiply the given mass by 1 mol/molar mass. To convert moles to mass, multiply the given number of moles by molar mass/1 mol.

25. Divide the volume by 22.4 L.

26. 567 g $CaCO_3$

27. 11.0 mol C_2H_6O

28. 33.6 L Cl_2

29. The balloons have the same number of molecules. Each balloon is filled with one mole of gas, and one mole of any gas has the same number of molecules. The masses of the balloons will differ.

30. 39.9 g/mol

31. gas A: 28.0 g, nitrogen; gas B: 64.1 g, sulfur dioxide; gas C: 16.0 g, methane

32. **BIGIDEA** She needs to convert the volume of the gas to moles. Then she can covert moles to mass. She cannot determine mass without knowing moles.

26. 5.66 mol $CaCO_3$ …

Ca (40 g/mol) + C (12 g/mol) + 3 O (16 g/mol x 3) = 100 g/mol

5.66 mol x 100 g/mol = 566 g $CaCO_3$

27. 508 g ethanol … C_2H_6O

C (12.0 g/mol x 2) + H (1.0 g/mol x 6) + O (16.0 g/mol) = 46.0 g/mol

508 g x 1 mol/46.0 g = 11.0 mol C_2H_6O

28. 1.50 mol x 22.4 L/mol = 33.6 Cl_2 (g)

30. 1.7824 g/L x 22.4 L/mol = 39.9 g/mol

31. 1.25 g/l x 22.4 L/mol = 28.0 g/mol N_2

2.86 g/l x 22.4 L/mol = 64.1 g/mol SO_2

0.714 g/l x 22.4 L/mol = 16.0 g/mol O_2

Sample Problems

Answers

FIGURE 10.9 The percent composition of $K_2Cr_2O_7$ is 26.5% K, 35.4% Cr, and 38.1% O.

33. Mass of compound = 9.03 g + 3.48 g = 12.51 g; (9.03 g Mg/12.51 g compound) × 100% = 72.2% Mg; (3.48 g N/12.51 g compound) × 100% = 27.8% N

34. Mass of O = 14.2 g − 13.2 g = 1.0 g O; (1.0 g O/14.2 g) × 100% = 7.0% O; (13.2 g Hg/14.2 g) × 100% = 93.0% Hg

35. **a.** (14.0 g N/17.0 g) × 100% = 82.4% N
b. (28.0 g N/80.0 g) × 100% = 35.0% N

36. **a.** (24.0 g C/30.0 g) × 100% = 80.0% C
(6.00 g H/30.0 g) × 100% = 20.0% H
b. (23.0 g Na/120.1 g) × 100% = 19.2% Na
(1.0 g H/120.1 g) × 100% = 0.83% H
(32.1 g S/120.1 g) × 100% = 26.7% S
(64.0 g O/120.1 g) × 100% = 53.3% O

37. **a.** 125 g NH_3 × (82.4 g N/100 g NH_3) = 103 g N
b. 125 g NH_4NO_3 × (35.0 g N/100 g NH_4NO_3) = 43.8 g N

38. **a.** 350 g C_2H_6 × (2.0×10^1 g H/100g C_2H_6) = 7.0×10^1 g H
b. 20.2 g $NaHSO_4$ × (0.83 g H /100 g $NaHSO_4$) = 0.17 g H

FIGURE 10.11 CH

39. **a.** 94.1 g O × (1 mol O/16.0 g O) = 5.88 mol O
5.9 g H × (1 mol H/1.0 g H) = 5.9 mol H
5.88 mol O/5.88 = 1.00 mol O
5.9 mol H/5.88 = 1.0 mol H
Empirical formula = HO

b. 67.6 g Hg × (1 mol Hg/200.6 g Hg) = 0.337 mol Hg
10.8 g S × (1 mol S/32.1 g S) = 0.336 mol S
21.6 g O × (1 mol O/16.0 g O) = 1.35 mol O
0.337 mol Hg/0.336 = 1.00 mol Hg
0.336 mol S/0.336 = 1.00 mol S
1.35 mol O/0.336 = 4.02 mol O
Empirical formula = $HgSO_4$

40. 62.1 g C × (1 mol C/12.0 g C) = 5.18 mol C
13.8 g H × (1 mol H/1.00 g H) = 13.8 mol H
24.1 g N × (1 mol N/14.0 g N) = 1.72 mol N
5.18 mol C/1.72 = 3.01 mol C
13.8 mol H/1.72 = 8.02 mol H
1.72 mol N/1.72 = 1.00 mol N
Empirical formula = C_3H_8N

INTERPRET DATA

a. 78 g
b. methanol, ethanoic acid, and glucose
c. The molar mass of glucose is six times greater than the molar mass of methanal.

FIGURE 10.12 Multiply the molar mass of methanal by 2.

41. $C_3Cl_3N_3$

42. molar mass/efm = 62/31 = 2
molecular formula = $2(CH_3O) = C_2H_6O_2$

41. C (12.0 g/mol x 1) + Cl (35.5 g/mol x 6) + N (14.0 g/mol x 1) = 61.5 g/mol

184.5 g/mol / 61.5 g/mol = 3 → $C_3Cl_3N_3$

Lesson Check Answers

43. Divide the mass of an element in the compound by the mass of the compound; then multiply by 100%.

44. The percent composition of a compound can be used to calculate the empirical formula of a compound.

45. The molecular formula of a compound is a simple whole-number multiple of the empirical formula.

46. 74.2% N, 25.8% O

47. 25.4% Ca, 30.4% C, 3.8% H, 40.5% O

48. 4.7 g

49. **BIG**IDEA $C_5H_{10}O_2$ is both its empirical and molecular formula.