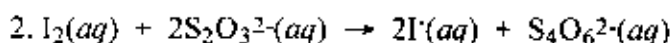
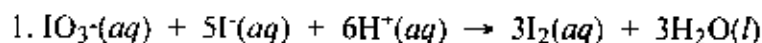


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1. Calculate the molar mass of rubidium carbonate, Rb_2CO_3 .
- A) 340.43 g/mol
 - B) 255.00 g/mol
 - C) 230.94 g/mol
 - D) 145.47 g/mol
 - E) 113.48 g/mol
2. The iodine "clock reaction" involves the following sequence of reactions occurring in a reaction mixture in a single beaker.



The molecular iodine (I_2) formed in reaction 1 is immediately used up in reaction 2, so that no iodine accumulates. What is the overall reaction occurring in this experiment?

- A) $\text{IO}_3^-(aq) + 3\text{I}^-(aq) + 2\text{S}_2\text{O}_3^{2-}(aq) + 6\text{H}^+(aq) \rightarrow 2\text{I}_2(aq) + \text{S}_4\text{O}_6^{2-}(aq) + 3\text{H}_2\text{O}(l)$
 - B) $\text{IO}_3^-(aq) + 4\text{S}_2\text{O}_3^{2-}(aq) + 6\text{H}^+(aq) \rightarrow \text{I}^-(aq) + 2\text{S}_4\text{O}_6^{2-}(aq) + 3\text{H}_2\text{O}(l)$
 - C) $\text{IO}_3^-(aq) + 6\text{S}_2\text{O}_3^{2-}(aq) + 6\text{H}^+(aq) \rightarrow \text{I}^-(aq) + 3\text{S}_4\text{O}_6^{2-}(aq) + 3\text{H}_2\text{O}(l)$
 - D) $\text{IO}_3^-(aq) + \text{I}_2(aq) + 8\text{S}_2\text{O}_3^{2-}(aq) + 6\text{H}^+(aq) \rightarrow 3\text{I}^-(aq) + 4\text{S}_4\text{O}_6^{2-}(aq) + 3\text{H}_2\text{O}(l)$
 - E) $\text{IO}_3^-(aq) + 2\text{I}_2(aq) + 6\text{S}_2\text{O}_3^{2-}(aq) + 6\text{H}^+(aq) \rightarrow 5\text{I}^-(aq) + 3\text{S}_4\text{O}_6^{2-}(aq) + 3\text{H}_2\text{O}(l)$
3. Potassium chloride is used as a substitute for sodium chloride for individuals with high blood pressure. Identify the limiting reactant and determine the mass of the excess reactant remaining when 7.00 g of chlorine gas reacts with 5.00 g of potassium to form potassium chloride.
- A) Potassium is the limiting reactant; 2.47 g of chlorine remain.
 - B) Potassium is the limiting reactant; 7.23 g of chlorine remain.
 - C) Chlorine is the limiting reactant; 4.64 g of potassium remain.
 - D) Chlorine is the limiting reactant; 2.70 g of potassium remain.
 - E) No limiting reagent: the reactants are present in the correct stoichiometric ratio.

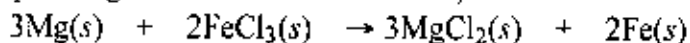
4. Aluminum oxide (used as an adsorbent or a catalyst for organic reactions) forms when aluminum reacts with oxygen.



A mixture of 82.49 g of aluminum ($M = 26.98 \text{ g/mol}$) and 117.65 g of oxygen ($M = 32.00 \text{ g/mol}$) is allowed to react. What mass of aluminum oxide ($M = 101.96 \text{ g/mol}$) can be formed?

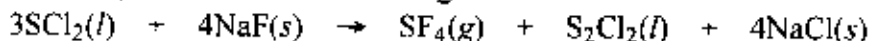
- A) 155.8 g
B) 200.2 g
C) 249.9 g
D) 311.7 g
E) 374.9 g
5. Copper(II) sulfate pentahydrate, $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$, is used as a fungicide and algicide. Calculate the mass of oxygen in 1.000 mol of $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$.
- A) 249.7 g
B) 144.0 g
C) 96.00 g
D) 80.00 g
E) 64.00 g
6. Lead(II) sulfide was once used in glazing earthenware. It will also react with hydrogen peroxide to form lead(II) sulfate and water. How many grams of hydrogen peroxide are needed to react completely with 265 g of lead(II) sulfide?
- A) 151 g
B) 123 g
C) 50.3 g
D) 37.7 g
E) 9.41 g

7. Magnesium reacts with iron(III) chloride to form magnesium chloride (which can be used in fireproofing wood and in disinfectants) and iron.



A mixture of 41.0 g of magnesium ($M = 24.31 \text{ g/mol}$) and 175 g of iron(III) chloride ($M = 162.2 \text{ g/mol}$) is allowed to react. What mass of magnesium chloride ($M = 95.21 \text{ g/mol}$) is formed?

- A) 68.5 g MgCl_2
 - B) 77.0 g MgCl_2
 - C) 71.4 g MgCl_2
 - D) 107 g MgCl_2
 - E) 154 g MgCl_2
8. How many grams of sodium fluoride (used in water fluoridation and manufacture of insecticides) are needed to form 485 g of sulfur tetrafluoride?



- A) 1940 g
 - B) 1510 g
 - C) 754 g
 - D) 205 g
 - E) 51.3 g
9. Ammonia, an important source of fixed nitrogen that can be metabolized by plants, is produced using the Haber process in which nitrogen and hydrogen combine.



How many grams of nitrogen are needed to produce 325 grams of ammonia?

- A) 1070 g
 - B) 535 g
 - C) 267 g
 - D) 178 g
 - E) 108 g
10. How many molecules of molecular oxygen react with four molecules of NH_3 to form four molecules of nitrogen monoxide and six molecules of water?
- A) 2
 - B) 10
 - C) 3
 - D) 4
 - E) 5

11. Potassium chlorate (used in fireworks, flares, and safety matches) forms oxygen and potassium chloride when heated.



How many grams of oxygen are formed when 26.4 g of potassium chlorate is heated?

- A) 223 g
B) 99.1 g
C) 10.3 g
D) 6.86 g
E) 4.60 g
12. In the combustion analysis of 0.1127 g of glucose ($\text{C}_6\text{H}_{12}\text{O}_6$), what mass, in grams, of CO_2 would be produced?
- A) 0.0451 g
B) 0.0825 g
C) 0.1652 g
D) 0.4132 g
E) 1.466 g
13. Balance the following equation:
- $$\text{B}_2\text{O}_3(s) + \text{HF}(l) \rightarrow \text{BF}_3(g) + \text{H}_2\text{O}(l)$$
- A) $\text{B}_2\text{O}_3(s) + 6\text{HF}(l) \rightarrow 2\text{BF}_3(g) + 3\text{H}_2\text{O}(l)$
B) $\text{B}_2\text{O}_3(s) + \text{H}_6\text{F}_6(l) \rightarrow \text{B}_2\text{F}_6(g) + \text{H}_6\text{O}_3(l)$
C) $\text{B}_2\text{O}_3(s) + 2\text{HF}(l) \rightarrow 2\text{BF}_3(g) + \text{H}_2\text{O}(l)$
D) $\text{B}_2\text{O}_3(s) + 3\text{HF}(l) \rightarrow 2\text{BF}_3(g) + 3\text{H}_2\text{O}(l)$
E) $\text{B}_2\text{O}_3(s) + 6\text{HF}(l) \rightarrow 2\text{BF}_3(g) + 6\text{H}_2\text{O}(l)$
14. A compound of bromine and fluorine is used to make UF_6 , which is an important chemical in processing and reprocessing of nuclear fuel. The compound contains 58.37 mass percent bromine. Determine its empirical formula.
- A) BrF
B) BrF_2
C) Br_2F_3
D) Br_3F
E) BrF_3

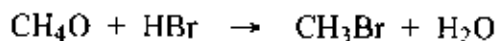
15. Lead (II) nitrate is a poisonous substance which has been used in the manufacture of special explosives and as a sensitizer in photography. Calculate the mass of lead in 139 g of $\text{Pb}(\text{NO}_3)_2$.
- A) 107 g
 - B) 90.8 g
 - C) 87.0 g
 - D) 83.4 g
 - E) 62.6 g
16. Terephthalic acid, used in the production of polyester fibers and films, is composed of carbon, hydrogen, and oxygen. When 0.6943 g of terephthalic acid was subjected to combustion analysis it produced 1.471 g CO_2 and 0.226 g H_2O . What is its empirical formula?
- A) $\text{C}_2\text{H}_3\text{O}_4$
 - B) $\text{C}_3\text{H}_4\text{O}_2$
 - C) $\text{C}_4\text{H}_3\text{O}_2$
 - D) $\text{C}_5\text{H}_{12}\text{O}_4$
 - E) $\text{C}_2\text{H}_2\text{O}$
17. Balance the following equation:
- $$\text{C}_8\text{H}_{18}\text{O}_3(l) + \text{O}_2(g) \rightarrow \text{H}_2\text{O}(g) + \text{CO}_2(g)$$
- A) $\text{C}_8\text{H}_{18}\text{O}_3(l) + 8\text{O}_2(g) \rightarrow 9\text{H}_2\text{O}(g) + 8\text{CO}_2(g)$
 - B) $\text{C}_8\text{H}_{18}\text{O}_3(l) + 11\text{O}_2(g) \rightarrow 9\text{H}_2\text{O}(g) + 8\text{CO}_2(g)$
 - C) $2\text{C}_8\text{H}_{18}\text{O}_3(l) + 22\text{O}_2(g) \rightarrow 9\text{H}_2\text{O}(g) + 16\text{CO}_2(g)$
 - D) $\text{C}_8\text{H}_{18}\text{O}_3(l) + 13\text{O}_2(g) \rightarrow 18\text{H}_2\text{O}(g) + 8\text{CO}_2(g)$
 - E) $2\text{C}_8\text{H}_{18}\text{O}_3(l) + 17\text{O}_2(g) \rightarrow 18\text{H}_2\text{O}(g) + 16\text{CO}_2(g)$
18. Which of the following samples contains the greatest total number atoms?
- A) 50.0 g of Li_2O
 - B) 75.0 g of CaO
 - C) 200.0 g of Fe_2O_3
 - D) 50.0 g of CO_2
 - E) 100.0 g of SO_3

19. Calculate the mass in grams of 8.35×10^{22} molecules of CBr_4 .
- A) 0.0217 g
 - B) 0.139 g
 - C) 7.21 g
 - D) 12.7 g
 - E) 46.0 g
20. Terephthalic acid, used in the production of polyester fibers and films, is composed of carbon, hydrogen, and oxygen. When 0.6943 g of terephthalic acid was subjected to combustion analysis it produced 1.471 g CO_2 and 0.226 g H_2O . If its molar mass is between 158 and 167 g/mol, what is its molecular formula?
- A) $\text{C}_4\text{H}_6\text{O}_7$
 - B) $\text{C}_6\text{H}_8\text{O}_5$
 - C) $\text{C}_7\text{H}_{12}\text{O}_4$
 - D) $\text{C}_4\text{H}_3\text{O}_2$
 - E) $\text{C}_8\text{H}_6\text{O}_4$
21. Alkanes are compounds of carbon and hydrogen with the general formula $\text{C}_n\text{H}_{2n+2}$. An alkane component of gasoline has a molar mass of between 125 and 130 g/mol. What is the value of n for this alkane?
- A) 4
 - B) 9
 - C) 10
 - D) 13
 - E) 14
22. Calculate the number of oxygen atoms in 29.34 g of sodium sulfate, Na_2SO_4 .
- A) 1.244×10^{23} O atoms
 - B) 4.976×10^{23} O atoms
 - C) 2.409×10^{24} O atoms
 - D) 2.915×10^{24} O atoms
 - E) 1.166×10^{25} O atoms

23. Determine the percent composition of potassium dichromate, $K_2Cr_2O_7$.
- A) 17.5 % K, 46.6 % Cr, 35.9 % O
 - B) 29.8 % K, 39.7 % Cr, 30.5 % O
 - C) 36.5 % K, 48.6 % Cr, 14.9 % O
 - D) 37.2 % K, 24.7 % Cr, 38.1 % O
 - E) none of the above
24. Hydroxylamine nitrate contains 29.17 mass % N, 4.20 mass % H, and 66.63 mass % O. If its molar mass is between 94 and 98 g/mol, what is its molecular formula?
- A) NH_2O_5
 - B) $N_2H_4O_4$
 - C) $N_3H_3O_3$
 - D) $N_4H_8O_2$
 - E) $N_2H_2O_4$
25. Hydroxylamine nitrate contains 29.17 mass % N, 4.20 mass % H, and 66.63 mass % O. Determine its empirical formula.
- A) HNO
 - B) H_2NO_2
 - C) HN_6O_{16}
 - D) $HN_{16}O_7$
 - E) H_2NO_3
26. Aluminum sulfate, $Al_2(SO_4)_3$, is used in tanning leather, purifying water, and manufacture of antiperspirants. Calculate its molar mass.
- A) 450.06 g/mol
 - B) 342.15 g/mol
 - C) 315.15 g/mol
 - D) 278.02 g/mol
 - E) 74.98 g/mol

27. The number of hydrogen atoms in 0.050 mol of $C_3H_8O_3$ is
- A) 3.0×10^{22} H atoms.
 - B) 1.2×10^{23} H atoms.
 - C) 2.4×10^{23} H atoms.
 - D) 4.8×10^{23} H atoms.
 - E) none of the above.
28. Potassium dichromate, $K_2Cr_2O_7$, is used in tanning leather, decorating porcelain, and water proofing fabrics. Calculate the number of chromium atoms in 78.82 g of $K_2Cr_2O_7$.
- A) 9.490×10^{25} Cr atoms
 - B) 2.248×10^{24} Cr atoms
 - C) 1.124×10^{24} Cr atoms
 - D) 3.227×10^{23} Cr atoms
 - E) 1.613×10^{23} Cr atoms
29. Hydrochloric acid is widely used as a laboratory reagent in refining ore for the production of tin and tantalum, and as a catalyst in organic reactions. Calculate the number of moles of HCl in 62.85 mL of 0.453 M hydrochloric acid.
- A) 28.5 mol
 - B) 1.04 mol
 - C) 0.139 mol
 - D) 0.0285 mol
 - E) 0.00721 mol
30. How many milliliters of 1.58 M HCl are needed to react completely with 23.2 g of $NaHCO_3$ ($M = 84.02$ g/mol)?
- $$HCl(aq) + NaHCO_3(s) \rightarrow NaCl(s) + H_2O(l) + CO_2(g)$$
- A) 638 mL
 - B) 572 mL
 - C) 536 mL
 - D) 276 mL
 - E) 175 mL

31. Methanol (CH_4O) is converted to bromomethane (CH_3Br) as follows:



If 12.23 g of bromomethane are produced when 5.00 g of methanol is reacted with excess HBr, what is the percentage yield?

- A) 40.9%
B) 82.6%
C) 100.%
D) 121%
E) 245%
32. Copper(II) sulfide, CuS , is used in the development of aniline black dye in textile printing. What is the maximum mass of CuS which can be formed when 38.0 mL of 0.500 M CuCl_2 are mixed with 42.0 mL of 0.600 M $(\text{NH}_4)_2\text{S}$? Aqueous ammonium chloride is the other product.
- A) 2.41 g
B) 1.82 g
C) 1.21 g
D) 0.909 g
E) 0.044 g
33. Aluminum oxide, Al_2O_3 , is used as a filler for paints and varnishes as well as in the manufacture of electrical insulators. Calculate the number of moles in 47.51 g of Al_2O_3 .
- A) 2.377 mol
B) 2.146 mol
C) 1.105 mol
D) 0.4660 mol
E) 0.4207 mol
34. How many mL of concentrated nitric acid (HNO_3 , 16.0 M) should be diluted with water in order to make 2.00 L of 2.00 M solution?
- A) 32.0 mL
B) 62.5 mL
C) 125 mL
D) 250. mL
E) 500. mL

35. What will be the final volume of a solution prepared by diluting 25 mL of 8.25 *M* sodium hydroxide to a concentration of 2.40 *M*?
- A) 330 mL
 - B) 210 mL
 - C) 86 mL
 - D) 60 mL
 - E) 7.3 mL
36. When 2.61 g of solid Na_2CO_3 is dissolved in sufficient water to make 250. mL of solution, the concentration of Na_2CO_3 is:
- A) 0.0246 *M*
 - B) 10.4 *M*
 - C) 0.205 *M*
 - D) 0.0985 *M*
 - E) 0.141 *M*
37. Sodium hydroxide, also known as caustic soda, is used to neutralize acids and to treat cellulose in making of cellophane. Calculate the number of moles of solute in 1.875 L of 1.356 *M* NaOH solution.
- A) 2.543 mol
 - B) 1.383 mol
 - C) 0.7232 mol
 - D) 0.3932 mol
 - E) 0.001383 mol
38. Calculate the molarity of a 23.55-mL solution which contains 28.24 mg of sodium sulfate (used in dyeing and printing textiles, $M = 139.04$ g/mol).
- A) 8.625 *M*
 - B) 1.199 *M*
 - C) 0.8339 *M*
 - D) 0.2031 *M*
 - E) 0.008625 *M*

39. Magnesium fluoride is used in the ceramics and glass industry. What is the mass of 1.72 mol of magnesium fluoride?
- A) 43.3 g
 - B) 62.3 g
 - C) 74.5 g
 - D) 92.9 g
 - E) 107 g
40. A 0.150 M sodium chloride solution is referred to as a physiological saline solution because it has the same concentration of salts as normal human blood. Calculate the mass of solute needed to prepare 275.0 mL of a physiological saline solution.
- A) 41.3 g
 - B) 31.9 g
 - C) 16.1 g
 - D) 8.77 g
 - E) 2.41 g
41. Analysis of a carbohydrate showed that it consisted of 40.0 % C, 6.71 % H, and 53.3 % O by mass. Its molecular mass was found to be between 140 and 160 amu. What is the molecular formula of this compound?
- A) $C_4H_8O_6$
 - B) $C_5H_{10}O_5$
 - C) $C_5H_{12}O_5$
 - D) $C_6H_{12}O_4$
 - E) none of the above
42. Lithium hydroxide is used in alkaline batteries. Calculate the molarity of a solution prepared by dissolving 1.495 moles of LiOH in enough water to give a final volume of 750. mL.
- A) 1.99 M
 - B) 1.50 M
 - C) 1.12 M
 - D) 0.502 M
 - E) 0.00199 M

43. Hydroxylamine hydrochloride is a powerful reducing agent which is used as a polymerization catalyst. It contains 5.80 mass % H, 20.16 mass % N, 23.02 mass % O, and 51.02 mass % Cl. What is its empirical formula?
- A) $\text{H}_2\text{N}_7\text{O}_8\text{Cl}_{18}$
 - B) $\text{H}_2\text{N}_2\text{O}_2\text{Cl}$
 - C) $\text{HN}_3\text{O}_4\text{Cl}_9$
 - D) H_4NOCl
 - E) H_4NOCl_2
44. What is the mass in grams of 0.250 mol of the common antacid calcium carbonate?
- A) 4.00×10^2 g
 - B) 25.0 g
 - C) 17.0 g
 - D) 4.00×10^{-2} g
 - E) 2.50×10^{-3} g
45. Calculate the number of moles in 17.8 g of the antacid magnesium hydroxide, $\text{Mg}(\text{OH})_2$.
- A) 3.28 mol
 - B) 2.32 mol
 - C) 0.431 mol
 - D) 0.305 mol
 - E) 0.200 mol