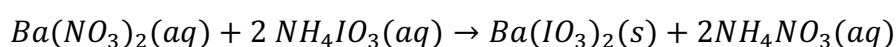
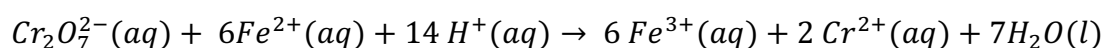


1. Chemists are always on the lookout for new and more effective fuels, especially as concerns increase about the availability of fossil fuels. If you become involved in this search, you will need to study combustion reactions. Write and balance the chemical equation for the combustion of liquid hexane, C_6H_{14} , to gaseous carbon dioxide and gaseous water.
2. Suppose you are working on water purification and need to know how much barium is present in a water sample. You can isolate barium ions (Ba^{2+}) by reacting them with another substance to form a precipitate. When concentrated ammonium iodate solution, $NH_4IO_3(aq)$, is added to an aqueous solution of barium nitrate, $Ba(NO_3)_2(aq)$, insoluble barium iodate, $Ba(IO_3)_2$ forms. The chemical equation for the precipitate reaction is

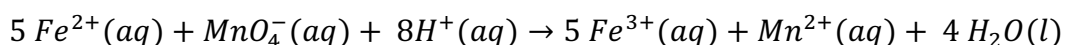


Write the net ionic equation for this reaction.

3. If you intend to use a precipitation reaction to produce a new compound, you need to be able to predict the products of the reaction and whether any of them will precipitate as insoluble solids. Predict the precipitate likely to form, if any, when aqueous solutions of sodium phosphate and lead(II) nitrate are mixed. Write the net ionic equation for the reaction.
4. Hydrochloric acid (HCl) reacts with sodium hydroxide (NaOH) in a neutralization reaction. If 25.0 mL of 0.10 M HCl is mixed with an unknown volume of 0.20 M NaOH, how many milliliters of NaOH are needed to completely neutralize the acid?
5. One of the most important reactions in industry is the conversion of sulfur dioxide, SO_2 , into sulfate ion, SO_4^{2-} . Suppose you are working on reactions like this; you would have to know whether to oxidize or reduce the starting compound. Is the conversion of SO_2 to SO_4^{2-} oxidation or reduction?
6. An element's position in the periodic table can be a clue not only to the ions it forms but also to its oxidation number in a compound. What is the oxidation number of (a) sulfur in SF_6 and (b) nitrogen in N_2O_4 ?
7. An environmental chemist needs to determine the amount of Fe^{2+} ions in a sample of polluted water from a rusting industrial plant. One procedure is to analyze the sample by using a solution of sodium dichromate, $Na_2Cr_2O_7$. Identify the oxidizing agent and the reducing agent in the following reaction.

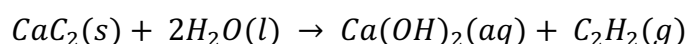


8. Suppose you are involved in the design of a steel plant and are concerned about its environmental impact. You need to know not only the amount of iron that you can extract from the ore supplied to the plant but also the amount of carbon dioxide that will be produced in the extraction. You decide to conduct laboratory experiments to investigate the process by which iron(III) oxide, Fe_2O_3 , which is present in iron ore, is reduced by carbon monoxide to produce metallic iron and carbon dioxide gas. (a) What mass of iron(III) oxide is needed to produce 10.0 g of iron by this process? (b) What mass of carbon dioxide is released when 10.0 g of iron is produced?
9. One cause of kidney stones is oxalic acid, which occurs naturally in some food such as rhubarb or spinach. If you were working in a food lab, you might need to determine the concentration of oxalic acid in a plant extract. Suppose that 25 mL of a solution of oxalic acid, $\text{H}_2\text{C}_2\text{O}_4$, which has 2 acid protons, is titrated with 0.100 M NaOH (aq) and that the stoichiometric point for reaction with both protons is reached when 38.0 mL of the solution of base is added. Find the molarity of the oxalic acid solution.
10. An experimental method to determine the percentage of Fe_2O_3 in iron ore is to titrate a sample of the ore with a solution of purple potassium permanganate, KMnO_4 . The ore is first dissolved in hydrochloric acid; the iron is then chemically reduced to iron(II) ions which react with MnO_4^- ions:



The stoichiometric point is reached when all the Fe^{2+} has reacted and is detected when the purple color of the permanganate ion persists. This method assumes that the ore contains no impurities that might also react with permanganate ion. A sample of ore of mass 0.202 g was dissolved in hydrochloric acid and the iron reduced to iron(II). The resulting solution required 16.7 mL of 0.0108M KMnO_4 (aq) to reach the stoichiometric point. (a) What mass of iron(II) ions is present? (b) What is the mass percentage of iron in the ore sample?

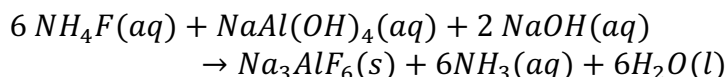
11. Incomplete combustion of the fuel in a poorly tuned engine can produce toxic carbon monoxide along with the usual carbon dioxide and water. You might be working for an engine manufacturer and asked to assess the efficiency of an off-road motorcycle engine by determining the percentage yield of carbon dioxide. In one test, the engine burns 1.00L of octane (of mass 702g) and produces 1.84 kg of carbon dioxide. What is the percentage yield of carbon dioxide? Octane is C_8H_{18} .
12. Calcium carbide, CaC_2 , reacts with water to form calcium hydroxide and the flammable gas ethyne (acetylene) in the reaction



This reaction was once used for fuel lamps on bicycles and miner's helmets because it is easily transported and acetylene burns with a bright flame. (a) Which is the limiting reactant

when 100.0 g of water reacts with 100.0g of calcium carbide? (b) What mass of ethyne can be produced? (c) What mass of excess reactant remains after the reaction is complete?

13. An important step in the refining of aluminum metal is the manufacture of cryolite, Na_3AlF_6 , from aluminum fluoride, sodium aluminate and sodium hydroxide in aqueous solution:



Unfortunately, by-products can form, reducing the yield. You might be asked to investigate the efficiency of the process. You mix 100.0 g of NH_4F with 82.6g of $\text{NaAl}(\text{OH})_4$ and 80.0 g of NaOH , and collect 75 g of Na_3AlF_6 . What is the percentage yield of the reaction?

14. If you become an organic chemist, you will almost certainly use combustion analyses at some point. Suppose you carry out a combustion analysis on 1.621 g of a newly synthesised compound, which is known to contain only C, H and O. The masses of water and carbon dioxide produced are 1.902 g and 3.095g, respectively. What is the empirical formula of the compound.

Quick answers

1. $2 \text{C}_6\text{H}_{14}(l) + 19 \text{O}_2(g) \rightarrow 12 \text{CO}_2(g) + 14 \text{H}_2\text{O}(g)$
2. $\text{Ba}^{2+}(aq) + 2 \text{IO}_3^-(aq) \rightarrow \text{Ba}(\text{IO}_3)_2(s)$
3. $3 \text{Pb}^{2+}(aq) + 2 \text{PO}_4^{3-}(aq) \rightarrow \text{Pb}_3(\text{PO}_4)_2(s)$
4. 12.5 mL
5. Oxidation
6. (a) +6 and (b) +4
7. Fe^{2+} ion is the reducing agent
8. (a) 14.3g (b) 11.8 g
9. $0.0760 \text{ mol} \times \text{L}^{-1} \text{H}_2\text{C}_2\text{O}_4$
10. (a) 50.4 mg (b) 25.0%
11. 85.2 %
12. (a) CaC_2 (b) 40.6 g (c) 43.8 g
13. 79.4%
14. C:H:O = 2:6:1