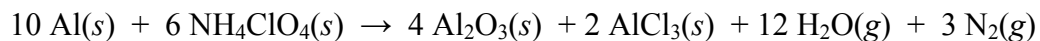


Chapter 3 Example Problems

1. The perchlorate ion, a major component of solid rocket fuel (and a minor constituent of air exposed to lightning), may inhibit thyroid functioning. The Environmental Protection Agency (EPA) has recently articulated a safe maximum exposure for ClO_4^- : A person should ingest no more than $0.7 \mu\text{g ClO}_4^-$ per kg of body weight per day (*Chemical and Engineering News*, 28 February 2005, p. 14).
 - (a) At 10 months old, my child Margaret weighed 16 lb. According to the EPA standard, what is the maximum number of ClO_4^- ions she should ingest per day? (1 kg = 2.205 lb)
 - (b) The EPA supervises the clean-up of especially polluted sections of land known as Superfund sites. At these sites, the concentration of ClO_4^- must be reduced to no higher than 18 parts per billion (ppb). Based on your answer to part (a), how many fluid ounces (fl oz) of water could Margaret safely drink per day if the water contained 18 ppb of ClO_4^- ? (Note: the density of $\text{H}_2\text{O}(l)$ is $1.0 \text{ g H}_2\text{O}/\text{mL H}_2\text{O}$, and $1 \text{ mL} = 0.03381 \text{ fl oz}$.)

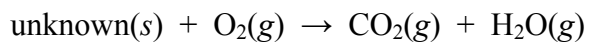
2. The following balanced chemical reaction describes what happens inside the two solid rocket boosters in the space shuttle upon launch:



This extremely exothermic (*i.e.* heat-releasing) reaction causes the boosters to reach a temperature of 3500 K. The water vapor and N₂ therefore exert a tremendous amount of upward pressure ($PV = nRT$; Chapter 5)—enough to lift the shuttle to an altitude of 28 miles.

- (a) How many total moles of gas can form when 300. g of Al and 300. g of NH₄ClO₄ react?
(b) When the reaction has gone to completion, how many grams of Al and NH₄ClO₄ remain?

3. An important application of stoichiometry is in chemical analysis. Stoichiometry can be used to determine the empirical formula of a substance. For example, an unknown substance containing C, H, and O combusts according to the following chemical equation:



In one experiment, 250.0 g of unknown underwent complete combustion to form 722.3 g CO_2 and 236.5 g H_2O . No other products were formed.

- Determine the mass percent of oxygen in the unknown.
- Find the empirical formula of the unknown.
- In a separate experiment, the molar mass of the unknown is determined to be 152 g mol^{-1} . Find the molecular formula of the unknown.
- Balance the combustion equation.