1 Cognitive reasoning in the chemical sciences 2.5

Study Group Review Problems

These are mostly problems that you have seen before. Solve these without referring to your notes.

1. A metal M forms an oxide X. X has the empirical formula MO_2 and is 13.38 mass percent oxygen. When heated X gives off oxygen and converts to Y, which is 9.334 mass percent oxygen. (a) What is the identity of metal M? (b) What is the empirical formula of the compound Y?

2. The mine in Rainbow Lake, Canada has high quality ore composed purely of CoO and Fe_2O_3. Every week 9.61×10^5 kg of ore are mined in this mine. The mine refines the ore into pure Co and pure Fe. The weight of the refined metal is 7.20×10^5 kg. By weight percent, what percentage of the original mined ore is CoO?

3. Upon heating, 120.34 g of a mixed $AlCl_3$ and $CaCl_2$ sample is reduced into 33.456g of a metallic alloy, which contains no chlorine. No metal atom leaves the sample. What was the molar ratio of the $AlCl_3$ to the total number of moles of compound in the initial chloride containing sample?

4. a). What is the difference between formal charge and oxidation states? What is the difference between 2ClBr and Cl_2Br_2?

b). Balance the following reaction:

$$CuSCN + KIO_3 + HCl \rightarrow CuSO_4 + KCl + HCN + ICl + H_2O$$

5. Two evacuated bulbs of equal volume are connected by a tube of negligible volume. One of the bulbs is placed in a constant-temperature bath at 225.0 K and the other bulb is placed in a constant temperature bath at 350.0 K. Exactly 1 mole of an ideal gas is injected into the system. Calculate the final number of moles of gas in each bulb.

6. On the planet Oberon, the atmosphere is entirely composed of nitrogen gas. There are 0.10 moles of N_2 for every liter of Oberon's air. A 2.0 L flask on the surface of this planet filled solely with argon has a small pin-hole. Nitrogen gas can effuse into the flask. At the same time argon gas can effuse out. Initially, there is absolutely no change in weight of the flask (this weight includes the weight of the gas inside the flask). The flask, the argon, and the air are all at the same temperature. Chemical analysis shows effusion is taking place. What was the initial number of moles of argon gas inside the flask?