1. A young cousin of yours is having a birthday party, and you have been tasked with inflating balloons. Say that you are able to inflate a balloon (which is to be treated as a perfect sphere) to a diameter of 30.0 cm. Inside the balloon, the temperature is 30.0 °C and the absolute pressure is 1.20 atm. Assume that you exhale pure N_2, which has molar mass 28.0 g mol^{-1}.

   (a) What is the mass of a single N_2 molecule?

   (b) What is the (average) kinetic energy per N_2 molecule inside the balloon?

   (c) How many N_2 molecules are in the balloon?

   (d) What is the total kinetic energy of the gas inside the balloon?

2. You have a summer engineering internship at a chemical plant. One of your assignments is to determine the specific heat capacity of an unknown chemical at the plant using only a small metal vat, hot water, and a thermometer. The vat weighs 200.0 g. Both the chemical and the vat are initially at 20.0 °C, and the water is at 80.0 °C. You pour 500.0 g of the chemical and 500.0 g of the water into the vat, and wait for the system to reach thermal equilibrium. You then measure the temperature of both liquids (and the vat) as 58.1 °C. You safely dispose of the mixture, wait for the vat to return to its initial temperature, and repeat the experiment. This time, you use 1000.0 g of the chemical and 500.0 g of the water, and measure the equilibrium temperature as 49.3 °C. Determine the specific heat of the chemical and of the metal vat. (Assume that the specific heat capacities of both are constant over this temperature range, and that no heat is lost to your surroundings.)