ID #33
Problem Set 8
Physics 202
February 8, 2018

1. 1 mol of gold weighs 197 g, so 1 gram of gold is $1/197 = 0.005\,08$ mol. The the total number of gold atoms we need to produce is

$$0.005\,08\,\text{mol} \cdot 6.022 \times 10^{23}\,\text{mol}^{-1} = 3.057 \times 10^{21}$$

Then

$$\frac{3.057 \times 10^{21}}{20\,000\,\text{s}^{-1}} = 1.53 \times 10^{17}\,\text{s} = 4.85\,\text{Gyr}$$

At this rate, it would take about a third of the age of the universe to create a single gram of gold.

2. Let the volume of the right chamber be 1, and let $R = 1$. Then the pressure in the right chamber is

$$P_R = \frac{nRT}{V} = 290$$

The chamber on the right is about 5 times larger, so $V \approx 5$. Then

$$P_L = \frac{nRT}{V} = \frac{350}{5} = 70$$

The piston will move right when released, because the pressure in the right chamber is far higher.

3. Let $a = nRT$. Then $0.3\,\text{m}^3(200\,\text{bar}) = a = V(1\,\text{bar}) \implies V = 60\,\text{m}^3$. Then the number of balloons that can be filled is $60\,\text{m}^3/0.01\,\text{m}^3 = 6000$.

4. The heat needed to bring the tea down from 100 °C to 65 °C is

$$Q = cmT = (1\,\text{cal/g°C})(200\,\text{g})(-35\,\text{°C}) = -7000\,\text{cal}$$

Because the ice will melt after being put into the glass, the enthalpy of fusion must also be considered. Therefore, the energy required to bring 1 gram of ice to 65 °C is

$$Q = 0.5 * 15\,\text{°C} + 79.72 + 1 * 65\,\text{°C} = 152.2\,\text{cal/g}$$

Then

$$\frac{7000\,\text{cal}}{152.2\,\text{cal/g}} = 45.98\,\text{g}$$

so about 46 grams of ice are needed to bring the tea to a comfortable temperature (it'll be very watered down, though.)