Possibly Useful Information:

Ideal Gas Constant: $R = 8.315$ J/mol·K
Avogadro's Number: $N_A = 6.02 \times 10^{23}$ mol^{-1}
Specific Heat (Iron): $c = 450$ J/kg·K
Specific Heat (Water): $c = 4186$ J/kg·K
Heat of Fusion (Water): $L = 3.33 \times 10^5$ J/kg

Boltzmann's Constant: $k = 1.38 \times 10^{-23}$ J/K
Specific Heat (Aluminum): $c = 900$ J/kg·K
Specific Heat (Ice): $c = 2100$ J/kg·K
Specific Heat (Steam): $c = 2010$ J/kg·K
Heat of Vaporization (Water): $L = 2.26 \times 10^6$ J/kg

An ideal gas is placed in a container whose volume can be changed. Initially the gas has a volume of 3.00 m^3, a temperature of 273 K, and a pressure of 1.013×10^5 N/m^2.

1) What is the average kinetic energy of the gas molecules in the container?
Answer: 5.65×10^{-21} J

2) An oxygen atom has a mass $m = 2.65 \times 10^{-26}$ kg. If the gas is composed of monatomic oxygen, what is the average speed of the oxygen atoms in the gas?
Answer: 6.53×10^2 m/s

3) A xenon atom has a mass $m = 2.18 \times 10^{-25}$ kg. If the gas is composed of monatomic xenon, what is the average speed of the xenon atoms in the gas?
Answer: 2.28×10^2 m/s

4) How many gas atoms are in the container?
Answer: 8.06×10^{25} atoms

An aluminum cup with a mass of 0.100 kg contains 0.250 kg of glycerin. Both the cup and its contents have an initial temperature of 10°C. A 0.290 kg piece of iron at 180°C is placed in the cup. Eventually, the aluminum cup, the glycerin, and the iron all have a temperature of 30°C.

5) How much heat leaves the iron?
Answer: 1.85×10^4 J

6) How much heat enters the aluminum?
Answer: 2.72×10^3 J

7) How much heat enters the glycerin?
Answer: 1.60×10^4 J

8) What is the specific heat of glycerin?
Answer: 2.29×10^3 J/kg·K

A 10-gram ice cube has been in a freezer at a temperature of -8.5°C for a long time. It is then removed from the freezer and placed in a 100-g aluminum cup containing an unknown amount of water. The cup and the water have an initial temperature of 20°C. Eventually, the cup contains nothing but water, and everything is at a temperature of 10°C.

9) How much heat did the ice cube gain as it warmed to its melting temperature?
Answer: 1.79×10^2 J

10) How much heat did the ice cube gain as it melted?
Answer: 3.33×10^3 J

11) How much heat did the melted water gain as it warmed to its final temperature?
Answer: 4.19×10^2 J

12) How much heat did the aluminum cup lose during the entire process?
Answer: 9.00×10^2 J

13) How much heat did the water that was initially in the cup lose during the entire process?
Answer: 3.02×10^3 J

14) How much water was initially in the cup?
Answer: 0.0723 kg