Problem 1
A piston-cylinder assembly contains \( m = 1 \) kg of substance at \( P_1 = 100 \) kPa. The initial volume is \( V_1 = 0.5 \) m\(^3\). Heat transfer to the substance causes a slow expansion at constant temperature. This process is terminated when the final volume is twice the initial volume.

1- Calculate the magnitude of the heat transfer required \( Q_{12} \) if the substance is nitrogen modeled as an ideal gas  
   \[ \text{[solution: } Q_{12} = 34.7 \text{ kJ]} \]
2- Calculate the magnitude of the heat transfer required \( Q_{12} \) if the substance is water (you will need to determine the state of the water in the initial and final states)  
   \[ \text{[solution: } Q_{12} = 666 \text{ kJ]} \]

Problem 2
A football official inflates a football to the required gauge pressure of \( P_{1g} = 89.6 \) kPa prior to a game. The football has an internal volume \( V = 2622 \) cm\(^3\) and the air is at a temperature \( T_1 = 23.9^\circ\text{C} \) when the football is first inflated.

The ball is taken onto the field, and by the time it is put into play, the air temperature inside the football has dropped to \( T_2 = -1.1^\circ\text{C} \). Assuming that air can be modeled as an ideal gas and that the volume of the football does not change significantly during the cooling process, calculate the following quantities:

1- The mass \( m \) of air in the ball
2- The gauge pressure \( P_{2g} \) of the air in the ball when play begins
3- The amount of heat transfer \( Q_{12} \) from the air in the ball during the process  
   \[ \text{[solution: } Q_{12} = -104 \text{ J]} \]
4- The initial gauge pressure \( P_g \) to which the ball must be inflated so that it will be at the required gauge pressure when the temperature reaches \( T_2 = -1.1^\circ\text{C} \)  
   \[ \text{[solution: } P_g = 107 \text{ kPa]} \]

Problem 3
A refrigerant R-134a tank is located outdoors. The tank has a volume \( V = 0.57 \) m\(^3\) and it is filled with a mass \( m = 34 \) kg of refrigerant at \( P_1 = 689 \) kPa. During the daytime, the tank is exposed to the sun, and heat transfer to the R-134a from the sun causes the refrigerant to reach a saturated vapor state.

1- Calculate the initial temperature \( T_1 \) and state of the R-134a prior to heating
2- Calculate the final temperature and pressure \((T_2, P_2)\) of the R-134a after heating
3- Calculate the amount of heat transfer \( Q_{12} \) to the R-134a