

Solve the following problems. Write the numerical answer on the blank space provided. Please show your work.

1. Calculate the following thermodynamic efficiencies.

A. Calculate the thermodynamic efficiency of an automobile engine in which the expansion temperature in the cylinders is 450 K and the ambient temperature is 300 K (2 points).

$$\eta = 1 - T_{\text{cold}}/T_{\text{hot}} = 1 - 300/450 = 0.333$$

Answer _____0.333_____

B. Suppose you drive the car to Fairbanks, Alaska in the middle of winter and the ambient temperature is 225 K. What is the efficiency in this case (2 points)?

$$\eta = 1 - T_{\text{cold}}/T_{\text{hot}} = 1 - 225/450 = 0.5$$

Answer _____0.5_____

C. At what T_{cold} will you an efficiency of 1 (1 point)?

Answer _____T = 0 K_____

2. Argon gas expands reversible into a balloon. The volume increases from 1 L to 300 L. The temperature is 310 K and the initial pressure of the gas is 300 atm.

A. How many moles of argon gas are present (2 points)?

$$n = PV/RT = (300 \text{ atm})(1 \text{ L})/(0.08206 \text{ L-atm/mol-K})(310 \text{ K}) = 11.8 \text{ moles}$$

Answer _____11.8 moles_____

B. Please calculate the entropy of the system for this expansion (2 points).

$$\Delta S = nR \ln(V_2/V_1) = (11.8 \text{ moles})(8.31 \text{ J/mol-K}) \ln(300/1) = 559 \text{ J/K}$$

Answer _____559 J/K_____

B. How would the entropy change if the gas were helium instead of argon (1 point)?

It would not change. The entropy calculation is for an ideal gas.

Answer _____No change_____