Physics I

Specific Heat

Problem 1.- You pour 25g of milk at 25ºC into a Styrofoam cup that contains 175 grams of coffee at 75ºC. What is the temperature of the mixture after they reach thermal equilibrium? Assume the specific heats of coffee and milk are the same and neglect the one of the cup.

Solution: The heat gained by the milk is equal to the heat lost by the coffee, so:

$$25g(T-25)=175g(75-T)$$

Where T is the final temperature of the mixture.
Solving for T:

$$(T-25)=7(75-T)\rightarrow T-25=525-7T\rightarrow 8T=550\rightarrow T=\mathbf{68.7\ ºC}$$

Problem 2.- A mixture of gases is found experimentally to have a heat capacity at constant volume of $C_v=2R$ per mole.

a) Calculate the value of gamma for this mixture.

b) Knowing that $P_1V_1^{\gamma}=P_2V_2^{\gamma}$ calculate the final pressure of the mixture if it expands adiabatically from an initial pressure of 1 atm and volume 1L to a final volume of 2L.

Solution: a) Since $C_v=2R$ then $C_p=3R$ and $\gamma=\frac{C_p}{C_v}=\frac{3R}{2R}=\mathbf{1.5}$

b) Knowing that $P_1V_1^{\gamma}=P_2V_2^{\gamma}$:

$$1\times1^{1.5}=P_2\times2^{1.5}\rightarrow P_2=\frac{1}{2^{1.5}}=\mathbf{0.35\ atm}$$

Problem 3.- Five moles of a monoatomic gas are heated at constant volume from an initial temperature of T_1=300K to T_2=500K. Calculate the heat necessary to do this.

Solution: Since the process happens at constant volume, we use the molar heat capacity C_v, which gives us:

$$Q=nC_v\Delta T=n\left(\frac{3}{2}R\right)\Delta T=5\left(\frac{3}{2}8.314\right)(500-300)=\mathbf{12{,}500\ J}$$