Part A : Find molar flow rate that corresponds to 1 SCCM

Molar volume of gases at STP = 22.4 L/mol

$$1 \text{ SCCM} = 1\frac{cm^3}{\min}\times\frac{1L}{1000cm^3}\times\frac{1\min}{60s}\times\frac{1mol}{22.4L}$$ (*1 point for correct units)*

1 SCCM = 7.44 x 10^{-7} mol/s *(1 point for correct answer)*

Part B : Develop an equation for the molar flow rate of N_2 in SCCM in terms of the measured temperature difference, the heat input to the heating coil, and the fraction of gas diverted to the sensor tube. State the assumptions.

(1 point for definition of system)

Assume: (*2 points for correct assumptions)*

(1) The system is at steady-state, i.e. no accumulation of mass
(2) Macroscopic kinetic and potential energy are negligible
(3) Work term is negligible
(4) No loss of heat to the surroundings

By 1st Law of Thermodynamics for Open system (*1 point for 1st Law)*

$$0 = x\dot{n}_1(h+e_K+e_P)_1 - x\dot{n}_2(h+e_K+e_P)_2 + \dot{Q} + \dot{W}_s$$ Equation (2.94)

Where: x = fraction of the gas diverted to the sensor tube

Q = heat input to the heating coil

Simplify the above equation with the assumptions

$$0 = x\dot{n}(h_1 - h_2) + \dot{Q} = -x\dot{n}\int_{T_1}^{T_2} c_p dT + \dot{Q}$$ *(1 point for equation)*

Assume c_p is constant (independent of temperature)

$$0 = -x\dot{n}c_p(T_2 - T_1) + \dot{Q}$$

Thus $\dot{n} = \dfrac{\dot{Q}}{xc_{p,N_2}(T_2 - T_1)}$ (in mol/sec) *(1 point for correct expression)*

To convert molar flow rate of N_2 in SCCM, divide the above expression by 7.44 x 10^{-7} mol/s

$$\boxed{\dot{n} = (7.44\times10^7)\frac{\dot{Q}}{xc_{p,N_2}(T_2 - T_1)}}$$ (in SCCM) *(1 point for correct answer)*

Part C : Find conversion factor for controlling SiH_4 instead of N_2

The conversion factor is $\boxed{\dfrac{c_{p,N_2}}{c_{p,SiH_4}}}$. (1 *points for correct answer)*

For controlling of SiH_4, multiply the equation from Part B by the conversion factor.