# AE-341: SQ1

# SQ-1 (27/01/2020) – 20 minutes

1. State True/Flase (2 points)
   (a) A vapor that is about to condense is saturated vapor.
   (b) An office worker claims that a cup of cold coffee on his table warmed up to 80°C by picking up energy from the surrounding air, which is at 25°C. The process violates some thermodynamic laws.

2. Proof that $M \propto \dfrac{\text{kinetic energy}}{\text{internal energy}}$ (4 points)

3. In certain components of propulsion engines, such as nozzles, compressors, and turbines, the residence time of the fluid within the component is so short that the heat transfer per unit mass of fluid is negligible compared to the specific work or the change in kinetic energy. For such adiabatic flows the T-S diagram immediately indicates the range of possible states ($ds \geq 0$) that can be reached from any initial point.

   (a) Show that on a T-S plane constant pressure lines for ideal gases must be concave upward, given that Cp must be positive. Show also that if any constant pressure line p1 is given on a T-S plane, a line corresponding to any other constant pressure p can be obtained by horizontal shift of magnitude of magnitude:

$$\Delta s = -R ln(\frac{p}{p_1})$$

(4 points)

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   (a) A vapor that is about to condense is saturated vapor. (T)
   (b) An office worker claims that a cup of cold coffee on his table warmed up to 80°C by picking up energy from the surrounding air, which is at 25°C. The process violates some thermodynamic laws. **(T)**

2. Proof that $M \propto \dfrac{\text{kinetic energy}}{\text{internal energy}}$ (4 points)

$$\frac{\text{kinetic energy}}{\text{internal energy}} = \frac{\frac{V^2}{2}}{e} = \frac{V^2}{2C_vT} = \frac{\gamma V^2}{2\frac{a^2}{\gamma-1}} = \frac{\gamma(\gamma-1)}{2}M^2$$

$$M \propto \sqrt{\frac{2}{\gamma(\gamma-1)}} \cdot \frac{V}{\sqrt{e}} \propto \cdot \frac{K.E.}{I.E.}$$

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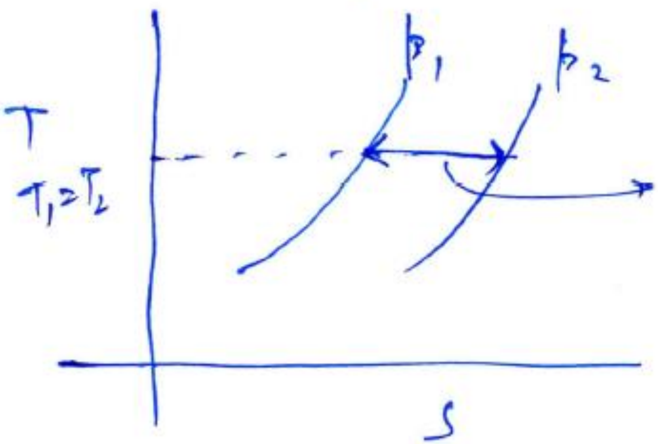
3.

$$T\,ds = dh - v\,dp \Rightarrow ds = \frac{C_p\,dT}{T} - R\,dp/p$$

$$\int_1^2 ds = \int_1^2 C_p \frac{dT}{T} - \int_1^2 R\frac{dp}{p} \Rightarrow s_2 - s_1 = C_p \ln\left(\frac{T_2}{T_1}\right) - R\ln\left(p_2/p_1\right)$$

Const. pressure line : $p_1 = p_2$, $\Delta s = C_p \ln\left(\frac{T_2}{T_1}\right)$




horizontal shift $\Delta s$ , $T_1 = T_2$ , $p_1 = p_1$ , $p_2 = p$

$$\boxed{\Delta s = -R\ln\left(p/p_1\right)}$$