ANSWERS TO SUMMARY QUESTIONS

1. The entropy of the universe cannot decrease, $\Delta S_{univ} \geq 0$.

2. From Clausius inequality, $dS \geq đQ/T$, we conclude that if heat enters a closed system its entropy must increase.

3. From the preceding we see that a necessary condition is heat rejection, $đQ < 0$. Sufficiency is added when $|đQ| > |đW^i_{irr}|$. (See eqn. IIIB-21.)

4. The Gibbs equation is a relationship between properties. It is applicable to any process, reversible or irreversible, that begins and ends in an equilibrium state. The form shown is restricted to simple compressible media but the equation can be reformulated for any substance.

5. The entropy.

6. An internally reversible process precludes entropy production within the system. (Production can occur in the surroundings, often at the interface between the system and the surroundings.) In a reversible process there is no production in either the system or the surroundings, $\Delta S_{univ} = 0$.

7. The temperature in the system is uniform.

8. The first law demands that energy be conserved. "It can't be destroyed." "Minimize entropy production" is a suitable new phrase, but we have a serious communication gap. Perhaps conserve "available energy" (see Unit IVA) would be more meaningful to the public at large.

Ans. 11. The cable is steady state. $\cancel{\frac{dU}{dt}} = \frac{đQ}{dt} + \frac{đW^i_{irr}}{dt} + \cancel{\frac{đW^i_{rev}}{dt}}$

$$\therefore -\frac{đQ}{dt} = \frac{đW^i_{irr}}{dt} = I^2R = 1.08 \cdot 10^4 \text{ W/m} \qquad \frac{dS_m}{dt} = \frac{1}{T_{eq}}\frac{đW^i_{irr}}{dt} = 33.28 \text{ W/(m K)}$$

$$\frac{dS_{rev,th}}{ft} = \frac{1}{T_B}\frac{đQ}{dt} = -33.43 \text{ W/(m K)} \qquad \frac{dS_{irr,th}}{dt} = \frac{\delta T_{neq}}{T_{eq}T_B}\frac{dQ}{dt} = 0.15 \text{ W/(m K)}$$

$$\frac{dS}{dt} = \frac{dS_{rev,th}}{dt} + \frac{dS_{irr,th}}{dt} + \frac{dS_m}{dt} = 0, \text{ the wire is in steady state.}$$

$$\frac{dS_{univ}}{dt} = \frac{dS_{sys}}{dt} + \frac{dS_{surr}}{dt} = -\frac{1}{T_B}\frac{đQ_{sys}}{dt} = 33.43 \text{ W/(m K)}$$