concepts or two different design modifications are under consideration, it may not be obvious which is better. In these cases a determination of production or the reduction in production for both alternatives can be an important criterion.

Exercise 11. A transmission cable in steady state carries a full load current of $3 \cdot 10^3$ A and has a resistance per length of $1.2 \cdot 10^3$ Ω/m. The joulean heating within the wire results in a mean temperature (an equilibrium value) that is 1.5°C above the surface temperature, 50°C. Calculate the magnitude of the thermally reversible and irreversible, as well as the irreversible mechanical contribution to the rate of entropy change of the wire (in W/m K). What is the rate of change of the entropy of the wire? What is the rate of increase of the entropy of the universe if the surroundings are reversible?

The problems of this section have specified a temperature distribution to enable the determination of thermal entropy production. The procedures by which such temperature distributions are deduced are treated in heat transfer courses. Thus the detailed consideration of thermal and mechanical production within the system by an explicit determination of δT_{neq} or $\delta \bar{F}_{neq}$ is beyond our scope in this course.[18] In subsequent units we will determine only the net production, ΔS_{univ}. The student should continue to recognize the contributions to such irreversibilities as to their thermal or mechanical origin.

SUMMARY QUESTIONS

The following questions are designed to aid you to verify your understanding of the important concepts of this unit before beginning application of the second law.

1. What condition does the second law impose on the entropy of the universe?

2. State a sufficient condition to assure that the entropy of a closed system increases.

3. What are the necessary and sufficient conditions to assure that the entropy of a closed system will decrease during a differential process?

4. What restrictions are placed on the application of the Gibbs equation, $ds = (du + p\,dv)/T$?

5. What property is constant during an adiabatic reversible process?

6. What is the difference between an internally reversible process and a reversible process?

7. State a sufficient condition to assure that thermal entropy production is not present within a system.

8. To combat the "energy crisis" we are bombarded with the slogan "conserve energy." From a thermodynamicist's perspective this request is vacuous! What is wrong with it and how would you rephrase it?

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[18]The determination of mechanical irreversibility is a topic of such courses as fluid and solid mechanics, electric circuits and electromagnetic fields.