1. (a) Consider a long cylinder of inside radius r_i, outside radius r_o, and length L, such as shown in Fig 1. We expose this cylinder to a temperature differential $T_i - T_o$, and ask what the heat flow will be , the thermal resistance in this case. Fourier law is applied to the conduction heat transfer, $q = -\dfrac{kA}{\Delta x}(T_2 - T_1)$. (10%), (b). Derive a relation for the critical radius of insulation for a cylinder. (10%)
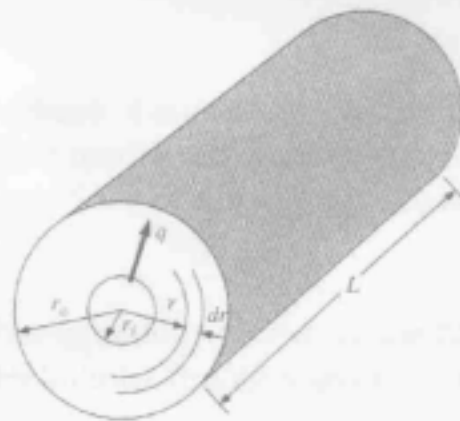

Fig. 1

2. Define the Reynolds number, Grashof number, Prandtl number, and Nusselt number. What are their physical meaning ? (ex. the ratio of difference force) (15%)

3. Suppose the heat-transfer coefficients for forced and free convection over vertical plat plates are to be compared. Develop an approximate relation between the Reynolds and Grashof numbers such that the heat-transfer coefficients for forced convection and pure free convection are equal. Assume laminar flow. (15%)

熱力學（*50分*）每題*10分*

1. Draw a figure to show the p-v diagram of a Carnot power cycle in which the system is a gas in a piston-cylinder assembly. Describe the four processes of the cycle.

2. Use a temperature-entropy diagram of the Rankine cycle to show the effects of turbine and pump irreversibilities.

3. Sketch of the phase diagram for water used to show the positions of the superheated vapor and compressed liquid. Also show the positions of the triple point and critical point.

4. What are the four equations known as the Maxwell relations? Also what are Helmholtz function and Gibbs Function?

5. Draw p-v diagrams of the air-standard Otto cycle and Diesel cycle.