

國立臺灣科技大學
八十八學年度碩士班招生考試試題

系所別：機械工程系研究所

組別：丙組

科目：熱力學

1. Use ideal gas equation of state to show that the universal gas constant R_u is equal to 8.314 kJ/(kmol·K). (10%)

2. The differential equation of pressure of a certain gas is given by one of the following equations:

$$dP = \frac{2RT}{(v-b)^2} dv + \frac{R}{v-b} dT$$

or

$$dP = -\frac{RT}{(v-b)^2} dv + \frac{R}{v-b} dT$$

where b is a constant and R is the gas constant.

Identify the correct equation, and then find the equation of state of that gas. (20%)

3. A 5-kg block of iron casting at 1000°C is thrown into a large lake which is at a temperature of 25°C. The iron block eventually reaches thermal equilibrium with the lake water. Assuming an average specific heat of 0.45kJ/(kg·°C) for the iron and 4.184 kJ/(kg·°C) for the water, determine (a) the entropy change of the iron block, (b) the entropy change of the lake water. (20%)

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4. An ideal gas undergoes a reversible thermodynamic cycle 1-2-3-1, as shown in Fig. 1. Process 1-2 is adiabatic expansion, 2-3 is constant pressure, and process 3-1 is constant volume. Show that the thermal efficiency of this heat engine is

$$\eta_{th} = 1 - k \frac{\frac{V_2}{V_1} - 1}{\frac{P_2}{P_1} - 1}$$

where $k = C_p / C_v$

(20%)

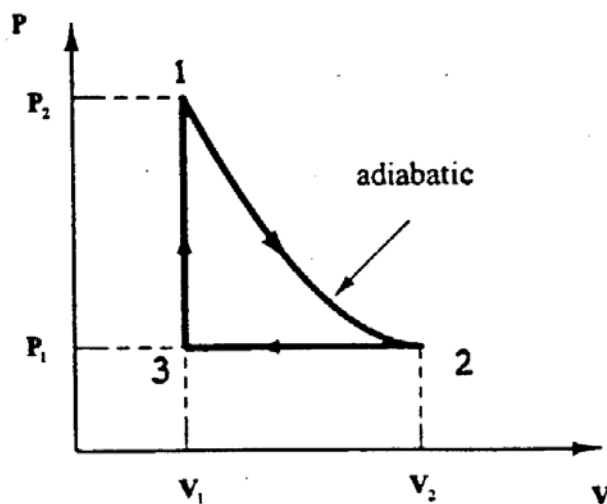


Fig.1

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5. Ice of mass M at the fusion temperature ($T_f = 0^\circ\text{C}$) is enclosed in a spherical cavity of diameter D . The cavity wall is of thickness L ($L \ll D$), and thermal conductivity k . If the outer surface of the wall is at a temperature $T_1 > T_f$, obtain an expression for the time required to completely melt the ice. (15%)

6. A long bar of rectangular cross section is 60mm by 90mm on a side as shown in Fig.2 and has a thermal conductivity of $2 \text{ W/m}\cdot\text{K}$. One surface is maintained at 100°C , while the remaining surfaces are maintained at 50°C . Using finite difference method with grid spacing of 30mm, determine the nodal temperatures of the cross section. (15%)

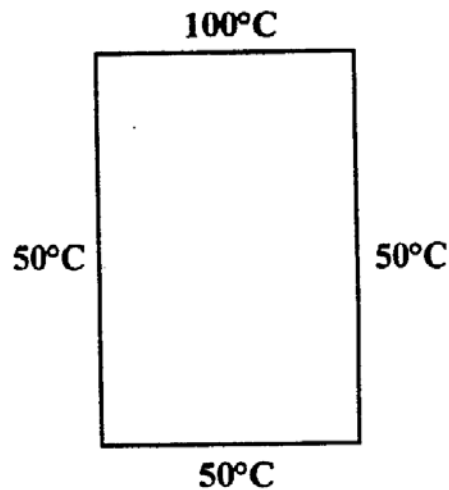


Fig.2