國立成功大學
111學年度碩士班招生考試試題

編　號：152

系　所：生物醫學工程學系

科　目：熱力學

日　期：0219

節　次：第 1 節

備　註：可使用計算機

※ 考生請注意：本試題可使用計算機。　請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

1. A bimetallic strip of total thickness x is straight at temperature T. What is the radius of curvature of the strip, R, when it is heated to temperature $T + \Delta T$? *The coefficients of expansion of the two metals are* α_1 *and* α_2, *respectively, with* $\alpha_1 > \alpha_2$. *Please assume that each metal has thickness* $x/2$, *and* $x \ll R$.
   (10 points)

2. Consider a cylinder with a frictionless piston composed of a semipermeable membrane permeable to water only. Let the piston separate a volume V of N moles of pure water from a volume V' of a dilute salt NaCl solution. There are N' moles of water and n moles of the salt in the solution. The system is in contact with a heat reservoir at temperature T.

   (a) Evaluate an expression for entropy of mixing in the salt solution.
   (15 points)

   (b) If the piston moves so that the amount of water in the salt solution doubles, how much work is done?
   (15 points)

   (c) Derive an expression for the pressure π across the semipermeable membrane as a function of the volume of the salt solution.
   (15 points)

3. Making reasonable assumptions, estimate the surface temperature of Neptune. Neglect any possible internal sources of heat. What assumptions have you made about the planet's surface and/or atmosphere? *Some useful date you may consider : radius of sun* $= 7 \times 10^5$ *km; radius of Neptune* $= 2.2 \times 10^4$ *km; mean sun-earth distance* $= 1.5 \times 10^8$ *km; mean sun-Neptune distance* $= 4.5 \times 10^9$ *km; Radiation rate from sun to earth* $= 1.4$ *kW/m^2; sun temperature is 6000 K.*
   (25 points)

4. A building at a temperature $T(K)$ is heated by an ideal heat pump which uses the atmosphere at $T_0(K)$ as heat source. The pump consumes power W and the building loses heat at a rate $\alpha(T - T_0)$. What is the equilibrium temperature of the building?
   (20 points)