

國立高雄大學 103 學年度研究所碩士班招生考試試題

科目：化工熱力學與化學反應 系所：化學工程及材料工程學系  
 工程 (甲組)  
 考試時間：100 分鐘 本科原始成績：100 分

是否使用計算機：是

**Table: Values of the universal gas constant**

$$\begin{aligned} R &= 8.314 \text{ J mol}^{-1} \text{ K}^{-1} = 8.314 \text{ m}^3 \text{ Pa mol}^{-1} \text{ K}^{-1} \\ &= 83.14 \text{ cm}^3 \text{ bar mol}^{-1} \text{ K}^{-1} = 8314 \text{ cm}^3 \text{ kPa mol}^{-1} \text{ K}^{-1} \\ &= 82.06 \text{ cm}^3 (\text{atm}) \text{ mol}^{-1} \text{ K}^{-1} = 62356 \text{ cm}^3 (\text{torr}) \text{ mol}^{-1} \text{ K}^{-1} \\ &= 1.987 (\text{cal}) \text{ mol}^{-1} \text{ K}^{-1} = 1.986 (\text{Btu})(\text{lb mole})^{-1} (\text{R})^{-1} \\ &= 0.7302 (\text{ft})^3 (\text{atm}) (\text{lb mol})^{-1} (\text{R})^{-1} = 10.73 (\text{ft})^3 (\text{psia})(\text{lb mol})^{-1} (\text{R})^{-1} \\ &= 1545 (\text{ft})(\text{lb}_f)(\text{lb mol})^{-1}(\text{R})^{-1} \end{aligned}$$

1. During the isothermal heat rejection process of a Carnot cycle, the working fluid experiences an entropy change of  $-1.3 \text{ kJ/K}$ . If the temperature of the heat sink is  $35^\circ\text{C}$ , determine (a) the amount of heat transfer, (b) the entropy change of the sink, and (c) the total entropy change for this process. (18%)

2. Under appropriate conditions A decomposes as follows:



R is to be produced from 1000 liter/hr of feed in which  $C_{A0} = 1 \text{ mol/liter}$ ,  $C_{R0} = C_{S0} = 0$ .

(a) What size plug flow reactor will maximize the yield of R, and what is the concentration of R in the effluent stream from this reactor? (12%)

(b) What size mixed reactor will maximize the yield of R, and what is  $C_{R,\text{max}}$  in the effluent stream from this reactor? (12%)

3. A frictionless piston-cylinder device, initially contains  $0.01 \text{ m}^3$  of argon gas at  $400 \text{ K}$  and  $350 \text{ kPa}$ . Heat is now transferred to the argon from a furnace at  $1200 \text{ K}$ , and the argon expands isothermally until its volume is double. No heat transfer takes place between the argon and the surrounding atmospheric air, which is at  $300 \text{ K}$  and  $100 \text{ kPa}$ . Determine (a) the useful work output, (b) the energy destroyed, and (c) the maximum work that can be produced during this process. (18%)

4. For the two CSTRs in series, 40% conversion is achieved in the first reactor. What is the volume of each of the two reactors necessary to achieve 90% overall conversion of the entering species A? (14% ) What is the volume necessary to achieve 90% conversion in one CSTR? (8%)

X	0.0	0.1	0.2	0.4	0.6	0.7	0.9
$(F_{A0}/-r_A)(\text{m}^3)$	0.89	1.09	1.33	2.05	3.54	5.06	8.0

5. At  $25^\circ\text{C}$  and atmospheric pressure the volume change of mixing of binary liquid mixtures of species 1 and 2 is given by the equation:

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$$\Delta V = x_1 x_2 [30x_1 + 20x_2]$$

Where  $\Delta V$  is in  $\text{cm}^3 \text{mol}^{-1}$ . At these conditions,  $V_1 = 110$  and  $V_2 = 90 \text{ cm}^3 \text{mol}^{-1}$ . Determine the partial molar volumes  $\bar{V}_1$  and  $\bar{V}_2$  in a mixture containing 40 mol% of species 1 at the given conditions. (18%)