

九十三年學年度工程科技研究所博士班入學考試

化學工程組 化學工程試題

填准考證號碼

第一頁 共一頁

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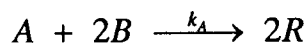
注意事項：

1. 本試題共六題，配分共 100 分，每題為 20 分。
2. 請按順序標明題號作答，不必抄題。
3. 全部答案均須答在答案卷之答案欄內，否則不予計分。

1. Three kilograms of water ($V_1 = 1006 \text{ cm}^3/\text{kg}$) in a piston/cylinder device at 30°C and 1.1 bar is compressed in a mechanically reversible, isothermal process to 1600 bar. Determine Q , W , ΔU , ΔH , and ΔS given that volume expansivity $\beta = 250 \times 10^{-6} \text{ K}^{-1}$ and isothermal compressibility $\kappa = 45 \times 10^{-6} \text{ bar}^{-1}$.

2. An air-standard Diesel cycle absorbs 1600 J/mol of heat (which simulates combustion). The pressure and temperature at the beginning of the compression step are 1 bar and 25°C , and the pressure at the end of the compression step is 5 bar. Assuming air to be an ideal gas for which $C_p = (7/2)R$ and $C_v = (5/2)R$, what are the compression ratio and expansion ratio of the cycle?

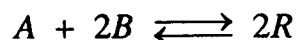
3. The exothermic reaction



is virtually irreversible at low temperatures and the rate law is

$$-r_A = k_A C_A^{1/2} C_B$$

Suggest a rate law that is valid at high temperatures, where the reaction is reversible:



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4. A tube 60 mm OD is lagged with a 55-mm layer of asbestos, for which the conductivity is $0.22 \text{ W/m}\cdot\text{C}$, followed with a 45-mm layer of cork with a conductivity of $0.06 \text{ W/m}\cdot\text{C}$. If the temperature of the outer surface of the pipe is 160°C and the temperature of the outer surface of the cork is 35°C , calculate the heat loss in watts per meter of pipe.
5. Benzene at 35°C is pumped at the rate of $10 \text{ m}^3/\text{h}$. The reservoir is at atmospheric pressure. The gauge pressure at the end of the discharge line is 350 kN/m^2 gauge. The discharge is 4 m above the pump. The pump suction 1.5 m, above the level in the reservoir. The pipe is 3.3 cm diameter. The friction in the suction line is known to be 3.25 kN/m^2 , and that in the discharge line is 38 kN/m^2 . The mechanical efficiency of the pump is 60 percent. The density of the benzene is 865 kg/m^3 , and its vapor pressure at 35°C is 25.6 kN/m^2 . Calculate (1) the developed head of the pump, (2) the total power input, (3) the net positive suction head.