

國立中正大學

109 學年度碩士班招生考試

試題

[第 2 節]

科目名稱	輸送現象與單元操作
系所組別	化學工程學系

—作答注意事項—

※作答前請先核對「試題」、「試卷」與「准考證」之系所組別、科目名稱是否相符。

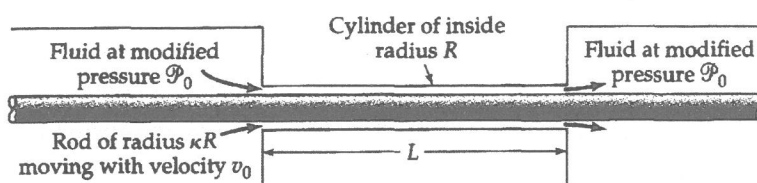
- 1.預備鈴響時即可入場，但至考試開始鈴響前，不得翻閱試題，並不得書寫、畫記、作答。
- 2.考試開始鈴響時，即可開始作答；考試結束鈴響畢，應即停止作答。
- 3.入場後於考試開始 40 分鐘內不得離場。
- 4.全部答題均須在試卷（答案卷）作答區內完成。
- 5.試卷作答限用藍色或黑色筆（含鉛筆）書寫。
- 6.試題須隨試卷繳還。

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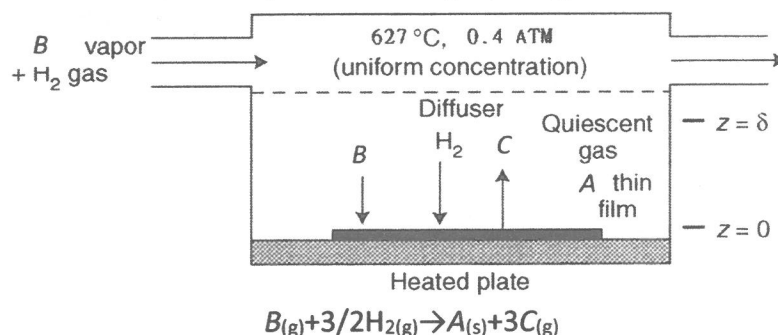
科目名稱：輸送現象與單元操作
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1. A cylindrical rod of radius kR moves axially with velocity $v_z = v_0$ along the axis of a cylindrical cavity of radius R as seen in the figure. The pressure at both ends of the cavity is the same, so that the fluid moves through the annular region solely because of the rod motion. The fluid is Newtonian, and is flowing in steady, incompressible, fully developed laminar flow. The outside wall of the annulus is stationary. In developing your equation, please state the reason for eliminating any term in the original equation.
 - (a) Find the velocity distribution in the narrow annular region. (15 points)
 - (b) Find the mass rate of flow through the annular region. (8 points)
 - (c) Obtain the viscous force acting on the rod over the length L . (7 points)



2. Consider the low-pressure chemical vapor deposition (LPVCD) diffusion reactor as shown below. It is desired to lay a thin film of the semiconductor A , onto a silicon wafer surface. A metal is not volatile, but its precursor (B , 114.72 g/gmol) is volatile. In the presence of an H_2 gas, at high temperature, B will decompose to solid A on a surface by the following reacting:



At 627°C , this surface reaction is diffusion limited.

- (a) Develop an integral model to predict the flux of B to the wafer surface. Keep your final model in algebraic form. Provide appropriate assumptions and boundary condition. At this point, you may not assume that the process is dilute. (10 points)

For the part (b) and (c), consider a process where the feed gas consists of 99.98 mol% H_2 and 0.02 mol% B . The temperature and total system pressure are 627°C and 0.40 atm , respectively. The binary diffusion coefficient of B in H_2 at 727°C and 1 atm is known to be $2.0\text{ cm}^2/\text{s}$.

- (b) What is the simplified form of the model previously developed in part (a)? (10 points)
- (c) What is the value of an appropriate diffusion coefficient for this process? (10 points)

Hint: $D_{AB_{T_2, P_2}} = D_{AB_{T_1, P_1}} \left(\frac{P_1}{P_2} \right) \left(\frac{T_2}{T_1} \right)$

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科目名稱：輸送現象與單元操作

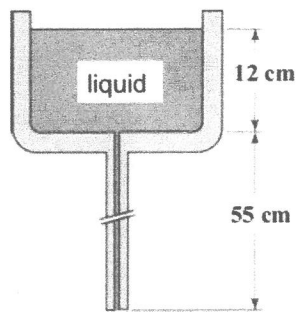
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3. To determine the kinematic viscosity of a liquid, a common type of viscosimeter consists of a large container with a depth of 12 cm and a 55-cm-long vertical tube attached to the bottom of container is used. The tube diameter is 0.18 cm. The liquid of constant density flows out of the viscosimeter at a rate of $1.9 \text{ cm}^3/\text{s}$.

(a) What is the kinematic viscosity of the liquid? (15 points)

(b) Is the tube flow laminar? (5 points)



4. A furnace wall is composed of three layers, 10 cm of firebrick ($k=1.56 \text{ W/m}\cdot\text{K}$), followed by 25 cm of kaolin insulating brick ($k=0.07 \text{ W/m}\cdot\text{K}$), and finally 8 cm of masonry brick ($k=1.0 \text{ W/m}\cdot\text{K}$). The temperature of the inner wall surface is 1400 K and the outer surface is at 400 K. What are the temperatures at the contacting surfaces? (20 points)