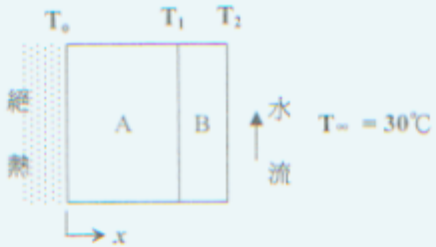
國立中正大學九十二學年度碩士班招生考試試題

系所別：化學工程學系　　科　目：輸送現象與單元操作

1. (25 points)

有一牆壁由 A 與 B 兩種材料組成（如下圖），其中材料 A 厚度為 50mm, k_A = 75 W/m·K 且均勻放熱 1.5×10^6 W/m^3；另一材料 B 厚度為 20mm, k_B = 150 W/m·K，且沒有放熱。已知材料 A 的一面為絕熱，而材料 B 的另一面使用 30℃的水流冷卻且其 h = 1000 W/m^2·K。（假設 AB 之間無熱傳阻力）



a. 在 steady state 下，請計算出 T_0、T_1 與 T_2

b. 並請畫出溫度之可能分佈圖

2. (25 points)

水上遊樂園內有一滑梯水道（寬度為 50cm），為了減少表面磨擦力，利用水流在滑梯表面形成一流動水膜。此水膜是經由滑梯頂端自然溢流產生，溜滑梯與地面角度為 45°。假設此水膜在 fully developed、steady-state 下厚度為 2.5mm，且水膜與滑梯表面為 non-slip，請問

a. 最大流速為多少?

b. 平均流速為多少?

c. 體積流量為多少?

d. 作用在平行於滑梯面上（z 方向）之力為多少?

(註：水密度為 1 g/cm^3，μ 為 10^{-2} g/cm·s，重力加速度為 980 cm/sec^2)

(Hint:利用 shell momentum balance)

3. (20 points)
For each of the following 10 terms, select **a proper definition** from the pool of definitions (a) to (j) and **a proper short feature** from the pool of features from (k) to (p). (不要抄題，依序寫出配對即可)

(1) Absorption
(2) Adsorption
(3) Crystallization
(4) Dehumidification
(5) Distillation
(6) Drying
(7) Filtration
(8) Humidification
(9) Leaching
(10) Liquid extraction

Definitions:
(a) The removal of solid particles from a fluid by passing the fluid through a porous medium.
(b) The formation of solid particles within a homogeneous phase.
(c) Soluble material is dissolved from its mixture with an inert solid by means of a liquid solvent.
(d) A solute is removed from either a liquid or gas through contact with a solid adsorbent, the surface of which has a special affinity for the solute.
(e) A pure liquid is partially removed from an inert or carrier gas by condensation. Usually, the carrier gas is virtually insoluble in the liquid.
(f) A soluble vapor is removed from its mixture with an inert gas by means of a liquid.
(g) A mixture of liquid is treated by a solvent that preferentially dissolves one or more of the components in the mixture.
(h) A liquid, usually water, is separated by the use of hot gas.
(i) To separate, by vaporization, a liquid mixture of miscible and volatile substances into individual components or, in some cases, into groups of component
(j) Warm liquid is brought into contact with unsaturated gas, part of the liquid is vaporized and the liquid temperature drops.

Features:
(k) The transfer of a solute from the gas phase into the liquid phase.
(l) The transfer of a solute from the liquid phase into the gas phase.
(m) The transfer of a solute from one liquid phase into a second immiscible liquid phase.
(n) The transfer of a solute from a solid into a fluid (liquid or gas) phase.
(o) The transfer of a solute from a fluid (liquid or gas) onto the surface of a solid.
(p) The unit operation involving particulate solids.

4. (30 points)
A packed tower is designed to strip component **A** from an aqueous stream into a countercurrent flowing air stream. The packed tower having a cross-sectional area of 1 m^2 is operated at the conditions of 293 K and 1 atm. The inlet aqueous stream contains 2 mol % **A** and outlet 0.5 %. The inlet liquid flow is 100 kg mol water/h. The **A**-free air flow is 500 kg mol/h. At the tower's operating conditions, the system satisfies Henry's law with a Henry's constant of 0.3 atm/(kg mol fraction of **A**). Under the given flow conditions, the individual mass-transfer liquid coefficient, k_x, is equal to 1.0 kg mol/(h m^2). Assume that 50% of the resistance to mass transfer is encountered in the liquid phase. The interfacial surface area per unit volume of this packed tower, a, is 200 m^2/m^3. Determine

(a) The overall mass-transfer coefficient based on the liquid-phase molar fraction gradient, K_x,
(b) The overall and individual mass-transfer coefficients based on the gas-phase molar fraction gradient, K_y and k_y
(c) The volumetric overall mass-transfer coefficient, $K_y a$
(d) The height of the packed tower based on $K_y a$.
(e) You have to draw a plot of y versus x for solving this problem and indicate the equilibrium curve and operating line on the plot. Here y and x are mass fractions of **A** in gas and liquid phases, respectively.