參考用

1(15%)

考慮吸收塔之質傳係數時，文獻提供之公式時常分成液相質傳係數、氣相質傳係數，甚至有液相、氣相整體(overall)或區域(local)質傳係數之分。究竟其差別何在？各種質傳係數使用之時機有何差異？用這些公式計算總質傳量時須注意哪些差異？

2(15%)

簡述乾濕球濕度計之原理。若要測試空氣中之水分濃度，除乾濕球溫度差之外，還需要何種資料？我們是否可用同樣原理測量空氣中其他成分之濃度？譬如測量儲藏廢溶劑之倉庫中揮發出之溶劑氣，是否有缺點或困難？

3) (10%)

The ever-popular cooking device燜燒鍋 is designed as the attached figure. Please identify all the relevant heat transfer processes. *(5%)* Also indicate the possible improvements that you may have according to the design and the materials in the attached figure. *(5%)*
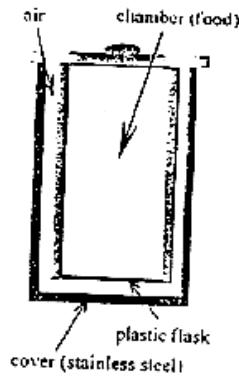

4) (25%)

A thin electrical heating element provides a uniform heat flux q" to the outer surface of a duct through which air flows. The duct wall has a thickness of 10 mm and a thermal conductivity of 20 W/m K.

(a) At a particular location, the air temperature is 30 °C and the convection heat transfer coefficient between the air and inner surface of the duct is 100 W/m^2 K. What hat flux q" is required to maintain the inner surface of the duct at $T_i = 85°C$? *(15%)*

(b) For the conditions of part a, what is the temperature (T_o) of the duct surface next to the heater? *(10%)*
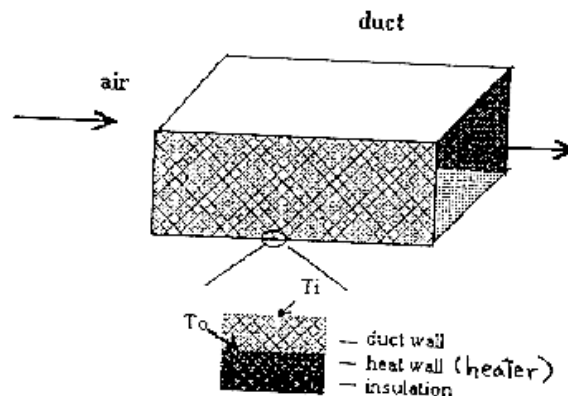
5) (15%)
(a) What dimensionless group(s) influence the friction factor for flow through a circular tube?
(b) If we plan to extend the use of friction-factor chart obtained from a circular tube system to flows through a non-circular conduit, will it work under turbulent flow and laminar flow? If the answer is yes, how do you define the characteristic length? If the answer is no, why?

6) (20%)
Air at 1.7 atm gauge and 15°C enters a horizontal 75-mm steel pipe that is 70 m long. The velocity at the entrance of the pipe is 60 m/s. Assuming isothermal flow, what is the pressure at the discharge end of the line? Viscosity μ = 0.0174 cP, friction factor f = 0.0044, gas constant R = 82.056×10^{-3} m^{3}atm/kgmol°K. In the derivation you may need a relationship, $u\,du = -u^2\rho^{-1}\,d\rho$, where u is the velocity and ρ is the density.