1.) The Prandtl number, Pr, is a dimensionless group important in heat transfer calculations. It is defined as $\mu C_p/k$, where C_p is the heat capacity of a fluid, μ is the fluid viscosity, and k is the thermal conductivity. For a particular fluid, $C_p = 0.305$ J/(g-℃), $k = 0.454$ W/(m-℃), and $\mu = 1800$ lb_m/(ft-h). Estimate the value of Pr without using a calculator (remember, it is dimensionless), showing your calculations; then determine it with a calculator. **(20%)**

2.) A stream containing 4.5 wt% chromium, Cr, is contained in the wastewater from a metal finishing plant. The wastewater stream is fed to a treatment unit that removes 92% of the chromium in the feed and recycles it to the plant. The residual liquid stream leaving the treatment unit is sent to a waste lagoon. The treatment unit has a maximum capacity of 4500 kg wastewater/h. If wastewater leaves the finishing plant at a rate higher than the capacity of the treatment unit, the excess (anything above 4500 kg/h) bypasses the unit and combines with the residual liquid leaving the unit, and the combined stream goes to the waste lagoon. Wastewater leaves the finishing plant at a rate $\dot{m}_1 = 6500$ kg/h. Calculate the flow rate of liquid to the waste lagoon, $\dot{m}_6$ (kg/h) **(10%)**, and the mass fraction of Cr in this liquid, x_6 (kg Cr/kg) **(10%)**.
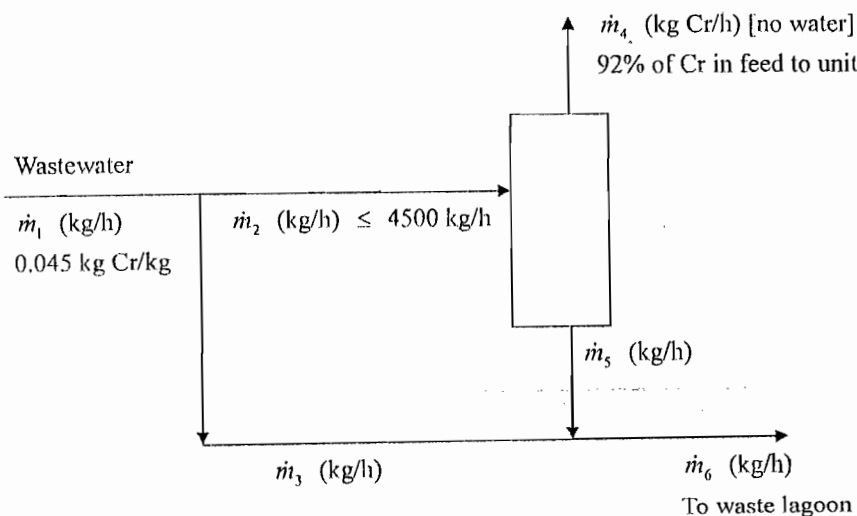
3.) Two aqueous sulfuric acid solutions containing 20.0 wt% H_2SO_4 (SG = 1.14) and 60.0 wt% H_2SO_4 (SG = 1.68) are mixed to form a 6.00 molar solution (SG = 1.47).
   (a) Calculate the mass fraction of sulfuric acid in the product solution. **(10%)**
   (b) Taking 100 kg of the 20 wt% feed solution as a basis, draw **(5%)** and label **(5%)** a flowchart of this process, labeling both masses and volume. Calculate the feed ratio (liters 20 wt% solution / liter 60 wt% solution). **(5%)**
   (c) What feed rate of the 60 wt% solution (L/h) would be required to produce 1250 kg/h of the product? **(5%)**

◀ 注意背面尚有試題 ▶

系別：化學工程與材料工程學系三年級　科目：質　能　均　衡

4.) A catalytic reactor is used to produce formaldehyde from methanol in the reaction

$$CH_3OH \rightarrow HCHO + H_2$$

A single-pass conversion of 80.0% is achieved in the reactor. The methanol in the reactor product is separated from the formaldehyde and hydrogen in a multiple-unit process. The production rate of formaldehyde is 1200.0 kg/h.

(a) Calculate the required feed rate of methanol to the process (kmol/h) if there is no recycle **(10%)**.

(b) Suppose the recovered methanol is recycled to the reactor and the single-pass conversion remains 80%. Determine the required fresh feed rate of methanol (kmol/h) **(10%)** and the rates (kmol/h) at which methanol enters **(5%)** and leaves the reactor **(5%)**.