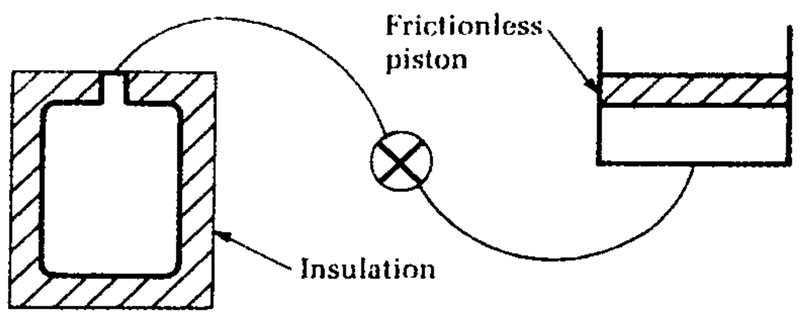
國立清華大學 102 學年度碩士班考試入學試題

系所班組別：動機系甲組

考試科目（代碼）：熱流學（1101）

1. Determine the work done by the air in a compressed-air cylinder ($V = 0.28\ m^3$) if it discharges into a cylinder-piston arrangement. The initial conditions of the compressed air are 35 bar, 150 ℃, whereas those of the cylinder-piston arrangement are 70 kPa, 24 ℃. Assume that the air is an ideal gas, the process is reversible and adiabatic, and the pressure in the cylinder-piston arrangement is always 70 kPa. (The gas constant for air is 0.287 kJ/kg·K) (15%)



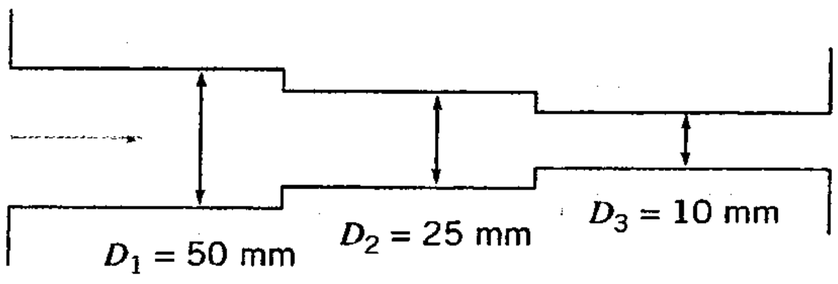
2. Please describe how to design a Stirling Cycle engine in the P-V and T-S diagrams. (5%) How to design this engine in the realistic case? (5%) Please explain the concept of the re-generation process and how to achieve it in the real design. (5%)

3. Standard air flow in a pipe system in which the area is decreased in two stages from 50 mm, to 25 mm, to 10 mm. Each section is 1 m long. The kinematic viscosity of air is $1.45\times10^{-5}\ m^2/s$.

(a) As the flow is increased, which section will become turbulent first? (5%)

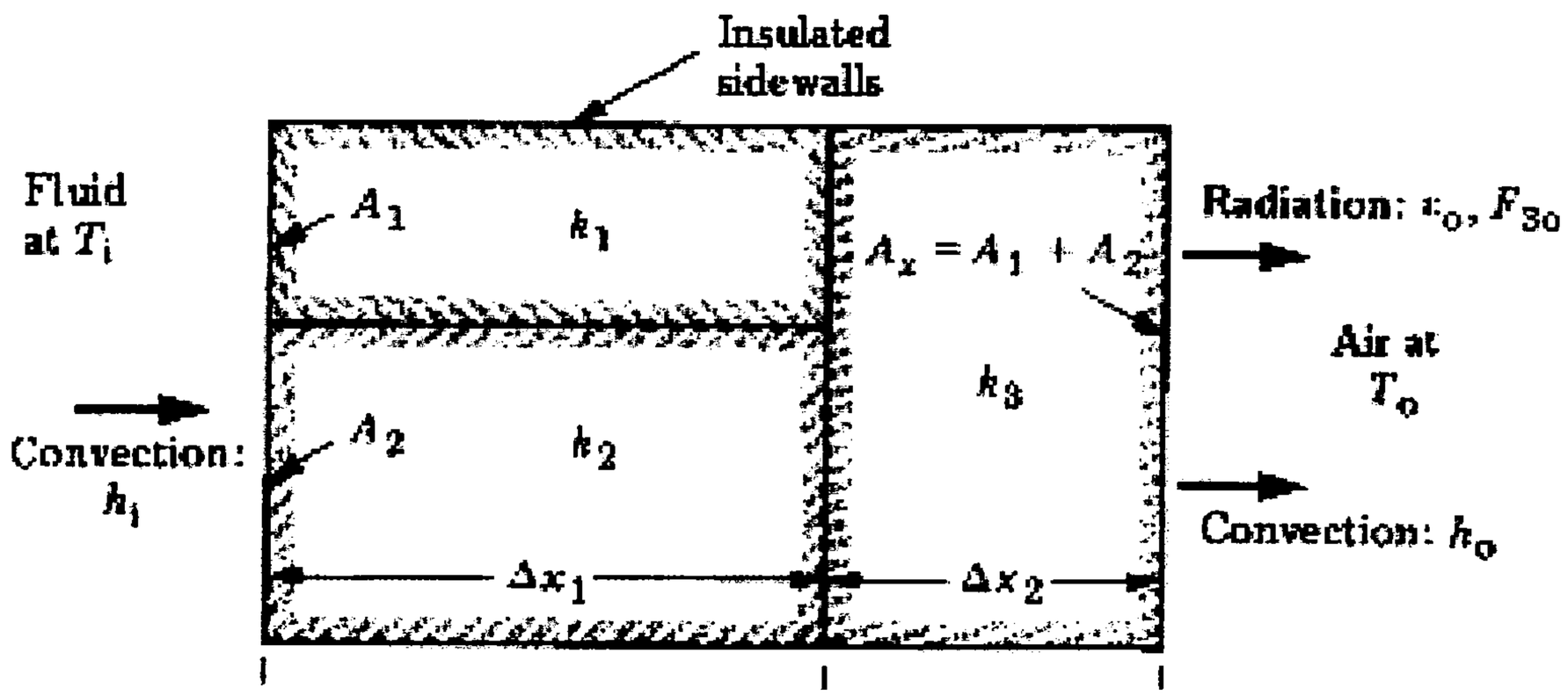
(b) Determine the flow rate at which one, two, then all three sections first become turbulent. (10%)

(C) At each of these flow rates, determine which sections, if any, attain fully developed flow. (5%)



4. A cyclist is able to attain a maximum speed of 30 km/hr on a calm day. The total mass of rider and bike is 65 kg. The rolling resistance of the tires is F_R =7.5 N, and the drag coefficient and frontal area are $C_D = 1.2$ and $A = 0.25\ m^2$. The cyclist bets that day, even though there is a headwind of 10 km/hr, she can maintain a speed of 24 km/hr. She also bets that cycling with wind support, she can attain a top speed of 40 km/hr. Which, if any, bets does she win? (15%)

5. As below is the illustrative one-dimensional conduction problem with combined series and parallel heat flow paths with convection and radiation at both ends. Please draw the equivalent electric circuit analogy. (5%) What is the overall heat flux represented by the symbols in the diagram? (10%)



6. Assume a cubic polynomial for the velocity profile in the laminar boundary layer flow (flat plate flow) as $\frac{u}{U} = a(\frac{y}{\delta}) + b(\frac{y}{\delta})^2 + c(\frac{y}{\delta})^3$, where U is the free stream velocity; and δ is the boundary layer thickness.

(a) What are the boundary conditions and explain their physical meaning. (10%)

(b) Solve the velocity profile (a=?, b=?, c=?) according to the boundary conditions. (10%)