1. Show that $COP_{HP} = COP_R + 1$ when both the heat pump and the refrigerator have the same Q_H and Q_L values. (20 分)

   Note: COP_{HP} = coefficient of performance of heat pump

   COP_R = coefficient of performance of refrigerator

   Q_H = magnitude of heat transfer between the cyclic device and the high- temperature medium at temperature T_H

   Q_L = magnitude of heat transfer between the cyclic device and the low- temperature medium at temperature T_L

2. An inventor claims to have developed a heat engine that receives 800 kJ of heat from a source at 400 K and produces 250 kJ of net work while rejecting the waste heat to a sink at 300 K. Is this a reasonable claim? Why? (10 分)

3. For perfect gas, show that $dS = Cv\dfrac{dT}{T} + R\dfrac{dv}{v}$ where S, Cv, R, T and v respectively stand for entropy, specific heat at constant volume, gas constant, fluid temperature and fluid specific volume. (20 分)

4. Air at 1.5 bar, 25^0C, initially occupying a cylinder volume of $0.01 m^3$, is compressed reversibly and adiabatically by a piston to the pressure of 8bar. Calculate the final temperature, the final volume, and the work done on the mass of air in the cylinder. (20 分)

5. 如圖所示。原先氮氣溫度為 300K ($27°$C)，壓力為 100atm。在排氣過程中，進行 $P\underline{V}^n = C_1$(常數) 的過程。若 $n = 1.2$，則壓力降到原先一半時，溫度為多少？請說明此過程為吸熱、絕熱，或放熱過程？(20 分)

   ($n \neq k$，$k = C_P/C_V = 1.4$，氮氣在鋼瓶內視為理想氣體)

$P\underline{V}^n = C_1$
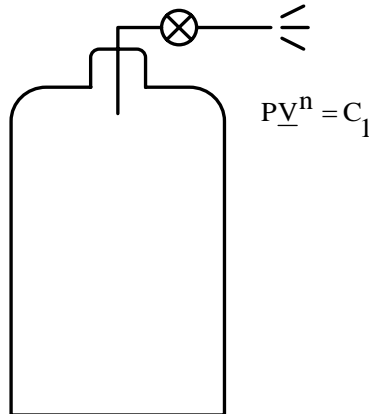
6. 壓縮機將空氣壓縮，對空氣做功。若壓縮比相同且同一台壓縮機，夏天(308K)所須的功較冬天(293K)為高或低？寫出所依據的理由或公式。假設壓縮機在操作過程中可視為絕熱過程。(10 分)

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