

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

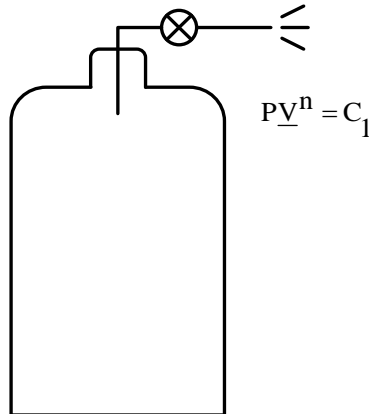
2. An inventor claims to have developed a heat engine that receives 800 kJ of heat from a source at 400 K and produces 250 kJ of net work while rejecting the waste heat to a sink at 300 K. Is this a reasonable claim? Why? (10 分)

3. For perfect gas, show that $dS = C_v \frac{dT}{T} + R \frac{dv}{v}$ where S , C_v , 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°C , initially occupying a cylinder volume of 0.01m^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 $PV^n = C_1$ (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)



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)