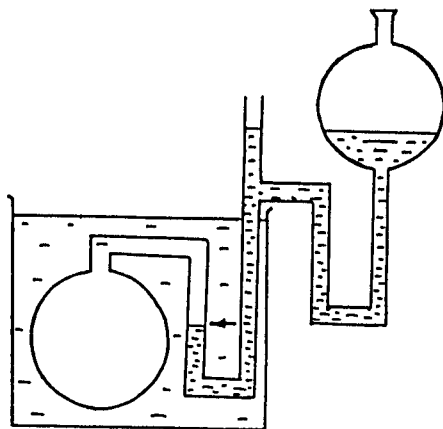


每題 20 分，計五題共 100 分

1. 1787 年 Charles 與 1802 年 Gay-Lussac 的觀察而奠定氣體壓力與熱度 (hotness) 的關係。後人發現可利用此關係來定義溫度，而製作了所謂 Constant-Volume Gas Thermometer，如下草圖所示：

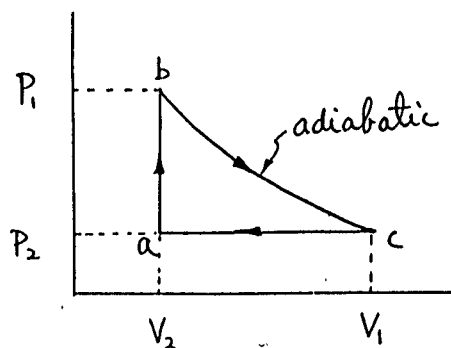
請問：

- (1) 如何運用該項設備來定義溫度？(如何操作該項實驗)。
- (2) 該定義之溫度是相對或絕對溫度？請說明。
- (3) 該定義之溫度與 Volume 內所用氣體種類是否有關？請說明。
- (4) 請詳細說明原理，並請如此定出溫度的計量 (scale)。



2. A tank with a volume of 10 ft^3 is initially evacuated. Atmospheric air at 10 psia, 50° F seeps into the tank slowly that heat transfer is allowed to maintain the temperature inside the tank equal to the atmospheric temperature. Please determine the amount of heat added to or removed from the tank if the pressure inside the tank reaches the atmospheric pressure. (for air $c_p = 0.24 \text{ Btu/lbm}^\circ \text{ R}$, $c_u = 0.17 \text{ Btu/lbm}^\circ \text{ R}$, $R = 0.0686 \text{ Btu/lbm}^\circ \text{ R}$)
3. A closed, insulated cylinder is divided into two unequal chambers A and B by an insulating piston. Initially, chamber A has n_A moles of ideal gas at T_A^o and P_A^o , while chamber B has n_B moles of a second ideal gas at T_B^o and P_B^o with $P_A^o > P_B^o$. This piston is now allowed to move freely till the pressure is equalized. (a) Can the final pressure be determined? If it cannot, give your explanation. If it can, what is it in terms of the given parameters? (12%) (b) Can the final temperatures of chamber A and B be determined? If so, what are they? (Assume constant heat capacities for both gases). (8%)

4. An ideal gas undergoes a cycle as shown. Derive the maximum thermal efficiency of the cycle in terms of the pressure ratio P_1/P_2 and the volume ratio V_1/V_2 .



5. 有一容器的容積是 V ，並維持定溫 T 。起始時容器內有 n_a 摩爾氣體 a ，現在加入 n_b 摩爾氣體 b 時量測到壓力上昇 ΔP 。假設 a, b 的純氣體以及 a 與 b 的混合氣體的體積變化特性均符合 Virial Equation of State，現在不考慮第三及更高次的 Virial Coefficients。請利用上列已知，導出 B_{ab} (Second Virial coefficient for the interaction between a and b) 的計算公式。

(已知： Virial Equation: $Z = 1 + B/v$,
 $B_{\text{mix}} = y_a^2 B_{aa} + 2y_a y_b B_{ab} + y_b^2 B_{bb}$
 v : molar volume
 z : compressibility factor
 y : composition of the gas)