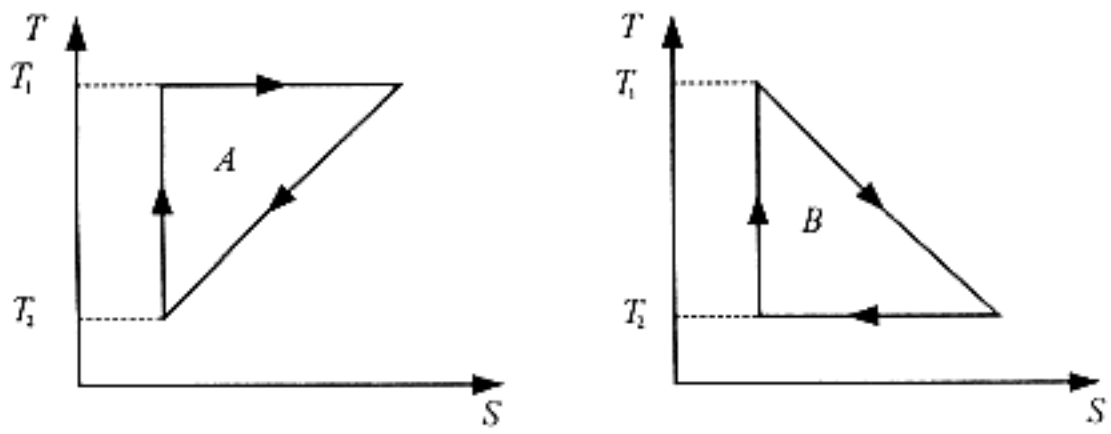
1. One mole of gas obeys Van der Waals equation of state, $(p + a/V^2)(V - b) = RT$. If its molar internal energy is given by $u = cT - a/V$ (in which $V$ is the molar volume, $a$ is one of the constants in the equation of state, and $c$ is a constant), calculate the molar heat capacities $C_v$ and $C_p$. (20%)

2. One mole of a monatomic perfect gas initially at temperature $T_0$ expands from $V_0$ volume to $2V_0$, (a) at constant temperature, (b) at constant pressure. Calculate the work of expansion and heat absorbed by the gas in each case. (20%)

3. A body of constant heat capacity $C_p$ and a temperature $T_i$ is put into contact with a reservoir at temperature $T_f$. Equilibrium between the body and the reservoir is established at constant pressure. Determine the total entropy change and prove that it is positive for either sign of $(T_f - T_i)/T_f$. You may regard $|T_f - T_i|/T_f < 1$. (20%)

(背面仍有題目,請繼續作答)

4. (a) Derive the expression for the efficiency of a Carnot engine directly from a *TS* diagram.
   (b) Compare the efficiencies of cycles *A* and *B* of the following figures. (20%)




5. The state of a new matter is $p = AT^3 / V$, where $p$, $V$ and $T$ are the pressure, volume and temperature, respectively, $A$ is a constant. The internal energy of the matter is

$$U = BT^n \ln(V / V_0) + f(T)$$

where $B$, $n$ and $V_0$ are all constants, $f(T)$ only depends on the temperature. Find $B$ in term of $A$, and the value of $n$. (20%)