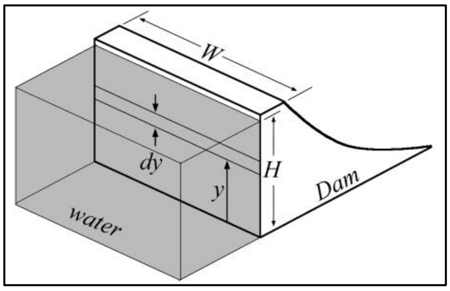
Open book. 寫下詳細的計算過程。 學號：__________________，姓名：_______________

1.

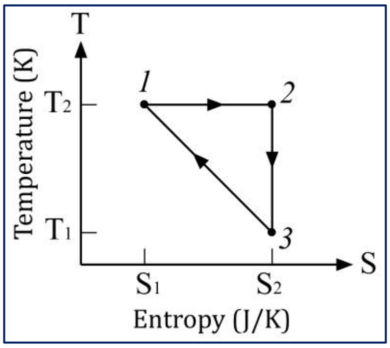


A dam has a width of W as shown in right figure. The surface of the freshwater behind the dam is filled to a height H of the dam.

(a) Find the net horizontal force exerted by the water on the dam.

(b) Find the torque exerted by the water about an axis along the bottom of the dam. (20%)

2.



One mole of a diatomic ideal gas is taken reversibly around the cycle shown in the T-S diagram (right figure). **The molecules do not rotate or oscillate**. Assume that the volume in state 1 is V_1.

(a) Find the heat Q transferred into the gas system for paths 1→2 and 2→3, and the full cycle.

(b) Find the works done by the gas for the isothermal and adiabatic processes.

(c) Find the volumes in state 2 and state 3.

(d) Find the change of internal energy ΔU for the full cycle?

(40%)

期末考場地分配、考試時間第二次段考相同。

2017 Fall 普通物理 B 第三次平時考

Ans:

1.

(a)

$$p = \frac{dF}{dA} = \rho g h, \text{where } h = H - y \text{ and } dA = W \cdot dy. \therefore F = \int dF = \int_0^H \rho h(H-y) \cdot W \cdot dy = \frac{1}{2}\rho g W H^2.$$

(b)

$$d\tau = dF \cdot y = \rho g y(H-y) \cdot dA. \therefore \tau = \int d\tau = \int_0^H \rho g W y(H-y) \cdot dy = \frac{1}{6}\rho g W H^3.$$

2.

$n = 1$ and $\gamma = 5/3$.

$1 \rightarrow 2$ is isothermal at T_2, so $\Delta U = 0 = Q_{12} - W_{12}$. $\Delta S = S_2 - S_1 = Q_{12}/T_2 > 0$, therefore, $Q_{12} = W_{12} > 0$.

Gas does positive work W_{12} by adsorbing heat Q_{12}.

$2 \rightarrow 3$: because $\Delta S = 0$, means $Q_{23} = 0$. So $2 \rightarrow 3$ is adiabatic and $\Delta T < 0$.

Gas does positive work W_{23}.

(a) $Q = Q_{12} + Q_{23} + Q_{31}$

Q_{12}: $\Delta S = S_2 - S_1 = \int_1^2 \frac{dQ}{T} = \frac{1}{T_2}\int_1^2 dQ = \frac{Q_{12}}{T_2}$, so $Q_{12} = T_2(S_2 - S_1)$

$Q_{23} = 0$

Q_{31}: $dS = dQ/T$, so $dQ = T \times dS$ and $T = M(S - S_2) + T_1$, where $M = \text{slope} = (T_2 - T_1)/(S_1 - S_2)$.

So $dQ = [M(S - S_2) + T_1] \times dS$

$$Q_{31} = \int_3^1 dQ = \int_3^1 [M(S-S_2) + T_1] \cdot dS = \frac{1}{2}(T_1 + T_2)(S_1 - S_2)$$

$Q = Q_{12} + Q_{23} + Q_{31} = \frac{1}{2}(T_2 - T_1)(S_2 - S_1)$ = area enclosed by the cycle.

(b) isothermal: $1 \rightarrow 2$, $W_{12} = Q_{12} = T_2(S_2 - S_1)$ (> 0)

Adiabatic: $2 \rightarrow 3$, $W_{23} = \left|\frac{p_3V_3 - p_2V_2}{\gamma - 1}\right| = \frac{nR}{\gamma-1}|T_3 - T_2| = \frac{3R}{2}(T_2 - T_1)$ (> 0)

(c) from (b) $W_{12} = nRT_2\ln(V_2/V_1) = T_2(S_2 - S_1)$, where $n = 1$. So $V_2 = V_1 \cdot \exp(\frac{S_2 - S_1}{R})$.

Sine $2 \rightarrow 3$ is adiabatic, so $T_2 \cdot V_2^{\gamma-1} = T_3 \cdot V_3^{\gamma-1}$, where $T_3 = T_1$.

Therefore, $V_3 = V_2 \cdot (\frac{T_2}{T_1})^{\frac{1}{\gamma-1}} = V_1 \cdot (\frac{T_2}{T_1})^{3/2} \cdot \exp(\frac{S_2 - S_1}{R})$

(d) $\Delta U = Q - W = 0$ for a full cycle.