Quiz | KEY

① Match the Thermodynamic Variable with the correct relation to the partition function Q

$\{A, P, S, U\}$

U $-\frac{1}{Q}\frac{\partial Q}{\partial \beta}$

S $-k\beta \frac{\partial \ln Q}{\partial \beta} + k\ln Q$

P $\frac{1}{\beta}\frac{\partial \ln Q}{\partial V}$

A $-\frac{1}{\beta}\ln Q$

U $-\frac{\partial \ln Q}{\partial \beta}$

P $\frac{1}{\beta Q}\frac{\partial Q}{\partial V}$

② Briefly list the characteristics of the following types of systems

ⓐ Isolated system: no exchange of matter or energy

ⓑ Open system: can exchange both matter and energy

ⓒ Adiabatic system: closed system except can not exchange heat energy

ⓓ Closed system: no exchange of matter, can exchange energy

③ A mole of ideal gas expands irreversibly under constant pressure (P = 1 atm) from 20 L to 30 L. How much work is done? (T = 300 K)

$$w = -P_{ex}\Delta V = -1\,atm\,(10\,L) = -10\,L\cdot atm$$

④ A mole of ideal gas expands reversibly from 20 L to 30 L. How much work is done? (T = 300 K)

$$w = -nRT\ln\frac{V_2}{V_1} = -(1\,mole)\left(0.082\,\frac{L\,atm}{K\,mol}\right)(300\,K)\ln\frac{30}{20} = -9.97\,L\,atm$$

Notice this answer is less than ③ even though ④ is maximum work. The reason for this is that ③ can not happen spontaneously because the pressure of a mole of ideal gas is less than 1 atm at 30 L.