



AP[®] Physics B 2003 Sample Student Responses Form B

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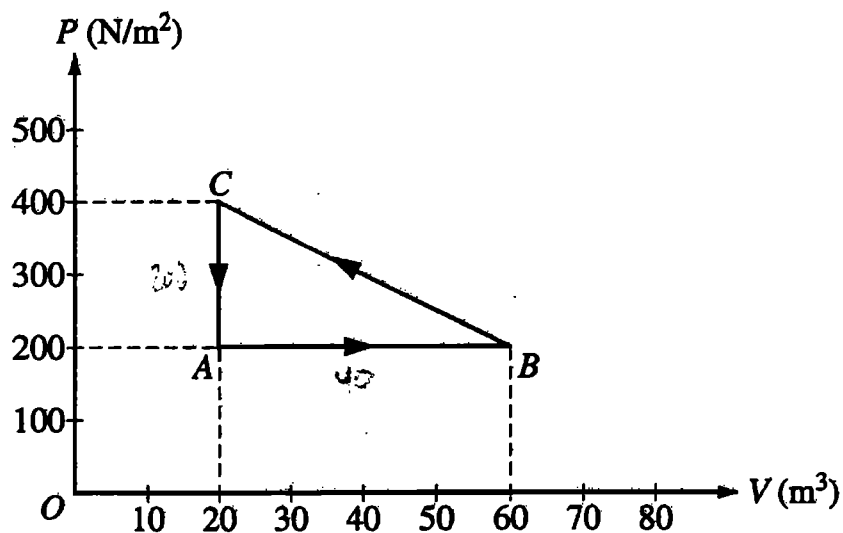
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5. (10 points)

One mole of an ideal gas is taken around the cycle $A \rightarrow B \rightarrow C \rightarrow A$ as shown on the PV diagram above.

(a) Calculate the temperature of the gas at point A.

$$PV = nRT$$

$$(200)(20) = 1(8.31)(T)$$

$$T = 481.34 \text{ Kelvin}$$

(b) Calculate the net work done on the gas during one complete cycle.

$$W = \text{Area enclosed by graph}$$

$$\frac{1}{2}(200)(40) = 4000 \text{ J}$$

(c) i. Is heat added to or removed from the gas during one complete cycle?

_____ added to the gas X removed from the gas

ii. Calculate the heat added to or removed from the gas during one complete cycle.

$$\Delta U = Q + W$$

$$0 = Q + 4000$$

$$Q = -4000 \text{ J}$$

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(d) After one complete cycle, is the internal energy of the gas greater, less, or the same as before?

___ greater ___ less X the same

Justify your answer.

Internal energy is dependent upon temperature alone.
After a complete cycle ABCA, the gas returns to
point A, at the same temperature. $\therefore U$ is the same.

(e) After one complete cycle, is the entropy of the gas greater, less, or the same as before?

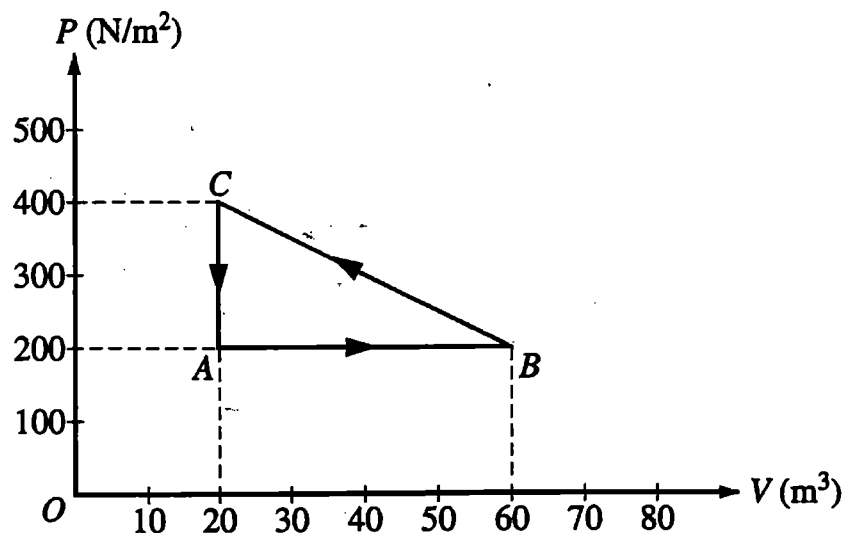
___ greater ___ less X the same

Justify your answer.

Entropy is the measure of the disorder or randomness of
a system. If the internal energy remains the same,
then the random movements of the gas will occur at the
same rate. \therefore Entropy is the same

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5. (10 points)

One mole of an ideal gas is taken around the cycle $A \rightarrow B \rightarrow C \rightarrow A$ as shown on the PV diagram above.

(a) Calculate the temperature of the gas at point A.

We know, $PV = nRT$.

$$\text{At A, } 200 \times 20 = 1 \times 8.31 \times T$$

$$\therefore T = 481.35 \text{ K}$$

(b) Calculate the net work done on the gas during one complete cycle.

Work done = work done in CA + work in AB + work in BC.

$$\therefore \text{Work done} = -(200 \times 40) + \left(\frac{200 + 400}{2} \right) (40) \quad \left[\begin{array}{l} \text{As } \Delta V = 0 \\ \text{in CA, there} \\ \text{is no work} \\ \text{done} \end{array} \right]$$

$$= -8000 + 12000$$

$$= 4000 \text{ J}$$

(c) i. Is heat added to or removed from the gas during one complete cycle?

___ added to the gas ___ removed from the gas

ii. Calculate the heat added to or removed from the gas during one complete cycle.

$$\text{At C, } T_{\text{emp}} = T_C = \frac{20 \times 400}{1 \times 8.31} = 962.69 \text{ K}$$

$$\text{At B, } T_{\text{emp}} = T_B = \frac{200 \times 60}{1 \times 8.31} = 1444.04 \text{ K}$$

$$\begin{aligned} \text{Total heat} &= \text{Heat}_{CA} + \text{Heat}_{AB} + \text{Heat}_{BC} \\ &= n C_p 481.35 - n C_p (962.69) + \end{aligned}$$

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(d) After one complete cycle, is the internal energy of the gas greater, less, or the same as before?

greater less the same

Justify your answer.

As the cycle reverts back to the same position as it started from with the original pressure $P = 400 \text{ N/m}^2$ and Volume $= 20 \text{ m}^3$, the internal energy is the same as temperature is the original one i.e. $T = 481.35 \text{ K}$.

(e) After one complete cycle, is the entropy of the gas greater, less, or the same as before?

greater less the same

Justify your answer.

After one complete cycle, the entropy is the same as before. Entropy measures the disorder in a system. At a constant pressure, volume and temperature as that of A, when the cycle is completed, entropy must be the same. This is because temperature measures the internal energy of a gas.

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