AP® Physics B
2003 Sample Student Responses
Form B

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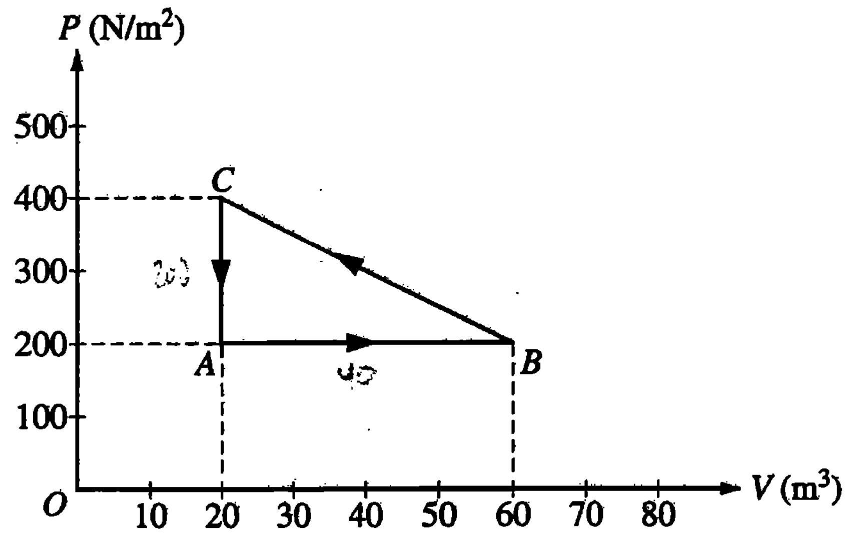

5. (10 points)

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.

$PV = nRT$

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

$T = 481.34$ kelvin

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

W = Area enclosed by graph

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

$\Delta U = Q + W$

$0 = Q + 4000$

$Q = -4000$ 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 return to point A, at the same temperature. ∴ 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. ∴ Entropy is the same

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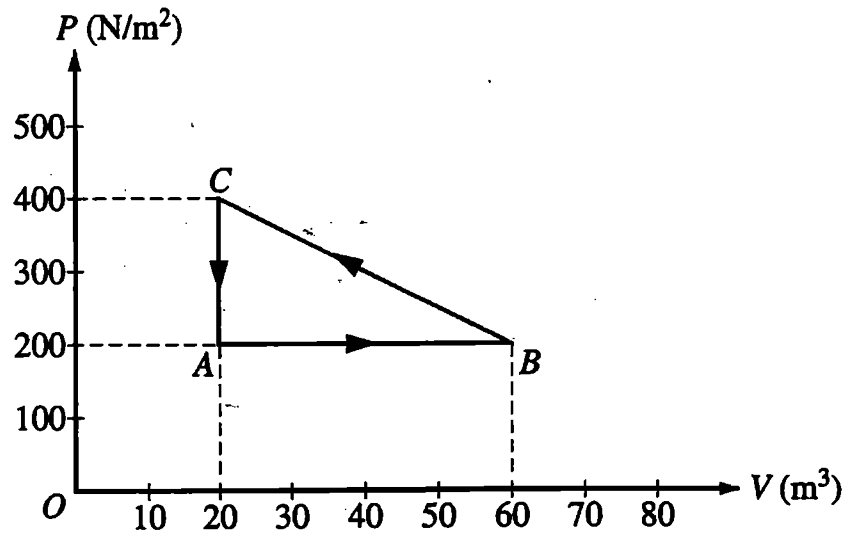

5. (10 points)
One mole of an ideal gas is taken around the cycle $A \rightarrow B \rightarrow C \rightarrow A$ as shown on the PV diagram above.

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

We know, $PV = nRT$.

At A, $200 \times 20 = 1 \times 8.31 \times T$.

or, $T = 481.35\ K$.

(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.

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

$= -8000 + 12000$

$= 4000\ J$

(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.

At C, temp $= t_C = \frac{20 \times 400}{1 \times 8.31} = 962.69\ K$

At B, temp $= t_B = \frac{200 \times 60}{1 \times 8.31} = 1444.04\ K$

Total heat = $Heat_{CA} + Heat_{AB} + Heat_{BC}$

$= nC_V\, 481.35 - n\, C_P(962.69) +$

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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 $P = 400\ N/m^2$ and Volume $= 20\ m^3$, the internal energy is the same as temperature is the original one ie $T = 481.35\ K$

(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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