AP® Physics B
2003 Sample Student Responses

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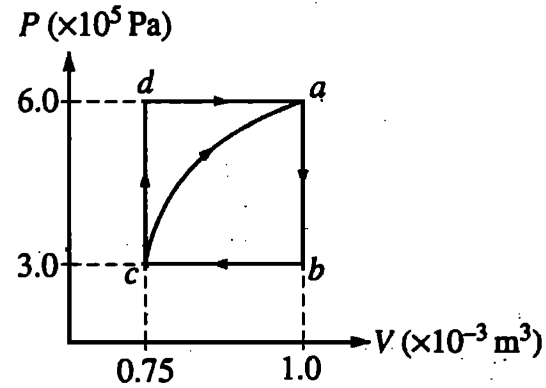
Wl



5. (10 points)
A cylinder with a movable piston contains 0.1 mole of a monatomic ideal gas. The gas, initially at state a, can be taken through either of two cycles, *abca* or *abcda*, as shown on the *PV* diagram above. The following information is known about this system.

$Q_{c\to a} =$ 685 J along the curved path

$W_{c\to a} = -120$ J along the curved path

$U_a - U_b = 450$ J

$W_{a\to b\to c} = 75$ J

(a) Determine the change in internal energy, $U_a - U_c$, between states a and c.

$\Delta U = \frac{3}{2} nR(\Delta T)$

$\Delta U = \frac{3}{2}(.1)(8.31)(722.02166 - 270.7581227)$

$\Delta U = 562.5$ J

(b) i. Is heat added to or removed from the gas when the gas is taken along the path *abc* ?

___ added to the gas X removed from the gas

ii Calculate the amount added or removed.

$\Delta U = Q + W$

$-562.5 = Q + 75$

$637.5 = Q$

GO ON TO THE NEXT PAGE.

W2

(c) How much work is done on the gas in the process *cda*?

$W = -6.0 \times 10^5 \cdot .25 \times 10^{-3}$

$W = -150\ J$

(d) Is heat added to or removed from the gas when the gas is taken along the path *cda*?

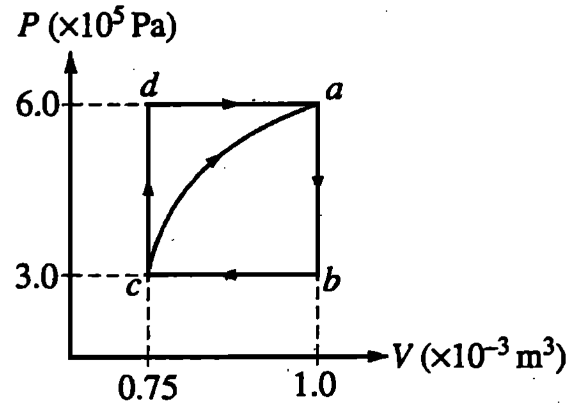
X added to the gas ____ removed from the gas

Explain your reasoning.

It must have a total energy greater than that at point C at point A. Because it is doing work and losing energy during this phase the excess energy must be added as heat.

GO ON TO THE NEXT PAGE.

X1



5. (10 points)
A cylinder with a movable piston contains 0.1 mole of a monatomic ideal gas. The gas, initially at state a, can be taken through either of two cycles, $abca$ or $abcda$, as shown on the PV diagram above. The following information is known about this system.

$Q_{c \to a} =$ 685 J along the curved path

$W_{c \to a} = -120$ J along the curved path

$U_a - U_b = 450$ J

$W_{a \to b \to c} = 75$ J

(a) Determine the change in internal energy, $U_a - U_c$, between states a and c.

$\Delta U = \Delta Q + \Delta W$ $\qquad$ $W_{a \to b \to c} = 75 J$

For pat $a \to b \to c$: $\Delta U = \Delta Q + 75 J$

$\Delta U_{a \to b \to c \to a} = 0 J$

$\Delta U_{c \to a} = Q_{c \to a} + W_{c \to a}$

$\Delta U_{c \to a} = 685 - 120 = 565 J$

(b) i. Is heat added to or removed from the gas when the gas is taken along the path abc ?

____ added to the gas $\qquad$ √ removed from the gas

ii Calculate the amount added or removed.

$\Delta U_{c \to a} + \Delta U_{a \to b \to c} = 0$

$565 + \Delta U_{a \to b \to c} = 0$

$\therefore U_{\Delta a \to b \to c} = -565$

$\Delta U = \Delta Q + \Delta W$

$-565 = \Delta Q + 75$

$-640 J = Q$

640 J of Heat was removed

GO ON TO THE NEXT PAGE.

X2

(c) How much work is done on the gas in the process *cda*?

$W = -P\Delta V$ $\Delta V_{c\to D} = 0$ $P_{d\to a} = 6\times10^5$

$\Delta V_{d\to a} = 0.25\times10^{-3}$

$W_{c\to D} = -P\Delta V_{c\to D} = 0$

$W_{d\to a} = -6\cdot10^5\cdot0.25\times10^{-3} = -1.5\times10^2 = -150$

$W_{c\to D} + W_{d\to a} = W_{cda} = -150\,J$

(d) Is heat added to or removed from the gas when the gas is taken along the path *cda*?

✓ added to the gas ____ removed from the gas

Explain your reasoning.

because if work from a→b→c was 75 and work from c→d→a was -150

75 J of heat was added from c→d→a.

GO ON TO THE NEXT PAGE.