

Q. 02

When a system goes from state A to state B, it absorbs 400 J of heat and it does 100 J of work.

- (a) For this transition, what is the system's change in internal energy?
(b) If the system moves from B to A, what is the change in internal energy?
(c) If in moving from A to B along a different path in which 300 J of work is done on the system, how much heat does it absorb?

Solution (a) From the first law,

$$\Delta U_{AB} = Q_{AB} - W_{AB} = (400 - 100) \text{ J} = 300 \text{ J}$$

- (b) Consider a closed path that passes through the state A and B. Since internal energy is a state function so ΔU is zero for a closed path.

Thus,
$$\Delta U = \Delta U_{AB} + \Delta U_{BA} = 0 \quad \text{or} \quad \Delta U_{BA} = -\Delta U_{AB} = -300 \text{ J}$$

- (c) The change in internal energy is the same for any path, so

$$\begin{aligned} \Delta U_{AB} &= \Delta U'_{AB} = Q'_{AB} - W'_{AB} \\ 300 \text{ J} &= Q'_{AB} - (-400 \text{ J}) \end{aligned}$$

and the heat exchanged is
$$Q'_{AB} = -100 \text{ J}$$

The negative sign indicates that the system loses heat in this transition.