Soln

Complete the Table

Step	Q	W	ΔU
A→B	(b) +	(a) −	+
B→C	+	(c) 0	(d) +
C→A	(e) −	(f) +	(g) −
Total	(h) −	(i) +	0

A→B: const P: • expanding, W ⊖ (a)

  • if ΔU ⊕, Q ⊕ (b)

B→C: const V: • $W = 0$ (c)

  • If $Q+$, ΔU ⊕ (d)
  (heat flows in)

C→A: compression • W ⊕ (f)
  P decreases

  • ΔU must be − (g)
  since $\Delta U_{cycle} = 0$

  • (first 2 stages ⊕)

  • <u>Note area under curve:</u>
  $+$ Work, $C → A$ greater
  magnitude than
  $-$ Work from $A → B$
  So: W_{net} ⊕ (i)

  • therefore $Q_{C→A}$ ⊖ (e)
  so that $\Delta U_{CYCLE} = 0$

  • Q_{TOTAL} ⊖ (h)

What is W_{net}?

$$W_{A→B} = -P\Delta V = -(20\ Pa)(3-1\ m^3) = -40\ J$$

$$W_{B \to C} = 0$$

$W_{C \to A}$: P not constant : linear function in V

$$P = mV + b$$

$$m = \frac{\Delta P}{\Delta V} = \frac{-20}{-2} = 10$$

$$P(V) = 10V + b$$

@ $V = 1$, $P = 20$

$$20 = 10(1) + b$$

$$b = 10$$

$$P(V) = 10V + 10$$

$$W_{C \to A} = -\int_{3}^{1} (10V + 10) \, dV$$

$$= -\frac{10V^2}{2}\Big|_{3}^{1} - 10V \Big|_{3}^{1}$$

$$= -5(1 - 9) - 10(1 - 3)$$

$$= +40 + 20$$

$$W_{C \to A} = 60 \text{ J}$$

$$W_{net} = -40 + 60 = \oplus 20 \text{ J}$$

Note: area of triangle is 20 J