

53. (a) The change in internal energy ΔE_{int} is the same for path iaf and path ibf . According to the first law of thermodynamics, $\Delta E_{\text{int}} = Q - W$, where Q is the heat absorbed and W is the work done by the system. Along iaf $\Delta E_{\text{int}} = Q - W = 50 \text{ cal} - 20 \text{ cal} = 30 \text{ cal}$. Along ibf $W = Q - \Delta E_{\text{int}} = 36 \text{ cal} - 30 \text{ cal} = 6 \text{ cal}$.
- (b) Since the curved path is traversed from f to i the change in internal energy is -30 cal and $Q = \Delta E_{\text{int}} + W = -30 \text{ cal} - 13 \text{ cal} = -43 \text{ cal}$.
- (c) Let $\Delta E_{\text{int}} = E_{\text{int}, f} - E_{\text{int}, i}$. Then, $E_{\text{int}, f} = \Delta E_{\text{int}} + E_{\text{int}, i} = 30 \text{ cal} + 10 \text{ cal} = 40 \text{ cal}$.
- (d) The work W_{bf} for the path bf is zero, so $Q_{bf} = E_{\text{int}, f} - E_{\text{int}, b} = 40 \text{ cal} - 22 \text{ cal} = 18 \text{ cal}$. For the path ibf $Q = 36 \text{ cal}$ so $Q_{ib} = Q - Q_{bf} = 36 \text{ cal} - 18 \text{ cal} = 18 \text{ cal}$.