Reading 2/13 Solutions

① Cons. of energy

$W_{a,out} = 40\,J$ $W_{c,out} = 30\,J$

$W_{b,out} = 40\,J$ $W_{d,out} = 50\,J$

$\eta = 1 - \frac{Q_c}{Q_H}$

$\eta_a = 1 - \frac{60\,J}{100\,J} = \boxed{0.40}$

$\eta_b = 1 - \frac{160}{200} = \boxed{0.20}$

$\eta_c = 1 - \frac{60}{90} = \boxed{0.33}$

$\eta_d = 1 - \frac{40}{90} = \boxed{0.56}$

$\boxed{d > (a = b) > c}$

② • Energy transfers spontaneously from hot to cold, but never from cold to hot

• There are no perfect engines: $\eta < 1$

• There are no perfect refrigerators: $K < \infty$

③ (a) $Q_H = 4000\,J$

$\eta = \frac{W_{out}}{Q_H}$

$= \frac{1000\,J}{4000\,J} = \boxed{0.25}$

$W_{out} = \overbrace{\frac{1}{2}(0.1\,m^3)(2\times10^4\,Pa)}^{\text{area}}$

$= 1000\,J$

(b) engine: $Q_c > 0$ is the heat delivered to the reservoir ("waste heat")

refrigerator: $Q_c > 0$ is the heat extracted from the cold reservoir