Questions

47. 'Heat death' refers to the idea that if everything had the same temperature, then no heat would flow. This doesn't imply that the final temp. is zero.

6. The first law says that energy taken in from the hot region, say 1000 J, should equal energy out to cold, 400 exhaust + 600 work.

9. The engine would work by taking heat between regions of different temp. The tube connects the engine to stream cold water below the warmer water at the surface.

13. First - implies that the energy of useful work cannot exceed the input energy.  \[ \sum \Delta W \leq \sum E \]

Second - implies that you cannot convert all thermal energy to mechanical energy.

19. On a cold day, the temp. difference between hot and cold regions will be greater, thus giving greater efficiency.

30. Actually, it is probably closer to the first law.
a.) The mechanical energy converts to thermal via friction. b.) The temp rises, decrease thanks to the latent thermal energy. c.) The entropy has probably risen — although the water as a whole is not moving, the increased heat means that the water molecules are moving randomly about their average locations, so the disorder has increased.

51] (b.) The crises refers to the amount of available energy which decreases as entropy increases.

55] The electricity used in the light bulb, converts to light and heat, and the light then converts to heat upon hitting the walls. So the lights do contribute to the heating.

Exercises

1] \[ Q_{in} = W + Q_{out} = 200 \text{ kJ} + 400 \text{ kJ} = 600 \text{ kJ} \]

5] \[ y = \frac{W}{Q_{in}} = \frac{-505}{200} = -0.25 \]

9] \[ y = 1 - \frac{T_{in}}{T_{th}} = 1 - \frac{285}{293} \approx 0.0273 \]

11] \[ T_{exhaust} = T_{cold}, \quad \text{then} \quad y = 1 - \frac{T_{c}}{T_{th}} = \frac{T_{th} - T_{c}}{T_{th}} \rightarrow T_{h} = \frac{T_{c}}{1 - y} \]

\[ T_{h} = \frac{827^\circ C}{1 - 0.60} = 750 \text{ K} = 477^\circ C \]
\[ Z_{\text{max}} = 1 - \frac{T_c}{T_h} = 1 - \frac{300}{400} = \frac{1}{4} \]

if \( T_c = 350 \text{ k} \) and \( Z = \frac{1}{4} \), then \( T_h = \frac{T_c}{1-Z} = \frac{350}{3/4} \approx 467 \text{ k} \)

15. \[ W = Q_{\text{out}} - Q_{\text{in}} = 1600 \text{ J} - 1000 \text{ J} = 600 \text{ J} \]

18. Extracted energy from cold air = \( Q_{\text{in}} \) from cold air.

\[ Q_{\text{in}} = Q_{\text{out}} - W = \left( \frac{2400}{1 \text{ sec}} \right) - \left( \frac{400 \text{ W}}{1 \text{ sec}} \right) = 2000 \text{ J} \text{ each second} \]

19. \[ C_{\text{pers}} = \frac{Q_{\text{in}}}{W} \]

\[ W = 400 \text{ J/ sec} \]

\[ \frac{Q_{\text{in}}}{\text{sec}} = \frac{400}{1 \text{ sec}} \times 3 \] \[ = (400 \text{ W}) \times 3 \text{ J/ sec} \]

\[ Q_{\text{out}} = Q_{\text{in}} + W = 1200 + 400 = 1600 \text{ J} \text{ net} \]

The engine takes in heat and is worked on, so the output heat is the sum.

22. 6 arrangements for 2 heads 2 tails.
4 for 3 heads, 1 tail or 3 tails.
1 for 4 heads or 1 tail.