By I.B.B.
On 11 / 17 / 2003

Q 12.7:

$$HEAT = c\, m\, T$$

therefore the heat of an object does not just depend on its Temperature, but also on its mass and its specific heat, c.

CQ 12.17

- First law: CONSERVATION OF ENERGY.
  We cannot build a engine that produces more energy than we put into it.

- Second law:
  Efficiency of a cyclic process is limited. Some energy has to be rejected to the environment and does stay in the cyclic process.

12.1 :

In chapter 10.6 we found that the pressure of an ideal gas is

$$P = \frac{2}{3} \frac{N}{V} \left(\frac{1}{2} m \overline{v^2} \right) \qquad [10.13]$$

If we have a monatomic ideal gas the whole energy is translational kinetic energy.

$$\Rightarrow \quad U = N \left(\frac{1}{2} m \overline{v^2} \right)$$

$$\Rightarrow \quad U = P \Big/ \left(\frac{2}{3} \frac{1}{V} \right) = \frac{3}{2} P \cdot V \qquad \text{q.e.d.}$$

12.5 :

First Law: $\Delta U = Q + W$

$$W = - P \Delta V$$

$\Rightarrow$ the work done is equal to the negative Area under the path in the PV-diagram.

IAF: $W = -4 \text{ atm} \times 2 \text{ liters}$

$$= -4 \times 1.013 \times 10^5 \frac{N}{m^2} \times 0.002 \, m^3 = -810 \, J$$

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to 12.5:

1F

$W =$ ~~[crossed out]~~ $- 3\,\text{atm} \times 2\,\text{liters} \times \frac{1}{2} + (-1\,\text{atm} \times 2\,\text{liters})$

(triangle) (rectangle)

$= -5\,\text{atm} \times \text{liters} = -5 \times 1.013 \times 10^5 \frac{N}{m^2} \times 0.001\,m^3$

$= -506\,J$

13F

$W = -2\,\text{liters} \times 1\,\text{atm} = -2 \times 1.013 \times 10^5 \frac{N}{m^2} \times 0.001\,m^3$

$= -202\,J$

12.15:

$\Delta U = Q + W$

W for diagonal path $W = -506\,J$

$\Delta U = ?\ ,\ W = 18\,J$

$\Rightarrow \Delta U = -506\,J + 418\,J = -82\,J$

$\Delta U = -82\,J,\quad W = -810\,J$

$\Delta U = Q + W \Leftrightarrow Q = \Delta U - W = -82\,J - (-810\,J) = 728\,J$

12.27

Maximum efficiency $\varepsilon = 1 - \frac{T_c}{T_h}$

$T_c = 430°C = (430 - 273)\,K$

$T_h = (1870 - 273)\,K$

$\varepsilon = 1 - \frac{157}{1597} = 67\%$

$0.42 \times 1.45 \cdot 10^5 J = 60200 J$

$= 60.2 kJ$

12.32

$T_c = 80°C = 353 K$

$T_h = 350° = 623 K$

efficiency: $\varepsilon = 1 - \frac{353K}{623K} = 43.3\%$

duration of cycle: 1.0 s

a) $W = 0.433 \times 21000 J =$

$\frac{W}{t} = \frac{0.433 \times 21000 J}{1 s} = \underline{\underline{9093 \text{ Watt}}}$

b) $Q = 0.567 \times 21000 J = \underline{\underline{11907 \text{ Joule}}}$

12.39

$T_{SUN} = 5700K$; $T_{EARTH} = 290K$

1000 J transferred

$\Delta S = ?$ $\Delta S = \frac{Q}{T}$

$$\Delta S = \Delta S_c + \Delta S_h = \frac{Q}{T_{EARTH}} + \frac{Q}{T_{SUN}}$$

$$= \frac{1000J}{290K} + \frac{-1000J}{5700K}$$

$$= ~~3.624 J/K~~ \ \underline{3.273 \ J/K}$$

12.41

Result	Possible Draws	Number of Same Result
• All H	HHHH	1
• 3×H, 1×T	HHHT, HHTH, HTHH, THHH	4
• 2×H, 2×T	HHTT, HTTH, TTHH, THHT, THTH, HTHT	6
• 3×T, 1×H	TTTH, TTHT, THTT, HTTT	4
All T	TTTT	1

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to 12.41

a) $2\times H, 2\times T$ most probable.

b) all heads or all tails most ordered.

c) $2\times H, 2\times T$ is most disordered result.

QQ12.3

$$\varepsilon = 1 - \frac{T_c}{T_h}$$

$\varepsilon_A = 0.3$

$\varepsilon_B = 0.375$

$\varepsilon_c = 0.5$

$\Rightarrow \quad \varepsilon_c > \varepsilon_B > \varepsilon_c$.