/ 60

Physics 30 - Lesson 40H
Thermodynamics

Pg 205 1, 3-8

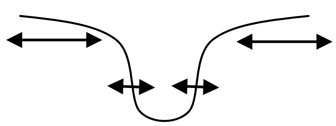
1)

1)
- expansion / contraction
- electrical conductivity / resistance
- color changes with temperature

3) The ring diameter will become larger since the linear expansion is greater than the volume expansion of the ring

4) The L_o should be the original length. The change in length is proportional to the starting length.
The final length should change as a result of temperature and coefficient of linear expansion.

5) Te hot ring lid is larger than the cool one and s therefore easier to remove (loosen)

6) 

Expansion and contraction of the long pipe on either end of the "U" is compensated for by the flexibility of the "U" shape

7) The value of 3.4ml /L /*C is true only for temperatures around 20*C. At different temperatures this value changes

8) Since the chimney expands and contracts with changes in temperature, any structure attached to it would move with the chimney. This would lead to structural damage of the house.

2)

$L_o = 15m @ 20^o C$

$\alpha = 2.5\times10^{-5} /^o C$

/4

$\Delta L = \alpha L_o \Delta T$

a) $\Delta L = (2.5\times10^{-5} /^o C)(25m)(-20^o C - 20^o C)$

$\Delta L = -0.015m(\text{contraction})$

$\Delta L = \alpha L_o \Delta T$

b) $\Delta L = (2.5\times10^{-5} /^o C)(15m)(50^o C - 20^o C)$

$\Delta L = 0.01125m(\text{expansion})$

3) $r = 10cm$

$V = 25L = 25000cm^3$

$h = ?$

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$V_o = h_o \pi r^2$ ✓

a) $h_o = \frac{V_o}{\pi r^2} = \frac{25000cm^3}{\pi(10cm)^2} = \boxed{79.58cm}$ ✓

$\Delta V = v_o \beta \Delta t$

b) $\Delta V = 25000cm^3(2.10\times10^{-4}/^oC)(45^oC - 20^oC)$

$\Delta V = 131.25cm^3$ ✓

$h_o^{'} = \frac{V^{'}}{\pi r^2} = \frac{25131.25cm^3}{\pi(10cm)^2} = \boxed{80.0cm}$ ✓

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4) ✓ - Heat – a transfer of energy from a hot to a cold object.

✓ - Internal Energy (Thermal Energy) – interchangeable terms that depend on the temperature of an object and it's S.H.C $E_{\text{int}} \alpha$ mcΔT

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✓ - Temperature – refers to how hot or cold something is and it independent of the size / amount of the object. It is related to the Kinetic energy of the molecules of the object.

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5 Pg 270 – 271 # 1 – 13 (odds)

1) The internal energy of the water vapor decreases!
✓ The heat in the water vapor is transferred to the cold beer (oops!) water. No work is done in the process

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3) More work is done for the isothermal process since the area under the isothermal graph is
✓ larger (Adiabatic involves no heat flow)

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5) The volume of the refrigerator is much less than the volume of the room thus the
✓ refrigerator acts as a heat sink. The heat produced in running the refrigerator is greater than the heat lost to the refrigerator, therefore – NO! Much too inefficient!

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7) $Efficiency = 1 - \frac{T_L}{T_H} = 1 - \frac{273.15+5}{273.15+25} = 6.7\%$ ✓

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✓ a) The engine might be feasible due to the vast quantities of tropical water available

✓ b) The heating of the deep water and cooling of the surface water would interrupt / influence biological norms for surrounding wildlife.

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9) Any 3 of the possible thousands will do!
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11) ✓ A) Cellular Respiration
✓ B) Solar Radiation
✓ C) Physics 30AP students working on this assignment

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13) Entropy always increases for any change ✓

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6) $W = P\Delta V$ ✓

A) $W = 3.0\times10^{5} N/m^{3}(3.0\times10^{-3}m^{3} - 15.0\times10^{-3}m^{3})$

$\boxed{W = -3.6kJ}$ ✓

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B) Since T is the same, no change in internal energy ✓

$\Delta u = 0$

$\Delta u = Q - W$

$\boxed{\therefore Q = W = 3.6kJ}$ ✓

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7) $\%eff = 1 - \frac{T_L}{T_H}(\times 100) = 1 - \frac{(273.15+230)}{(273.15+550)}\times 100$ ✓

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$\boxed{\%eff = 38.9\%}$ ✓

Bonus /3

$\Delta s = \Delta s_h + \Delta s_c$

$\Delta s = \frac{Q_h}{T_h} + \frac{Q_c}{T_c} = \frac{mc\Delta T_h}{T_h} + \frac{mc\Delta T_c}{T_c}$

$\Delta s = mc\left(\frac{\Delta T_h}{T_h} + \frac{\Delta T_c}{T_c}\right)$ ✓

$\Delta s = 50kg(4.19J/kg^{o}C)\left(\frac{-4K}{299K} + \frac{4K}{291K}\right)$

$\boxed{\Delta s = 0.077kJ}$ ✓

$18^{o}C \rightarrow 22^{o}C \leftarrow 26^{o}C$ ✓

$\Delta T = 4k$ to reach thermal equilibrium

Part B

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1) $T_i = 20^{o}C$

$T_f = 40^{o}C$

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$\alpha = 1.2\times10^{-5} /^{o}C$

$\Delta L = L_o \alpha \Delta T$ ✓

$\Delta L = L_o(.2\times10^{-5} /^{o}C)(20^{o}C) = 0.00024$

$\boxed{\therefore \%error\ is\ 0.024\%}$ ✓

* The measuring tape will expand; therefore, what is actually 1.0m long will measure as something **less** than a meter. ✓

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2) /3

$d = 28cm$

$r = 14cm = 0.14m$

$\Delta T = 180^o C$

$\Delta V = V_o \beta \Delta T$

$\Delta V = \frac{4}{3}\pi r^3 \beta \Delta T = \frac{4}{3}(0.14m)^3(35\times10^{-6}/^o C)(180^o C)$

$\boxed{\Delta V = 7.24\times10^{-5} m^3}$

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3) /4

$W = P\Delta V \leftarrow$ volume of steam

A) $W = 1.0\times10^5 N/m^2(1.63m^3)$

$\boxed{W = 163kJ}$

$\Delta U = Q - W$

B) $\Delta U = (539kcal \times 4.19kJ/kcal) - 163kJ$

$\boxed{\Delta U = 2095.41kJ}$

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4) /3

A) none – adiabatic means no heat flows in or out

B) $\Delta U = Q - W = 0 - 850J = \boxed{-850J}$

C) The temperature goes down since the internal energy decreases

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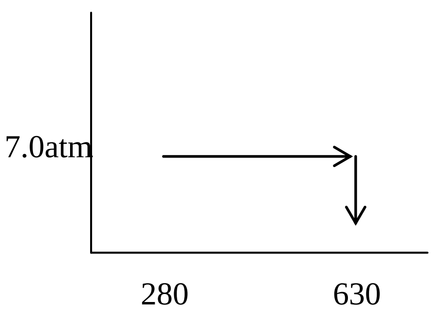
5) /3



A)

$W = P\Delta V$

$W = 7.0\times10^5 N/m^2(0.630\times10^{-3}m^3 - 0.280\times10^{-3}m^3)$

$\boxed{W = +245J}$

B)

$\Delta V = 0$

$\therefore Q = W = \boxed{+245J}$

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6) /2

$\%efficiency = 1 - \frac{T_L}{T_H}(\times100) = 1 - \frac{(273.15+318)}{(273.15+480)}\times100\%$

$\boxed{\%eff = 21.5\%}$

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7) /2

$\%efficiency = \frac{useful}{total} = \frac{2.50kJ}{(2.50+9.50kJ)}$

$\boxed{\%eff = 20.8\%}$

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8) $\text{theoretical efficiency} = 1 - \frac{T_L}{T_H} = 1 - \frac{(310 + 273.15)}{(545 + 273.15)} = 28.7\%$ ✓

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$\frac{1}{2}\text{efficiency} = 0.144$ ✓

$\text{heat loss} = 1.0 - 0.144 = 0.856$

$W_{useable} = Pt = 1.0 \times 10^6 W(3600s) = 3.6 \times 10^9 J$ ✓

$W_{total} = \frac{W_{useable}}{0.144} = \frac{3.6 \times 10^9 J}{0.144} = \boxed{2.5 \times 10^{10} J}$ ✓

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9) Bonus /3

$\Delta s = \frac{Q}{T_{avg}} = \frac{mc\Delta T}{T_{avg}} = \frac{1.0kg(4.19J/kg^oC)(100^oC)}{(50 + 273)K}$ ✓ ✓

$\boxed{\Delta s = +1.3kJ/K}$ ✓