TUTORIAL ANSWERS (THERMAL PROPERTIES OF MATERIALS)

Guided Ex. 2 Pg 351 Francis

1.) Electrical energy supplied by heater = heat gained by block

$VIt = mc\,\Delta T$

$\Delta T = (VIt) / (mc) = (12*2.5*7.5*60) / (1.5*910)$

$\Delta T =$ **9.9 K**

2.) Heat loss by copper cube = heat gained by AL can + heat gained by water

$(0.11*c*(100 - 14)) = (0.08*910*(14 - 10)) + (0.2*4200*(14 - 10))$

$c =$ **386 $Jkg^{-1}K^{-1}$**

3.) Electrical energy supplied by heater = heat gained by milk + heat gained by bottle

$(240*1*t) = (0.2*3900*(38 - 18)) + (24*(38 - 18))$

$t =$ **67 s**

Guided Ex. 3 Pg 354 Francis

1.) heat lost by cabbage = heat gained by ice

$mc\,\Delta T = mL$

$(2.5*2000*(20 - 0)) = m\,(3.4 \times 10^5)$

m = **0.29 kg**

2.) Total heat = latent heat of vaporization + heat lost during cooling from 100°C to 40°C.

$Q = (0.2*2.26 \times 10^6) + (0.2*4.2 \times 10^3*(100 - 40))$

Q = **502 400 J**

3.) amount of heat extracted by freezer = heat extracted in cooling the water from 24°C to 0°C + latent heat extracted in changing water into ice at 0°C.

$Q = mc\ \Delta T + mL$

$Q = (1 \times 10^3*3 \times 10^{-3})\,(4.2 \times 10^3)(24 - 0) + (1 \times 10^3*3 \times 10^{-3})(3.37 \times 10^5)$

Q = 1 313 400 J

Rate of heat extraction, P = Q/t

P = 1 313 400 / (50*60) = **$437.8\ Js^{-1}$**

4.) a.) VIt = mL

$(24*3*60) = (4.8 \times 10^{-3})\,L$

L = **$9 \times 10^5\ Jkg^{-1}$**

b.) $V_1 I_1 t = m_1 L + H$ --- (1)

$V_2 I_2 t = m_2 L + H$ --- (2)

$L = [(V_2 I_2 - V_1 I_1)\,t\,] / (m_2 - m_1)$

$L = [((20*2.5) – (24*3))*60] / [(3.25 – 4.8) \times 10^{-3}]$

$L =$ **8.52×10^5 Jkg^{-1}**

5.) **For way (i)** ;

$\Delta U = 1350 – 300 = 1050$ J

$W = (300\ 000)*(0.003 – 0.001) =$ **– 600J** (volume expanded)

$Q = 1050 – (– 600) =$ **1650 J**

For way (ii) ;

$\Delta U = 1350 – 300 = 1050$ J

$W = [(300\ 000+200\ 000) / 2]*(0.003 – 0.001) =$ **– 500J** (volume expanded)

$Q = 1050 – (– 500) =$ **1550 J**

For way (iii) ;

$\Delta U = 1350 – 300 = 1050$ J

$W = (200\ 000)*(0.003 – 0.001) =$ **– 400J** (volume expanded)

$Q = 1050 – (– 400) =$ **1450 J**

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5.)

a.) When ice change to water, the regular structure / pattern of molecules in ice changes to irregular structure / pattern in water. The spacing is closely packed in water. Then for cold water to hot water spacing will increase. Finally from hot water to steam, molecules spacing now is widely spaced apart.

b.) K.E of molecules determines the temperature. No change in temperature implies no change in K.E. therefore.

c.) The sum of the random potential and kinetic energies of all the molecules in a body.

d.) $Q = \Delta U$; no work done because ΔV almost zero.

$Q = mL$

$(5.25 - 1.89) \times 10^5 = (1)L$

$L =$ **3.36×10^5 Jkg^{-1}**

e.) $W = p\Delta V$

$= (1.01 \times 10^5)(1.67 - 0.00104) =$ **1.69×10^5 J**

f.) $\Delta U = Q + W$

$(26.9 \times 10^5 - 5.99 \times 10^5) = Q + (-1.69 \times 10^5)$

$Q = 22.6 \times 10^5 = mL$; $m = 1$kg

$L =$ **22.6×10^5 Jkg^{-1}**

g.) Refer notes on determination of the specific latent heat of vaporization of water by electrical method.

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2.) d.)

Total energy required = heat required to raise it from 20°C to 78°C + latent heat of vaporization

$Q = mc\Delta T + mL$

$Q = (0.79*1.0*2.4)(78 – 20) + (0.79*840)$

Q = **773.6 J**

e.)

i.) The increase in internal energy of a substance is equal to the sum of the heat supplied to the substance and the work done on the substance.

ii.) More energy is required to weaken and break the intermolecular bonds for the liquid to gas phase compared to solid to liquid.

Vaporisation required large volume change (expansion), thus more external work needed to be done against the atmospheric pressure.

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2.) a.) i.) Volume increase on evaporation. Thus work need to be done to push against atmospheric pressure.

ii.) K.E of molecules remained constant since no temperature change but P.E. of molecules change as the separation of molecules change.
Thus, the internal energy changes. U = K.E + P.E.

b.) According to $\Delta U = Q + W$, since internal energy changes (increases), there must be heat supply to the system in order for the molecules to do work against the atmospheric pressure.