Thermal Physics Revision

Q1. Complete the following table;

Degrees Celsius	Kelvin
0°C	273 K
340°C	613 K
178°C	451 K
-271 °C	2 K
157 °C	430 K

Q2. An **isolated system** is set up with 600mL water at 300K and 400g copper at 670 K (c_{copper}= 390 J kg^{-1} K). At what temperature will equilibrium be achieved, in degrees celsius?

m_w= $600\times 10^{-3} kg$

c_w=$4180\, J\, kg^{-1} K^{-1}$

m_c= $400\times 10^{-3} kg$

c_c=$390\, J\, kg^{-1} K^{-1}$

$T_{i(water)}$= 300 *K*

$T_{i\,(copper)}$= 670 *K*

T_f is unknown for both substances. But as equilibrium will be reached, this value will be the same for both substances.

$$Q=mc\,\Delta T$$

$$Q_{lost\ by\ copper}=Q_{gained\ by\ water}$$

So,

$$m_c c_c \Delta T_c = m_w c_w \Delta T_w$$

$$400\times 10^{-3}\times 390\times (670-T_f)=600\times 10^{-3}\times 4180\times (T_f-300)$$

$$156(670-T_f)=2508(T_f-300)$$

$$104520-156\,T_f=2508\,T_f-752400$$

$$104520+752400=2508\,T_f+156\,T_f$$

$856920=2664\,T_f$

$$T_f = \frac{856920}{2664} = 321.67\,K$$

$$321.67 - 273 = 48.7\,°C\,(3\,S.F)$$

Q3. 1kg of ice at -30°C is added to a 2kg cast iron pot at 10°C on top of a stove. After 30min, 400g of boiling water remains in the pot. At what power is the stove operating? ($c_{cast\ iron}$= 460 J kg^{-1} K)

Steps required

Q1 Heat solid ice from -30°C to 0°C

Q2 Melt ice to liquid

Q3 Heat up liquid water from 0°C to 100°C

Q4 Vaporize 600g of water to steam

AND

Q5 Heat up cast iron from 10°C to 100°C

$$Q_1 = mc\,\Delta T$$

$$\text{¿}\,1 \times 2100 \times (0 - (-30))$$

$$\text{¿}\,6.30 \times 10^4\,J$$

$$Q_2 = m\,L_f$$

$$\text{¿}\,1 \times 3.34 \times 10^5$$

$$\text{¿}\,3.34 \times 10^5\,J$$

$$Q_3 = mc\,\Delta T$$

$$\text{¿}\,1 \times 4180 \times (100 - 0)$$

$$\text{¿}\,4.18 \times 10^5\,J$$

$$Q_4 = m\,L_v$$

$$\text{¿}\, 0.600 \times 2.26 \times 10^{6}$$

$$\text{¿}\, 1.36 \times 10^{6}\, J$$

$$Q_4 = mc\Delta T$$

$$\text{¿}\, 2 \times 460 \times (100 - 10)$$

$$\text{¿}\, 8.28 \times 10^{4}\, J$$

$$Q_{total} = Q_1 + Q_2 + Q_3 + Q_4 + Q_5$$

$$\text{¿}\, 6.30 \times 10^{4} + 3.34 \times 10^{5} + 4.18 \times 10^{5} + 1.36 \times 10^{6} + 82.8 \times 10^{4}$$

$$\text{¿}\, 2946300$$

$$\text{¿}\, 3.00 \times 10^{6}\, J$$

Power=energy/time

$$P = \frac{3.00 \times 10^{6}}{30 \times 60}$$

$$\text{¿}\, 1.67\, kW$$

Q4. Using an example, explain the difference between temperature and heat.

Temperature is ave kinetic energy of particles. Heat is total kinetic energies of all particles in a system. Plus suitable example.

Q5. Burning 1 kg of petrol produces 32.6 MJ of energy.

a) If the efficiency of a particular car is 28%, how much of this energy from the petrol is converted into useful mechanical energy?

$$\eta = \frac{useful\ energy}{total\ energy} \times 100$$

Rearranging gives;

$$useful\ energy = \frac{total\ energy \times \eta}{100}$$

$$\text{¿}\, 32.6 \times .28$$

$$\text{¿}\, 9.13\, MJ$$

b) What happens to the remainder of the energy?

Lost as heat in engine etc.