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** isset up with 600mL water at 300K and 400g copper at 670 K (ccopper= 390 J kg-1 K). At what temperature will equilibrium be achieved, in degrees celsius?

mw= $600×10^{-3}kg$

cw=$4180 J kg^{-1}K^{-1}$

mc= $400×10^{-3}kg$

cc=$390 J kg^{-1}K^{-1}$

Ti(water)= 300 *K*

Ti (copper)= 670 *K*

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

$$Q=mcΔT$$

$$Q\_{lost by copper}=Q\_{gained by water}$$

So,

$$m\_{c}c\_{c}ΔT\_{c}=m\_{w}c\_{w}ΔT\_{w}$$

$$400×10^{-3}×390×\left(670-T\_{f}\right)=600×10^{-3}×4180×\left(T\_{f}-300\right)$$

$$156\left(670-T\_{f}\right)=2508\left(T\_{f}-300\right)$$

$$104520-156T\_{f}=2508T\_{f}-752400$$

$$104520+752400=2508T\_{f}+156T\_{f}$$

$856920=2664T\_{f}$

$$T\_{f}=\frac{856920}{2664}=321.67 K$$

$$321.67-273=48.7 ° C (3 S.F)$$

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? (ccast 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

$$Q\_{1}=mc∆T$$

$$=1×2100×\left(0-(-30)\right)$$

$$=6.30 ×10^{4}J$$

$$Q\_{2}=mL\_{f}$$

$$=1×3.34×10^{5}$$

$$=3.34×10^{5}J$$

$$Q\_{3}=mc∆T$$

$$=1×4180×\left(100-0\right)$$

$$=4.18×10^{5}J$$

$$Q\_{4}=mL\_{v}$$

$$=0.600×2.26×10^{6}$$

$$=1.36×10^{6}J$$

$$Q\_{4}=mc∆T$$

$$=2×460×(100-10)$$

$$=8.28×10^{4}J$$

$$Q\_{total}=Q\_{1}+Q\_{2}+Q\_{3}+Q\_{4}+Q\_{5}$$

$$=6.30×10^{4}+3.34×10^{5}+4.18×10^{5}+1.36×10^{6}+82.8×10^{4}$$

$$=2946300$$

$$=3.00×10^{6}J$$

Power=energy/time

$$P=\frac{3.00×10^{6}}{30×60}$$

$$=1.67kW$$

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.

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

$$η=\frac{useful energy}{total energy}×100$$

Rearranging gives;

$$useful energy=\frac{total energy × η}{100}$$

$$=32.6×.28$$

$$=9.13MJ$$

b) What happens to the remainder of the energy?

Lost as heat in engine etc.