THERMAL AND CHEMICAL EFFECTS OF CURRENT(a short note)

Thomson showed that the 3 effects (Thomson, Peltier and Seebeck) are all consequences of one basic phenomenon. Therefore, they can be quantitatively related to each other.

Thomson effect is related to the emf that develops between two parts of a single metal when they are at different temperatures.

$dV = \sigma dT$

where dT is the temperature difference between the two ends of the metal. dV is the potential difference. σ is called Thomson coefficient.

The three effects Seebeck, Peltier and Thomson are quantitatively defined in terms of the three coefficients V, π and σ.

V is called the thermoelectric emf
π is the Peltier heat
σ is the Thomson emf

The rate of change of the thermoelectric emf with temperature (dV/dT) is called the thermopower or the Seebeck coefficient S.

$S = dV/dT$

The Peltier coefficient π is defined as follows: The heat absorbed when a charge q coulombs passes from metal A to metal B is $q\pi$ joules.

Heat energy = $q\pi$
π = heat (J)/q (c) (unit of π is volt.)
π is related to S by $\pi = TS$
σ is related to S by $\sigma = -T(dS/dT)$

Assignment on Thermal And Chemical Effects Of Current

1. What is the value of Seebeck coefficient at the neutral temperature of a thermocouple?

2. Which thermocouple is suitable in the range 50 K to 400 K?

3. What is Seebeck effect? Sketch a graph to show the variation of emf with rise in temperature of the hot junction of a thermocouple, while the other junction is kept at 0° C. Mark neutral and inversion temperature on the graph.

4. A primary and a secondary cell have the same emf. Which one these will provide a higher value of maximum current?

5. Give the direction of thermo electric current
(i) at the cold junction of copper bismuth thermocouple
(ii) at the hot junction of iron copper thermocouple

6. What is a thermocouple?

7. State Faraday's laws of electrolysis.

8. Compare Peltier effect and Joule's heating effect.

9. Two bulbs rated 25 W, 110 V and 100 W, 110 v are connected in series to a 220 V supply. Which of the bulbs if any will fuse? What would happen if the two bulbs are connected in parallel to the same supply?

10. Two tinned copper wires have same area of cross section and lengths in ratio 2:3. Show that both wires fuse at the same value of current.
(Hint: At equilibrium heat produced = heat lost due to radiations)
$i^2R = (2\pi rl)h$ where h is rate of loss of heat per unit surface area of temperature T).

11. A thermocouple has cold junction at 0° C and when hot junction is at θ degrees the thermo-emf is $\mathcal{E} = (200 + 0.02\theta^2)\mu V$. What is the temperature of hot junction if the thermo-emf produced is 7.5 mV?

12. In a copper voltameter a current of 1.5 A is passed for 1 hour. The mass of copper deposited is 1.75g. Find electro chemical equivalent of copper. If the same mass of copper is to be deposited in 20 minutes, what current must be passed through voltameter?

13. An ammeter was calibrated by connecting it in the series with a copper voltameter. The mass of copper deposited in 20 minutes was 4.064 g. The ammeter shows a reading of 10 A all through. What is the percentage error in the ammeter? Electro-chemical equivalent of Cu = 3.29×10^{-5}g $^0C^{-1}$

14. Explain any one application of thermoelectricity.

15. For a copper-iron and a chromel-alumel thermocouple, plots between thermo-emf and the temperature t of the hot junction (when the cold junction is at 0^0 C) satisfies the equation

$$V = \alpha\,\theta + \frac{1}{2}\beta\,\theta^2$$

with $\alpha = 14\ \mu\ V\,^0C^{-1}$ and $\beta = -0.04\ \mu\ V\,^0C^{-2}$ for copper-constantan thermocouple and $\alpha = 41\ \mu\ V\,^0C^{-1}$ and $\beta = +0.002\ \mu\ V\,^0C^{-2}$ for chromel-alumel thermocouple. Which of the two thermocouples would you use to measure temperature in the range 500^0 C to 600^0 C? (Chromel-alumel)

16. Give the direction of thermoelectric current
    (i) at the cold junction of copper-bismuth
    (ii) at the hot junction of iron-copper
    (iii) at the cold junction platinum-lead.

17. Two wires of tinned copper having identical cross-section (= $10^{-6} m^2$) and lengths 10 cm and 15 cm are to be used as fuses. Show that the fuses will melt at the same value of current in each case.