Heating and Chemical Effect of Current

SET Self Evaluation Test - 20

1. An electric kettle has two coils. When one of these is switched on, the water in the kettle boils in 6 minutes. When the other coil is switched on, the water boils in 3 minutes. If the two coils are connected in series, the time taken to boil the water in the kettle is

(a) 3 *minutes* (b) 6 *minutes*
(c) 2 *minutes* (d) 9 *minutes*

2. A $3°$ rise in temperature is observed in a conductor by passing a certain current. When the current is doubled, the rise in temperature will be

(a) $15°C$ (b) $12°C$
(c) $9°C$ (d) $3°C$

3. Two indentical electric lamps marked 500 *W*, 220 *V* are connected in series and then joined to a 110 *V* line. The power consumed by each lamp is

(a) $\frac{125}{4}W$ (b) $\frac{25}{4}W$
(c) $\frac{225}{4}W$ (d) 125 *W*

4. When 1 *gm* hydrogen $(e.c.e. = 1.044 \times 10^{-8} kg/C$ forms water, 34 *kcal* heat is liberated. The minimum voltage required to decompose water is

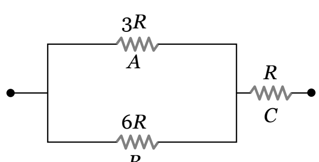
(a) 0.75 *V* (b) 3 *V*
(c) 1.5 *V* (d) 4.5 *V*

5. In how much time, one *litre* of H_2 will be collected by 5 *A* current ? (If $Z = 1 \times 10^{-8} kg/C$ and density of $H_2 = 0.09\ kg/m^3$)

(a) 30 *minutes* (b) 15 *minutes*
(c) 45 *minutes* (d) 60 *minutes*

6. The three resistances *A*, *B* and *C* have values 3*R*, 6*R* and *R* respectively. When some potential difference is applied across the network, the thermal powers dissipated by *A*, *B* and *C* are in the ratio

(a) 2 : 3 : 4
(b) 2 : 4 : 3
(c) 4 : 2 : 3
(d) 3 : 2 : 4



7. If the length of the filament of a heater is reduced by 10%, the power of the heater will

(a) Increase by about 9% (b) Increase by about 11%
(c) Increase by about 19% (d) Decrease by about 10%

8. A thermo couple develops 40 $\mu V/kelvin$. If hot and cold junctions be at 40° *C and 20* °*C* respectively then the emf develops by a thermopile using such 150 thermo couples in series shall be

(a) $150 mV$ (b) $80 mV$
(c) $144 mV$ (d) $120 mV$

9. Amount of electricity required to pass through the H_2O voltmeter so as to liberate 11.2 *litre* of hydrogen will be

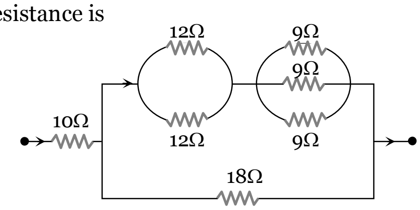
(a) 1 *Faraday* (b) $\frac{1}{2}$ *Faraday*
(c) 2 *Faraday* (d) 3 *Faraday*

10. The resistance of the filament of a lamp increases with the increase in temperature. A lamp rated 100 *W*, 220 *V* is connected across 220 *V* power supply. If the voltage drops by 10% then the power of lamp will be

(a) 90 *W* (b) 81 *W*
(c) Between 90 *W* and 100 *W* (d) Between 81 *W* and 90 *W*

11. In the following circuit, 18Ω resistor develops $2\ J/sec$ due to current flowing through it. The power developed across 10Ω resistance is

(a) 125 *W*
(b) 10 *W*
(c) $\frac{4}{5}W$
(d) 25 *W*



12. If resistance of the filament increases with temperature, what will be power dissipated in a 220 *V*- 100 *W* lamp when connected to 110 *V* power supply

(a) 25 *W* (b) < 25 *W*
(c) > 25 *W* (d) None of these

13. Total surface area of a cathode is $0.05 m^2$ and 1 *A* current passes through it for 1 *hour*. Thickness of nickle deposited on the cathode is (Given that density of nickle = $9 gm/cc$ and it's E.C.E. = $3.04 \times 10^{-4} gm/C$)

(a) 2.4 *m* (b) $2.4 \mu m$
(c) 2.4 μm (d) None of these

14. Two bulbs consume same power when operated at 200 *V* and 300 *V* respectively. When these bulbs are connected in series across a D.C. source of 500 *V*, then

(a) Ratio of potential difference across them is 3/2
(b) Ratio of potential difference across them is 9/4
(c) Ratio of power consumed across them is 4/9
(d) Ratio of power consumed across them is 2/3

Answers and Solutions

(SET -20)

1. (d) In series $\frac{1}{P_S} = \frac{1}{P_1} + \frac{1}{P_2}$

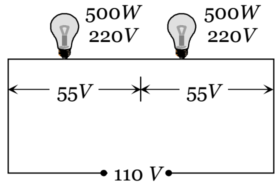
$\Rightarrow \frac{1}{(H_s/t_s)} = \frac{1}{(H_1/t_1)} + \frac{1}{(H_2/t_2)}$

$\because H_s = H_1 = H_2$ So $t_s = t_1 + t_2 = 6 + 3 = 9 min$

2. (b) $i^2Rt = C\theta = 3C$; C = Thermal capacity

when $i_1 = 2i \Rightarrow C\theta_1 = 4i^2Rt = 4 \times 3C \Rightarrow \theta_1 = 12^o C$

3. (a) Voltage across each bulb $V' = \frac{110}{2} = 55W$ so, power consumed by each bulb will be



$P' = \left(\frac{55}{220}\right)^2 \times 500$

$= \frac{125}{4} W$

4. (c) $m = Zit \Rightarrow it = \frac{m}{Z} = \frac{1 \times 10^{-3}}{1.044 \times 10^{-8}} C = \frac{10^5}{1.044} C$

Given $H = 34\ kcal = 4.2 \times 34 \times 10^3\ J$

$\Rightarrow$ Heat generated $H = Vit = V.\frac{10^5}{1.044}$

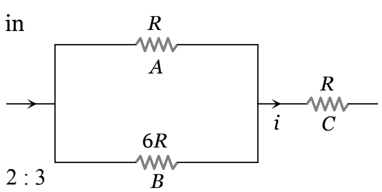
$\Rightarrow V = \frac{4.2 \times 34 \times 1.044}{10^2} = 4.2 \times 0.34 \times 1.044 = 1.5\ V$

5. (a) $m = zit \Rightarrow 10^{-3} \times 0.09 = 1 \times 10^{-8} \times 5 \times t \Rightarrow t = 30\ min$

6. (c) Thermal power in $A = P_A = \left(\frac{2i}{3}\right)^2 3R = \frac{4}{3}i^2R$

Thermal power in $B = P_B = \left(\frac{i}{3}\right)^2 6R = \frac{2}{3}i^2R$

Thermal power in



$C = P_C = i^2R$

$\Rightarrow P_A : P_B : P_C$

$= \frac{4}{3} : \frac{2}{3} : 1 = 4 : 2 : 3$

7. (b) $P \propto \frac{1}{R}$ and $R \propto l \Rightarrow P \propto \frac{1}{l}$

$\Rightarrow \frac{P_1}{P_2} = \frac{l_2}{l_1} \Rightarrow \frac{P_1}{P_2} = \frac{(100-10)}{100} = \frac{90}{100} \Rightarrow P_2 = 1.11 P_1$

% change in power $= \frac{P_2 - P_1}{P_1} \times 100 = 11\%$

8. (d) The temperature difference is $20^o C = 20\ K$. So that thermo emf developed

$E = \alpha\theta = 40 \frac{\mu V}{K} \times 20 K = 800\ \mu V$

Hence total emf $= 150 \times 800 = 12 \times 10^4\ \mu V = 120\ mV$

9. (a) 22.4 *litre* H_2 =1 mole of H_2 = N molecules of H_2 ***

= $2N$ atoms of H.

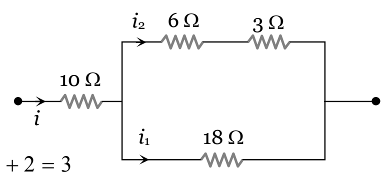
So charge required to liberate 22.4 *litre* of H_2 = $2Ne$ = $2F$.

Hence charge required to liberate 11.2 *litre* of H_2 = F.

10. (d) Let the resistance of the lamp filament be R. Then $100 = \frac{(220)^2}{R}$. When then voltage drops, expected power is $P = \frac{(220 \times 0.9)^2}{R'}$. Here R' will be less than R, because now the rise in temperature will be less. Therefore P is more than $\frac{(220 \times 0.9)^2}{R} = 81W$

But it will not be 90% of earlier value, because fall in temperature is small. Hence (d) is correct.

11. (b) The given circuit can be redrawn as follows



$\frac{i_1}{i_2} = \frac{9}{18} = \frac{1}{2}$

and $i = i_1 + i_2$

$\Rightarrow \frac{i}{i_1} = 1 + \frac{i_2}{i_1} = 1 + 2 = 3$

From $P = i^2R \Rightarrow \frac{P_{10\Omega}}{P_{18\Omega}} = \left(\frac{i}{i_1}\right)^2 \times \frac{10}{18} \Rightarrow P_{10\Omega} = 10W$

12. (c) If resistance does not vary with temperature P consumed $= \left(\frac{V_A}{V_R}\right)^2 \times P_R = \left(\frac{110}{220}\right)^2 \times 100 = 25W$. But in second cases resistance decreases so consumed power will be more than 25 W

13. (c) Mass deposited = density × volume of the metal

$m = p \times A \times X$ .....(i)

Hence from Faraday's first law $m = Zit$ .....(ii)

So from equation (i) and (ii)

$Zit = \rho \times Ax \Rightarrow x = \frac{Zit}{\rho A}$

$= \frac{3.04 \times 10^{-4} \times 10^{-3} \times 1 \times 3600}{9000 \times 0.05} = 2.4 \times 10^{-6} m = 2.4 \mu m$

14. (c) $P = \frac{V^2}{R}$ $\therefore R = \frac{V^2}{P}$ or $R \propto V^2$ *i.e.* $\frac{R_1}{R_2} = \left(\frac{200}{300}\right)^2 = \frac{4}{9}$

When connected in series potential drop and power consumed are in the ratio of their resistances. So, $\frac{P_1}{P_2} = \frac{V_1}{V_2} = \frac{R_1}{R_2} = \frac{4}{9}$