27. (c) Resistance of carbon filament decreases with temperature while that of tungsten increases with temperature

In series $P_{Consumed} \propto R$ *i.e.* tungsten bulb will glow more brightly

28. (c) Power of the combination $P_s = \frac{P}{n} = \frac{1000}{2} = 500\,W$

29. (b) For parallel combination $P_{Consumed} \propto \text{Brightness} \propto P_{Rated}$

30. (b) Resistance of 25 *W* bulb $= \frac{220 \times 220}{25} = 1936\,\Omega$

Its safe current $= \frac{220}{1936} = 0.11\ amp.$

Resistance of 100 *W* bulb $= \frac{220 \times 220}{100} = 484\,\Omega$

Its safe current $= \frac{220}{484} = 0.48\ amp.$

When connected in series to 440 *V* supply, then the current $I = \frac{440}{(1936 + 484)} = 0.18\,amp.$

Thus current is greater for 25 *W* bulb, so it will fuse.

31. (b) $P = i^2R \Rightarrow \frac{\Delta P}{P} = \frac{2\Delta i}{t}$ ($R \to$ Constant)

$\Rightarrow$ % change in power $= 2 \times$ % change in current

$$= 2 \times 1 = 2\%$$

32. (b) $P_{\max} = n\left(\frac{E^2}{4r}\right) = 2\left(\frac{2 \times 2}{4 \times 1}\right) = 2\,W$

33. (a) $H \propto \frac{1}{R}$ (If *V* = constant) $\Rightarrow \frac{H_1}{H_2} = \frac{R_2}{R_1} = \frac{l_2A_1}{l_1A_2}$

$= \frac{l_2r_1^2}{l_1r_2^2}$

$\Rightarrow H_2 = 2H_1$

34. (d) $\frac{H}{t} = \frac{V^2}{R} \Rightarrow \frac{H}{t} \propto \frac{1}{R}$

35. (c) $H = i^2Rt$ and $i = \frac{q}{t}$. Hence $H = \frac{q^2R}{t}$; $\therefore\ H \propto q^2$

36. (b) $E = \frac{1100 \times 4}{1000} = 4.4\ kWh$

37. (d) After some time, thermal equilibrium will reach.

38. (b) At constant p.d., heat produced $= \frac{V^2}{R}$ *i.e.* $H \propto \frac{1}{R}$

39. (a) Power $= 3.75 \times 200\,W = 750\,W \approx 1\,H.P.$

40. (a) $\frac{V^2}{R} = P \Rightarrow R = \frac{V^2}{P} = \frac{220 \times 220}{100} = 484\Omega$

41. (a) Since $P = VI \Rightarrow I = \frac{P}{V} = \frac{250000}{10000} = 25\ A$

42. (b) Power lost in cable $= 10 \times (25)^2 = 6250\,W = 6.25\ kW$

43. (d) Heat generated in both the cases will be same because the capacitor has the same energy initially

$= \frac{1}{2}CV^2 = \frac{1}{2} \times 200 \times 10^{-6} \times (200)^2 = 4\,J$

44. (d) The bulbs are connected in parallel, hence each bulb consumes $\frac{48}{2} = 24\,W.$ Therefore

$\frac{V^2}{R} = 24$

$\Rightarrow R = \frac{6 \times 6}{24} = 1.5\,\Omega$

45. (a)

46. (c) The bulbs are in series, hence they will have the same current through them.

47. (a) When resistance is connected in series, brightness of bulb decreases because voltage across the bulb decreases.

48. (b) $R = \frac{V^2}{P} \Rightarrow R_1 = \frac{200 \times 200}{100} = 400\,\Omega$ and

$R_2 = \frac{100 \times 100}{200} = 50\,\Omega.$ Maximum current rating $i = \frac{P}{V}$

So $i_1 = \frac{100}{200}$ and $i_2 = \frac{200}{100} \Rightarrow \frac{i_1}{i_2} = \frac{1}{4}$.

49. (a) $\frac{R_1}{R_2} = \frac{P_2}{P_1} = \frac{100}{40} = \frac{5}{2}$. Resistance of 40 *W* bulb is $\frac{5}{2}$ times than 100 *W*. In series, $P = i^2R$ and in parallel, $P = \frac{V^2}{R}$. So 40 *W* in series and 100 *W* in parallel will glow brighter.

50. (a) $P = \frac{V^2}{R} \Rightarrow \frac{P_P}{P_S} = \frac{R_S}{R_P} = \frac{(R_1 + R_2)}{R_1R_2/(R_1 + R_2)} = \frac{(R_1 + R_2)^2}{R_1\,R_2}$

$\Rightarrow \frac{100}{25} = \frac{(R_1 + R_2)^2}{R_1R_2} \Rightarrow \frac{R_1}{R_2} = \frac{1}{1}$

51. (b) Total power $P = (800 + 3 \times 100)$

Also $P = Vi \Rightarrow 1100 = 220 \times i \Rightarrow i = 5A$

52. (c) Because $R \propto \frac{1}{P}$

53. (a) An ideal cell has zero resistance.

54. (c) Power loss in transmission $P_L = \frac{P^2 R}{V^2} \Rightarrow$ $P_L \propto \frac{1}{V^2}$

55. (c) $H = \frac{V^2 t}{4.2\,R}$ or $\frac{H}{t} = \frac{V^2}{4.2\,R}$

$\Rightarrow 800 = \frac{20 \times 20}{4.2 \times R} \Rightarrow R = \frac{5}{42} = 0.119 \approx 0.12\,\Omega$

56. (a) Heat produced $H = \frac{V^2 t}{4.2R} = H \propto \frac{1}{R}$ Hence $\frac{H_1}{H_2} = \frac{R_2}{R_1}$

57. (d) $\frac{H}{t} = i^2 R$. Here total $R = (21 + 4) = 25\ \Omega$

$\Rightarrow$ Rate of energy consumed $= 0.2 \times 0.2 \times 25$ $= 1\ J/s$

58. (b) When the heating coil is cut into two equal parts and these parts are joined in parallel, the resistance of coil is reduced to one fourth, so power consumed will become 4 times *i.e.* 400 Js^{-1}.

59. (d) The resistance of 40 *W* bulb will be more and 60 *W* bulb will be less.

60. (a) In series $P_{Consumed} \propto \text{Brightness} \propto \frac{1}{P_{Rated}}$

61. (d) $E = P \times t = 1000\,W \times 30\ sec = 3 \times 10^4\ J$

62. (a) Resistance R_1 of 500 *W* bulb $= \frac{(220)^2}{500}$

Resistance R_2 of 200 *W* bulb $= \frac{(220)^2}{200}$

When joined in parallel, the potential difference across both the bulbs will be same.

Ratio of heat produced $= \frac{V^2/R_1}{V^2/R_2} = \frac{R_2}{R_1} = \frac{5}{2}$

When joined in series, the same current will flow through both the bulbs.

Ratio of heat produced $= \frac{i^2 R_1}{i^2 R_2} = \frac{R_1}{R_2} = \frac{2}{5}$

63. (d) Charge $q = it = 0.5\,A \times 3600\,\text{sec} = 1800$ *culoumb*

64. (b) $H = i^2 Rt = \frac{V^2 t}{R} = \frac{120 \times 120 \times (10 \times 60)}{6} = 14.4 \times 10^5$ *joule*

65. (b) In parallel $P_{consumed} \propto \text{Brightness} \propto \frac{1}{R}$

$P_A > P_B$ (given) $\quad \therefore\ R_A < R_B$

66. (d) $R = \rho \frac{l}{A}$ and $P \propto \frac{1}{R} \Rightarrow P \propto \frac{A}{l} \Rightarrow P \propto \frac{d^2}{l} \Rightarrow$ $P_A = 2P_B$

67. (a) $t_S = t_1 + t_2 = 30 + 30 = 60$ *minutes*

68. (a) For power transmission power loss in line $P_L = i^2 R$

If power of electricity is *P* and it is transmitted at voltage *V*, then $P = Vi \Rightarrow i = \frac{P}{V}$

$P_L = \left(\frac{P}{V}\right)^2 R = \frac{P^2 R}{V^2}$

$= \frac{2.2 \times 10^3 \times 2.2 \times 10^3 \times 10}{22000 \times 22000} = 0.1W$

69. (a) $P = i^2 R$ (*i* and *R* are same)

So *P* will be same for given resistors.

70. (c) Since $H \propto i^2$, so on doubling the current, the heat produced and hence the rise in temperature becomes four times.

71. (a) *Watt-hour meter* measures electric energy.

72. (d) Total energy consumed $= \frac{60 \times 8}{1000} = 0.48\ kWH$

So cost $= 0.48 \times 1.25 = 0.6\ Rs$

73. (a) $P_S = \frac{P}{n} = \frac{40}{4} = 10\ W.$

74. (b) As temperature increases resistance of filament also increases.

75. (a) Current through the combination $i = \frac{120}{(6+9)} = 8\ A$

So, power consumed by $6\ \Omega$ resistance $P = (8)^2 \times 6 = 384\ W$

76. (d) $P = \frac{V^2}{R} = \frac{(225)^2}{50} = 1012.5 \approx 1000\ W$

77. (b) $P = Vi \Rightarrow i = \frac{P}{V} = \frac{100}{200} = 0.5\ A$

78. (b) $H = i^2 Rt \Rightarrow R = \frac{H}{i^2 t} = \frac{80}{4 \times 10} = 2\,\Omega$

79. (d) Heat produced = Energy stored in capacitor

$= \frac{1}{2} CV^2 = \frac{1}{2} \times 4 \times 10^{-6} \times (400)^2 = 0.32\ J$

80. (d) $P = \frac{V^2}{R} = \frac{(110)^2}{10} = \frac{12100}{10} = 1210\ W$

81. (a) $P_{consumed} = \left(\frac{V_A}{V_R}\right)^2 \times P_R = \frac{(160)^2}{(200)^2} \times 100 = 64\ W$

82. (d) For maximum power $r = R$

83. (d) $P = i^2R \Rightarrow 22.5 = (15)^2 \times R \Rightarrow R = 0.10\ \Omega$

84. (d) $R_1 = \rho\frac{l_1}{A_1}$ and $R_2 = \rho\frac{l_2}{A_2} \Rightarrow$

$$\frac{R_1}{R_2} = \frac{l_1}{l_2}.\frac{A_2}{A_1} = \frac{l_1}{l_2}\left(\frac{r_2}{r_1}\right)^2$$

Given $\frac{l_1}{l_2} = \frac{1}{2}$ and $\frac{r_1}{r_2} = \frac{2}{1}$ or $\frac{r_2}{r_1} = \frac{1}{2} \Rightarrow \frac{R_1}{R_2} = \frac{1}{8}$

$\therefore$ Ratio of heats $\frac{H_1}{H_2} = \frac{V^2/R_1}{V^2/R_2} = \frac{R_2}{R_1} = \frac{8}{1}$

85. (a) $P = Vi = 250 \times 2 = 500\ W$

86. (a) $P = \frac{V^2}{R} \Rightarrow 100 = \frac{(200)^2}{R} \Rightarrow R = \frac{4 \times 10^4}{10^2} = 400\,\Omega$

Now, $i = \frac{V}{R} = \frac{100}{400} = \frac{1}{4}\,amp$

87. (a, d) $R_{steel} = 2R_{Al}$. In series $H \propto R$ (i is Same)

So, H will be more in steel wire . In parallel $H \propto \frac{1}{R}$ (V is Same), so H will be more in aluminium wire.

88. (a) $H = i^2Rt \Rightarrow \frac{H}{t} = i^2R = \frac{i^2\rho l}{\pi r^2}$

89. (b)

90. (a) $H = \frac{V^2}{R}.t \Rightarrow \frac{H_1}{H_2} = \frac{R_2}{R_1} = \frac{R}{2R} = \frac{1}{2}$

91. (b)

92. (a) In parallel $P_{Consumed} \propto P_{Rated}$

93. (b)

94. (a) $P = \frac{V^2}{R} \Rightarrow R = \frac{V^2}{P} = \frac{(220)^2}{40} = 1210\,\Omega$

95. (b) $P = Vi \Rightarrow i = \frac{P}{V} = \frac{60}{220} = \frac{3}{11}\,amp$

96. (a) In series, $P_{Consumed} \propto \frac{1}{P_{Rated}} \propto V_{Applied}$

i.e. more voltage appears on smaller wattage bulb, so 25 *W* bulb will fuse

97. (c) Because in series current is same.

98. (b) $P = \frac{V^2}{R} \Rightarrow \frac{P_1}{P_2} = \frac{R_2}{R_1} \Rightarrow \frac{6}{P_2} = \frac{4}{6} = \frac{2}{3} \Rightarrow P_2 = 9\,W$

99. (c) $\frac{H}{t} = P = \frac{V^2}{R} \Rightarrow P \propto \frac{1}{R}$ also $R \propto \frac{l}{A} \propto \frac{l^2\rho}{A.l\rho}$

$\Rightarrow R \propto \frac{l^2}{m} \Rightarrow R \propto l^2$ (for same mass)

So $\frac{P_A}{P_B} = \frac{l_B^2}{l_A^2} = \frac{4}{1} \Rightarrow P_A = 20\,W$

100. (a) $P = \frac{V^2}{R} \Rightarrow \frac{R_1}{R_2} = \frac{P_2}{P_1} = \frac{60}{40} = \frac{3}{2}$

101. (b) $P \propto V^2 \Rightarrow \frac{P}{P_0} = \left(\frac{V}{V_0}\right)^2 \Rightarrow P = \left(\frac{V}{V_0}\right)^2 P_0$

102. (c) $P = \frac{V^2}{R} \Rightarrow R \propto \frac{1}{P}$

So resistance of the 100*W* bulb will be minimum

103. (a) In parallel $\frac{1}{t_p} = \frac{1}{t_1} + \frac{1}{t_2} \Rightarrow t_p = \frac{t_1t_2}{t_1 + t_2}$

$= \frac{5 \times 10}{5 + 10} = \frac{50}{15} = 3.33\,\text{min} = 3\,min.\,20\,sec$

104. (a) For maximum joule heat produced in resistor external resistance = Internal resistance.

105. (d)

106. (c) $H = \frac{V^2}{R}t \Rightarrow \frac{H_1}{H_2} = \frac{R_2}{R_1} = \frac{4}{2} = \frac{2}{1}$

107. (a) If resistances of bulbs are R_1 and R_2 respectively then in parallel $\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2} \Rightarrow$

$$\frac{1}{\left(\frac{V^2}{P_p}\right)} = \frac{1}{\left(\frac{V^2}{P_1}\right)} + \frac{1}{\left(\frac{V^2}{P_2}\right)}$$

$\Rightarrow P_P = P_1 + P_2$

108. (b)

109. (b) When wire is cut into two equal parts then power dissipated by each part is $2P_1$

So their parallel combination will dissipate power $P_2 = 2P_1 + 2P_1 = 4P_1$

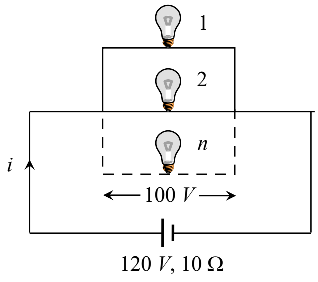
Which gives $\frac{P_2}{P_1} = 4$

110. (d) $P = \frac{V^2}{R} \Rightarrow \frac{P_2}{P_1} = \frac{V_2^2}{V_1^2}$ ($\because R$ is constant)

$\Rightarrow \frac{P_2}{P_1} = \left(\frac{100}{200}\right)^2 = \frac{1}{4} \Rightarrow P_2 = \frac{P_1}{4} = \frac{40}{4} = 10\,W$

111. (c) When each bulb is glowing at full power,

Current from each bulb $= I = \frac{50}{100} = \frac{1}{2}A$

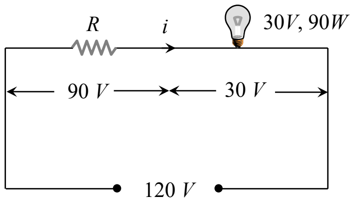


So main current $i=\frac{n}{2}A$

Also $E=V+ir\Rightarrow 120=100+\left(\frac{n}{2}\right)\times 10\Rightarrow n=4$

112. (b) $R=\frac{V^2}{P}=\frac{(250)^2}{10^3}=62.5\,\Omega$

113. (c) Suppose resistance R is corrected in series with bulb. Current through the bulb $i=\frac{90}{30}=3\,A$



Hence for resistance $V=iR\Rightarrow$ $90=3\times R\Rightarrow R=30\,\Omega$

114. (a) $i\propto r^{3/2}\Rightarrow\frac{r_2}{r_1}=\left(\frac{i_2}{i_1}\right)^{3/2}=\left(\frac{3}{1.5}\right)^{2/3}=(4)^{1/3}$

$\Rightarrow r_2=(4)^{1/3}\times r_1=4^{1/3}$ (∵ $r_1=1\ mm$)

115. (c) In series $P'=\frac{P}{n}=\frac{60}{3}=20\ watts$

116. (c) $R=\frac{V^2}{P}=\frac{(220)^2}{60}=807\,\Omega$

117. (d) $\frac{P_1}{P_2}=\left(\frac{V_1}{V_2}\right)^2\Rightarrow\frac{1000}{P_2}=\left(\frac{220}{110}\right)^2=4\Rightarrow P_2=250\,W$

118. (a) $P_S=\frac{P_1P_2}{P_1+P_2}=\frac{100\times200}{100+200}=\frac{200}{3}\approx 65\ watt$

119. (d) $H=\frac{V^2t}{R\times J}\,Calories=\frac{Pt}{J}=\frac{210\times5\times60}{4.2}=15000\,cal$

120. (c) Using conservation of energy

Supplied electric energy = absorbed heat energy

$\Rightarrow i^2Rt=mST$

$\Rightarrow T\propto i^2$ (T - change in temperature)

i.e. when i is doubled T will be four times *i.e.* $5\times4=20^oC$

121. (b) Energy $=P\times t=2\times1\times30=60\ kWH=60$ unit

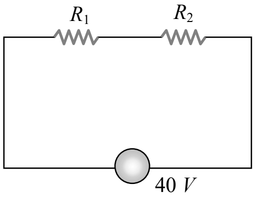
122. (d) Bulb (I) : Rated current $I_1=\frac{P}{V}=\frac{40}{220}=\frac{2}{11}amp.$

Resistance $R_1=\frac{V^2}{P}=\frac{(220)^2}{40}=1210\,\Omega$

Bulb (II) : Rated current $I_2=\frac{100}{220}=\frac{5}{11}amp$

Resistance $R_2=\frac{(220)^2}{100}=484\,\Omega$

When both are connected in series across 40 V supply



Total current through supply

$I=\frac{40}{R_1+R_2}=\frac{40}{1210+484}=\frac{40}{1254}=0.03A$

This current is less than the rated current of each bulb. So neither bulb will fuse.

Short Trick : Since $V_{Applied}<V_{Rated}$, neither bulb will fuse.

123. (a) Both R and $2R$ in parallel (V – constant)

So using $P=\frac{V^2}{R}\Rightarrow\frac{P_1}{P_2}=\frac{R_2}{R_1}\Rightarrow\frac{H_1}{H_2}=\frac{R_2}{R_1}=\frac{2}{1}$

124. (a) Power $P=Vit=250\times4=1000\,W=1kW$

Energy $=P\times t=1\ kW\times60\ sec=60\ kJ$

125. (a) $P=\frac{V^2}{R}\Rightarrow P\propto\frac{1}{R}$ (V - constant)

∴ When one bulb will fuse out resistance of the series combination will be reduced.

Hence from $P_{Consumed}\propto\frac{1}{R}$ illumination will increase.

126. (c) $P=\frac{V^2}{R}\Rightarrow R=\frac{V^2}{P}=\frac{25\times25}{25}=25\,\Omega$

127. (a) $P_{Rated}=\frac{V_{Rated}^2}{R}\Rightarrow R\propto\frac{1}{P_{Rated}}$ (V - constant)

So bulb of high power will have less resistance.

128. (d) $P_{Rated} \propto \frac{1}{R} \Rightarrow \frac{R_1}{R_2} = \frac{P_2}{P_1} = \frac{60}{40} = \frac{3}{2}$

129. (a) Energy $= \frac{V^2}{R} \times t = \frac{10 \times 10}{50} \times 3600 = 7200\ J$

130. (c) Energy $\frac{V^2}{R} t = \frac{200 \times 200 \times 2}{80} = 1000\ Wh$

131. (a) Energy $= P \times t = 100 \times 2 \times 60 = 12000\ J = 12 \times 10^3\ J$

132. (c) Heat $H = \frac{V^2 t}{R} \Rightarrow H \propto \frac{1}{R}$ (If V, t constant)

$$\Rightarrow \frac{H_S}{H_P} = \frac{R_P}{R_S} = \frac{\left(\frac{R \times 2R}{3R}\right)}{(R + 2R)} = \frac{2}{9}$$

133. (c) $i \propto \frac{1}{R}$ and $P \propto \frac{1}{R} \Rightarrow i \propto P$ *i.e.* in parallel bulb of higher power will draw more current.

134. (c) Resistance of A is greater than the resistance of combination of B and C, hence voltage drop across A will be greater than that across B or C. Also $H = \frac{V^2 t}{R}$

$\Rightarrow H \propto V^2$ so $H_A > (H_B = H_C)$ (R = constant)

135. (b) $P = Vi \Rightarrow i = \frac{2.2 \times 10^3}{22000} = \frac{1}{10} A$

Now loss of power $= i^2 R = \left(\frac{1}{10}\right)^2 \times 100 = 1\ W$

136. (c) $P = \frac{V^2}{R}$. If resistance of heater coil is R, then resistance of parallel combination of two halves will be $\frac{R}{4}$

So $\frac{P_1}{P_2} = \frac{R_2}{R_1} = \frac{R/4}{R} = \frac{1}{4}$

137. (c) Total kWh consumed $= \frac{60 \times 8 \times 30}{1000} = 14.4$

Hence cost $= 14.4 \times 1.25 = 18\ Rs$

138. (c) Current capacity of a fuse wire should be slightly greater then the total rated load current.

139. (b)

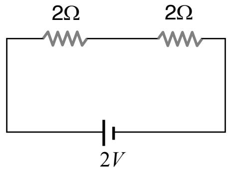
140. (d) Colliding electrons lose their kinetic energy as heat.

141. (a) It is called safe current and is proportional to $r^{3/2}$.

142. (c)

143. (d) $i = \frac{P}{V} = \frac{50}{250} = 0.2\ amp.$

144. (c) In steady state the branch containing capacitors, can be neglected. So reduced circuit is as follows



Power $P = \frac{V^2}{R} = \frac{(2)^2}{4} = 1\ W$.

145. (b) $P = \frac{V^2}{R_{eq}} \Rightarrow 150 = \frac{(15)^2}{[2R/(R+2)]} = \frac{225 \times (R+2)}{2R}$

$\Rightarrow R = \frac{450}{75} = 6\Omega$.

146. (c) $P = \frac{V^2}{R} \Rightarrow \frac{P_1}{P_2} = \frac{R_2}{R_1} = \frac{1}{2}$.

147. (c) $H = \frac{V^2 t}{R} \Rightarrow \frac{H_{Half}}{H_{Full}} = \left(\frac{R_{Full}}{R_{Half}}\right) = \frac{R}{R/2} = 2$

$\Rightarrow H_{Half} = 2 \times H_{Full}$.

148. (c) It is given $R_{Hot} = 10\, R_{Cold}$ also resistance at rated temperature $R = \frac{V^2}{P} = \frac{200 \times 200}{100} = 400\,\Omega$.

So resistance when lamp not in use.

$R_{Cold} = \frac{R_{Hot}}{10} = \frac{400}{10} = 40\,\Omega$

149. (a) The chemical energy reduced in battery

$= VIt = 6 \times 5 \times 6 \times 60\ J = 10800\ J = 1.08 \times 10^4\ J$

150. (c) The heat generated = IVt $= 2.1 \times 15 \times 1 = 31.5 J$

$= 31.5/4.2\ cal = 7.5 cal.$ $[\because 1\ cal = 4.2 J]$

151. (a) Resistance $\propto \frac{1}{\text{power}}$. Thus, 40 W bulb has a high resistance. Because of which there will be more potential drop across 40 W bulb. Thus 40 W bulb will glow brighter.

152. (c) When bulbs are connected in series,

$P = \frac{V^2}{R} = \frac{V^2}{3R}$

When bulbs are connected in parallel,

$P' = \frac{V^2}{R'} = \frac{V^2 \times 3}{R} = 3 \times 3P = 9P.$

153. (c) Time $t_S = t_1 + t_2 = 35$ min.

Chemical Effect of Current

1. (d) As sugar cannot be decomposed into ions and ions are responsible for conduction.

2. (c) $\because \frac{Z_1}{Z_2} = \frac{E_1}{E_2} \Rightarrow Z_2 = \left(\frac{E_2}{E_1}\right).Z_1$

3. (d) $\frac{m_{Zn}}{m_{Ag}} = \frac{E_{Zn}}{E_{Ag}} \Rightarrow m_{Ag} = W\left(\frac{E_{Ag}}{E_{Zn}}\right) = 3.3\,W = 3.5\,W$

4. (d) 96500 *coulombs* of charge is needed to deposit one gram equivalent of an element at an electrode.

5. (c) As $\frac{m_{Cu}}{m_{Ag}} = \frac{E_{Cu}}{E_{Ag}} = \frac{\frac{1}{2}(\text{Atomic weight})_{Cu}}{(\text{Atomic weight})_{Ag}}$

6. (d) $V_2 = \frac{22.4 \times 1}{1} = 22.4\ litre$ at NTP

$\because$ 11.2 *litre* of H_2 is liberated by 96,500 C

$\therefore$ 22.4 *litre* of H_2 is liberated by 96500 × 2 = 1,93,000 C

7. (b) From $m = ZQ$; if $Q = 1C \Rightarrow m = Z$

8. (d)

9. (b) Because H has positive charge.

10. (a) Because H_2O is used as electrolyte.

11. (b) $m = Zit \Rightarrow 1 = 0.00033 \times 2 \times t$

$\therefore\ t = \frac{1}{0.00066 \times 60}\,min = \frac{100000}{3960} \approx 25\,min$

12. (b) $3 = 1.5(1 + r) \Rightarrow r = 1\Omega$

13. (b)

14. (c) $m = Zit = Zq$; $q = \frac{5 \times 10^{-3}}{3.387 \times 10^{-7}}\,amp\text{-}sec$

or $q = \frac{5 \times 10^{-3}}{3.387 \times 10^{-7} \times 3600}\,amp\text{-}hr = 4.1$

15. (b) Charge $Q = I\,t = 1.6 \times 60 = 96\ C$

Let n be the number of Cu^{+2} ions, then

$ne = Q \Rightarrow n = \frac{Q}{e} = \frac{96}{2 \times 1.6 \times 10^{-19}} = 3 \times 10^{20}$

16. (a) In the first case, $Zit = m$

In the second case, $Z \times \frac{i}{4} \times 4t = m$

17. (b) $\frac{\text{Mass of } O_2 \text{ ions}}{\text{Mass of } Ag \text{ ions}} = \frac{\text{Chemical equivalent of } O_2}{\text{Chemical equivalent of } Ag}$

$\Rightarrow \frac{0.8}{m} = \frac{8}{108} \Rightarrow m = 10.8\,gm$

18. (c)

19. (a) $F = Ne = 6 \times 10^{23} \times 1.6 \times 10^{-19}$

20. (d) Since 1 *faraday* deposits 1 *gm* equivalent.

21. (c) Equivalent weight of copper $= \frac{64}{2} = 32$

$\frac{\text{Equivalent weight of } Cu}{\text{Equivalent weight of } Ag} = \frac{\text{Weight of } Cu \text{ deposited}}{\text{Weight of } Ag \text{ deposited}}$

Weight of copper deposited $= \frac{10.8 \times 32}{108} = 3.2\,gm$

22. (b)

23. (c)

24. (a) $m \propto q \Rightarrow m \propto it$

25. (d) Equivalent weight of aluminium $= \frac{27}{3} = 9$

So 1 *faraday* = 96500 C are required to liberate 9 *gm* of Al.

26. (b) By Faraday's law, $m \propto it$.

$\therefore\ \frac{m_1}{m_2} = \frac{i_1 t_1}{i_2 t_2} \Rightarrow \frac{m}{m_2} = \frac{4 \times 120}{6 \times 40} \Rightarrow m_2 = \frac{m}{2}$

27. (a) $m \propto it$

28. (c) Amount of metallic sodium appears

$m = Zit = \left(\frac{A}{VF}\right)it$

$= \left(\frac{23}{1 \times 96500}\right) \times 16 \times 10 \times 60 = 2.3\ gm$

29. (a)

30. (a) $m = Zit \Rightarrow Z = \frac{m}{it}$

$= \frac{4.572}{5 \times 45 \times 60} = 3.387 \times 10^{-4}\ gm/C$

31. (b) Faraday constant = 1 mole electron charge = Ne

$= 6.02 \times 10^{23} \times 1.6 \times 10^{-19} = 96500$

32. (d) $m = Zit = 0.126 \times 10^{-3} \times 5 \times 3600 = 2.27\,gm$

33. (b) $\frac{m_1}{m_2} = \frac{E_1}{E_2}$ (By faraday law for same current and time)

Where E_1 and E_2 are the chemical equivalents and m_1 and m_2 are the masses of copper and silver respectively.

$E = \frac{\text{Atomic weight}}{\text{Valency}}$. $E_1 = \frac{63.57}{2} = 31.79$ and

$E_2 = \frac{107.88}{1} = 107.88$

$\therefore\ \frac{1\,mg}{m_2} = \frac{31.79}{107.88} \Rightarrow m_2 = \frac{107.88}{31.79}\,mg = 3.4\,mg$

34. (a) $m = Zit \Rightarrow \frac{m}{Zit} = 1\,(\text{constant})$

35. (b) Positive ions get deposited on cathode.

36. (c) $m = Zit$ or $m \propto it$

$$\therefore \frac{m_1}{m_2} = \frac{i_1 t_1}{i_2 t_2} \Rightarrow \frac{9}{m_2} = \frac{10^5}{50 \times 20 \times 60} \Rightarrow m_2 = 5.4\ gm$$

37. (c) Electroplating only provides a thin deposition of a metal on the surface which in no way can give hardness to the metal.

38. (b)

39. (d) $m = Zit \Rightarrow \frac{m_{Cu}}{m_{Zn}} = \frac{Z_{Cu}}{Z_{Zn}}$

$$m_{Cu} = m_{Zn}\frac{Z_{Cu}}{Z_{Zn}} = 0.13 \times \frac{31.5}{32.5} = 0.126\ g$$

40. (b) $m = Zit \Rightarrow m = \frac{ZVt}{R} \Rightarrow m \propto Vt \Rightarrow \frac{m_1}{m_2} = \frac{V_1 t_1}{V_2 t_2}$

$$\Rightarrow \frac{2}{m_2} = \frac{12 \times 30}{6 \times 45} \Rightarrow m_2 = 1.5\ gm$$

41. (c) $i = \frac{m}{Zt} = \frac{0.972}{0.00018 \times 3 \times 3600} = 0.5\ A$

42. (b) The current through the voltameter is same as drawn from the battery outside it.

43. (d) The resistance of the cell is independent of e.m.f.

44. (a) $m = Zit = 3.3 \times 10^{-7} \times 3 \times 2 = 19.8 \times 10^{-7}\ kg$

45. (c) $m = zq$, z = atomic mass / valence

46. (c)

47. (a)

48. (b) 1 faraday (96500*C*) is the electricity which liberated that amount of substance which is equal to equivalent wt. So liberated amount of Cu is $\frac{63.5}{2} = 31.25\ gm \approx 32\ gm$

49. (b) $m = Zit \Rightarrow 20 \times 10^{-3} = \left(\frac{32}{96500}\right) \times 0.15 \times t$

$$= 6.7\ min = 6\ min\ 42\ sec$$

50. (b) 22.4 *litre* H_2 = 1 mole H_2 = N molecules of H_2

$= 2N$ atom of H

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

Hence charge required to liberate 0.224 *litre* of H_2 $= \frac{2F}{22.4} \times 0.224 = \frac{2F}{100} = 2 \times 965\ C$

So current $i = \frac{Q}{t} = \frac{2 \times 965}{100} = 19.3\ amp$

51. (a)

52. (d) $m = Zit \Rightarrow Z = \frac{m}{it} = \frac{4.5}{4 \times 40 \times 60} = 47 \times 10^{-5}\ g/C$

53. (d) Charge supplied per minute = 3.2 × 60 = 192 *C*

Charge $2e$ liberates one Cu^{+2} ion

$\therefore$ No of Cu^{+2} ion liberate by 192 *C*

$$= \frac{192}{2e} = \frac{192}{2 \times 1.6 \times 10^{-19}} = 6 \times 10^{20}$$

54. (a) $m = Zit \Rightarrow i = \frac{m}{Zt} = \frac{0.99}{0.00033 \times 1200} = 2.5 A$

Hence heat generated in the coil is

$$H = i^2 Rt = (2.5)^2 \times 0.1 \times 1200 = 750\ J$$

55. (c) $\frac{m_1}{m_2} = \frac{Z_1}{Z_2} \Rightarrow m_2 = \frac{m_1 Z_2}{Z_1} = \frac{14 \times 1.2 \times 10^{-6}}{7 \times 10^{-6}} = 2.4\ g$

56. (c) $m = Zit \Rightarrow t = \frac{m}{Zi} = \frac{m \times F}{E \times i}$ $\left(\because Z = \frac{E}{F}\right)$

$$t = \frac{27 \times 96500}{108 \times 2} = 12062.5\ sec = \frac{12062.5}{3600}\ hr = 3.35\ hr$$

57. (d) $m = zq \Rightarrow z \propto \frac{1}{q} \Rightarrow \frac{z_1}{z_2} = \frac{q_2}{q_1}$ ......(i)

also $q = q_1 + q_2 \Rightarrow \frac{q}{q_2} = \frac{q_1}{q_2} + 1$

$$\Rightarrow q_2 = \frac{q}{1 + \frac{q_1}{q_2}} \qquad ......(ii)$$

From equation (i) and (ii) $q_2 = \frac{q}{1 + \frac{z_2}{z_1}}$

58. (c) From Faraday's law, m/E = constant where m = mass of substance deposited, E = chemical equivalent.

$$\therefore \frac{m_2}{m_1} = \frac{E_2}{E_1} \Rightarrow m_2 = \frac{108}{32} \times 1.6 = 5.4 g$$

59. (a) $q = it$ = current × time

Thermo-Electricity

1. (b) Production of e.m.f. by temperature difference is known Seeback effect.

2. (c) Production of heat at junctions due to current is known as Peltier effect.

3. (d)

4. (a)

5. (c) When there is no deflection, then this temperature is called inversion temperature. It is given by the relation

$\theta_n = \frac{\theta_i + \theta_c}{2}$

Where θ_c is temperature of cold junction $= 20^o C$ and neutral temperature $\theta_n = 270^o C$

$\therefore\ \theta_i = 2\theta_n - \theta_c = 540 - 20 = 520^o C$

6. (b)

7. (a) Thermo e.m.f. of a thermo couple depends on the nature of metals.

8. (a)

9. (a) According to the definition.

10. (a) $T_n = \frac{T_i + T_C}{2} \Rightarrow T_i = 2T_n - T_C$

11. (a)

12. (d)

13. (b) Based on Peltier effect.

14. (c) Peltier effect

15. (b) Thermopile is used for detection of heat radiation and measurement.

16. (b) $H = \sigma i t \Delta\theta$ $\Rightarrow$ If $i = 1\ A$, $\Delta\theta = 1°C$, $t = 1 sec$ then $H = \sigma$.

17. (a) According to Seebeck effect

18. (a) At neutral temperature, $\frac{dE}{dT} = 0$

19. (a) According to Seebeck effect.

20. (b)

21. (d)

22. (a) As a rule, more the metals are separated from each other in the thermoelectric series, the greater will be the thermo *emf.*

23. (b) $T_n = \frac{T_i + T_c}{2} = \frac{10 + 530}{2} = 270^o C$

24. (a) Joule effect is not reversible.

25. (b)

26. (c)

27. (c) The graph between thermo *emf* and temperature of hot junction is parabolic in shape.

28. (d) At neutral temperature E is maximum so

$\frac{dE}{dt} = 0 \Rightarrow \frac{d}{dt}(At - Bt^2) = 0 \Rightarrow A - 2Bt = 0 \Rightarrow$

$t = \frac{A}{2B}$

29. (c) $t_n = \frac{t_1 + t_c}{2} \Rightarrow 280 = \frac{t_i + 15}{2} \Rightarrow t_i = 545^o C$

30. (a)

31. (a) A is false because at neutral temperature thermo emf is maximum. B is true.

32. (b) Thermo-electric power $P = \frac{dE}{d\theta}$; at t_n, $E \to$ maximum. So $P \to$ zero.

33. (d) By using $H = \sigma Q\theta$

$\Rightarrow\ H = (10 \times 10^{-6}) \times 10 \times (60 - 50) = 10^{-3}\ J = 1\ mJ$

34. (c) No change in neutral temperature but temperature of inversion is $t_i = 2t_n - t_c \Rightarrow$

$t_i = 2 \times 270 - 40 = 500^o C$

35. (c)

36. (d) $t_i = 2t_n - t_c \Rightarrow t_i = 2 \times 350 - 30 = 670^o C$

37. (c)

38. (d) Neutral temperature is independent of temperature of cold junction.

39. (d)

40. (a) $E = at + bt^2$ at inversion temperature E will be minimum

Thus $\frac{dE}{dt} = 0 \Rightarrow \frac{d}{dt}[at + bt^2] = 0$

$\Rightarrow a + 2bt = 0 \Rightarrow t = -\frac{a}{2b}$

41. (d)

42. (a) $i = \frac{e}{R} \Rightarrow 3 \times 10^{-7} = \frac{(30 \times 10^{-6}) \times \theta}{50} \Rightarrow \theta = 0.5°$

43. (b) $t_n = \frac{\alpha}{\beta} = \left(\frac{500}{5}\right) = 100°C$

Also $t_n = \frac{t_i + t_c}{2} \Rightarrow 100 = \frac{t_i + 0}{2} \Rightarrow t_i = 200°C$

44. (b) At neutral temperature, thermal emf will be maximum.

$\therefore \frac{de}{dt} = a + bt$

For maximum or minima, $a + bt_n = 0$

$\therefore\ t_n = -a / b$

Critical Thinking Questions

1. (d) $P_1 = \frac{(220)^2}{R_1}$ and $P_2 = \frac{(220 \times 0.8)^2}{R_2}$

$\frac{P_2}{P_1} = \frac{(220 \times 0.8)^2}{(220)^2} \times \frac{R_1}{R_2} \Rightarrow \frac{P_2}{P_1} = (0.8)^2 \times \frac{R_1}{R_2}$ Here $R_2 < R_1$

(because voltage decreases from 220 $V \to$ 220 × 0.8 V

It means heat produced → decreases)

So $\frac{R_1}{R_2} > 1 \Rightarrow P_2 > (0.8)^2 P_1 \Rightarrow P_2 > (0.8)^2 \times 100\,W$

Also $\frac{P_2}{P_1} = \frac{(220\times 0.8)i_2}{220\,i_1}$, Since $i_2 < i_1$ (we expect)

So $\frac{P_2}{P_1} < 0.8 \Rightarrow P_2 < (100\times 0.8)$

Hence the actual power would be between $100\times(0.8)^2\,W$ and (100 × 0.8) *W*

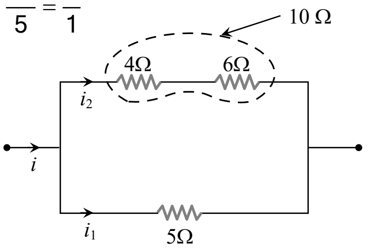
2. (b) $W = JH \Rightarrow P\times t = J\times ms\Delta\theta$

$\Rightarrow t = \frac{J\times m\times s\Delta\theta}{P}$ (For water 1 *litre* = 1*kg*)

$\Rightarrow t = \frac{4.2\times 1\times 1000\times(40-10)}{836} = 150\,sec$

Short Trick : use formula $t = \frac{4200\times m\times\Delta\theta}{P}$

3. (b) $\frac{i_1}{i_2} = \frac{R_2}{R_1} = \frac{10}{5} = \frac{2}{1}$



Also heat produced per sec *i.e.* $\frac{H}{t} = P = i^2R$

$\Rightarrow \frac{P_5}{P_4} = \left(\frac{i_1}{i_2}\right)^2\times\frac{5}{4} = \left(\frac{2}{1}\right)^2\times\frac{5}{4} = \frac{5}{1} \Rightarrow P_4 = \frac{10}{5} = 2\,cal/s$

4. (d) $220\times 9 = n(60) \Rightarrow n = 33$

5. (c) $H = \frac{V^2}{R}t$

Since supply voltage is same and equal amount of heat will produce, therefore

$\frac{R_1}{t_1} = \frac{R_2}{t_2}$ or $\frac{R_1}{R_2} = \frac{t_1}{t_2}$ .....(i)

But $R\propto l \Rightarrow \frac{R_1}{R_2} = \frac{l_1}{l_2}$ .....(ii)

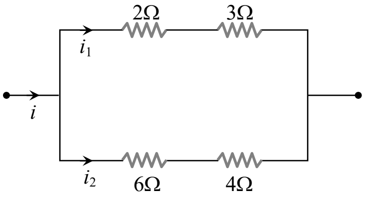
By (i) and (ii), $\frac{l_1}{l_2} = \frac{t_1}{t_2}$ .....(iii)

Now $l_2 = \frac{2}{3}l_1 \Rightarrow \frac{l_1}{l_2} = \frac{3}{2}$

∴ By equation (iii), $\frac{3}{2} = \frac{15}{t_2} \Rightarrow$

$t_2 = 10$ *minutes*

6. (d)



Resistance of upper branch $R_1 = 2+3 = 5\Omega$

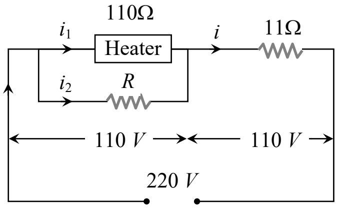
Resistance of lower branch $R_2 = 4+6 = 10\Omega$

Hence $\frac{i_1}{i_2} = \frac{R_2}{R_1} = \frac{10}{5} = 2$

$\frac{\text{Heat generated across } 3\,\Omega\,(H_1)}{\text{Heat generated across } 6\,\Omega\,(H_2)} = \frac{i_1^2\times 3}{i_2^2\times 6} = \frac{4}{2} = 2$

∴ Heat generated across 3 Ω = 120 *cal/sec*

7. (a) Power consumed by heater is 110 *W* so by using $P = \frac{V^2}{R}$



$110 = \frac{V^2}{110} \Rightarrow V = 110\,V.$ Also from figure

$i_1 = \frac{110}{110} = 1A$ and $i = \frac{110}{11} = 10\,A.$ So

$i_2 = 10-1 = 9\,A$

Applying *Ohms* law for resistance *R*, *V* = *iR*

$\Rightarrow 110 = 9\times R \Rightarrow R = 12.22\,\Omega$

8. (c) $P_{consumed} = \left(\frac{V_A}{V_R}\right)^2\times P_R = \left(\frac{110}{115}\right)^2\times 500 = 457.46\ W$

So, percentage drop in power output

$= \frac{(500-457.46)}{500}\times 100 = 8.6\%$

9. (d) Heat produced $= \frac{V^2}{R}t$

i.e. when voltage is halved, heat produced becomes one-fourth. Hence time taken to heat the water becomes four times.

10. (b) Electric power consumed by kettle $P = 220\times 4\,W$

Heat required

$H = 1000\times 1(100-20) = 1000\times 80\ cal = 4200\times 80\ J$

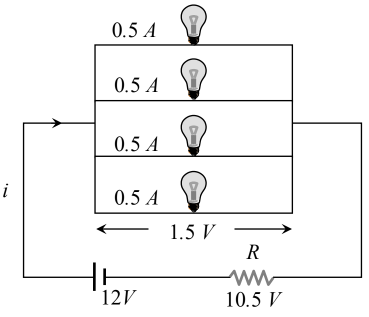
$P = \frac{H}{t} \Rightarrow H = P\times t$

$\therefore\ 220\times 4\times t = 4200\times 80 \Rightarrow t = 6.3$ *minutes*

11. (c) $H = \frac{V^2}{R}\times t = \frac{(210)^2}{20}\times 1 = mL$

$\therefore \frac{(210)^2}{20} = m \times 80 \times 4.2 \quad \Rightarrow m = 6.56\ g/s$

12. (b) For normal brightness of each bulb see following circuit. Current through each bulb = 0.5 *A*



So main current $i = 2A$

Also, voltage across the combination $= 1.5\ V$

So voltage across the resistance $= 10.5\ V$

Hence for resistance $V = iR \Rightarrow 10.5 = 2 \times R \Rightarrow R = \frac{21}{4}\Omega$

13. (d) $P = \frac{V^2}{R}$ so $R = \frac{V^2}{P} \Rightarrow R_1 = \frac{V^2}{100}$ and $R_2 = R_3 = \frac{V^2}{60}$

Now $W_1 = \frac{(250)^2}{(R_1+R_2)^2}.R_1$, $W_2 = \frac{(250)^2}{(R_1+R_2)^2}.R_2$

and $W_3 = \frac{(250)^2}{R_3}$

$W_1 : W_2 : W_3 = 15 : 25 : 64$ or $W_1 < W_2 < W_3$

14. (a) Power dissipated ∝ $R_{\text{equivalent}}$

15. (a) The current taken by the silver voltameter

$I_1 = \frac{m}{Zt} = \frac{1}{11.2 \times 10^{-4} \times 30 \times 60} = 0.496\ A$

and by copper voltameter

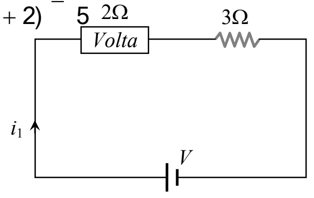
$I_2 = \frac{1.8}{6.6 \times 10^{-4} \times 30 \times 60} = 1.515\ A$

Total current $I = (I_1 + I_2) = 2.011\ A$

Power $P = IV = 2.011 \times 12 = 24.132\ J/\sec$

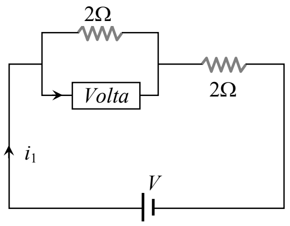
16. (d) Initially current through the voltameter

$i_1 = \frac{V}{(3+2)} = \frac{V}{5}$



Finally main current $i = \frac{V}{3+1} = \frac{V}{4}$

Hence current through voltameter $i_2 = \frac{V}{8}$



$\because$ Rate of deposition $(R) = \frac{m}{t} = Zi \Rightarrow R \propto i$

$\therefore$ % drop in rate $= \frac{R_2 - R_1}{R_1} \times 100 = \frac{i_2 - i_1}{i_1} \times 100$

$= \frac{\left(\frac{V}{8} - \frac{V}{5}\right)}{\frac{V}{5}} \times 100 = -37.5\%$

17. (d) Comparing the given equation with standard equation

$E = \alpha t + \frac{1}{2}\beta t^2$

$\alpha = 40$ and $\frac{1}{2}\beta = -\frac{1}{20} \Rightarrow \beta = -\frac{1}{10}$

Hence neutral temperature $t_n = -\frac{\alpha}{\beta} = \frac{-40}{-1/10}$

$\Rightarrow t_n = 400^o C$

18. (a) Comparing the given equation with standard equation $E = \alpha t + \frac{1}{2}\beta t^2$, we get $\alpha = 14$ and $\frac{1}{2}\beta = -0.02$

$\Rightarrow \beta = -0.04$

Hence neutral temperature $t_n = -\frac{\alpha}{\beta}$

$= -\frac{14}{-0.04} = 350°C$

19. (a) We know that thermoelectric power $S = \frac{dE}{dT}$

Given $E = k(T - T_r)\left[T_0 - \frac{1}{2}(T + T_r)\right]$

By differentiating the above equation *w.r.t.* *T* and

Putting $T = \frac{1}{2}T_o$, we get $S = \frac{1}{2}kT_o$

20. (b) Comparing the given equation with $E=\alpha t+\frac{1}{2}\beta t^2$

We get $\alpha=16$ and $\frac{1}{2}\beta=-0.04\Rightarrow\beta=-0.08$

$\Rightarrow t_n=-\frac{\alpha}{\beta}=-\frac{16}{-0.08}=200^\circ C$

Also $t_i=2t_n-t_c\Rightarrow t_i=2\times(200)-0=400^\circ C$

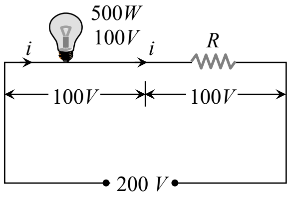
21. (c) $m=Zit\Rightarrow 20\times10^{-3}=\left(\frac{32}{96500}\right)\times0.15\times t$

$=6.7\,min=6\,min\,42\,sec.$

22. (b) $e=iR\Rightarrow 25\times10^{-6}\times\Delta\theta=10^{-5}\times40$

$\Delta\theta=\frac{40\times10^{-5}}{25\times10^{-6}}=\frac{400}{25}=16^\circ C$

23. (b)



Rated current through the circuit $i=\frac{500}{100}=5A$

Potential difference across *R*, $100=5\times R\Rightarrow R=20\Omega$

24. (b) By using $e_0^{100}=e_0^{32}+e_{32}^{70}+e_{70}^{100}$

$\Rightarrow 200=64+76+e_{70}^{100}\Rightarrow e_{70}^{100}=60\,\mu V$

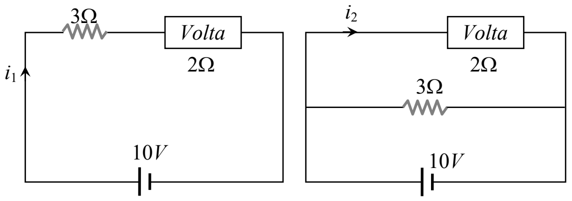
25. (d) In the normal condition current flows from *X* to *Y* through cold. While after increasing the temperature of hot junction beyond temperature of inversion. The current is reversed *i.e.* *X* to *Y* through hot junction or *Y* to *X* through cold junction.

26. (a) $H=\pi it=(2\times10^{-9})\times2.5\times(2\times60)=6\times10^{-7}\ J=6\ erg$

27. (b) Remember mass of the metal deposited on cathode depends on the current through the voltameter and not on the current supplied by the battery. Hence by using $m=Zit$, we can say $\frac{m_{Parallel}}{m_{Series}}=\frac{i_{Parallel}}{i_{Series}}$

$\Rightarrow m_{Parallel}=\frac{5}{2}\times1=2.5\ gm$

Hence increase in mass = 2.5 – 1 = 1.5 *gm*



28. (c) Mass deposited $m=\text{Density}\times\text{Volume of the metal}$

$\Rightarrow m=\rho\times Ax$. Also $m=Zit$, so $Zit=\rho Ax$

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

$=\frac{0.00033\times10^{-3}\times1.5\times20\times60}{(50\times10^{-4})\times9000}=1.3\times10^{-5}\ m$

29. (a) $i=\frac{m}{Zt}=\frac{2.0124}{1.118\times10^{-3}\times3600}=0.5\ A$

$\Rightarrow$ Error $=0.54-0.5=0.04\ A$

30. (b) Total charge supplied $=1\times10=10\ C$

$\because$ 2 electronic charge $(3.2\times10^{-19}\ C)$ liberates one Cu^{++} ion

$\therefore$ Number of Cu^{++} ions liberated by 10 *C* charge

$=\frac{1}{3.2\times10^{-19}}\times10=3.1\times10^{19}$

31. (d) $\because\ m=Zit$ or $i=\frac{m}{Zt}$

For silver voltmeter

$i_1=\frac{m_1}{Z_1t}=\frac{2}{1.118\times10^{-3}\times1800}=0.994\ amp$

For copper voltameter

$i_2=\frac{m_2}{Z_2t}=\frac{1}{3.294\times10^{-4}\times1800}=1.687\ amp$

$\therefore$ Power of circuit $=V(i_1+i_2)$

$=6\times(0.994+1.687)$

$=6\times2.681\approx16\ W$

32. (a) Let the temperature of molten metal is t^oC.

The thermo-emf $e=10\times10^{-6}\ t\ volt$

Current in the circuit

$i=\frac{e}{R+R_G}=\frac{10^{-5}t}{8+1.6}=\frac{10^{-5}t}{9.6}\ amp.$

But $i=\frac{V}{R_G}=\frac{8\times10^{-3}}{8}$

$$\therefore \ \frac{10^{-5}t}{9.6} = \frac{8\times10^{-3}}{8} \text{ or } t = \frac{9.6\times10^{-3}}{10^{-5}} = 960^o C$$

33. (a) $\because$ Peltier coefficient $\pi = T\frac{de}{dT}$ and

$t^o C = T - 273$

$\therefore \ e = a(T-273) + b(T-273)^2$

Differentiating *w.r.t. T* $\frac{de}{dT} = a + 2b(T-273)$

$\pi = T\frac{de}{dT} = T[a+2b(T-273)] \Rightarrow$

$\pi = (t+273)(a+2bt)$

34. (d) $\frac{Q}{t} = \frac{V^2}{4.2\ R} = \frac{m}{t}.L$

$\therefore \ \frac{m}{t} = \frac{V^2}{4.2\ RL} = \frac{(210)^2}{4.2\times50\times80} \approx 2.625\ gm$

35. (d) $H = i^2RT = i^2\left(\frac{\rho l}{A}\right)t = \frac{i^2\rho Vt}{A^2}$ (V = volume, = *Al*)

$\Rightarrow H \propto \frac{1}{r^4} \Rightarrow \frac{H_1}{H_2} = \left(\frac{r_2}{r_1}\right)^4 = \left(\frac{2}{1}\right)^4 = \frac{16}{1}$.

36. (d) Thermoelectric power $P \propto \theta$

$\Rightarrow \frac{P_{100} - P_{80}}{P_{80}} \times 100 = \frac{100-80}{80} \times 100 = 25\%$

37. (d) The sensitivity of the thermocouple will be

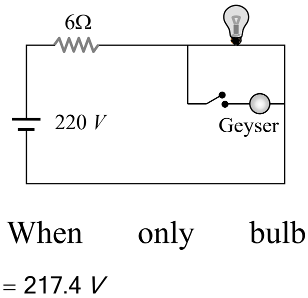
$= 500\mu V/^o C - (-72\mu V/^o C) = 572\mu\ V/^o C$

Therefore for a $100^o C$ temperature difference, the thermo e.m.f. will be

$E = 572\times10^{-6}\times100(volt) = 57.2\times10^{-3} = 57.2\ mV.$

38. (d) At cold junction, current flows from copper to nickel and from iron to copper, and at hot junction from nickel to iron, thus the contributions add.

39. (b) $R_{Bulb} = \frac{220^2}{100} = 484\ \Omega$, $R_{Geyser} = \frac{220^2}{1000} = 48.4\ \Omega$



(i) When only bulb is ON, $V_{Bulb} = \frac{220\times484}{490} = 217.4\ V$

(ii) When geyser is also switched ON, equivalent resistance of bulb and geyser is

$R = \frac{484\times48.4}{484+48.4} = 44\,\Omega$

Voltage across the bulb

$V_{Bulb} = \frac{220\times44}{50} = 193.6\ V$

Hence the potential drop is $217.4 - 193.6 = 23.8\ V$

40. (b) $i = \frac{24-12}{3} = 4\ A$, Time of charging $t = \frac{360`}{V.i}$

$\Rightarrow t = \frac{360}{12\times4} = 7.5\ hours.$

41. (a) $I = \frac{m}{Zt} = \frac{2.68}{\frac{108}{96500}\times10\times60} = \frac{2.68}{108}\times\frac{965}{6} \approx 4\ A$

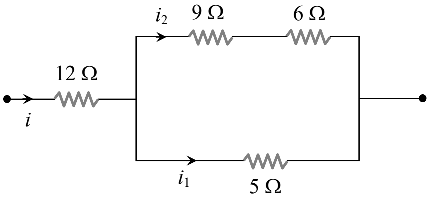
Energy $= I^2Rt = 4^2\times20\times600 = 192\ kJ.$

42. (d) Comparing with standard equation $E = \alpha t + \frac{1}{2}\beta t^2$

$\alpha = a$ and $\beta = 2b \Rightarrow$ $t_n = -\frac{a}{2b} = -\frac{1}{2}\times700 = -350^o C$

This is not possible.

43. (b) $\frac{i_1}{i_2} = \frac{15}{5} = \frac{3}{1}$ … (i)



Also $\frac{H}{t} = i^2R \Rightarrow 45 = (i_1)^2\times5$

$\Rightarrow i_1 = 3\ A$ and from equation (i) $i_2 = 1\ A$

So $i = i_1 + i_2 = 4\ A$

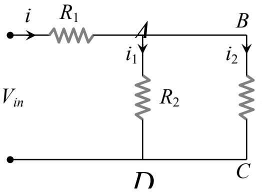
Hence power developed in 12Ω resistance

$P = i^2R = (4)^2\times12 = 192\ W$

44. (a) Heat gained by water = Heat supplied by container - heat lost $\Rightarrow$ $mS\Delta\theta = 1000t - 160t$

$\Rightarrow t = \frac{2\times4.2\times1000\times50}{840}$ = 8 *min* 20 *sec*

45. (c) As the voltage in R_2 and R_3 is same therefore, according to,



$H = \frac{V^2}{R}.t,\ R_2 = R_3$

Also the energy in all resistance is same.

$\therefore\quad i^2 R_1 t = i_1^2 R_2 t$

Using $i_1 = \frac{R_3}{R_2 + R_3} i = \frac{R_3}{R_3 + R_3} i = \frac{1}{2} i$

Thus $i^2 R_1 t = \frac{i^2}{4} R_2 t$ or, $R_1 = \frac{R_2}{4}$

Graphical Questions

1. (b) Area = *it* = 2 *Coulomb* and $m = zit \Rightarrow z = \frac{m}{it} = \frac{m}{2}$
2. (d) $U \propto i^2$, hence the graph between *U* and *i* is parabolic in nature and should be above graph (*b*).
3. (d) $E = \alpha t + \frac{1}{2}\beta t^2$, graph between *E* and *t* will be a parabola, such that first emf increases and then decreases.
4. (a) Thermo electric power $P = \frac{dE}{d\theta} = \alpha + \beta\theta$

   Comparing it with $y = mx + c$, option (a) is correct.
5. (b) The filament of the heater reaches its steady resistance when the heater reaches its steady temperature, which is much higher than the room temperature. The resistance at room temperature is thus much lower than the resistance at its steady state. When the heater is switched on, it draws a larger current than its steady state current. As the filament heats up, its resistance increases and current falls to steady state value.
6. (a) *Cu* voltameter with soluble electrodes obeys ohms law. In water voltameter, in the beginning when *V* is small $(< 1.7\ volt)$, very little current flows, the voltameter does not obey ohms law. As soon as *V* exceeds 1.7 *volt* (back e.m.f.) the current increases steadily according to ohms law.
7. (d) Thermal energy in resistor is $U = i^2 R t$

   where $R = R_0(1 + \alpha t) \Rightarrow$

   $U = i^2 R_0 (1 + \alpha t) t = i^2 R_0 t + i^2 R_0 t^2$

   So $\frac{dU}{dt} = i^2 R_0 (1 + \alpha t)$

   With the time temperature increases, hence dU/dt increases. This is best shown by curve (*d*).
8. (b) $m = Zit$ and it = Area of given curve

   = Area of triangle + Area of rectangle

   $\Rightarrow i\,t = \frac{1}{2} \times (2 \times 60) \times 1 + (6 - 2) \times 60 \times 1 = 300$

   $\therefore\ Z = \frac{m}{it} = \frac{m}{300}$
9. (d) Terminal voltage $V = E - Ir$. Hence the graph between *V* and *i* will be a straight line having negative slope and positive intercept.

   Thermal power generated in the external circuit

   $P = EI - I^2 r$. Hence graph between *P* and *I* will be a parabola passing through origin.

   Also at an instant, thermal power generated in the cell = $i^2 r$ and total electrical power generated in the cell = *Ei*. Hence the fraction $\eta = \frac{I^2 r}{EI} = \left(\frac{r}{E}\right) I$; so $\eta \propto I$. It means graph between η and *I* will be a straight line passing through origin.

Assertion and Reason

1. (a) The possibility of an electric bulb fusing is higher at the time of switching ON and switching OFF because inductive effect produces a surge at the time of switching ON and OFF.
2. (a) The resistance, $R = \frac{V^2}{P} \Rightarrow R \propto 1/P$

   i.e., higher is the wattage of a bulb, lesser is the resistance and so it will glow bright.
3. (c) Assertion is true but reason is false. Fuse wire must have high resistance because in series current remains same, therefore

according to Joule's law $H=\frac{i^2Rt}{4.2}$, heat produced is high if *R* is high. The melting point must be low so that wire may melt with increase in temperature. As the current equal to maximum safe value, flows through the fuse wire, it heats up, melts and break the circuit.

4. (a) Resistance of 50 *W* bulb is two times the resistance of 100 *W* bulb. When bulbs are connected in series, 50 *W* bulb will glow more as $P=i^2R$(current remains same in series). In parallel the 100 *W* bulb will glow more as $P=V^2/R$(potential difference remain same in parallel).

5. (d) When two bulbs are connected in series, the resistance of the circuit increases and so the voltage in each decreases, hence the brightness and the temperature also decreases. Due to decrease in temperature, the resistance of the carbon filament will slightly increase while that of metal filament will decrease. Hence, carbon filament bulb will glow more brightly $(P=i^2R)$. Also carbon is not a semiconductor.

6. (e) Voltage of dc source is constant but in ac, peak value of voltage is $\sqrt{2}$ times the *rms.* voltage. Hence bulb will glow with more brightness when connected to an ac source of the same voltage.

7. (a) When cold water is poured on half portion of the wire, its resistance decreases due to decrease in temperature. As a result of this total resistance of circuit decreases *i.e.* current through each portion of wire increases *i.e.* rest of the half portion becomes still more hot.

8. (a) As filament of bulb and line wire are in series, hence current through both is same. Now, because $H=\frac{i^2Rt}{4.2}$ and resistance of the filament of the bulb is much higher than that of line wires, hence heat produced in the filament is much higher than that in line wires.

9. (b) Neutral temperature is the temperature of hot junction, at which the thermo e.m.f. produced in the thermocouple becomes maximum. It is independent of cold junction and depends on the nature of materials of two metals used to form thermocouple.

10. (d) Because of heat production every resistance has a maximum power rating, the maximum power that can be dissipated without overheating the device. When this rating is exceeded, heat is produced, due to which resistance may change unpredictably.

11. (a) The e.m.f. of a Leclanche cell falls, because of the partial polarisation due to accumulation of hydrogen gas. In case, Leclanche cell is used in experiment, where current is drawn after short breaks, then during each break, hydrogen gas escapes and Mn_2O_3 converts into MnO_2 by taking oxygen from the atmosphere. As a result, the cell regains its original e.m.f.

12. (a) When lamp *B* or *C* gets fused equivalent resistance of *B* and *C* increases. In series voltage distributes in the ratio of resistance, so voltage appears across *B* increases or in other words voltage across *A* decreases.

13. (d) When switch *S* is closed, bul*b C* is short circuited, so voltage *V* distributes only in two parts *i.e.* voltage on Bulb *A* and *B* increases as compared previously. Hence illumination of Bulb *A* and *B* increases.

14. (a)

15. (c) The electrical appliances with metallic body like heater, press *etc*. have three pin connections. Two pins are for supply line and third pin is for earth connection for safety purposes.

16. (c) A laser beam is a beam of light which is light amplification by stimulated emission of radiation.

The energy per unit area of the laser beam is very high as compared to the torch light.

17. (a) Follow hint of question 15 of this section.

18. (c) Thomson e.m.f. in lead is practically zero.

19. (b) The presence of water molecules reduces force between ions by $1/81$ times because the value of dielectric constant of water is 81. That is why the separation between ions becomes easier.

20. (b) Here reason is not the correct explanation of the assertion, which is correct.

21. (d) Here assertion and reason are not correct.