Network Analysis

Practice Test - I (Solutions).

1. $i(t) = 1 - 4e^{-2t} + 3e^{-3t}$ A. for $t \geq 0$.

$$q(t) = \int_{-\infty}^{t} i(t)\,dt$$

$$= \int_{-\infty}^{0} i(t)\,dt + \int_{0}^{t} i(t)\,dt$$

$$= 0 + \int_{0}^{t} (1 - 4e^{-2t} + 3e^{-3t})\,dt$$

$$= (t + 2e^{-2t} - e^{-3t})\ \text{A C}$$

2. $V = 5000$ V.

Energy = (Voltage × Charge)

$= (5000 \times 1.602 \times 10^{-19})$ $\quad \because e^- = -1.602 \times 10^{-19}$ C $= -p^+$

$= 8.01 \times 10^{-16}$ J.

This energy should be stored in the form of Kinetic Energy.

$\Rightarrow K.E = \frac{1}{2} m_p v_p^2 = 8.01 \times 10^{-16}$

$\Rightarrow v_p^2 = + \sqrt{\frac{8.01 \times 10^{-16} \times 2}{1832 \times 9.11 \times 10^{-31}}}$ $\quad \because m_e = 9.11 \times 10^{-31}$ kg.

$= 979.736$ Km/sec. $= 7.797 \times 10^5$ m/sec.

3. $V = 20$ KV.

Energy $= (20 \times 10^3 \times 1.602 \times 10^{-19})$ J.

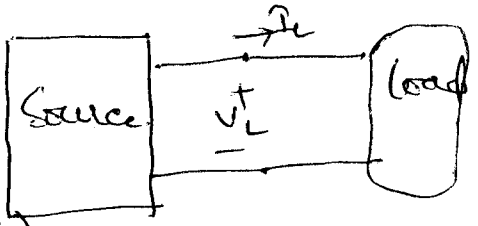
$= 3.204 \times 10^{-15}$ J.

$\Rightarrow K.E = \frac{1}{2} m_e v_e^2 = 3.204 \times 10^{-15}$

$\Rightarrow v_e = + \sqrt{\frac{3.204 \times 10^{-15} \times 2}{9.1066 \times 10^{-31}}} = 83.885 \times 10^6$ m/sec.

4. $V_L = 16 - 4I_L^2$ for $0 \le I_L \le 2$

$= 0$ for $I_L \ge 2$



Power absorbed by load $= (V_L I_L)$

(a) for $I_L = 1A$, $V_L = 16 - 4I_L^2$

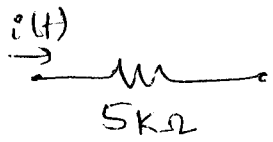
$= 12 \cdot V$

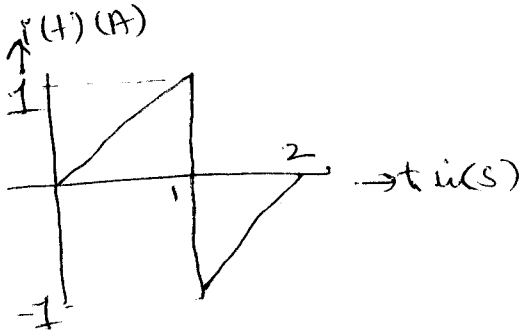
$\Rightarrow P_{ab} = 12 \times 1 = 12W$.

(b) for $I_L = 2A$, $V_L = 0 \cdot V$.

$\Rightarrow P_{ab} = 0(2) = 0W$

5.





(a) $i(t) = t$ for $0 \le t \le 1$

$p(t) = i^2(t) \cdot R$.

$= t^2 \cdot (5 \times 10^3) \cdot W$ for $0 \le t \le 1$

Energy, $E = \int_{-\infty}^{t} p(t)\, dt$

$= \int_{-\infty}^{0} p(t)\, dt + \int_{0}^{t} p(t)\, dt$

$= 0 + \int_{0}^{t} 5 \times 10^3 \cdot t^2 \cdot dt$ for $0 \le t \le 1$

$= \left\{ \frac{5 \times 10^3}{3} \times t^3 \right|_0^1 = \frac{5 \times 10^3}{3}$ J.

By Symmetry, $E|_0^1 = E|_1^2$

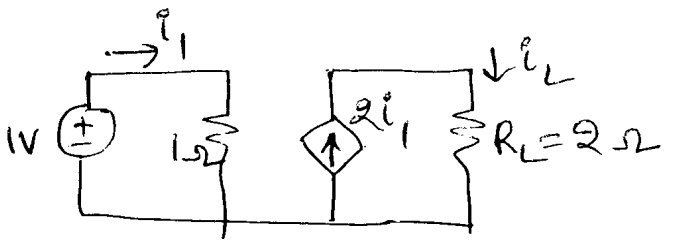
$\Rightarrow$ Total Energy, for $0 \le t \le 2$,

$E = 2 \times E|_0^1 = \frac{2 \times 5 \times 10^3}{3} = \frac{10^4}{3}$ J.

(b) By symmetry, as Area under $i(t)\Big|_0^1$ = Area under $i(t)\Big|_1^2$ ③

$\Rightarrow$ Total charge transferred = 0. for $0 \le t \le 2$.

6.

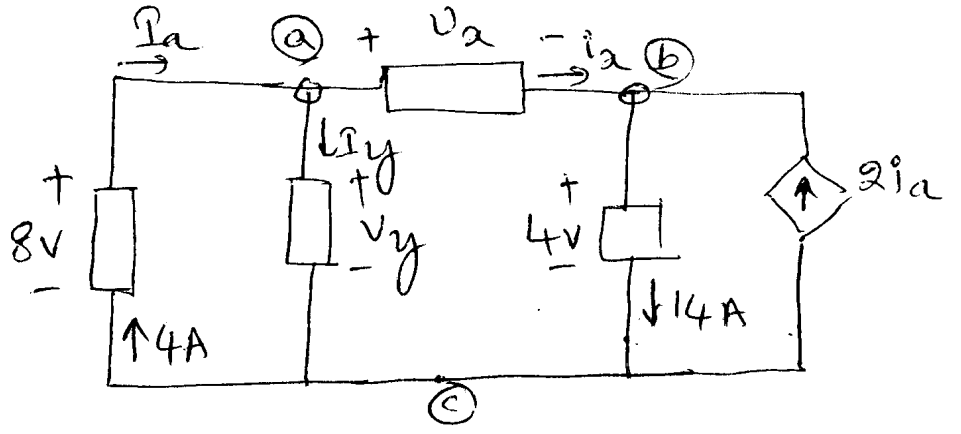


$\Rightarrow i_1 = \frac{1}{1} = 1A;$

$\Rightarrow i_L = 2i_1 = 2A.$ $\Rightarrow$ P-absorbed by $R_L = i_L^2 R$

$= 4 \times 2 = 8W.$

7.



$I_a = 4A;$ $\Rightarrow 2i_a = 8A;$

By applying KCL @ node b;

$14 - 2i_a - i_x = 0$

$\Rightarrow i_x = -14 + 2i_a$

$= -14 + 8 = -6A.$ ——— ①

By applying KCL @ node a;

$-I_a + I_y + i_x = 0.$

$\Rightarrow I_y = I_a - i_x$

$= 4 + 6 = 10A.$ ——— ②.

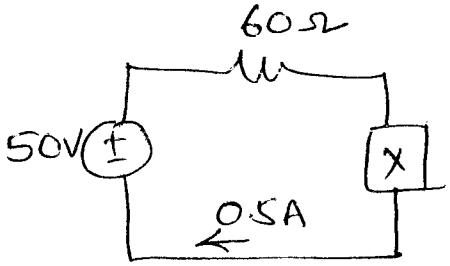
By applying KVL thro' 8V element and v_y,

$$v_y = 8V \quad \text{---(3)}$$

By applying KVL thro' v_y, v_2 and 4V,

$$v_2 = v_y - 4$$
$$= 8 - 4$$
$$= 4V \quad \text{---(4)}$$

8.

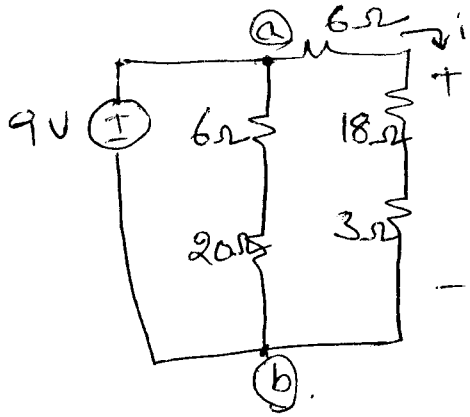


Power delivered by 50V
$= 50 \times 0.5$
$= 25W$

Power absorbed by $60\Omega = 0.5^2 \times 60$
$= 15W$.

⇒ Power absorbed by X = Power delivered by 50V
− Power absorbed by 60Ω
$= 25 - 15$
$= 10W$.

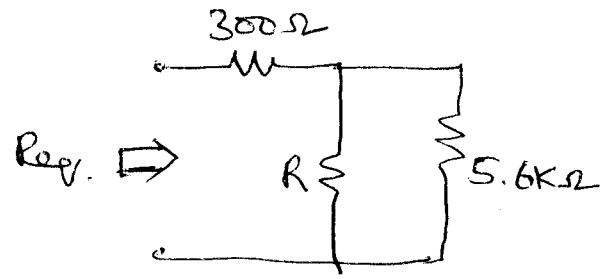
9.



$$i_x = \frac{9}{(6+18+3)} \cdot A.$$
$$= \frac{1}{3} A.$$
$$\Rightarrow v_x = i_x (18+3)$$
$$= 7 \cdot V$$

10.

(a)



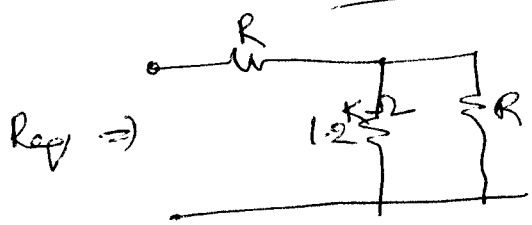
$$R_{eq} = [5.6\times10^3 \,||\, R] + 300 \quad ; \; R_{eq} = 1000\,\Omega$$

$$700 = \frac{5.6\times10^3 \times R}{R + 5.6\times10^3}$$

$$\Rightarrow 700R + 700\times5.6\times10^3 = 5.6\times10^3 \times R$$

$$\Rightarrow R = 800\,\Omega$$

(b)



$R_{eq} = 1000\,\Omega$.

$$R_{eq} = (1.2K \,||\, R) + R$$

$$\Rightarrow \frac{1.2\times10^3 \times R}{1.2\times10^3 + R} + R = 1000$$

$$\Rightarrow R^2 + 2.4\times10^3 R - 1000 = 0$$

$$R = \frac{-2.4\times10^3 \pm \sqrt{(2.4\times10^3)^2 + 4\times1000}}{2}$$

$$=$$

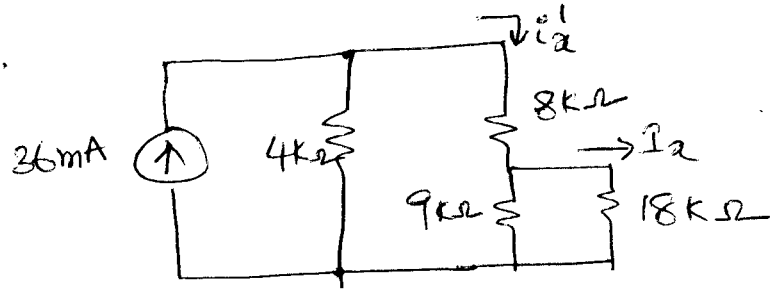
$$R^2 + 2.4\times10^3 R - 1000(1.2\times10^3 + R) = 0$$

$$\Rightarrow R^2 + 1.4\times10^3 R - 1.2\times10^6 = 0$$

$$\Rightarrow R = \frac{-1.4\times10^3 \pm \sqrt{(1.4\times10^3)^2 + 4\times1.2\times10^6}}{2}$$

$$= \left(\frac{1.4 + 2.6}{2}\right)\times10^3 = 600\,\Omega$$

11.



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Combination of 8K, 9K & 18KΩ will give

$$(9K \,||\, 18K) + 8K = \left(\frac{9\times18}{9+18} + 8\right) K\Omega$$

$$= 14\,K\Omega$$

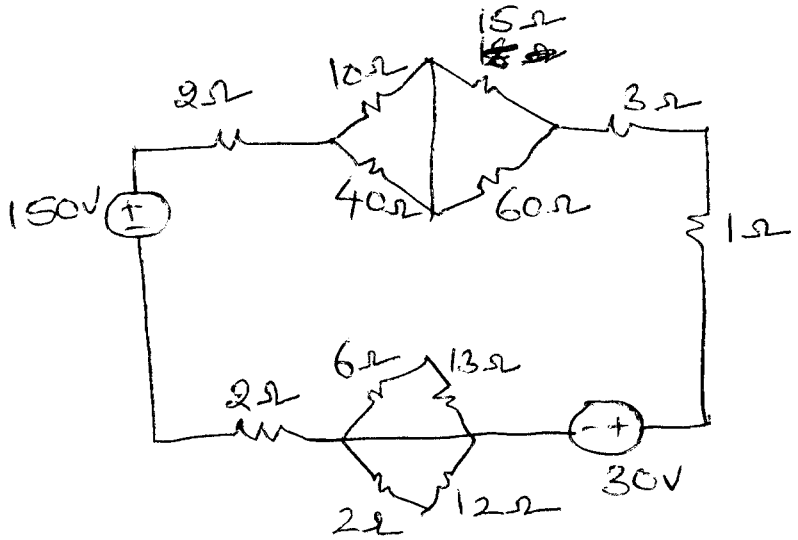
By current Division Rule,

$$i_a' = \frac{36\times10^{-3} \times 4\times10^{3}}{(4\times10^{3} + 14\times10^{3})} = 8\,mA$$

Again by current Division Rule,

$$I_a = i_a' \left(\frac{9}{9+18}\right) = 8\left(\frac{9}{27}\right) = \frac{8}{3}\,mA$$

12.



Combination of 6Ω, 13Ω, 2Ω & 12Ω need not be considered as they are short circuited.

Combination of 10Ω, 15Ω, 40Ω & 60Ω will give $(10||40 + 15||60)\,\Omega = \frac{10\times40}{10+40} + \frac{15\times60}{15+60}$

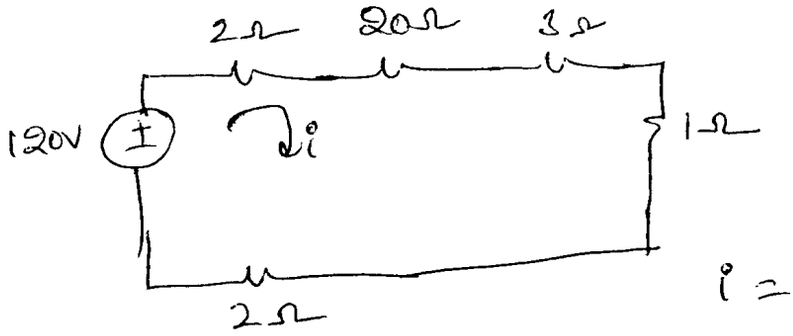
$= 8 + 12$

$= 20\,\Omega$.

After source Combination of 150V & 30V still give

$150 - 30 = 120V$.

⇒ Circuit will become.



$i = \frac{120}{28}$

$= \frac{30}{7}$ A.

⇒ Power absorbed by $1\Omega = i^2 \times R$

$= \left(\frac{30}{7}\right)^2 \times 1 = \underline{\frac{900}{49}}$ W

By current Division, current flowing through 10Ω,

$= i \times \frac{40}{10+40} = \frac{24}{7}$ A.

Power absorbed by $10\Omega = \left(\frac{24}{7}\right)^2 \times 10$

$= \underline{1.17\ KW}$.

Power absorbed by $13\Omega = 0$ [∵ No current is flowing thro'].

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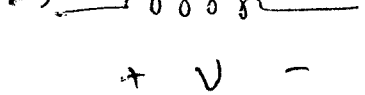
13.



$i = 80t\,e^{-100t}$. m.A. for $t > 0$.

$L = 50\,mH$.

to find $t_{i_{max}}$

$$i(t) = 80t\,e^{-100t} \text{ .mA}$$

$$\frac{di}{dt}(t) = 80\,t\,(-100)e^{-100t} + 80\,e^{-100t} = 0.$$

$\Rightarrow$ ~~$t = 100$~~ $t = 0.01$ sec.

$\Rightarrow$ ~~t~~

$\Rightarrow t_{i_{max}} = 0.01$ sec

$$\Rightarrow I_{max} = 80t\,e^{-100t}\Big|_{t=0.01} = 0.2943 \text{ A}.$$

to find $t_{v_{max}}$:

$$v(t) = L\frac{di}{dt}$$

$$= 50\times10^{-3}\left(80e^{-100t} - 8000t\,e^{-100t}\right)$$

$$\frac{dv(t)}{dt}\Big|_{t_{v_{max}}} = 0$$

$$\Rightarrow -100e^{-100t} - 100\left(e^{-100t} + t(100)e^{-100t}\right) = 0$$

$$\Rightarrow +1 + (1 - 100t) = 0$$

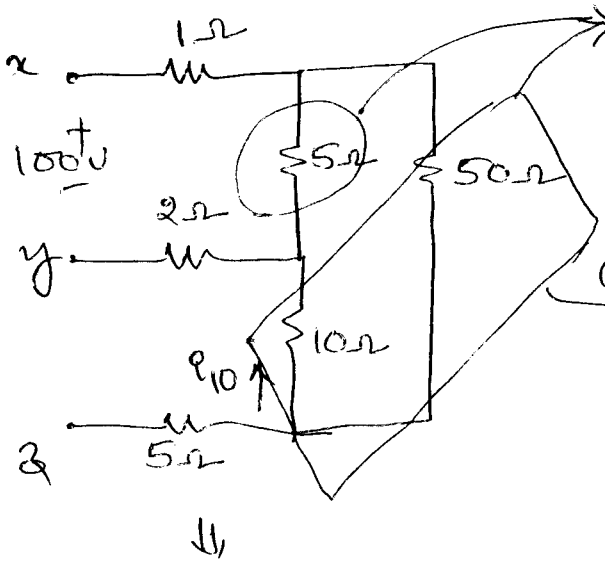
$$\Rightarrow t = \frac{2}{100} = \underline{0.02 \text{ sec}}.$$

$t_{v_{max}} = 0.02$ sec.

$$\Rightarrow V_{max} = 50\times10^{-3}\left(80e^{-100t} - 8000t\,e^{-100t}\right)\Big|_{t=0.02}$$

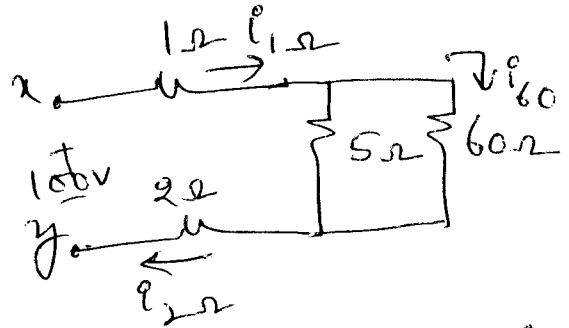
$$= -0.541 \Rightarrow |V_{max}| = \underline{0.541\,V}$$

14.



$V_{yz} = ?$ Connected in parallel.

Connected in series as thro' 5Ω no current will flow.



$$i_{1\Omega} = \frac{100}{5\|60 + 1 + 2}$$

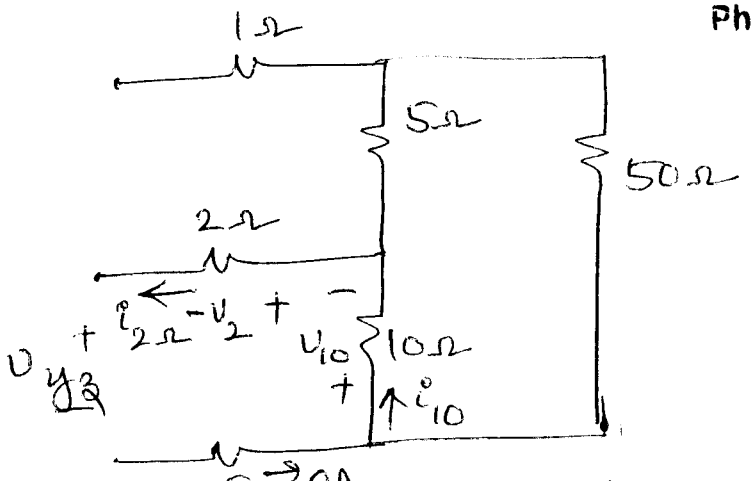
$$= 13.13\ A.$$

$$i_{60\Omega} = \frac{i_1 \times 5}{5+60} \qquad i_{2\Omega} = i_{1\Omega} = 13.13\ A.$$

$$= 1.0101\ A.$$

$$\Rightarrow i_{10} = 1.0101\ A.$$

⇒ Ckt will become

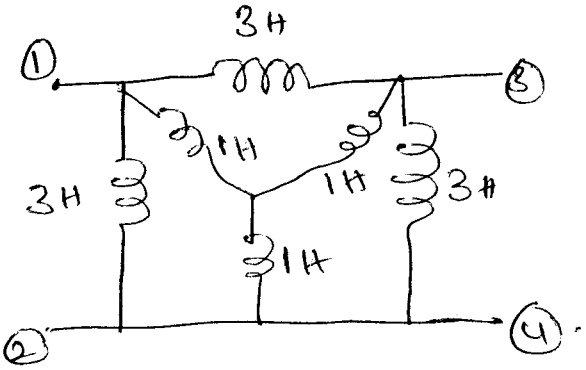


Applying KVL thro' V_{yz}, V_2 & V_{10}

$$V_{yz} = -V_2 - V_{10}$$

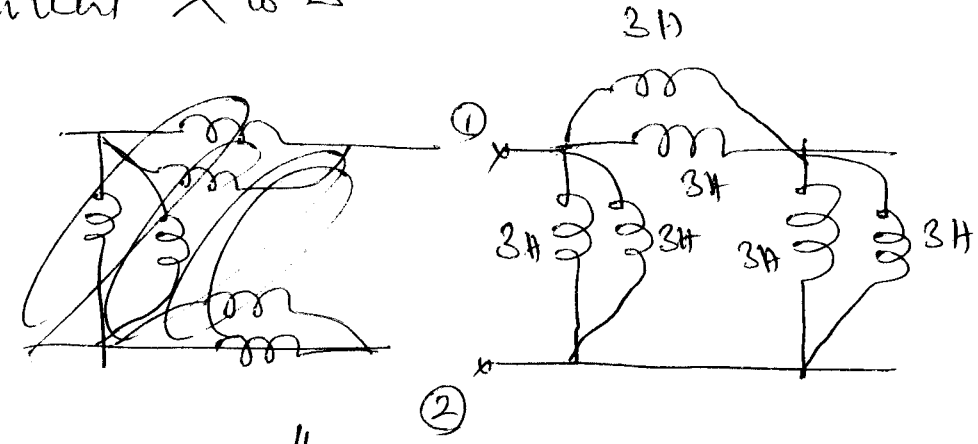
$$= -2 \times i_{2\Omega} - 10 \times i_{10} = -36.361\ V.$$

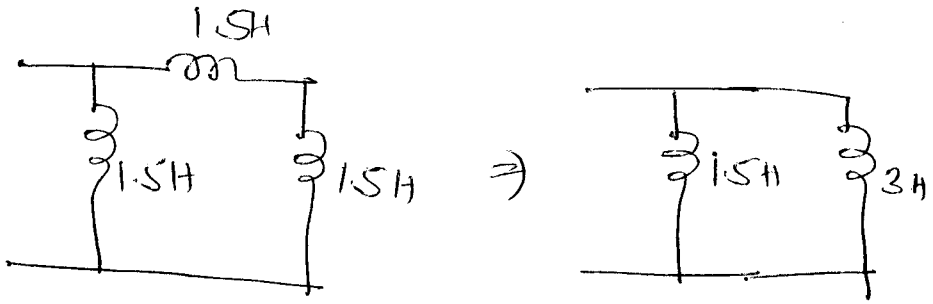
15.

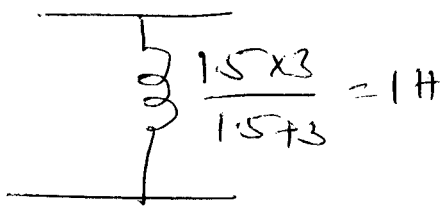


$L_{eq} \Rightarrow$

Convert $\curlywedge$ to Δ







$\Rightarrow L_{eq} = 1H$

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