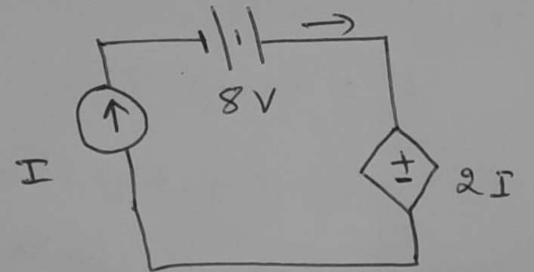
Objective type Questions - gate questions

Ex: For circuit diagram shown in fig, determine the power absorbed by the independent voltage source and dependent voltage source for $I = 4A$, $5mA$, $-3A$.



Solution: (P_1) $P_{\text{independent source}} = VI = -8I$

The negative power indicates that it is producing power (delivering) instead of absorb

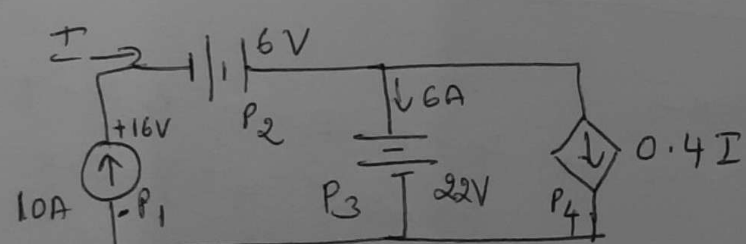
(P_2) $P_{\text{dependent source}} = VI = 2I\,I = 2I^2$

(i) $I = 4A$, $P_1 = -32W$, $P_2 = 32W$

$I = 5mA$, $P_1 = -40W$, $P_2 = 50\mu W$

$I = -3A$, $P_1 = 24W$, $P_2 = 18W$

Ex. Calculate the power absorbed by each component in the circuit shown



Solution: $P_1 = -10 \times 16 = -160W$ → negative indicates delivering power to other components in the circuit.

$$P_2 = -6 \times 10 = -60\,W$$

$$P_3 = 12 \times 6 = 132\,W$$

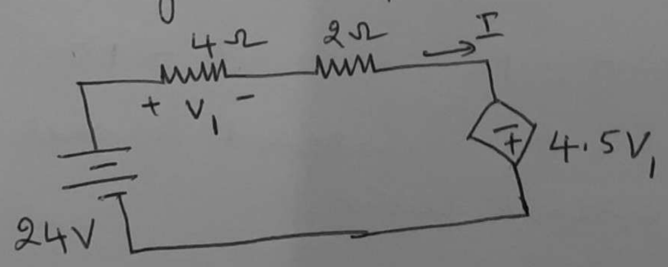
$$P_4 = 0.4\,(10)\,22 = 88\,W$$

dependent source provides a current of $(0.4)(10) = 4A$. This current flows into the positive terminal. Since this source also has 22V positive at the top $\therefore P_4 = 22(4) = 88W$

$$P_1 + P_2 + P_3 + P_4 = -160 - 60 + 132 + 88 = 0W$$

The sum of 0W indicates that the power absorbed by components is equal to the power delivered. This result is true for every ckt.

Ex: For the circuit shown, calculate I and the power absorbed by the dependent source



Solution:

$V_1 = 4I$

Apply KVL $\rightarrow$ $4I + 2I - 4.5V_1 = 24$

$$6I - 4.5(4I) = 24$$

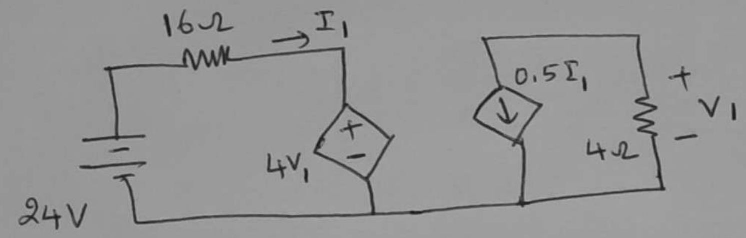
$$I = -\frac{24}{12} = -2A$$

$$P_{dependent} = -4.5\,V_1\,I$$

$$P = 4.5(4I).I = 4.5(4)(-2)(-2) = -72W$$

Objective-type

Ex: Find V_1 in the circuit of Fig shown



Solution. $V_1 = -0.5I_1(4) = -2I_1$ — (1)

Apply KVL to mesh 1

$$16I_1 + 4V_1 = 24 \quad \text{— (2)}$$

Sub (1) in sub (2)

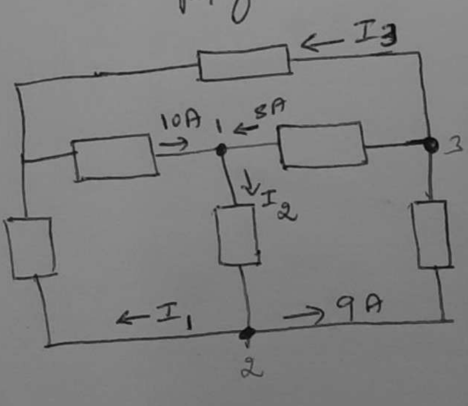
$$16I_1 + 4(-2I_1) = 24$$

$$8I_1 = 24$$

$$I_1 = 3A$$

$$\therefore V_1 = -2(3) = -6V$$

Ex: Find the unknown currents in the circuit shown in Fig



Solution: KCL at node 1

$$I_2 = 10 + 8 = 18A$$

At node 2

$$I_2 = I_1 + 9$$

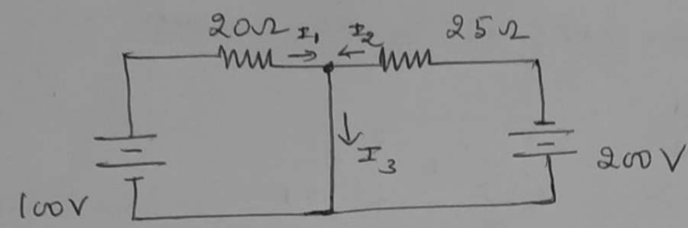
$$I_1 = I_2 - 9 = 18 - 9 = 9A$$

At 3

$$I_3 + 8 = 9$$

$$I_3 = 9 - 8 = 1A$$

Ex: Find the current I_3 for the circuit shown in fig

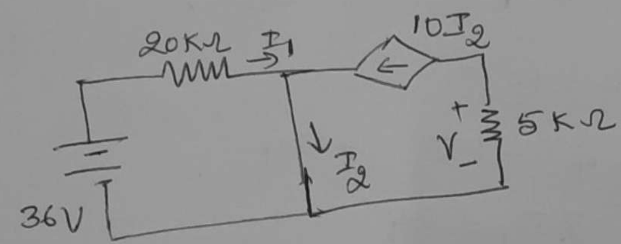


Solution:

$$I_1 = \frac{100}{20} = 5A , \quad I_2 = -\frac{200}{25} = -8A$$

$$I_3 = I_1 + I_2 = 5 - 8 = -3A$$

Ex: calculate V in the circuit of fig



Solution:

$$V = 5K(10 I_2)$$

$$I_2 = I_1 + 10 I_2$$

$$I_1 = \frac{36}{20K} = 1.8mA$$

$$I_2 - 10 I_2 = I_1$$

$$-9I_2 = 1.8m$$

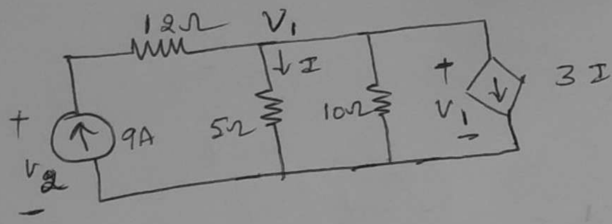
$$I_2 = -\frac{1.8m}{9} = -0.2mA$$

$$V = 5K(10)(-0.2m)$$

$$V = 10V$$

$$\boxed{V = 10V}$$

Ex: calculate V_1 and V_2 in the circuit



Solution: KCL at V_1

$$\frac{V_1}{5} + \frac{V_1}{10} + 3I = 9$$

$$I = V_1/5$$

$$\frac{V_1}{5} + \frac{V_1}{10} + 3\left(\frac{V_1}{5}\right) = 9$$

$$V_1\left(\frac{1}{5} + \frac{1}{10} + 3/5\right) = 9$$

$$V_1 = 10V$$

KCL at V_1 w.r.t V_2

$$\frac{V_1 - V_2}{12} + \frac{V_1}{5} + \frac{V_1}{10} + 3I = 0$$

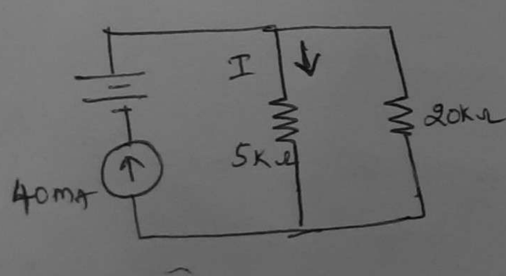
$$\frac{V_1 - V_2}{12} + \frac{V_1}{5} + \frac{V_1}{10} + 3\left(\frac{V_1}{5}\right) = 0$$

$$V_1\left(\frac{1}{12} + \frac{1}{5} + \frac{1}{10} + 3/5\right) = V_2/12$$

$$10\left(\frac{1}{12} + \frac{1}{5} + \frac{1}{10} + 3/5\right) = V_2/12$$

$$V_2 = 118V$$

EX: Calculate I in the circuit of fig shown



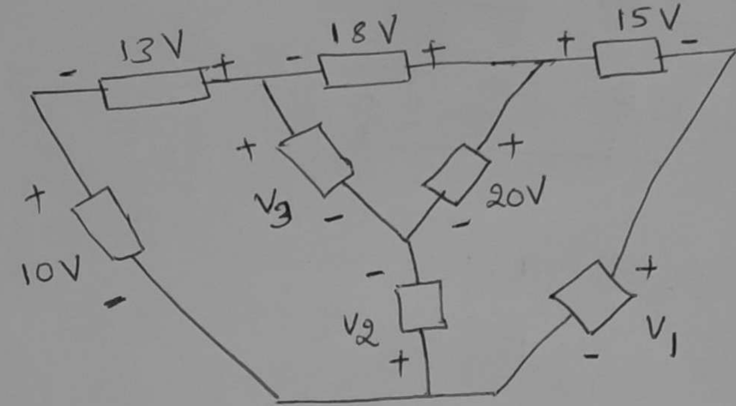
Solution:

By current division,

$$I = \frac{20K \times 40mA}{5K + 20K}$$

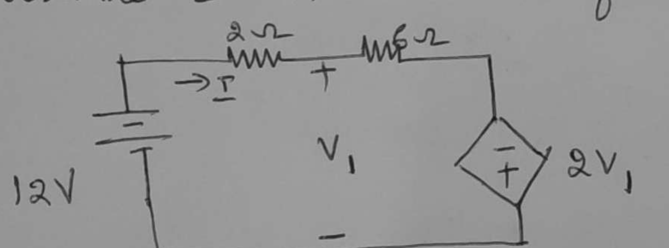
$$I = 32mA$$

Ex: Find V_1, V_2 and V_3 for the circuit shown in fig



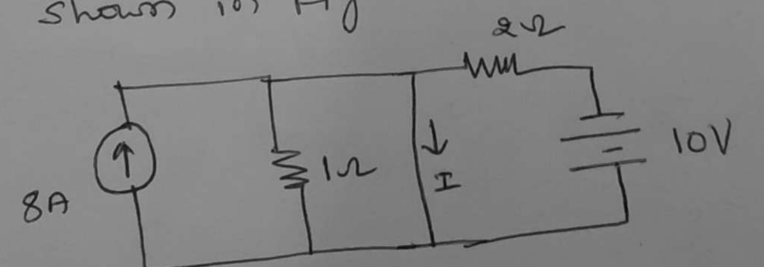
Ans: $V_1 = 26V$, $V_2 = -21V$, $V_3 = 2V$

Ex: Determine I in the circuit of shown in figure



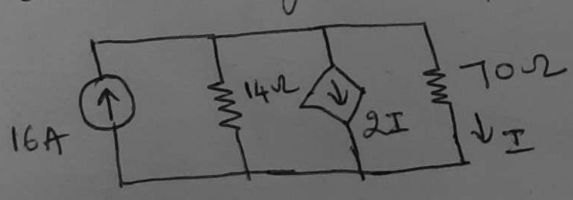
Ans: $I = 3A$

Ex: Find the short circuit current I in the circuit shown in fig



Ans: $I = 3A$

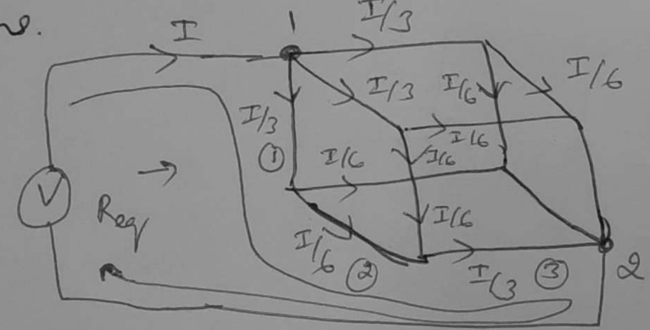
Ex: In the circuit of fig, calculate I and also the power absorbed by the dependent source.



Ans: 2A, 560W

Ex: Twelve 1Ω resistances are used to form a cube. The resistance between two diagonally opposite corners of the cube is $\underline{5/6}$

Ans.



KVL

$$V = \frac{I}{3} \cdot R + \frac{I}{6} \cdot R + \frac{I}{3} \cdot R$$

$$V = \left(\frac{R}{3} + \frac{R}{6} + \frac{R}{3}\right) I$$

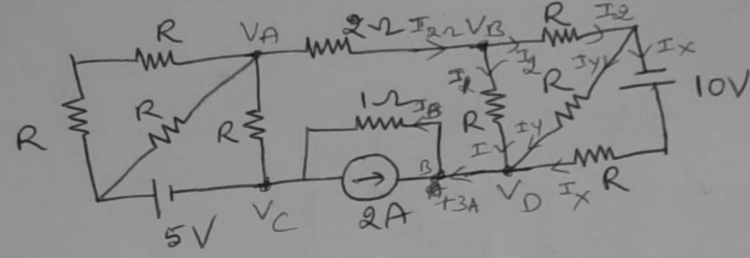
$$R_{eq} = \frac{V}{I} = \frac{2R}{6} + \frac{R}{6} + \frac{2R}{6}$$

$$R_{eq} = \frac{5R}{6}\ \Omega$$

If $R = 1\Omega$, the $R_{eq} = \underline{\underline{5/6}}\ \Omega$

Ex: If $R_1 = R_2 = R_4 = R$ and $R_3 = 1.1R$ in the bridge circuit shown in fig, then the reading in the ideal voltmeter ~~connect~~ connected between a and b is $\underline{-0.238}$ V

Ex: If $V_A - V_B = 6V$, then $V_C - V_D$ is



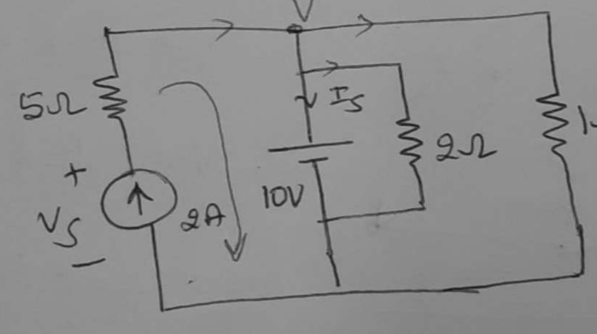
Solution: $I_{2\Omega} = \frac{6}{2} = 3A$ $\quad V_A - V_B = 6$

Kcl at B $\quad I_B = 2 + 3 = 5A$

$V_C - V_D = -(I \times 1\Omega)$

$V_C - V_D = -5 \times 1 = -5V$

Ex: The circuit shown, find I_S, V_S and current in the 1Ω resistor



Solution: Kcl at V $\quad$ But $V = 10$

$-2 + I_S + \frac{V}{2} + \frac{V}{1} = 0$

$-2 + I_S + 5 + 10 = 0$

$I_S + 13 = 0$

$\boxed{I_S = -13A}$

KVL: $-V_S + 5 \times 2 + 10 = 0$

$-V_S + 10 + 10 = 0$

$\boxed{V_S = 20V}$

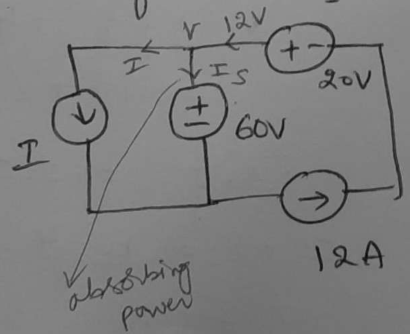
Current in 1Ω resistor

$I_{1\Omega} = \frac{V}{1}$

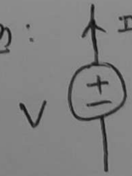
$= \frac{10}{1} = 10A$

$V = 5 - 2.2$

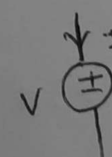
Ex: In the interconnection of ideal sources shown in fig it is known that the 60V source is absorbing power. Which of the foll can be the value of the current source I



Solution:

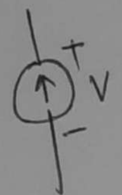


$P = VI \rightarrow$ delivering power

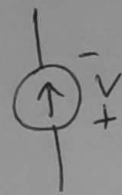


$P = VI \rightarrow$ absorbed

depends on direction of current



current source delivered power



current source absorbing power

KCL at V

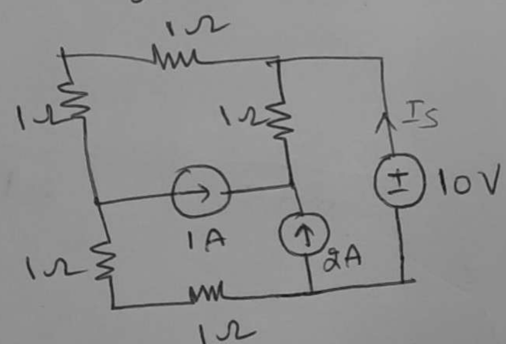
$$I + I_S = 12$$

$$I = 12 - I_S$$

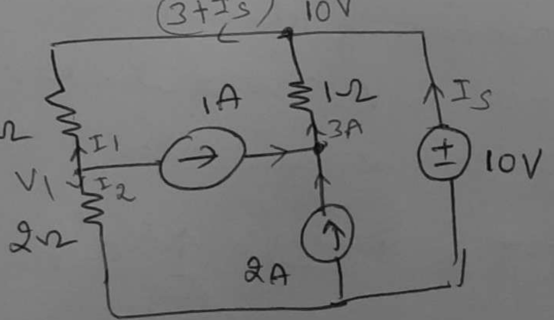
or $I_S = 12 - I$ To get $I_S = +ve$ → Absorbing power

$$\boxed{I < 12A}$$

Ex: In the circuit shown, the power supplied by the voltage source is ______



Solution : $P_{10V} = 10 \cdot I_S$



KCL at V_1

$$\frac{V_1 - 10}{2} + 1 + \frac{V_1}{2} = 0$$

$$V_1\left(\frac{1}{2} + \frac{1}{2}\right) = 4$$

$$V_1 = 4V$$

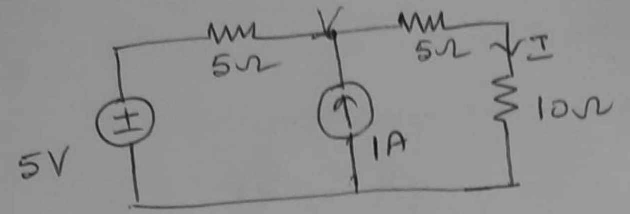
$$(3 + I_S) = \frac{10 - V_1}{2}$$

$$3 + I_S = \frac{10 - 4}{2} = 3$$

$$I_S = 0A$$

$P_{10V} = 10(0) = \underline{0W}$

Ex: In the fig, the value of the current I is ___



Solution: KCL at V

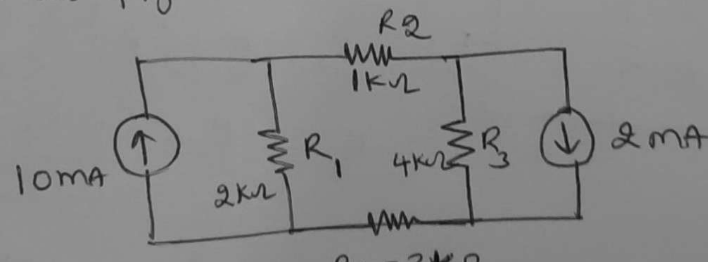
$$\frac{V-5}{5} + \frac{V}{15} - 1 = 0$$

$$V\left(\frac{1}{5} + \frac{1}{15}\right) = 2$$

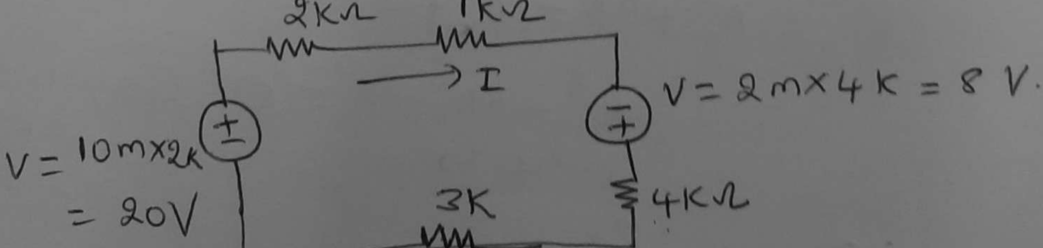
$$V = 7.5\,V$$

$$I = \frac{V}{5+10} = \frac{V}{15} = \frac{7.5}{15} = 0.5\,A$$

Ex: The magnitude of current (in mA) thro' the resistor R_2 in the fig shown is

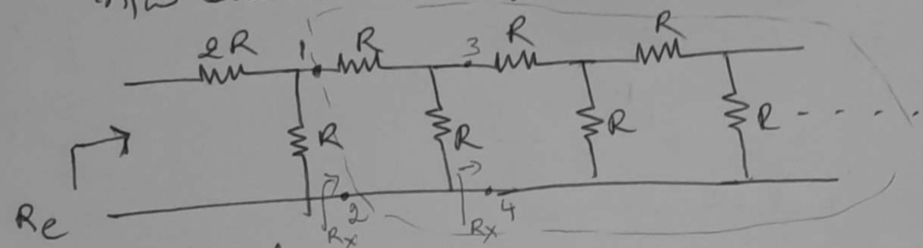


Solution: Source transformation technique



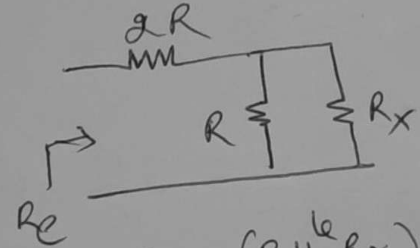
$$I = \frac{8+20}{10} = 2.8\,mA$$

Ex: The equivalent resistance in the infinite ladder n/w shown in the figure R_e

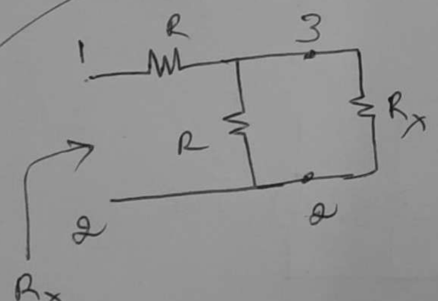


The value of $\frac{R_e}{R}$ is ____

Solution.



$$R_e = (R \parallel R_x) + 2R$$



$$R_x = R + (R \parallel R_x)$$

$$R_x = R + \frac{(R.R_x)}{R+R_x}$$

$$= \frac{R^2 + RR_x + RR_x}{R+R_x}$$

$$R_x^2 + RR_x = R^2 + 2RR_x$$

$$R_x^2 - RR_x - R^2 = 0$$

$$ax^2 + bx + c = 0$$

$a = 1$, $b = -R$, $c = -R^2$

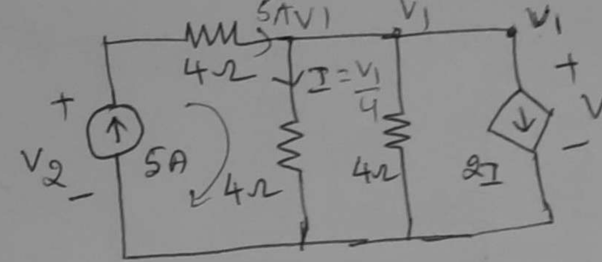
$$R_x = \frac{R + \sqrt{R^2 + 4R^2}}{2} = \frac{R + \sqrt{5R^2}}{2}$$

$$R_x = \frac{R \pm \sqrt{5} \times R}{2} = \frac{R + \sqrt{5}R}{2} = \frac{1+\sqrt{5}}{2} \cdot R = 1.62R$$

$$R_e = \frac{R \times 1.62R}{R + 1.62R} + 2R = 2.618R \Rightarrow \frac{R_e}{R} = 2.618$$

*6

Ex: In the given ckt, the values of V_1 & V_2 are —



Solution. $\boxed{5V, 25V}$

KCl at V_1

$$-5 + \frac{V_1}{4} + \frac{V_1}{4} + 2I = 0$$

But $I = \frac{V_1}{4}$

$$-5 + \frac{V_1}{4} + \frac{V_1}{4} + 2\left(\frac{V_1}{4}\right) = 0$$

$$V_1 = 5\,V$$

$$I = \frac{V_1}{4} = \frac{5}{4}\,A$$

Apply KVL to mesh 1

$$4 \times 5 + 4I = V_2$$

$$20 + 4\left(\frac{5}{4}\right) = V_2$$

$$V_2 = 25\,V$$

Ex: In the circuit shown, the voltage V_x (in volts) is —

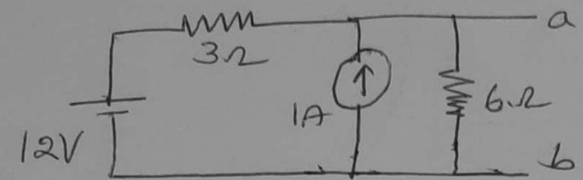
Solution: KCl at V_x

$$-5 + 0.5V_x + \frac{V_x}{20} + \frac{V_x - 0.25V_x}{10} = 0$$

$$5 = 0.5V_x + \frac{V_x}{20} + 0.075V_x$$

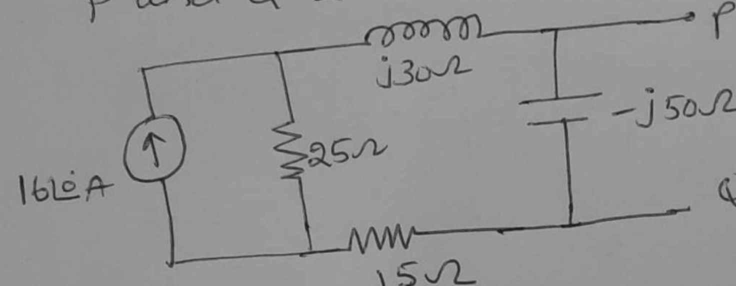
$$V_x = 8 \text{ Volts}$$

Ex: For the circuit shown in the figure, the Thevenin equivalent V_g (in volts) across terminal a-b is



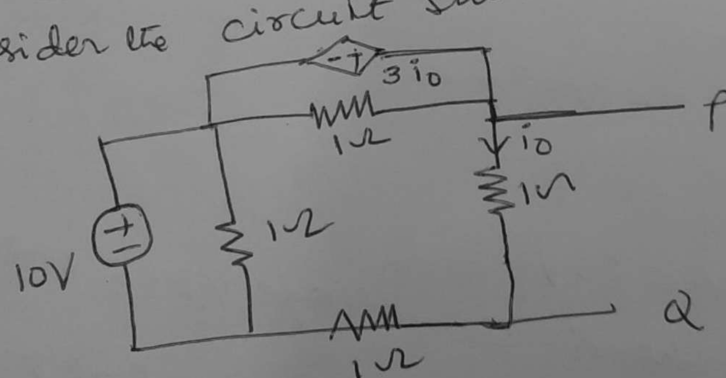
solution: $V_{Th} = 10V$

Ex: In the circuit shown below, the Norton equivalent current in amperes with respect to terminals P and Q is



Ans: $(6.4 - j4.8)A$

Ex: consider the circuit shown in the fig



The Thevenin equivalent resistance across P-Q is ____

Ans: 1Ω