L3-BET-27Oct2021-Teams6-7

23 October 2021 16:35

Illustration 1

Two incandescent bulbs have the following ratings:

Bulb-1: 120 V, 60 W **Bulb-2:** 240 V, 480 W

a) Both of them are connected in series across a voltage source.
   i. Which bulb will glow brighter and why?
   ii. What is the maximum voltage that can be applied so that none of the bulbs fuse?

b) Now both of them are connected in parallel across a voltage source.
   i. Which bulb will glow brighter and why?
   ii. What is the maximum voltage that can be applied so that none of the bulbs fuse?

Assume that the incandescent bulbs are purely resistive.

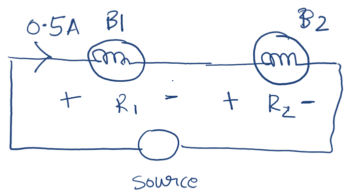
$P = VI$

$P = I^2 R$

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

	Bulb 1 : 120V, 60W	Bulb 2: 240V, 480W
	$I_{r1} = \frac{P_{r1}}{V_{r1}} = \frac{60}{120} = 0.5A$	$I_{r2} = \frac{P_{r2}}{V_{r2}} = \frac{480}{240} = 2A$
	$R_1 = \frac{V_{r1}^2}{P_{r1}} = \frac{120^2}{60} = 240\Omega$	$R_2 = \frac{V_{r2}^2}{P_{r2}} = 120\Omega$
	or $R_1 = \frac{P_{r1}}{I_{r1}^2} = \frac{60}{(0.5)^2} = 240\Omega$	or $R_2 = \frac{P_{r2}}{I_{r2}^2} = \frac{480}{(2)^2} = 120\Omega$

(a) Series Connection



max. current permitted = 0.5A

$P_1 = (0.5)^2 \times R_1 = (0.5)^2 \times 240 = 60W$

$P_2 = (0.5)^2 \times R_2 = (0.5)^2 \times 120 = 30W$

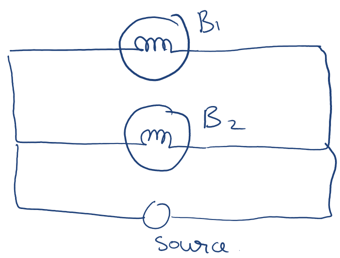
(i) $\because$ $P_1 > P_2$, B1 will glow brighter

(ii) $V_{Total} = (0.5 * R_1) + (0.5 * R_2)$

$= (0.5 * 240) + (0.5 * 120)$

$= 180$ Volts

(b) Parallel Connection



(ii) → max. voltage permitted = 120V → rating of B_1

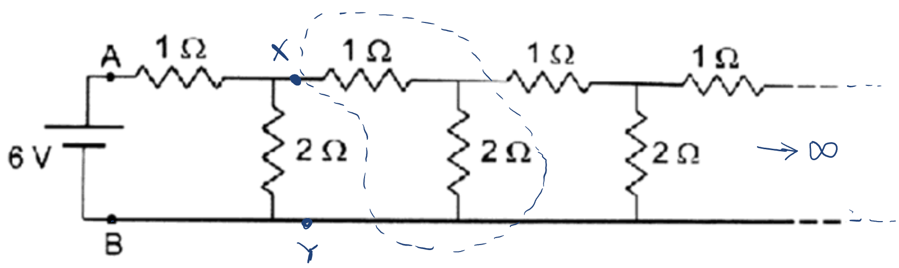
$P_1 = \frac{120^2}{240} = 60W$

$P_2 = \frac{120^2}{120} = 120W$

(i) → $\because$ $P_2 > P_1$, B2 will glow brighter

Illustration 2

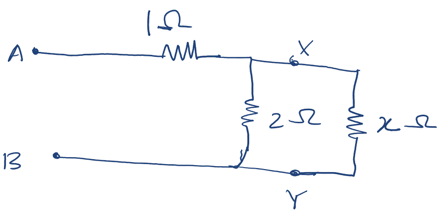
What is the equivalent resistance across the terminals A & B in the network shown?



Let $R_{AB} = x\ \Omega$

Then $R_{XY} = x\ \Omega$

Replace the circuit XY onwards with $x\ \Omega$



$R_{AB} = 1\Omega$ in series with $(2 \parallel x)\ \Omega$

$R_{AB} = 1 + \frac{2x}{2+x}$

$$x = \frac{2+x}{1+\frac{2x}{2+x}} \quad \text{or} \quad x^2 - x - 2 = 0$$

$$x^2 - 2x + x - 2 = 0 \quad \text{or} \quad \underline{x = 2} \quad \text{and } x = -1 \rightarrow \times \text{ Neglected}$$

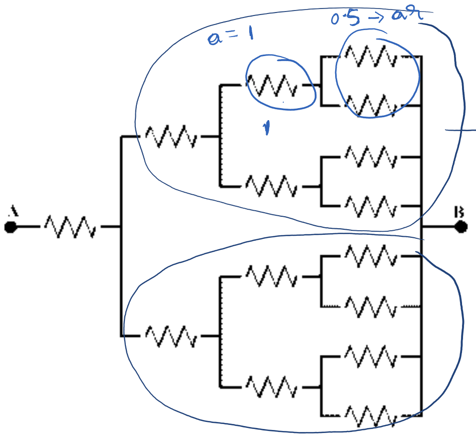
$$\boxed{R_{AB} = x\,\Omega = 2\,\Omega}$$

Illustration 3

15 resistors are connected as shown in the diagram. Each of the resistors has resistance 1 Ω.

a) Find the equivalent resistance of the network between A & B.

b) What will be the equivalent resistance of this network if the resistors arranged in the sequence extends to infinity?



$$\frac{ar}{a} = \frac{0.5}{1} = 0.5 = r$$

$$① \; \left[(1\|1 + 1) \,\|\, (1\|1 + 1) \right] + 1$$

0.5 → 1.5, 0.5 → 1.5 → 0.75 → 1.75

$$② \; \left[(1\|1 + 1) \,\|\, (1\|1 + 1) \right] + 1$$

→ 1.75

$$\{ ① \,\|\, ② \} + 1$$

→ 0.875 + 1

$$\boxed{R_{AB} = 1.875\,\Omega} \quad \text{(i)}$$

Geometric Sequence or progression

$a, ar, ar^2, ar^3, \ldots\ldots ar^{n-1}$

1st term = a

n^{th} term = $a\,r^{n-1}$

Sum of n terms = $\frac{a(1-r^n)}{1-r}$

Sum up to ∞

$$S_\infty = \frac{a}{1-r}$$

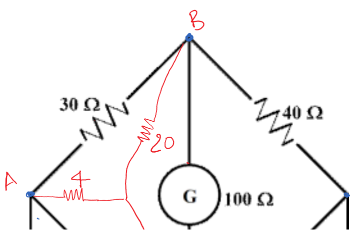
Here, $a = 1$

$r = 1/2$

$$\boxed{S_\infty = \frac{1}{1-1/2} = 2\,\Omega} \quad \text{(ii)}$$

Illustration 4

For the circuit shown, determine the total power supplied by the source using star-delta transformation.

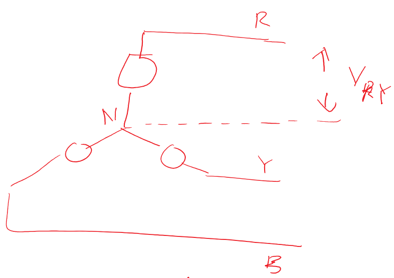


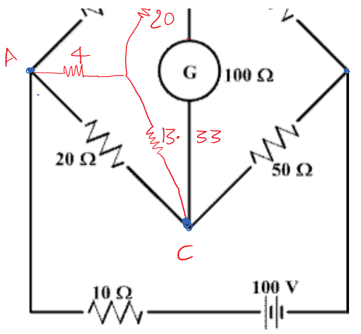
$R_{AB} = 30\,\Omega$

$R_{BC} = 100\,\Omega$

$R_{CA} = 20\,\Omega$

$$R_A = \frac{R_{AB} R_{AC}}{R_{AB} + R_{BC} + R_{CA}} = \frac{30 \times 20}{30 + 100 + 20} = \frac{600}{150} = 4\,\Omega$$

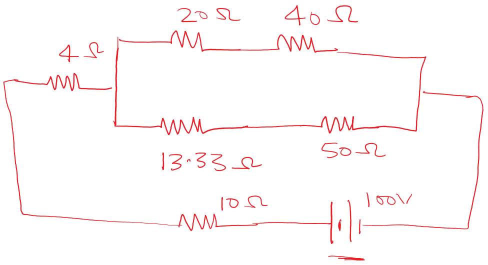




$$R_A = \frac{R_{AB} R_{AC}}{R_{AB}+R_{BC}+R_{CA}} = \frac{30 * 20}{30+100+20} = \frac{600}{150} = 4\ \Omega$$

$$R_B = \frac{R_{AB} * R_{BC}}{R_{AB}+R_{BC}+R_{CA}} = \frac{30 * 100}{150} = 20\ \Omega$$

$$R_C = \frac{R_{CA} * R_{BC}}{R_{AB}+R_B+R_{CA}} = \frac{20 * 100}{150} = 13.33\ \Omega$$



$$R_{Total} = (4 + 10) + \left((20+40) \,||\, (13.33+50)\right)$$

$$\underline{R_{Total}} = 44.8107\ \Omega$$

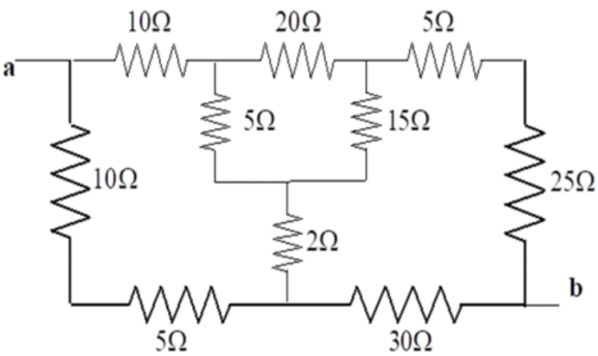
$$P = \frac{V^2}{R} = \frac{100^2}{44.8107} = \underline{223.1608\ \text{Watts}}$$

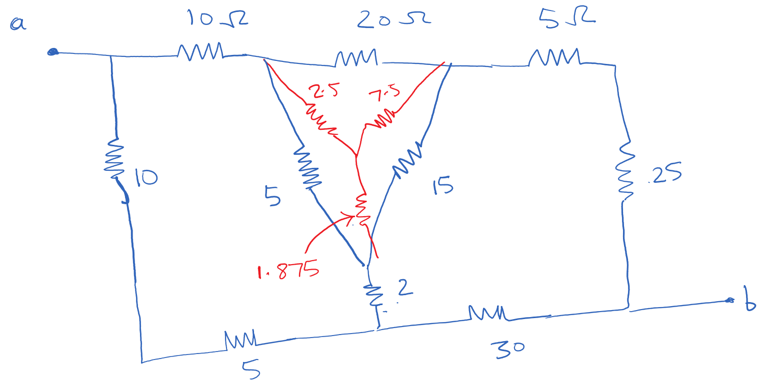
$$= I^2R = \left(\frac{100}{44.8107}\right)^2 * 44.8107 = \underline{223.1608\ W}$$

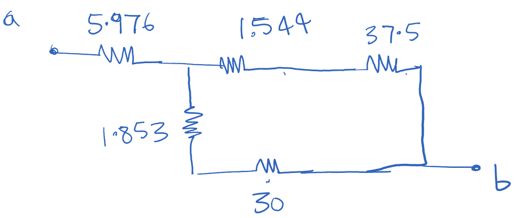
$$= VI = (100) * \left(\frac{100}{44.8107}\right) = \underline{223.1608\ W}$$

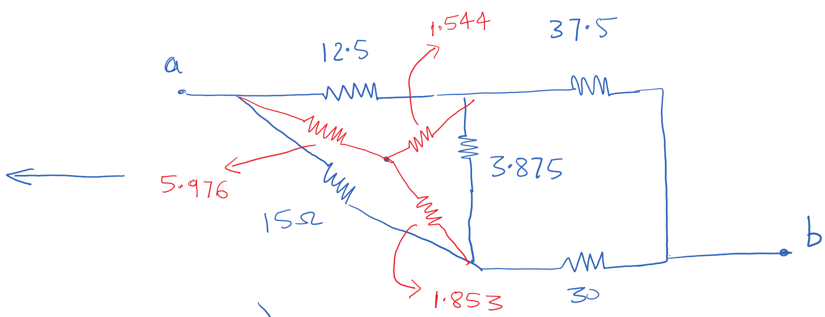
Illustration 5

Determine the resistance between terminals a & b of the network shown in figure, using Star-Delta transformation.









$$R_{ab} = 5.976 + \left((1.544 + 37.5) \,||\, (1.853+30)\right)$$

$$\boxed{R_{ab} = 23.518\ \Omega}$$