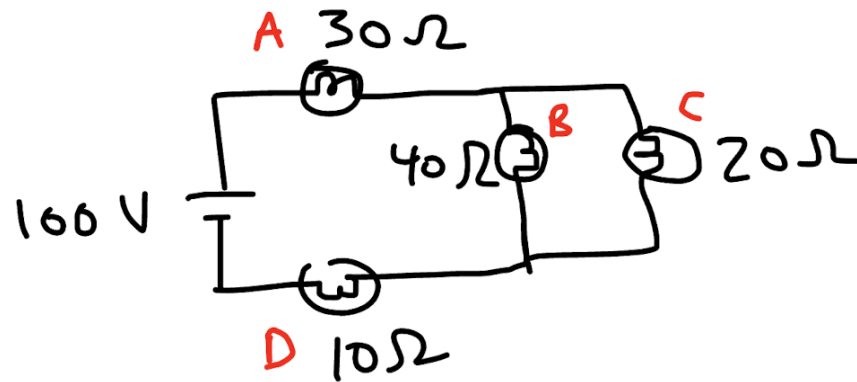


Four bulbs are connected in the circuit below to a 100 V power source.



- a) Determine the power dissipated by each bulb.
- b) Another bulb is connected parallel to bulbs B and C. How does the brightness of each bulb change?

Bulbs A and D are...

brighter                       dimmer                       the same

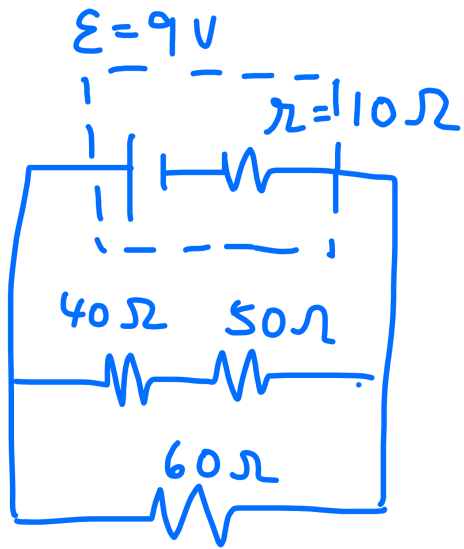
Bulbs B and C are...

brighter                       dimmer                       the same

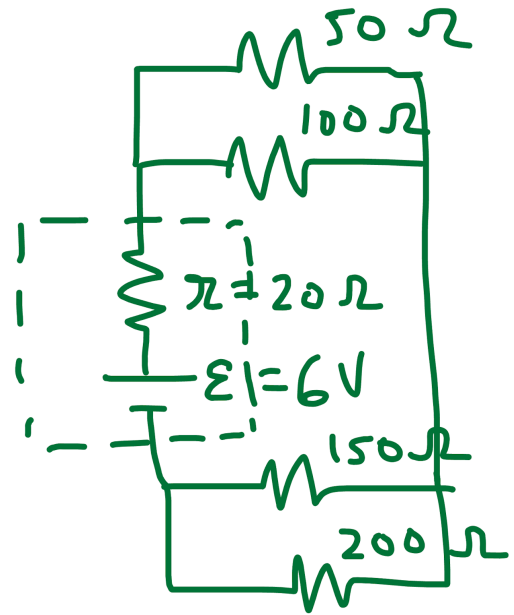
Explain.

Determine the terminal voltage of the battery for each circuit.

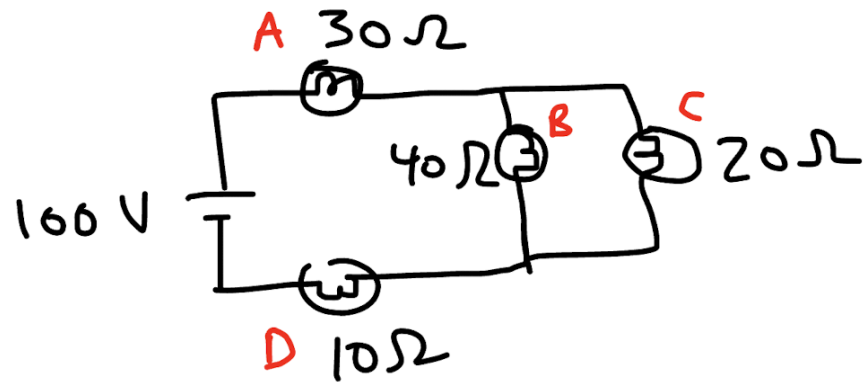
a)



b)



Four bulbs are connected in the circuit below to a 100 V power source.



a) Determine the power dissipated by each bulb.

$$\frac{1}{R_{eq}} = \frac{1}{R_B} + \frac{1}{R_C}$$

$$R_{eq} = \left( \frac{1}{20} + \frac{1}{40} \right)^{-1} = 13.\bar{3} \Omega$$

$$R_T = R_A + R_{eq} + R_D = 30 + 13.\bar{3} + 10 = 53.\bar{3} \Omega$$

$$I_T = \frac{V_T}{R_T} = \frac{100}{53.\bar{3}} = 1.875 \text{ A}$$

$$V_{eq} = I_{eq} R_{eq} = (1.875)(13.\bar{3}) = 25 \text{ V}$$

$$I_T = I_A = I_{eq} = I_D = 1.875 \text{ A}$$

$$V_{eq} = V_B = V_C = 25 \text{ V}$$

$$P_A = I_A^2 R_A = (1.875)^2 (30) = \boxed{105 \text{ W}}$$

$$P_B = \frac{V_B^2}{R_B} = \frac{25^2}{40} = \boxed{15.6 \text{ W}}$$

$$P_C = \frac{V_C^2}{R_C} = \frac{25^2}{20} = \boxed{31.3 \text{ W}}$$

$$P_D = I_D^2 R_D = (1.875)^2 (10) = \boxed{35.2 \text{ W}}$$

b) Another bulb is connected parallel to bulbs B and C. How does the brightness of each bulb change?

Bulbs A and D are...

brighter      \_\_\_ dimmer      \_\_\_ the same

WHEN ANOTHER RESISTOR IS ADDED IN PARALLEL TO BULBS B AND C, THE TOTAL RESISTANCE OF THE CIRCUIT DECREASES. BY OHM'S LAW, THE DECREASE IN RESISTANCE RESULTS IN AN INCREASE IN TOTAL CURRENT. AS THIS TOTAL CURRENT PASSES THROUGH BULBS A AND D, THE POWER AND THEREFORE THE BRIGHTNESS INCREASE ( $P=I^2R$ ,  $P \propto I^2$ ).

Bulbs B and C are...

\_\_\_ brighter       dimmer      \_\_\_ the same

Explain.

AS MORE CURRENT PASSES THROUGH BULBS A AND D, BY OHM'S LAW, THE POTENTIAL VOLTAGE ACROSS THE BULBS INCREASES.

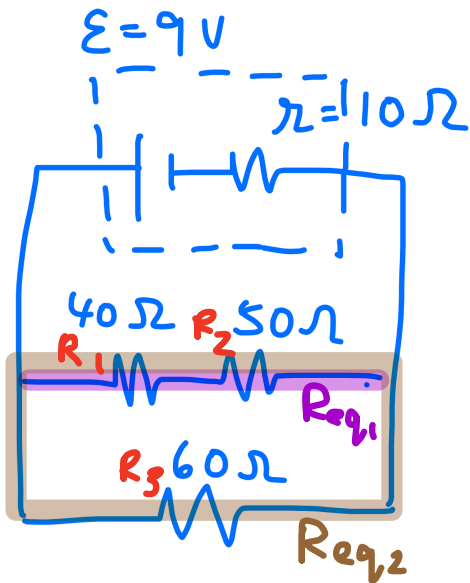
SINCE  $V_T$  HAS NOT CHANGED, BY KIRCHHOFF'S LOOP RULE,  $V_B$  AND  $V_C$  MUST DECREASE. THE POWER AND THEREFORE THE BRIGHTNESS DECREASE ( $P=\frac{V^2}{R}$ ,  $P \propto V^2$ ).

ALTERNATE EXPLANATION FOR BULBS B AND C:

AS A BULB IS ADDED IN PARALLEL TO BULBS B AND C, THERE IS A NEW PATH FOR CURRENT TO FLOW. THIS REDUCES THE CURRENT TO B AND C. THE POWER AND THEREFORE THE BRIGHTNESS DECREASE ( $P=I^2R$ ,  $P \propto I^2$ ).

Determine the terminal voltage of the battery for each circuit.

a)



$$R_{eq1} = R_1 + R_2 = 40 + 50 = 90 \Omega$$

$$\frac{1}{R_{eq2}} = \frac{1}{R_{eq1}} + \frac{1}{R_3}$$

$$R_{eq2} = \left( \frac{1}{90} + \frac{1}{60} \right)^{-1} = 36 \Omega$$

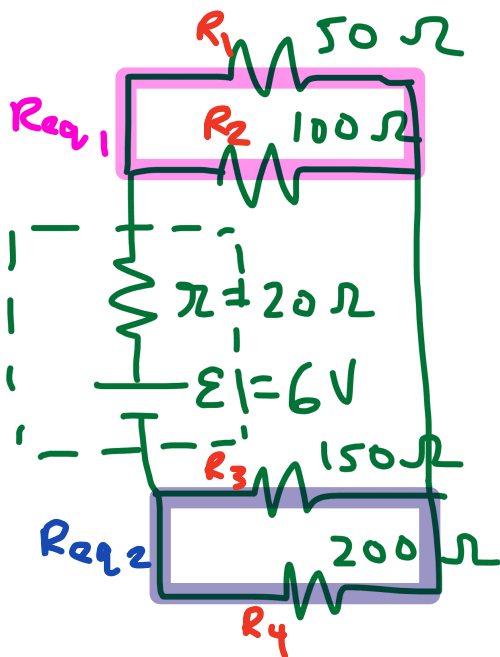
$$R_T = R_{eq2} + r = 36 + 10 = 46 \Omega$$

$$I_T = \frac{V_T}{R_T} = \frac{9}{46} = 0.196 \text{ A}$$

$$V_r = I_r r = (0.196)(10) = 1.96 \text{ V}$$

$$V_{\text{TERMINAL}} = \mathcal{E} - V_r = 9 - 1.96 = \boxed{7.04 \text{ V}}$$

b)



$$\frac{1}{R_{eq1}} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$R_{eq1} = \left( \frac{1}{50} + \frac{1}{100} \right)^{-1} = 33.3 \Omega$$

$$\frac{1}{R_{eq2}} = \frac{1}{R_3} + \frac{1}{R_4}$$

$$= \left( \frac{1}{150} + \frac{1}{200} \right)^{-1} = 85.7 \Omega$$

$$R_T = R_{eq1} + R_{eq2} + r$$

$$= 33.3 + 85.7 + 20 = 139 \Omega$$

$$I_T = \frac{V_T}{R_T} = \frac{6}{139} = 0.0432 \text{ A}$$

$$V_r = I_r r = (0.0432)(20) = 0.863 \text{ V}$$

$$V_{\text{TERMINAL}} = \mathcal{E} - V_r = 6 - 0.863 = \boxed{5.14 \text{ V}}$$