AP® Physics B
2002 Sample Student Responses

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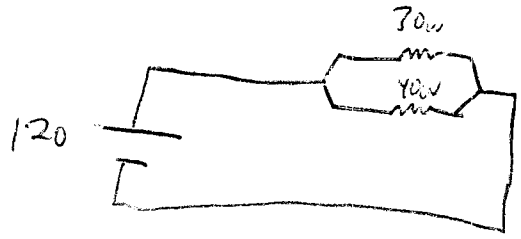
3. (15 points)

Two lightbulbs, one rated 30 W at 120 V and another rated 40 W at 120 V, are arranged in two different circuits.

(a) The two bulbs are first connected in parallel to a 120 V source.

i. Determine the resistance of the bulb rated 30 W and the current in it when it is connected in this circuit.



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

$30 = \frac{120^2}{r}$

$r = \frac{120^2}{30}$

$r = 480\,\Omega$

$V = IR$

$I = \frac{V}{R}$

$I = \frac{120}{480}$

$I = .25\,A$

ii. Determine the resistance of the bulb rated 40 W and the current in it when it is connected in this circuit.

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

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

$r = \frac{120^2}{40}$

$r = 360\,\Omega$

~~$I = \frac{V}{R}$~~

$V = IR$

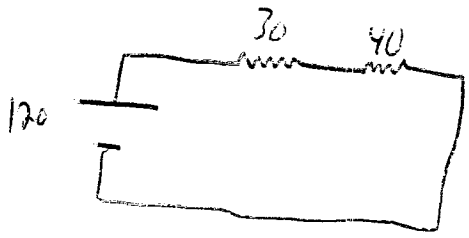
$I = \frac{V}{R}$

$I = \frac{120}{360}$

$I = .33\,A$

(b) The bulbs are now connected in series with each other and a 120 V source.

i. Determine the resistance of the bulb rated 30 W and the current in it when it is connected in this circuit.



$V = IR$

$V_{eq} = I_{eq} R_{eq}$

$I_{eq} = \frac{V_{eq}}{R_{eq}}$

$I_{eq} = \frac{120}{(30+480)}$

$I = I_{eq} = .143\,A$

$V = IR$

$V = .143(480)$

$V = 68.57\,V$

$r = 480\,\Omega$ – constant

ii. Determine the resistance of the bulb rated 40 W and the current in it when it is connected in this circuit.

$V = IR$

$I_{eq} = \frac{V_{eq}}{R_{eq}}$

$I_{eq} = \frac{120}{(360+480)}$

$I = I_{eq} = .143\,A$

$r = 360\,\Omega$ constant

GO ON TO THE NEXT PAGE.

(c) In the spaces below, number the bulbs in each situation described, in order of their brightness.
(1 = brightest, 4 = dimmest)

2 30 W bulb in the parallel circuit

1 40 W bulb in the parallel circuit

3 30 W bulb in the series circuit

4 40 W bulb in the series circuit

(d) Calculate the total power dissipated by the two bulbs in each of the following cases.

i. The parallel circuit

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

$P = \frac{120^2}{360} + \frac{120^2}{480} = 30 + 40 = 70W$

ii. The series circuit

$P = I^2 R$

$P = .143^2(480) + .143^2(360)$

$\boxed{P = 7.9 + 9.8 = 17.16W}$

GO ON TO THE NEXT PAGE.

3. (15 points)

Two lightbulbs, one rated 30 W at 120 V and another rated 40 W at 120 V, are arranged in two different circuits.

(a) The two bulbs are first connected in parallel to a 120 V source.

i. Determine the resistance of the bulb rated 30 W and the current in it when it is connected in this circuit.

$P = IV = I^2R = V^2/R$

$30 = 120^2/R$

$R = 480\ \Omega$

$I = \frac{V}{R} = \frac{120}{480} = .25\text{A}$

Current stays same

ii. Determine the resistance of the bulb rated 40 W and the current in it when it is connected in this circuit.

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

$40 = \frac{120^2}{R}$

$R = 360\ \Omega$

$I = \frac{V}{R} = \frac{120}{360} = .3\text{A}$

(b) The bulbs are now connected in series with each other and a 120 V source.

i. Determine the resistance of the bulb rated 30 W and the current in it when it is connected in this circuit.

$P = IV = V^2/R$

$30 = 120^2/R$

$R = 480\ \Omega$

assume $R_{40} = 360\ \Omega$

$R_T = 480 + 360 = 840\ \Omega$

$I = \frac{V}{R} = \frac{120}{840} = .14\text{A}$

Current stays same

ii. Determine the resistance of the bulb rated 40 W and the current in it when it is connected in this circuit.

$P = V^2/R$

$40 = 120^2/R$

$R = 360\ \Omega$

assume $R_{30} = 480\ \Omega$

$I = \frac{V}{R} = \frac{120}{840} = .14\text{A}$

GO ON TO THE NEXT PAGE.

(c) In the spaces below, number the bulbs in each situation described, in order of their brightness.
(1 = brightest, 4 = dimmest)

2 30 W bulb in the parallel circuit

1 40 W bulb in the parallel circuit

4 30 W bulb in the series circuit

3 40 W bulb in the series circuit

(d) Calculate the total power dissipated by the two bulbs in each of the following cases.

i. The parallel circuit

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

$\frac{1}{R_{Total}} = \frac{1}{480} + \frac{1}{360} = 205.7\ \Omega$

$P = V^2/R = 120^2/205.7 = \boxed{70\ W}$

ii. The series circuit

$R_{Total} = 480 + 360 = 840\ \Omega$

$P = V^2/R = 120^2/840 = \boxed{17.1\ W}$

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