SERIES $I_{total} = I_1 = I_2 = I_3$

$R_{total} = R_1 + R_2 + R_3$

$V_{total} = V_1 + V_2 + V_3$

PARALLEL $I_{total} = I_1 + I_2 + I_3$

$\frac{1}{R_{total}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$

$V_{total} = V_1 = V_2 = V_3$

OHMS' LAW $V = IR$

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

ENERGY $E = Pt = IVt = I^2Rt = \frac{V^2t}{R}$

Physics
Power & Energy with Series & Parallel Circuits

Name KEY
Date __________

1. Suppose you have a 15 A circuit breaker in series with the following parallel combinations all across 120-V: Television – 10 Ω, Alarm Clock – 60 Ω, Lamp – 40 Ω. Can you have all 3 things on at the same time?

   12 A + 2 A + 3 A = 17 A — no b/c it exceeds amount of 15 A allowed

2. A curling iron of resistance 80-0 Ω is plugged into a 120-V outlet. How much thermal energy is produced in 60 seconds?

   $R = 80.0\,\Omega$, $V = 120\,V$
   $P = \frac{V^2}{R}$ → = 180 W
   $E = \frac{V^2}{R}t$
   $E = \frac{(120\,V)^2}{80\,\Omega} \cdot 60\,s$ = 10,800 J ⟹ 21600 J (2 min)

3. A 13.0-Ω resistors and a 52.0-Ω resistors are connected in series and placed across a 135-V generator.
   * changed to 130 V

   a) What is the equivalent resistance of the circuit?

   $R_T = 13 + 52 = 65\,\Omega$

   b) What is the value of the current in the circuit?

   $135\,V = I \cdot 65$ → $I = 2.08\,A$
   (130 V): $130 = I \cdot 65$ → $I = 2\,A$

   c) What is the potential drop (voltage) across each resistor?

   $V = 2.08\,A \cdot 13\,\Omega = 27.04\,V$
   $V = 2.08 \cdot 52\,\Omega = 108.16$
   (130 V): $V = 2\,A \cdot 13 = 26\,V$; $V = 2\,A \cdot 52 = 104\,V$

   d) Calculate the power of each resistor.

   $P = I^2R$
   $P = (2.08)^2(13\,\Omega) = 56.2\,W$
   $P = (2.08)^2(52) = 225\,W$
   (130 V): $P = (2^2)(13) = 52\,W$; $P = (2^2)(52) = 208\,W$

   e) What is the total power of the circuit?

   $P = 56.2 + 225 = 281.2\,W$
   (130 V): $P = 52 + 208 = 260\,W$

4. A 3.0-Ω resistor, a 6.0-Ω resistor and two 12.0-Ω resistors are connected in parallel and placed across a ~~48.0~~ 9 V power supply.

a) What is the equivalent resistance of the circuit?

$$\frac{1}{R_T} = \frac{1}{3} + \frac{1}{6} + \frac{1}{12} + \frac{1}{12} = \frac{4}{12} + \frac{2}{12} + \frac{1}{12} + \frac{1}{12} = \frac{8}{12} = \frac{12}{8} \quad R_T = 1.5\,\Omega$$

b) What is the value of the current in each branch of the circuit?

$9.0\,V = I \cdot 1.5$ $\quad I = 6\,A$

FLIP

c) What is the value of the total current through the circuit?

3Ω: $9 = I \cdot 3 = 3A$

6Ω: $9 = I \cdot 6 = 1.5A$

12Ω: $9 = I \cdot 12 = 0.75A,\ 0.75$

d) Calculate the power of each resistor.

3Ω: $P = 3A \cdot 9 = 27\,W$

6Ω: $P = 1.5A \cdot 9 = 13.5\,W$

12Ω: $P = 0.75 \cdot 9 = 6.75\,W,\ 6.75\,W$

e) What is the total power of the circuit?

$P = 27 + 13.5 + 6.75 + 6.75 = 54\,W$

5. A blow dryer rated at 1500 W is plugged into an outlet of 120-V. What is the resistance of the blow dryer?

$P = 1500\,W$ $\quad P = \frac{V^2}{R}$ $\quad 1500\,W = \frac{120^2}{R}$ $\quad 1500R = 14{,}400$

$V = 120\,V$ $\quad R = 9.6\,\Omega$

7. A digital clock has a resistance of 12,000 Ω and is plugged into a 115-V outlet.

a) How much current does it draw?

$115\,V = I \cdot 12{,}000\,\Omega$ $\quad I = 0.00958\,A$ $\quad (9.58 \times 10^{-3}\,A)$

b) How much power does it use?

$P = I^2 R = (9.58 \times 10^{-3})^2 (12{,}000)$ $\quad P = 1.10\,W \Rightarrow 0.0011\,KW$

c) If the clock is constantly on (in use 24 hours a day), how much energy in kWh does the clock use in one day?

$E = 0.0011\,KW \cdot 24\,hr = 0.0264\,KWh$

c) If the owner of the clock pays \$0.10 per kWh, how much does it cost to operate the clock for 30 days?

$0.0264 \cdot 30 = 0.792\,KWh \cdot 0.10 = \$0.08$

in 30 days

8. Tim left for school at 6:45 a.m. and forgot to turn off her TV, which is rated at 300 W when plugged into a 120-V source. After he came home from school, he left the TV on until leaving for work at ~~4 p.m.~~ 3:45 pm = 9 hr

a) How much energy (in kWh) did the TV use?

$E = 300\,W \cdot 9\,hr = \frac{2700\,W \cdot hr}{1} \times \frac{1\,KW}{1000\,W} = 2.7\,KWhr$

b) At \$0.13 per kWh, how much did it cost to run the TV?

$2.7\,KWh \cdot 0.13 = \$0.35$