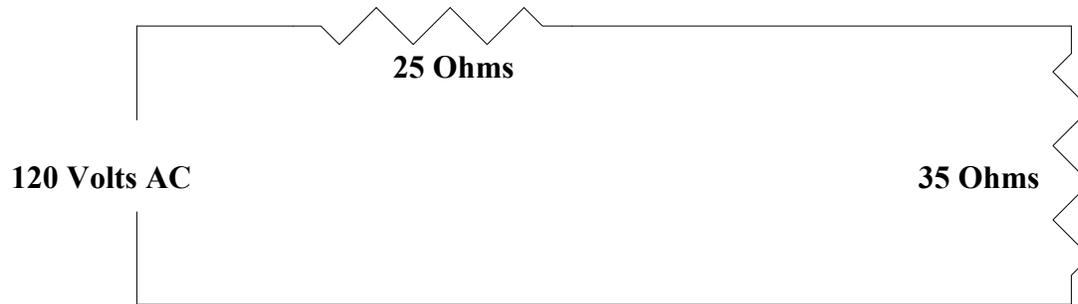




NAME: \_\_\_\_\_ DATE: \_\_\_\_\_  
(Please Print)

**RESISTOR NETWORK AND OHMS LAW PRACTICE EXAM**  
(See formulas at the back of this exam)



1. Based on the drawing above, what is the total circuit resistance?

This is a series circuit. In a series circuit, the total resistance is simply the sum of the resistors:  $R_1 + R_2 + R_3 + \dots$   
 $25 + 35 = 60\Omega$

Answer 60 $\Omega$

2. Based on the drawing above, what is the current flow in the circuit?

From question #1 above, you know that the total resistance is  $60\Omega$  and that the source voltage is 120V. Using Ohm's law or the Power Equations,  $I = E/R$ , or  $120V/60\Omega$ , or 2 Amps.

Answer 2 Amps

3. Based on the drawing above, what is the voltage drop across the 25 ohm resistor?

From question #2 above, you know that the total current flow (and thus the current through the  $25\Omega$  resistor) is 2 amps. Using Ohm's law or the Power Equations,  $E = I \times R$ , or  $2 \text{ amps} \times 25\Omega$ , or 50 Volts.

Answer 50 Volts



4. Based on the drawing above, what is the total circuit resistance?

This is a parallel circuit. In a parallel circuit, the total resistance is calculated by the formula:  $1/(1/R_1+1/R_2+1/R_3+...)$  or, if you only calculate 2 resistors at a time:  $R_1 \times R_2 / R_1 + R_2$   
 $1/(1/6+1/12)$ , or  $1/(2/12+1/12)$ , or  $1/(3/12)$ , or  $1/(1/4)$ , or 4 Ohms.  
 OR  
 $6 \times 12 / 6 + 12$ , or  $72/18$ , or 4 Ohms

Answer 4 Ω

5. Based on the drawing above, what is the total current flow in the circuit?

From question #1 above, you know that the total resistance is  $4\Omega$  and that the source voltage is 120V. Using Ohm's law or the Power Equations,  $I=E/R$ , or  $120V/4\Omega$ , or 30 Amps.

Answer 30 Amps

6. Based on the drawing above, what is the current flow through the 6 ohm resistor?

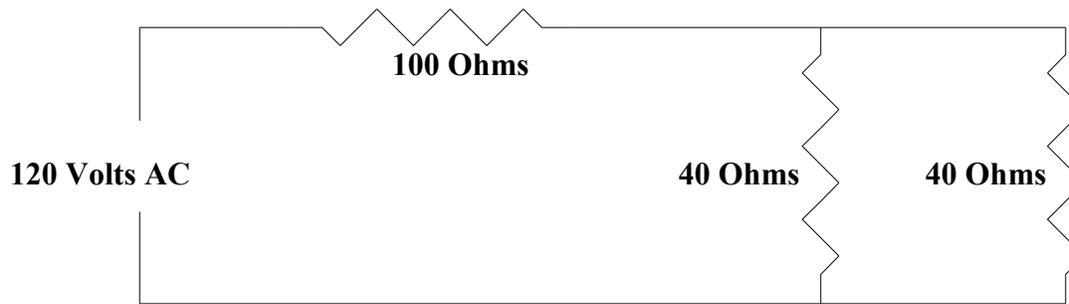
In a parallel circuit, the voltage across a load is equal to the source voltage. Think of normal house wiring where you will get 120 volts no matter where you plug in!  
 Using Ohm's law or the Power Equations,  $I=E/R$ , or  $120V/6\Omega$ , or 20 Amps.

Answer 20 Amps

7. Based on the drawing above, how much power is consumed by the 12 ohm resistor?

Again, in a parallel circuit, the voltage across a load is equal to the source voltage.  
 Using Ohm's law or the Power Equations,  $P=E^2/R$ , or  $120^2V/12\Omega$ , or  $14400V/12\Omega$ , or 1200 Watts.

Answer 1200 Watts



8. Based on the drawing above, what is the total circuit resistance?

This is a combination series/parallel circuit. As seen in the above examples, it's much easier to calculate the total resistance of a series circuit rather than a parallel. Because of this, I usually try to turn any parallel parts of the circuit into a single equivalent resistor, which can then be easily added to any other series resistors. It's also usually easier to start at a point furthest from the source voltage.

First, find the equivalent resistance of the (2) 40 ohm resistors. (See #4 above)

$R_1 \times R_2 / R_1 + R_2$ , or  $40 \times 40 / 40 + 40$ , or  $1600 / 80$ , or  $20 \Omega$

You can now replace the (2) 40 ohm resistors with a single 20 ohm and simply add it to the 100 ohm resistor that it's in series with!

Now,  $20 \Omega + 100 \Omega = 120 \Omega$

Answer

120  $\Omega$

9. Based on the drawing above, what is the total current flow in the circuit?

From question #8 you know the total circuit resistance.

Using Ohm's law or the Power Equations,  $I = E/R$ , or  $120V / 120 \Omega$ , or 1 Amp.

Answer

1 Amp

10. Based on the drawing above, what is the voltage across one of the 40 ohm resistors?

Remember that since the 40 ohm resistors are in parallel, the voltage across them will be the same for either one.

First, find the equivalent resistance of the (2) 40 ohm resistors, which is 20 ohms. (See #8 above)

You know the current through the "20 ohm" resistor is 1 amp from # 9 above.

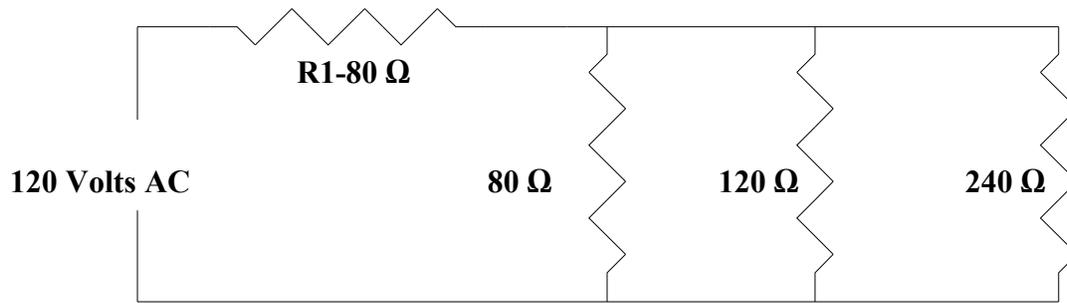
So,  $E = I \times R$ , or  $1 \text{ Amp} \times 20 \Omega$ , or 20 volts.

Can you guess the voltage across the 100 ohm resistor? If you start with a voltage of 120 volts and drop 20 volts across the (2) 40 ohm resistors (20 ohm equivalent) the remainder is 100 volts.

$120 - 20 = 100$  volts

Answer

20 Volts



11. Based on the above drawing, how much current is flowing through the 120 ohm resistor?

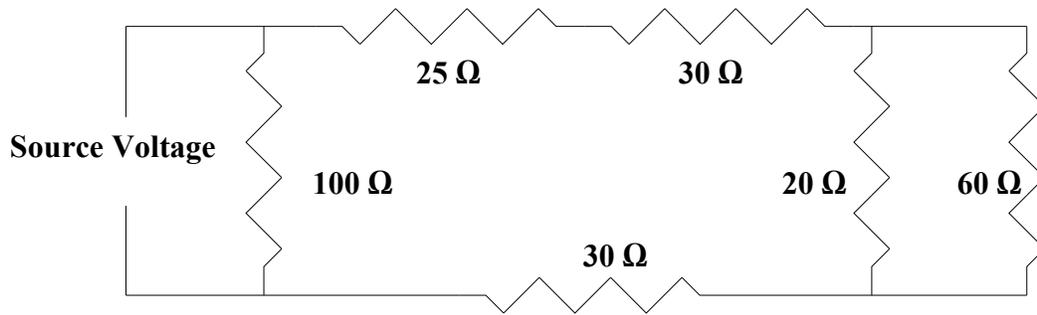
This is certainly a multi-part calculation!  
 There are several ways to work this problem, but here's how I would do it:  
 If you can find the voltage across the 120 ohm resistor, you can easily calculate the current with a simple Ohm's Law calculation.  
 The first step would be to find the equivalent resistance of the 3 parallel resistors.  
 $R = 1 / (1/R_1 + 1/R_2 + 1/R_3)$ , or  $1 / (1/80 + 1/120 + 1/240)$ , or  $1 / (6/480 + 4/480 + 2/480)$ , or  $1 / (12/480)$ , or  $1 / (1/40)$ , or  $40 \Omega$ .  
 The total circuit resistance is:  $R_{Total} = R_1 + R_2$ , or  $80\Omega + 40\Omega = 120\Omega$ .  
 The total circuit current is:  $I = E/R$ , or  $120V/120\Omega$ , or 1 Amp.  
 Now, the voltage across the 80, 120 and 240 ohm resistors (40 ohm equivalent) is  $E = I \times R$ , or 1 Amp x  $40\Omega$ , or 40 Volts.  
 And finally, the current through the 120 ohm resistor can be calculated by:  $I = E/R$ , or 40 Volts/ $120\Omega$ , or 1/3 Amp. Whew!

Answer 1/3 Amps

12. Based on the above drawing, what is the voltage drop across R1?

From question #11 above, you know that the total current flow (and thus the current through the  $80\Omega$  resistor) is 1 amp. Using Ohm's law or the Power Equations,  $E = I \times R$ , or 1 amps x  $80\Omega$ , or 80 Volts.

Answer 80 Volts



13. Based on the drawing above, what is the equivalent circuit resistance?

Here's another combination series/parallel circuit. The key to solving this is to break it down into small steps (and not panic!).

First, start at the point furthest from the source voltage and work your way back.

Find the equivalent resistance of the parallel 20 and 60 ohm resistors.

$R = \frac{20\Omega \times 60\Omega}{20\Omega + 60\Omega}$ , or  $\frac{1200\Omega}{80\Omega}$ , or  $15\Omega$ .

This equivalent resistance is in series with the 25, 30 and 30 ohm resistors, and can simply be added to those values.

$R = 25\Omega + 30\Omega + 15\Omega$  (calculated above)  $+ 30\Omega$ , or  $100\Omega$ .

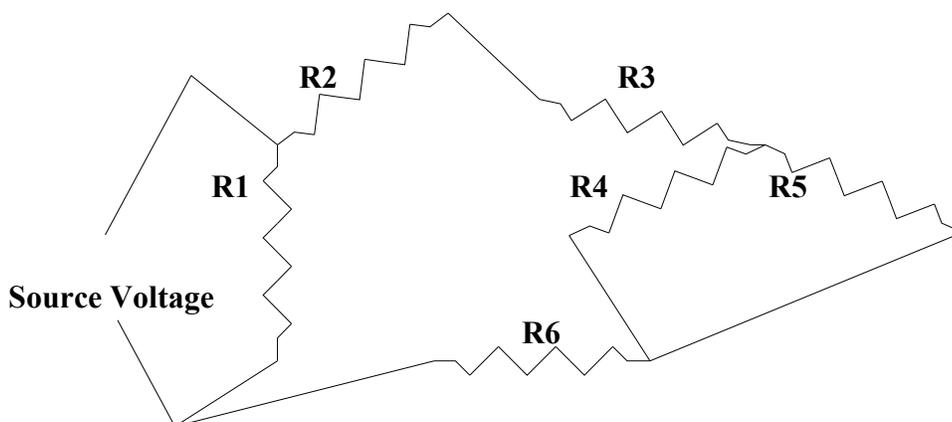
This calculated 100 ohm resistance is now in parallel with the final resistor in the circuit, also 100 ohms.

$R = \frac{100\Omega \times 100\Omega}{100\Omega + 100\Omega}$ , or  $50\Omega$ .

Notice that if you have 2 parallel resistors of the same value, the equivalent resistance is  $\frac{1}{2}$  (half) the value of one of the resistors—a real time saver for those calculations!

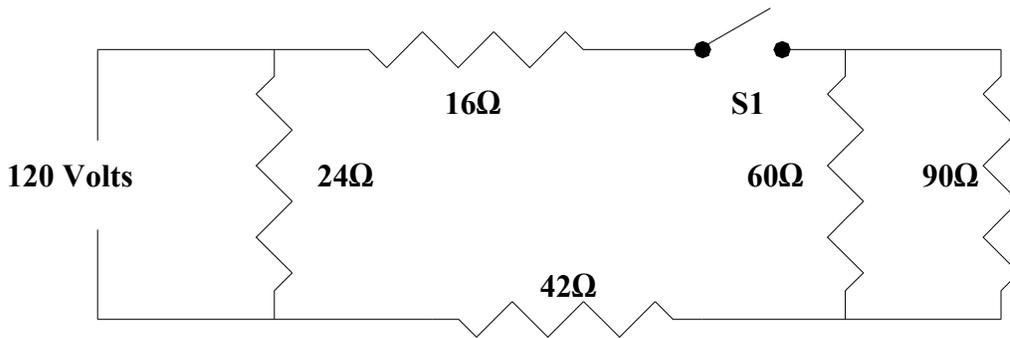
Answer 50 Ω

14. Take a look at the resistor network below. What do you notice about this diagram?



Answer Same as #13

If you look closely, you will see that this is the exact same diagram as in question #13 above. Don't be fooled by the way the circuit is drawn. In fact, what I usually do is to re-draw a diagram like this to make the series and parallel resistors more obvious, such as in question #13!



15. Based on the drawing above, what is the equivalent circuit resistance if S1 is closed?

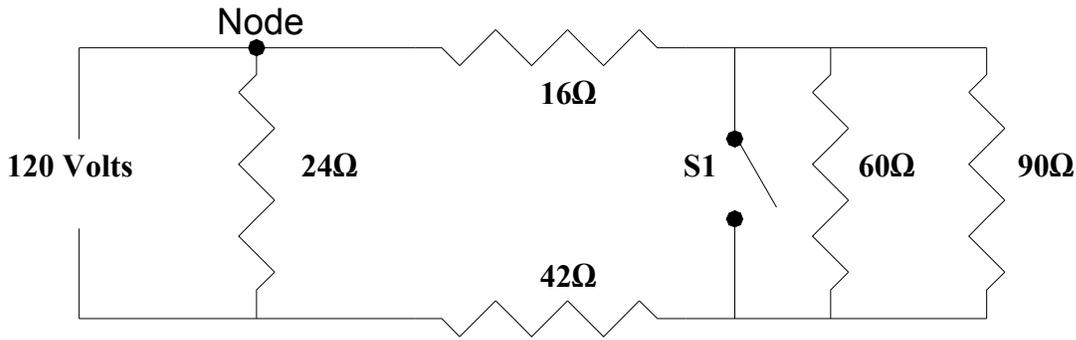
Closing S1 creates a circuit with all of the resistors being included. Again, starting from the farthest point from the 120 volt source, we have a 60 and 90 ohm resistor in parallel.  $1/(1/60\Omega+1/90\Omega)$ , or  $1/(3/180\Omega+2/180\Omega)$ , or  $1/(5/180)$ , which when you have a fraction that includes  $1/(\text{some fraction})$ , you may simply invert the fraction, so that we now have  $180/5$ , or  $36\Omega$ . Of course with only 2 resistors in parallel, you could use the formula  $R1 \times R2 / R1 + R2$ , or  $60\Omega \times 90\Omega / 60\Omega + 90\Omega$ , or  $5400\Omega / 150\Omega$ , or  $36\Omega$ . The 36 ohm equivalent resistance is in series with the 16 and 42 ohm resistors, which simply add together.  $36\Omega + 16\Omega + 42\Omega = 94\Omega$ . The 94 ohm equivalent resistance is now in parallel with the 24 ohm resistor, so that  $24\Omega \times 94\Omega / 24\Omega + 94\Omega$ , or  $2256\Omega / 118\Omega$ , or  $19.12\Omega$ .

Answer 19.12 Ω

16. Based on the drawing above, what is current flow through the circuit if S1 is open?

Opening S1 removes the 16, 60, 90 and 42 ohm resistors from the circuit. The only thing left is the 24 ohm resistor. A simple Ohm's Law calculation gives us our answer:  $I = E/R$ , or  $120V/24\Omega$ , or 5 Amps.

Answer 5 Amps



17. Based on the drawing above, what is the equivalent circuit resistance if S1 is closed?

Closing S1 creates a shunt around the 60 and 90 ohm resistors. This is basically a wire with no resistance, which in effect removes those resistors from consideration in this circuit.

We now have a 16 and a 42 ohm resistor in series which add together creating a 58 ohm equivalent resistance.

This 58 ohm equivalent resistance is now in parallel with the 24 ohm resistor, which can be solved using our parallel resistor formula:

$58\Omega \times 24\Omega / 58\Omega + 24\Omega$ , or  $1392\Omega / 82\Omega$ , or  $16.98\Omega$

Answer

**16.98 Ω**

18. Based on the drawing above, what is the current flow through the 16 ohm resistor if S1 is open?

As with many of these types of circuits, there are several ways to solve the problem.

You'll notice that opening S1 makes the circuit identical to the example in question 15 with that S1 closed!

The total circuit resistance was calculated in question 15, which is 19.12 ohms. We can calculate the total circuit current using Ohm's Law, or  $I = E/R$ , or  $120V / 19.12\Omega$ , or 6.28 Amps.

We can also calculate the current through the 24 ohm resistor similarly, or  $I = E/R$ , or  $120V / 24\Omega$ , or 5 Amps.

Notice that at the junction point between the 24 ohm and 16 ohm resistors (also known as a "node") is where the current splits into two directions.

The 2 paths that the current takes must equal the total current. Since we know the total current, as well as the current flowing through the 24 ohm resistor, we can calculate the current through the 16 ohm resistor.

$I_{Total} = I_{24\Omega} + I_{16\Omega}$ , or  $I_{16\Omega} = I_{Total} - I_{24\Omega}$ , or  $6.28A - 5A = 1.28$  Amps.

Note that this 1.28 amps flows through the 16 ohm resistor, the 42 ohm resistor, and splits again through the paralleled 60 and 90 ohm resistors.

For an extra challenge, try to calculate the current through the 60 and 90 ohm resistors!

Answer

**1.28 Amps**

# Electrical Exam Formulas

1)  $P = I \times E$ ,  $P(3 \text{ Phase}) = I \times E \times 1.73$

2)  $E = I \times R$

3)  $P = I \times E \times (\text{Pf})$

4)  $V_d = (2 \times K \times D \times I) / \text{CM}$

5)  $V_d (3 \text{ Phase}) = (1.73 \times K \times D \times I) / \text{CM}$

6) Parallel Resistors

$$R_t = \frac{1}{1/R_1 + 1/R_2 + \dots + 1/R_n}$$

OR

$$R_t = \frac{R_1 \times R_2}{R_1 + R_2}$$

7) Series Resistors

$$R_t = R_1 + R_2 + \dots + R_n$$

P= Power in watts

I=Current in amps

E=Voltage in volts

R=Resistance in ohms,  $R_t$ =Total resistance

$V_d$ =Voltage drop in volts

Pf=Power factor

D=Distance (one way) in feet

CM=Circular mils of wire (Ch. 9, Table 8)

K=Resistance of a circular mil-foot (Approx. 12.9 for Cu, 21.2 for Al)

HP=746 Watts

