Resistance in Parallel Circuits

57. In Figure 2, R_1 is 6 ohms. R_1 is connected across the 24-volt battery. According to Ohm's law, the current through R_1 must be ________________ amperes.

58. R_2 is a 4-ohm resistor and is also connected across the 24-volt battery. The current through R_2 is ________________ amperes.

59. The battery is causing 6 amperes to flow through R_2 and 4 amperes to flow through R_1.

    The total current furnished by the battery is ________________ amperes.

60. According to Ohm's law, if a 24-volt battery is causing a 10-ampere current to flow through a resistance, the value of that resistance must be ________________ ohms.

61. Connecting a 4-ohm resistor and a 6-ohm resistor in parallel causes them to act like a single 2.4-ohm resistor.

    The effective resistance of a 4-ohm resistor and a 6-ohm resistor connected in parallel is (calculated as the sum of the resistances/ calculated in a different way).

62. Ohm's law can be used to develop a general equation for finding the effective resistance of resistors in parallel. Let the voltage be <u>one</u> volt; then, applying the formula

$$I = \frac{E}{R},$$

the total current for the one-volt supply is

$$I_t = \frac{\_\_\_\_\_\_}{R_t}$$

(where I_t = total current, and R_t = total resistance).

63. The total current per volt through the total (or effective) resistance is

$$\frac{1}{R_t}.$$

The total current also equals the sum of the individual currents through the individual resistances. If there are three resistors, R_1, R_2, and R_3, the individual currents can be written

$$I_1 = \frac{1}{R_1},\ I_2 = \frac{1}{R_2},\ \text{and } I_3 = \frac{1}{R_3}.$$

Then the total current is

$$\frac{1}{R_t} = \_\_\_\_\_\_ + \_\_\_\_\_\_ + \_\_\_\_\_\_.$$

64. The general equation

$$\frac{1}{R_t} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

is necessary for resistors of different values; but when the resistors are all equal, the solution is greatly simplified. If $R_1 = R_2 = R_3$, etc., then

$$R_t = \frac{R}{N},$$

where N is the number of resistors. If three 15-ohm resistors are connected in parallel, the effective resistance is __________ ohms.

65. Two 30-ohm resistors are connected in parallel. Their effective resistance is __________ ohms.

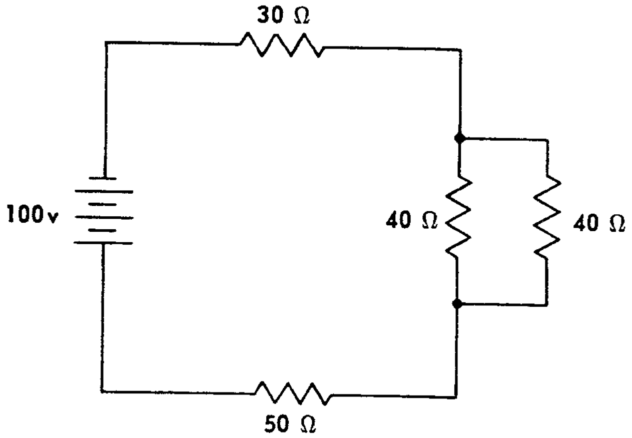
66. These resistors are available.

Resistance	Quantity
100 ohms	5
25 ohms	2
150 ohms	2
120 ohms	10

To get an effective resistance of 20 ohms, ________________ resistors of ________________ ohms can be connected in parallel.

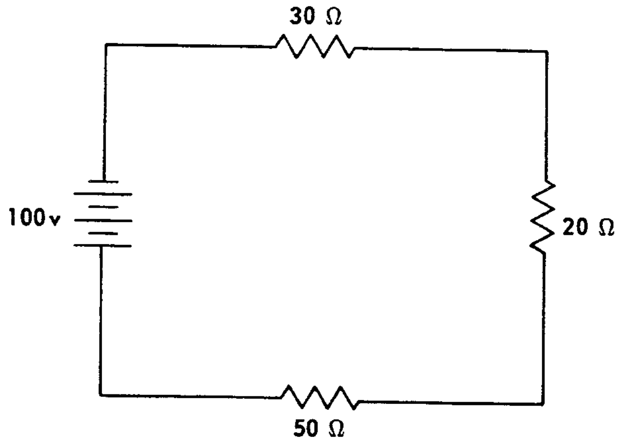
67. If the ten 120-ohm resistors were connected in parallel, their effective resistance would be ________________ ohms.

68. A parallel set of resistors can also be part of a series connection.



The two 40-ohm resistors in parallel are equal to one ________________-ohm resistor.

69. The electrical representation of the circuit can now be redrawn like this.



The total resistance is ________________ ohms, and the current from the battery is ________________ amperes.

70. In any series-parallel combination of resistors, the total resistance can be found by first finding the equivalent resistance for every set of ________________ resistances.

71. After the equivalent resistance is calculated for each parallel set, the series resistances can be ________________ to get the total.

72. Any combination of resistors in series and/or parallel can be replaced by ________________ (how many) equivalent resistor(s).

Voltage Drop

73. Look at Exhibit 4. A voltmeter across the battery would read ________________ volts.

74. The voltage read by meter V_1 is ________________ volts.

75. The voltmeter V_2 should read ________________ volts.

76. Voltmeters connected in a circuit such as that in Exhibit 4, but with any number of resistors connected in parallel, read the same because they are all connected to the same ________________.

77. Look at Exhibit 5. A voltmeter connected to points A and C reads ________________ volts.

78. In Exhibit 5, a voltmeter connected to points A and B is connected across one-half the total resistance. The voltage across that resistance is (one-half/ the same as) the battery voltage.

79. It can be proved that the voltage across half the total resistance equals half the total applied voltage.

Step 1: The total resistance is ________________ ohms.

80. Step 2: According to Ohm's law, the current in the circuit is ________________ amperes.

81. Step 3: If a 10-ohm resistor has 1 ampere flowing through it, the voltage across it must be E = IR, or ________________ volts.

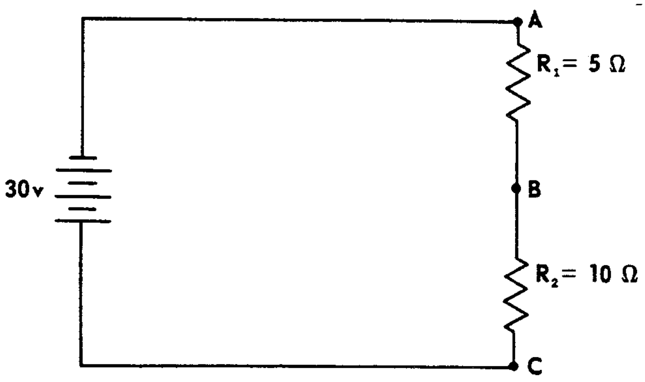
82. The measured voltage across R_1 is 10 volts and the calculated voltage is also 10 volts. A meter connected between B and C, across R_2, should read _______________ volts.

83. Both of the measurements and Ohm's law show that a 10-volt force or potential difference exists across R_1 and also across R_2. The sum of the voltages or potential differences across both resistors equals the voltage applied by the _______________.

84. The difference in potential which exists between the ends of a resistor when a current flows through the resistor is called a voltage drop.

In a circuit such as that in Exhibit 5, the applied voltage from the battery equals the sum of the _______________ _______________ across the various resistors.

85. Look at this circuit.



The total resistance is _______________ ohms.

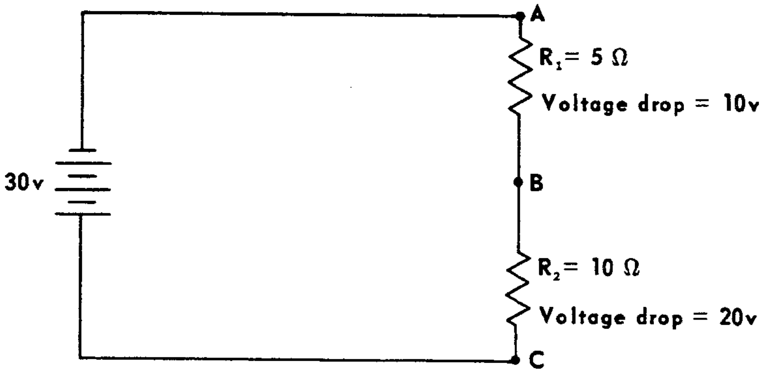
The current through the circuit is _______________ amperes.

86. In the above circuit the voltage drop across R_1 must be _______________ volts.

The voltage drop across R_2 must be _______________ volts.

87. The sum of the voltage drops equals _______________ _______________.

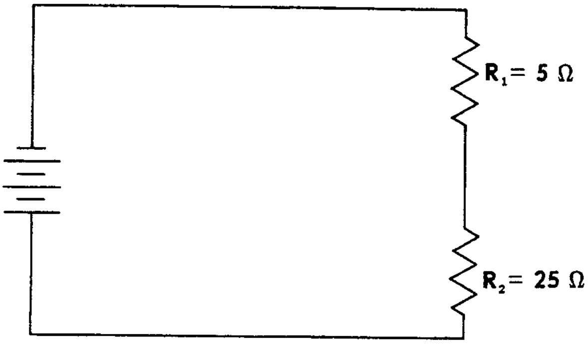
88. Look at the circuit again.



The ratio of the resistances is 5/10, or 1/2. The ratio of the voltage drops across these resistors is ______________.

The ratio of the resistances equals the ratio of the ______________ ______________ across them.

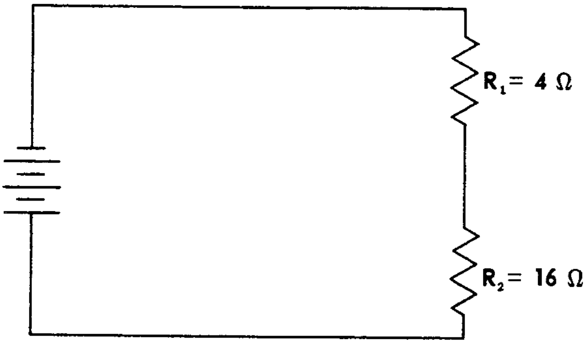
89. Here is another circuit.



The voltage drop across R_1 is 20 volts. The voltage drop across R_2 must be ______________ volts. (Resistance ratio = 5/25 = 1/5.)

90. The voltage supplied by the battery must be ______________ volts.

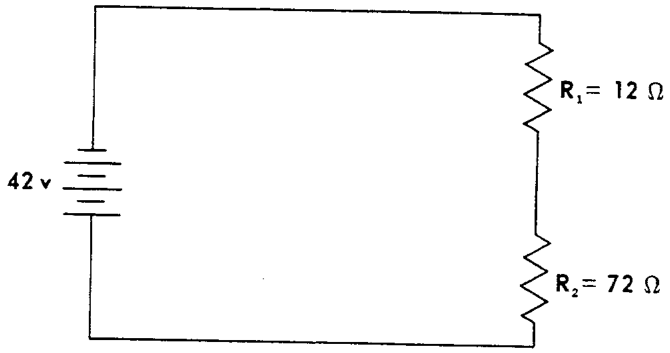
91. Look at this circuit.



If the voltage drop measured across R_1 is 10 volts, the voltage drop across R_2 is ______________ volts.

92. The applied voltage from the battery must be ________________ volts.

93. Here is another series circuit.



The total resistance is ________________ ohms. The 12-ohm resistor is what fraction of the total resistance? ________________

94. If the ratio of the resistance of R_1 to the total resistance is 1/7, the ratio of the voltage drop across R_1 to the total applied voltage should be ________________.

The applied voltage from the battery is 42 volts, so the voltage across R_1 must be 1/7 of 42, or ________________ volts.

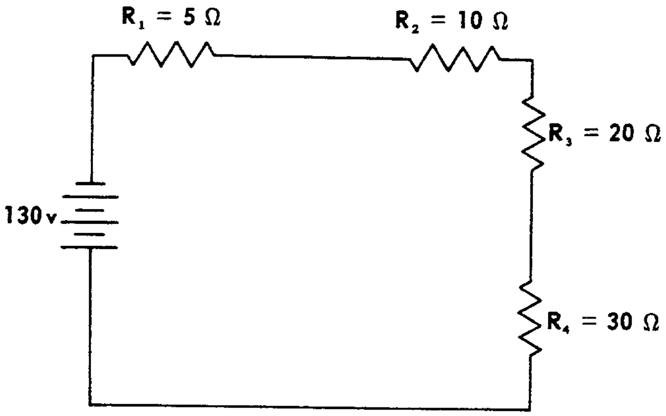
95. The resistance of R_2 is what fraction of the total resistance? ________________.

The voltage across R_2 must be ________________ (fraction) of the applied voltage, or ________________ volts.

96. The voltage drops across the resistors should have the same ratio as the resistances.

The resistance ratio is 12/72. The voltage ratio for R_1 and R_2 is 6/36. The ratios (are equal/ are not equal).

97. The ratio principle applies to any number of resistors connected in series across a source of voltage. Look at the circuit below.



The total resistance is ______________ ohms.

98. Write the fractions which give the ratios of the individual resistances to the total resistance.

R_1 = 5 ohms = 5/65

R_2 = 10 ohms = ______________

R_3 = 20 ohms = ______________

R_4 = 30 ohms = ______________

99. The voltage drop across each resistor must be the same fraction of the total voltage.

R_1 = 5 ohms = 5/65; 5/65 x 130v = 10v

R_2 = 10 ohms = 10/65; _____ x _____ = _____

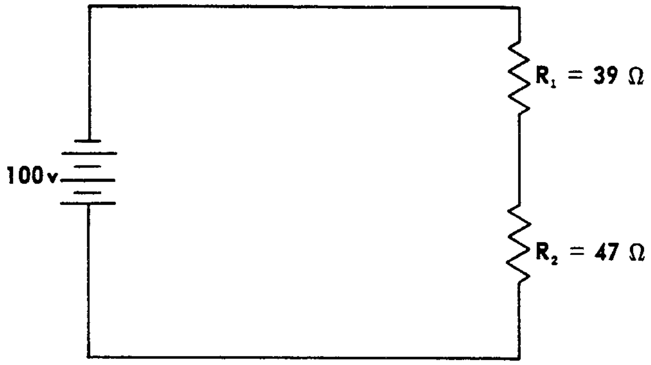
R_3 = 20 ohms = 20/65; _____ x _____ = _____

R_4 = 30 ohms = 30/65; _____ x _____ = _____

100. The sum of the individual voltage drops must equal the voltage applied from the source.

The sum of the above individual voltage drops (equals/does not equal) 130 volts as applied by the battery.

101. The fractions that express the resistance ratios may not be as convenient as those in the preceding examples, but the method is always the same.



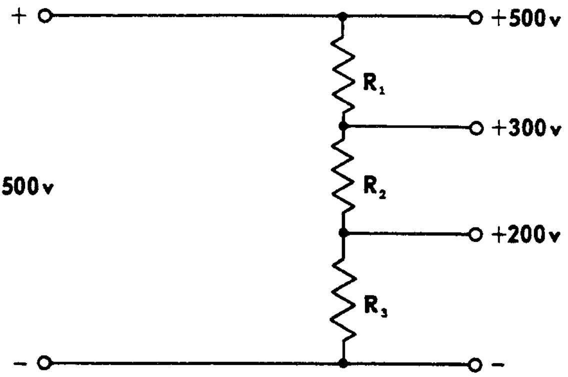
The voltage drop across R_1, to two decimal places, is ______ volts. The voltage drop across R_2, to two decimal places, is ______ volts.

The answers add to ______________ volts, so the answers (are correct/are not correct).

Resistors as Voltage Dividers

102. Resistors connected in series across a source of voltage are often used as voltage dividers. The result of their individual voltage drops is to divide the voltage of the ______________ into two or more smaller voltages.

103. This circuit can be used as a voltage divider.

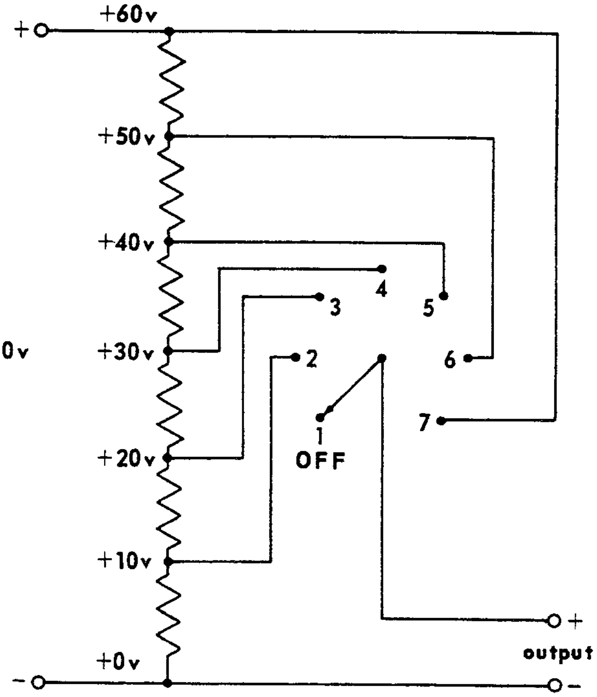


The voltage drop across R_3 is ______________ volts.

104. The voltage drop across R_3 is 200 volts. The voltage drop across $R_3 + R_2$ is 300 volts. Therefore, the drop across R_2, alone, must be ______________ volts.

105. Similarly, the voltage drop across only R_1 is ______________ volts.

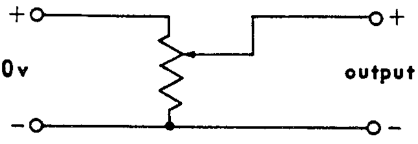
106. Look at this voltage-divider circuit.



The arrow represents the movable conductor in the seven-position switch. At position 1, as shown, the output voltage is ______________ volts.

By turning the switch to positions 2 through 7, the output voltage can be any value from ______________ volts to ______________ volts, in steps of ______________ volts.

107. It is often necessary to make finer adjustments than the 10-volt steps in the above circuit. One method of making the output voltage continuously variable is to use a variable resistance connected as a <u>potentiometer</u>.

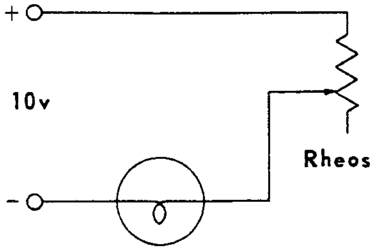


Potentiometer

The arrow on the potentiometer represents a movable contact which can slide along the resistance element. The output voltage is continuously variable from ______________ volts to ______________ volts.

108. To produce a continuously variable output voltage, a ________________ can be used.

109. Another connection of a variable resistor, a <u>rheostat</u>, is used to control the current, as in this circuit.

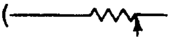


Like the potentiometer, a rheostat is a ________________ resistor.

Unlike the potentiometer, the rheostat connection makes use of only ________________ connections.

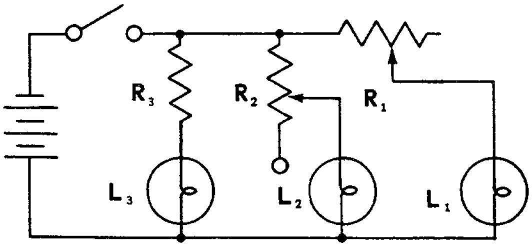
110. A rheostat serves as a current control because it is a variable resistance connected in series with another resistance (the bulb, in this case).

In the above circuit, the bulb has a resistance of 5 ohms and is connected across a 10-volt source. When the rheostat is turned to its zero resistance setting (), the current in the circuit is ________________ amperes.

111. When the rheostat is turned to its maximum resistance position (), its own resistance is 45 ohms.

The current in the circuit is then reduced to ________________ amperes.

112. Circle the potentiometer and the rheostat.



113. When connected in a circuit, a rheostat is readily distinguishable from a potentiometer because a rheostat uses ________________ connections, and a potentiometer uses ________________ connections.

114. Whenever a resistor opposes flow of current in a circuit, some of the electrical energy is used up in the resistor and changed to heat energy. Heating elements in stoves, electric irons, toasters, and so on, are actually one type of ______________.

115. Carbon is a rather poor conductor of electricity. Many fixed resistors are either sticks of ______________, or a glass or ceramic tube covered with a film of ______________.

116. Carbon resistors can handle only about 2 to 3 watts of heat without overheating and becoming either open or shorted, unless they are made quite large.

Resistors made of resistance wire that is wound around a glass or ceramic form can handle ten times as much heat for a given size.

A small resistor marked 100 ohms, 25 watts, would almost certainly be a ______________-______________ resistor.

117. Variable resistors that are listed in parts catalogs as rheostats are often rated at 5 watts to several thousand watts. They are usually ______________-______________.

118. The volume controls on tube-type radio and television receivers are potentiometers that handle very small amounts of power. The resistance elements in them could be made of ______________.

119. If a 100-ohm wire-wound resistor burned out and was replaced with a 100-ohm carbon resistor, the carbon resistor would probably overheat and become ______________.

120. In d-c circuits, the power being used up can be calculated from the formula $P = EI$, where P is the power in watts, E is the voltage, and I is the current in amperes.

If a 10-volt battery causes 2 amperes to flow through a resistor connected across the battery, the resistor produces ______________ watts of heat.

121. The voltage drop across a resistor is 50 volts, and the current through it is 4 amperes. The resistor is producing or dissipating _______________ watts of heat.

122. Power can also be determined from the current and resistance.

The basic formula is $P = EI$; but $E = IR$, so

$$P = IR \times I$$

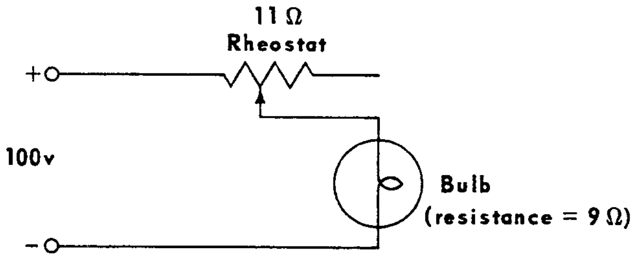
or

$$P = I \times IR = I^2R.$$

A 10-ohm resistor is carrying 2 amperes of current. It is dissipating ($2^2 \times 10$) watts, or _______________ watts.

A 50-ohm resistor carrying 3 amperes dissipates _______________ watts.

123. Look at this circuit.



The rheostat can be varied from 0 ohms to _______________ ohms.

With the rheostat at maximum resistance, the total resistance (including the bulb) is _______________ ohms.

The current in the circuit with the rheostat at maximum resistance is _______________ amperes.

The 11-ohm rheostat must be capable of handling at least _______________ watts ($P=I^2R$).