Section 1

BASIC ELECTRICAL EFFECTS

Exhibits 1 through 12 are placed in the center of the book so that they may be removed easily for reference. Please remove them now so that you will have them available when needed.

Units of Electrical Measurement

1. Electrical energy comes from two main sources. The energy used in houses, on farms, and in factories comes from large generators. A flashlight gets its electrical energy from ________________.

2. The current obtained from a battery is direct current (dc). Direct current always flows in ________________ direction.

3. Most of the electrical energy used in homes, factories, and businesses is distributed as an alternating current, that is, it flows first in one ________________ and then ________________.

4. One basic unit of measurement of electrical energy is the <u>coulomb</u>.

   A coulomb is the same kind of measurement as a gallon; therefore, a coulomb is a measurement of (pressure/quantity).

5. A better known unit of measurement is the <u>ampere</u> (abbreviated amp). An ampere represents the amount of electrical current which provides one coulomb of electrical energy in one second. An ampere is a unit of (rate of flow/pressure).

6. A third unit is the unit of resistance, the <u>ohm</u>. Wires that carry an electrical current never do it perfectly; they always offer some ________________.

7. Resistance is expressed as so many ________________.

8. Fill in the chart.

Unit name	Unit of
coulomb	quantity
______________	rate of flow (current)
______________	resistance to flow

9. The fourth unit of measurement is the volt.

An electrical "push" of one volt is needed to cause one ampere to flow through a resistance of one ohm. The volt is a unit of (quantity/rate/pressure).

10. To make a current of one ampere flow through a resistance of one ohm requires an electrical pressure of one ______________.

11. Electrical pressure is measured in ______________, current is measured in ______________, and resistance is measured in ______________.

Ohm's Law

12. The relationship of volts, amperes, and ohms can be expressed as a mathematical equation.

1 volt = 1 ampere x 1 ohm (the ohm symbol is Ω).

To cause 5 amp to flow through 1 ohm requires ______________ volts.

13. The statement, v = amp x ohms, is known as Ohm's law. According to Ohm's law, if a pressure of 10 volts is applied to 2 ohms (10 volts = amp x 2 ohms), a current of ______________ amperes results.

14. A pressure of 25 volts causes 2 amperes to flow through an unknown resistance.

v = amp x ohms; ohms = ?

Ohm's law can be applied to find that the resistance is ______________ ohms.

15. Find the unknown quantity.

Volts	Amperes	Ohms
30	2	____
____	10	10
100	____	50

16. Ohm's law is frequently written in this form:

$$E = IR.$$

E is the electromotive force or pressure measured in ________________.

I is the intensity of the current measured in ________________.

R is the resistance measured in ________________.

17. Ohm's law states that E = ______________.

18. Ohm's law is also expressed as

$$I = \frac{E}{R} \text{ and as } R = \frac{E}{I}.$$

Both equations are just different algebraic forms of the same equation, E = ________________.

Although the two forms

$$I = \frac{E}{R} \quad \text{and} \quad R = \frac{E}{I}$$

can be used when solving for I or for R, it is about as easy to use the simpler form, E = IR, putting in the two known values. This makes it unnecessary to remember the two equations in the fraction form.

19. In the equation E = IR, E is measured in ________________, I in ________________, and R in ________________.

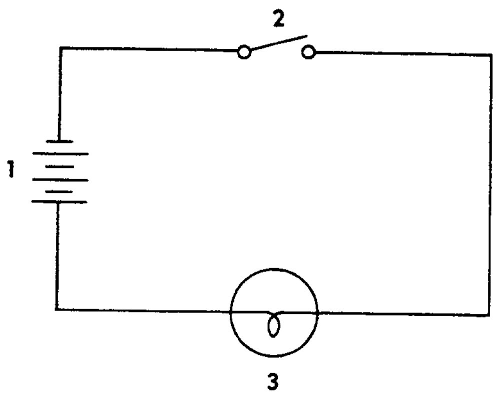
Symbols

20. A special kind of shorthand is used to describe electrical circuits.

    Exhibit 1 shows some of the symbols used in drawing electrical circuits.

    A straight line indicates a _______________.

21. Here is a simple circuit.



    This circuit shows that a (1) _______________ is connected by conductors to a (2) _______________ and a (3) _______________.

Series and Parallel Circuits

22. In the circuit above, the lamp is not lit because the switch is _______________.

23. The simple circuit above can be traced from the battery through the switch, through the lamp, and back to the battery.

    A circuit that can be traced through each component in order is called a (series/parallel) circuit.

EXHIBIT 1

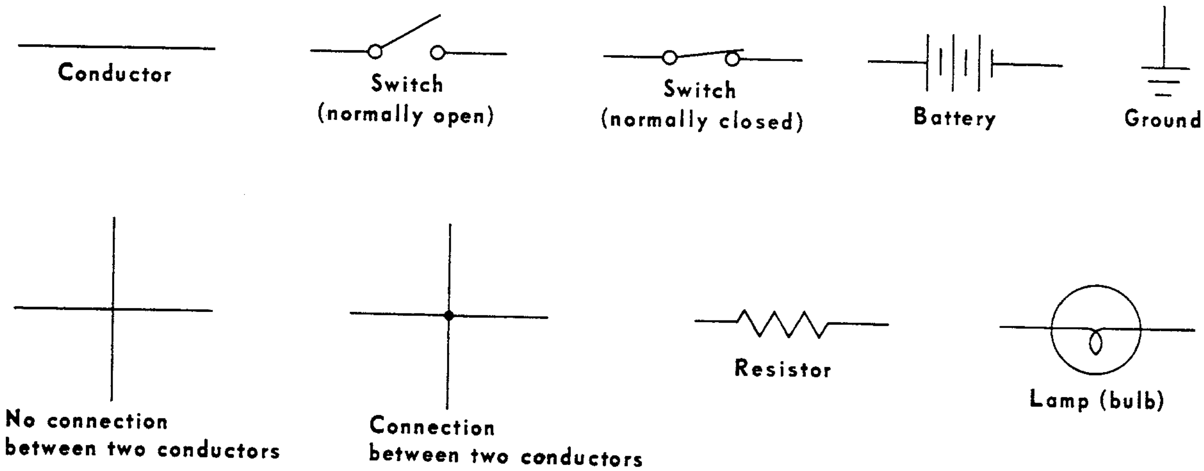


EXHIBIT 2

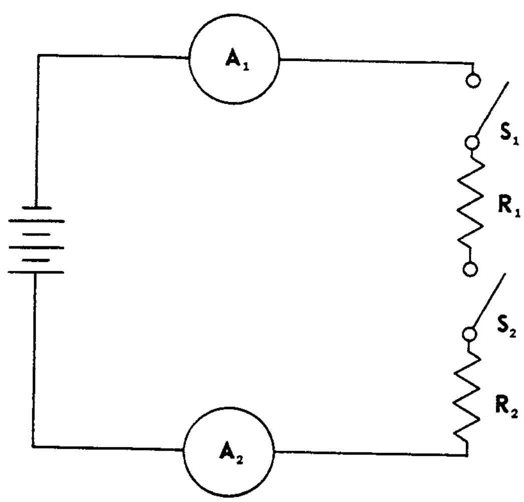


Figure 1

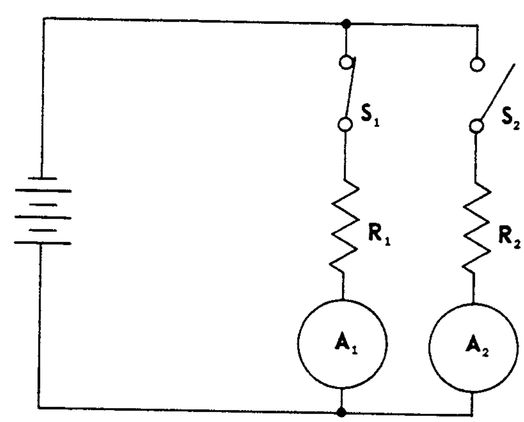
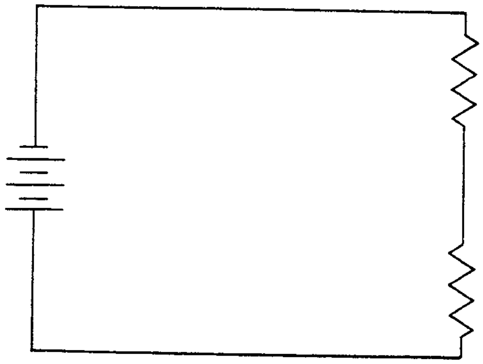


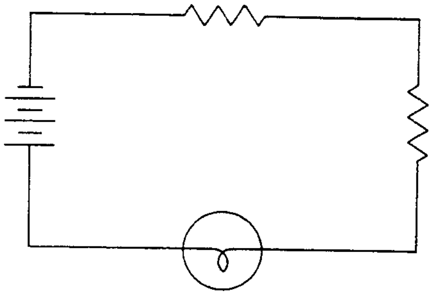
Figure 2

24. Here is another series circuit.



This circuit consists of two ______________ connected in series to a battery.

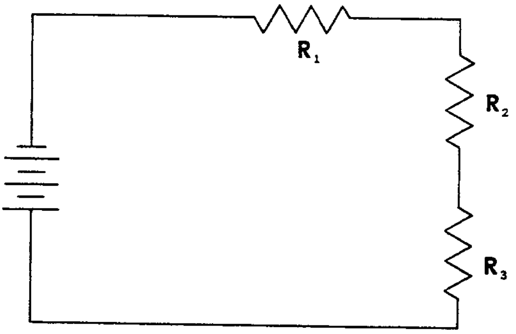
25. Look at this circuit.



The parts in this circuit are connected in ______________.

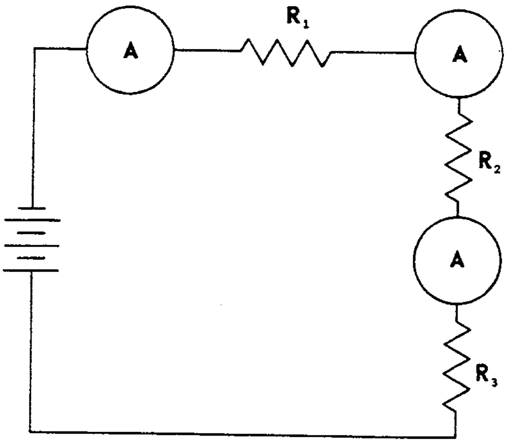
26. In the circuit above, if one could follow a single electrical charge from one end of the battery back to the other, it would demonstrate that in a series circuit, (the same/a different) current flows through every part in the circuit.

27. Look at this circuit.



Because the resistors R_1, R_2, and R_3 are connected in series across the battery, the ______________ current flows through them all.

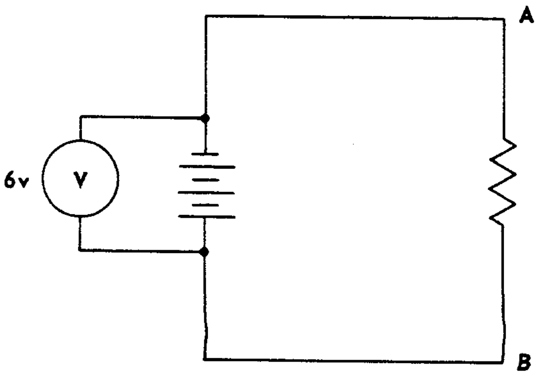
28. Meters to measure current (ammeters) can be connected in the circuit like this.



If the ammeter at R_1 reads 2 amperes, the meter at R_2 reads ______________ amperes and the meter at R_3 reads ______________ amperes.

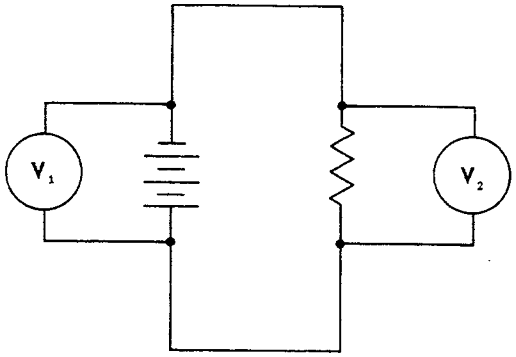
29. No matter where current meters are connected in a series circuit, the meters read the ______________ current.

30. In this circuit, a voltmeter is connected across (in parallel with) the battery to measure its voltage.



The meter reads 6 volts. If the meter were connected to points A and B across the resistor, it would read ______________ volts.

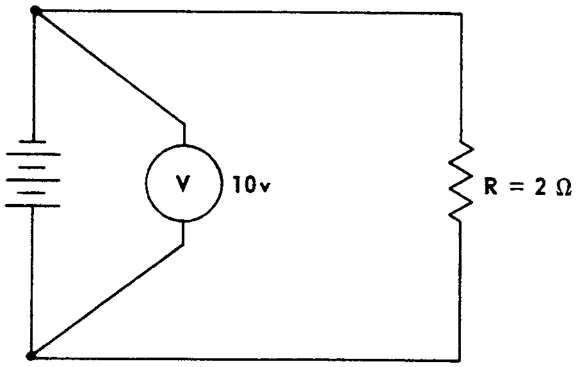
31. Two voltmeters are connected as shown in this circuit.



Meter V_2 reads 10 volts. Meter V_1 must read ________________ volts.

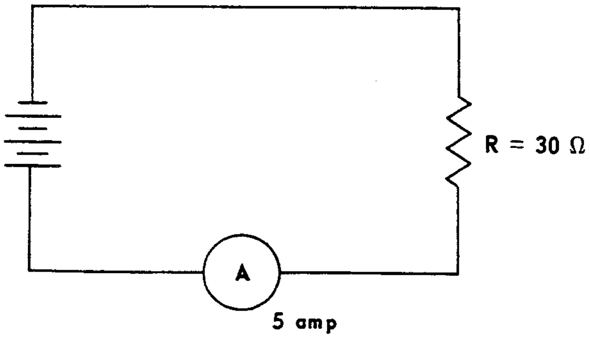
32. In a circuit such as the one above, the voltage across the battery and the voltage across the resistor are ________________.

33. Look at this circuit.



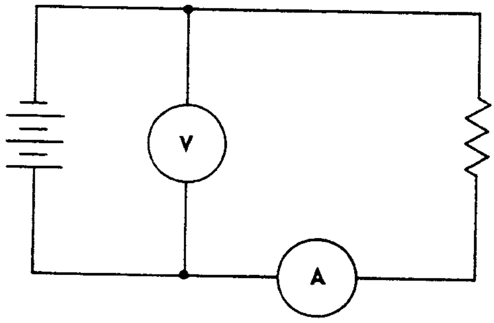
The current flowing through R is ________________ amperes (E = IR).

34. Calculate the voltage of the battery.



Battery voltage = ________________.

35. Compare the way in which a voltmeter and an ammeter are connected in a circuit.



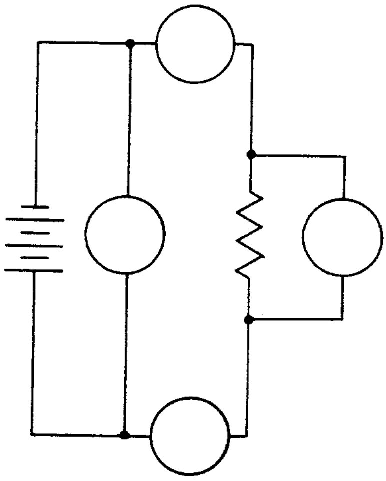
The ________________ is connected across (in parallel with) the battery.

The ________________ is connected in series with the other components.

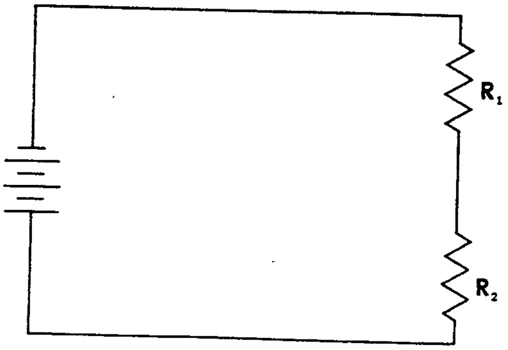
36. An ammeter must always be connected in series with the components of the circuit in which the flow of electricity is being measured because the same ________________ must flow through it and the other parts.

37. A voltmeter must be connected across (in parallel with) the component in which voltage is being measured because the volt is a measurement of electrical ________________, not flow.

38. Identify each ammeter with an A, each voltmeter with a V.

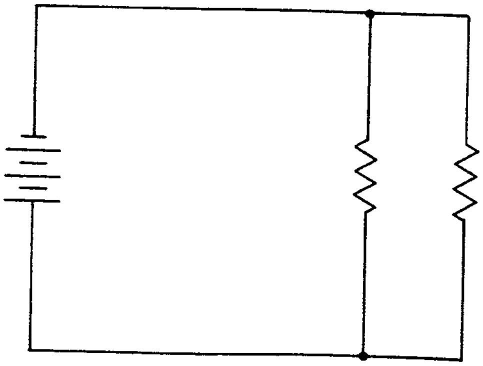


39. Look at this circuit.



The circuit is a (series/parallel) circuit.

40. Here is another circuit with one battery and two resistors.



The resistors are connected across the battery in (series/parallel).

Resistance in Series Circuits

41. Look at Exhibit 2. Figure 1 is a circuit consisting of two ammeters, A_1 and A_2, two switches, S_1 and S_2, and two resistors, R_1 and R_2, connected in ________________.

42. In Figure 1, if S_1 and S_2 are closed and if A_1 reads 2 amperes, A_2 must read ________________ amperes.

43. In Figure 1, if S_1 is open, A_1 and A_2 read ________________ amperes.

44. In Figure 1, if S_1 is closed and S_2 is open, the ammeters read ________________ amperes.

45. In a series circuit, the current flowing throughout the circuit is (the same/different) no matter where it is measured.

In a series circuit, if a switch is open anywhere in the circuit, current (flows/does not flow) in that circuit.

46. Look at Figure 2 in Exhibit 2. S_1 is closed, the battery voltage is 10 volts, and R_1 is a 10-ohm resistor. According to Ohm's law, the current through R_1 is ______________ amperes.

47. Now assume that S_2 is closed, the battery voltage is 10 volts, and R_2 is a 5-ohm resistor.

The current through R_2, as measured by A_2, should be ______________ amperes.

48. If R_1 is 10 ohms and R_2 is 5 ohms, the currents through A_1 and A_2 (are/are not) equal.

49. In a series circuit, the current throughout the circuit is the same.

In a parallel circuit, the currents in the parallel branches (are/need not be) equal.

50. In Figure 1, if S_1 is open, the current through (R_1 / R_2 / both R_1 and R_2) is interrupted.

51. In Figure 2, if S_1 is open, the current through (R_1 / R_2 / both R_1 and R_2) is interrupted.

52. Assume that Figure 1 shows S_1 and S_2 closed. If S_2 is then opened, current (continues to flow/ no longer flows) through R_1.

Current (flows/does not flow) through R_2.

In Figure 2, assume that S_1 and S_2 are in the positions shown. Current (flows/does not flow) through R_1.

Current (flows/does not flow) through R_2.

53. Opening one branch of a parallel circuit (affects/does not affect) the other parallel branches in that circuit.

54. Look at Exhibit 3. In Figure 1, R_1 and R_2 are in series and the current must flow through both of them. The total resistance of R_1 and R_2 is the ________________ of the two resistances.

55. In Figure 1, the two resistors, R_1 and R_2 (R_1 = 6 ohms, R_2 = 4 ohms), can be replaced by a single ________________-ohm resistor without affecting the current.

56. In a series circuit, the total resistance in the circuit is (the sum of the individual resistances/equal to the single largest resistance).

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).

EXHIBIT 3

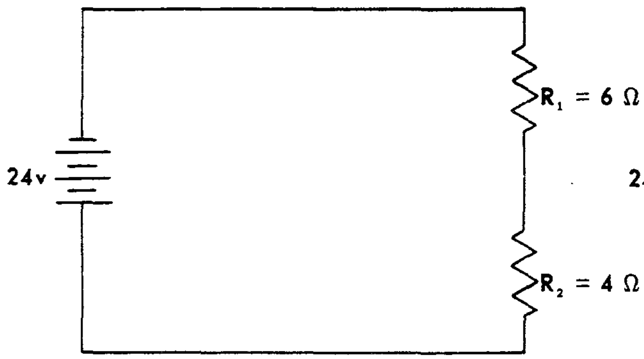


Figure 1

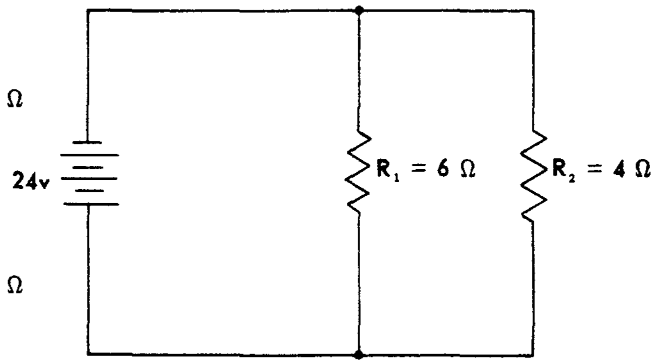


Figure 2

EXHIBIT 4

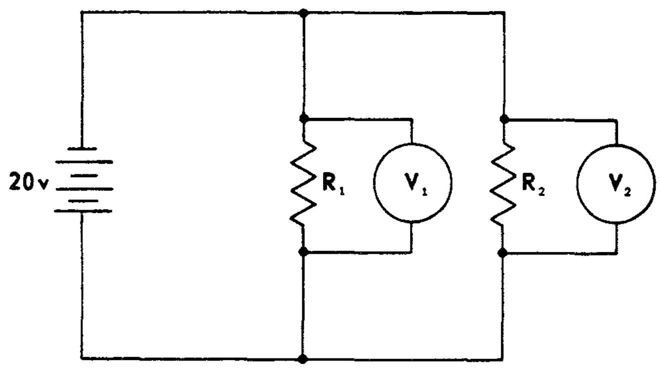


EXHIBIT 5