# Physics 11
## Circuits Unit Retest Solutions

| | a. | b. | c. | d. |
|---|---|---|---|---|
| 1. | X | | | |
| 2. | | X | | |
| 3. | | | X | |
| 4. | | | | X |
| 5. | | X | | |
| 6. | | | | X |
| 7. | | | | X |
| 8. | | X | | |
| 9. | | X | | |
| 10. | | | | X |
| 11. | | X | | |
| 12. | | | | X |
| 13. | X | | | |
| 14. | X | | | |
| 15. | | X | | |
| 16. | | | X | |
| 17. | | | X | |
| 18. | | | X | |
| 19. | | X | | |
| 20. | | | | X |

1. **Problem**
   The current flowing in an electric circuit can be increased by
   a. increasing voltage and decreasing resistance
   b. decreasing voltage and increasing resistance
   c. increasing voltage and increasing resistance
   d. decreasing voltage and decreasing resistance

   **Solution**
   Ohm's law states that
   $$I = \frac{V}{R}$$
   Therefore, current can be increased by increasing voltage and decreasing resistance.

2. **Problem**
   An ammeter is connected in _________ and a voltmeter is connected in ________.
   a. series, series
   b. series, parallel
   c. parallel, series
   d. parallel, parallel

   **Solution**
   An ammeter is connected in series and a voltmeter is connected in parallel.

3. **Problem**
   A battery is rated at $3.7\,\mathrm{V}$ and $2100\,\mathrm{mAh}$. How much energy does the battery store at full charge?
   a. $14.7\,\mathrm{kJ}$
   b. $22.4\,\mathrm{kJ}$
   c. $28\,\mathrm{kJ}$
   d. $31.2\,\mathrm{kJ}$

   **Solution**
   Convert to SI units and multiply the voltage by the charge:
   $$E = QV = (2100\,\mathrm{mAh} \times 3.6\,\mathrm{C/mAh})(3.7\,\mathrm{V}) = 28\,\mathrm{kJ}$$

4. **Problem**
   What voltage is applied across a $2.7\,\Omega$ resistor if the current is $5.8\,\mathrm{A}$?
   a. $4.8\,\mathrm{V}$
   b. $13\,\mathrm{V}$
   c. $0.44\,\mathrm{V}$
   d. $16\,\mathrm{V}$

   **Solution**
   Use Ohm's law:

$$V = IR = (5.8\,\mathrm{A})(2.7\,\Omega) = 16\,\mathrm{V}$$

5. **Problem**
   A lamp draws a current of $8.5\,\mathrm{A}$ when it is connected to a $6.4\,\mathrm{V}$ source. What is the resistance of the lamp?

   a. $1.3\,\Omega$
   b. $0.75\,\Omega$
   c. $0.67\,\Omega$
   d. $54\,\Omega$

   **Solution**
   Use Ohm's law:

$$R = \frac{V}{I} = \frac{6.4\,\mathrm{V}}{8.5\,\mathrm{A}} = 0.75\,\Omega$$

6. **Problem**
   A lamp with a resistance of $6.8\,\Omega$ is placed across a potential difference of $8.5\,\mathrm{V}$. What is the current through the lamp?

   a. $30\,\mathrm{A}$
   b. $0.8\,\mathrm{A}$
   c. $58\,\mathrm{A}$
   d. $1.2\,\mathrm{A}$

   **Solution**
   Use Ohm's law:

$$I = \frac{V}{R} = \frac{8.5\,\mathrm{V}}{6.8\,\Omega} = 1.2\,\mathrm{A}$$

7. **Problem**
   A voltage source of $6.1\,\mathrm{V}$ delivers a current of $6.2\,\mathrm{A}$ to an electric motor that is connected across its terminals. What power is consumed by the motor?

   a. $66\,\mathrm{W}$
   b. $0.98\,\mathrm{W}$
   c. $62\,\mathrm{W}$
   d. $38\,\mathrm{W}$

   **Solution**
   Use the formula for the power in a circuit:

$$P = IV = (6.2\,\mathrm{A})(6.1\,\mathrm{V}) = 38\,\mathrm{W}$$

8. **Problem**
   An electronic device is powered by a $4.4\,\mathrm{V}$ battery. The current used to operate the device is $190\,\mathrm{mA}$. How much energy does the device use in $9.4\,\mathrm{minutes}$?

   a. $7.9\,\mathrm{J}$
   b. $470\,\mathrm{J}$
   c. $110\,\mathrm{J}$
   d. $7900\,\mathrm{J}$

   **Solution**
   Find the power of the device using $P = IV$ and multiply by the time. Remember to convert all units.

   $$E = Pt = IVt = (0.19\,\mathrm{A})(4.4\,\mathrm{V})(9.4 \times 60\,\mathrm{s}) = 470\,\mathrm{J}$$

9. **Problem**
   As more resistors are added in **series** to a constant voltage source, the power supplied by the source

   a. increases.
   b. decreases.
   c. remains the same.
   d. not enough information.

   **Solution**
   The total resistance increases, causing the total current to decrease. Since the voltage is constant and $P = IV$, the power decreases.

10. **Problem**
    Three resistors are connected in **series**. Their resistances are $33\,\Omega$, $66\,\Omega$, and $78\,\Omega$. What is the equivalent resistance of the resistors?

    a. $95\,\Omega$
    b. $160\,\Omega$
    c. $220\,\Omega$
    d. $180\,\Omega$

    **Solution**
    The equivalent resistance of resistors in series is the sum of the resistances.

    $$R = R_1 + R_2 + R_3 = 177\,\Omega$$

11. **Problem**
    When different resistors are connected in parallel, it is true that

    a. the power dissipated in each is the same.
    b. the potential difference across each is the same.
    c. their equivalent resistance is greater than the resistance of one of the resistors.
    d. the same current flows in each one.

    **Solution**
    The potential difference is the same across resistors in parallel.

12. **Problem**
You have a $60\,\mathrm{W}$ light bulb and a $100\,\mathrm{W}$ light bulb. Instead of connecting them the normal way, you make a circuit that places them in series across the normal household voltage. Which statement is correct?

    a. Both bulbs glow at the same reduced brightness.
    b. Both bulbs glow at the same increased brightness.
    c. The $100\,\mathrm{W}$ bulb glows brighter than the $60\,\mathrm{W}$ bulb.
    d. The $60\,\mathrm{W}$ bulb glows brighter than the $100\,\mathrm{W}$ bulb.

    **Solution**
    The $60\,\mathrm{W}$ bulb has a higher resistance than the $100\,\mathrm{W}$, which is why it is normally dimmer (bulbs are normally connected in parallel). However, when the two bulbs are connected in series, there is a greater voltage drop across the $60\,\mathrm{W}$, making it brighter (the current is the same for bulbs in series).

13. **Problem**
A total of 495 resistors, all with resistance $147\,\Omega$, are connected in **parallel**. What is the equivalent resistance of the resistors?

    a. $0.3\,\Omega$
    b. $0.38\,\Omega$
    c. $0.41\,\Omega$
    d. $0.34\,\Omega$

    **Solution**
    The equivalent resistance of resistors in parallel when they all have the same resistance $R_i$ is

$$R = \left(\frac{1}{R_i} + \frac{1}{R_i} + \frac{1}{R_i} + ...\right)^{-1} = \frac{R_i}{495} = 0.3\,\Omega$$

14. **Problem**
A total of 169 Christmas light bulbs, all with resistance $0.52\,\Omega$, are connected in **series**. What is the equivalent resistance of the lights?

    a. $88\,\Omega$
    b. $110\,\Omega$
    c. $120\,\Omega$
    d. $50\,\Omega$

    **Solution**
    The equivalent resistance of resistors in series when they all have the same resistance $R_i$ is

$$R = R_i + R_i + R_i + ... + R_i = 169R_i = 88\,\mathrm{k}\Omega$$

15. **Problem**
Two resistors are connected in **parallel**. Their resistances are $220\,\Omega$ and $415\,\Omega$. A battery applies $4.2\,\text{V}$ to the combination. What is the current through the $220\,\Omega$ resistor?

   a. $16\,\text{mA}$
   b. $19\,\text{mA}$
   c. $14\,\text{mA}$
   d. $12\,\text{mA}$

**Solution**
The full voltage of the battery is applied to both resistors. The current through the first resistor is

$$I = \frac{V}{R} = \frac{4.2\,\text{V}}{220\,\Omega} = 19\,\text{mA}$$

16. **Problem**
Two resistors are connected in **series**. Their resistances are $4\,\Omega$ and $1\,\Omega$. A difference in potential of $18\,\text{V}$ is applied to the combination. What is the current through the $1\,\Omega$ resistor?

   a. $2.8\,\text{A}$
   b. $2.4\,\text{A}$
   c. $3.6\,\text{A}$
   d. $3.2\,\text{A}$

**Solution**
The equivalent resistance of resistors in series is the sum of the resistances.

$$R = R_1 + R_2 + R_3 = 5\,\Omega$$

The current is the same through all components in series and its value is

$$I = \frac{V}{R} = \frac{18\,\text{V}}{5\,\Omega} = 3.6\,\text{A}$$

17. **Problem**
Two resistors are connected in **parallel**. Their resistances are $36\,\Omega$ and $37\,\Omega$. A battery applies $16\,\text{V}$ to the combination. What is the current drawn from the battery?

   a. $1.6\,\text{A}$
   b. $1.2\,\text{A}$
   c. $0.88\,\text{A}$
   d. $1\,\text{A}$

**Solution**
The equivalent resistance of resistors in parallel is

$$R = \left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right)^{-1} = 18.2465753\,\Omega$$

The current drawn from the battery is

$$I = \frac{V}{R} = \frac{16\,\text{V}}{18.2465753\,\Omega} = 0.88\,\text{A}$$

18. **Problem**
Three resistors are connected in **parallel**. Their resistances are $52\,\Omega$, $61\,\Omega$, and $79\,\Omega$. What is the equivalent resistance of the resistors?

a. $14\,\Omega$
b. $19\,\Omega$
c. $21\,\Omega$
d. $16\,\Omega$

**Solution**
The equivalent resistance of resistors in parallel is

$$R = \left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right)^{-1} = 21\,\Omega$$

19. **Problem**
A $400\,\text{mA}$ current flows into a parallel combination of a $93\,\Omega$ and a $71\,\Omega$ resistor. What current flows through the $93\,\Omega$ resistor?

a. $150\,\text{mA}$
b. $170\,\text{mA}$
c. $140\,\text{mA}$
d. $310\,\text{mA}$

**Solution**
The total current is equal to the sum of the current through each resistor

$$I = I_1 + I_2$$

The voltage across each resistor is the same and $V = IR$ so

$$I_1 R_1 = I_2 R_2$$

Combining the two equations and solving for $I_1$ gives

$$I_1 = \left(\frac{R_2}{R_1 + R_2}\right) I = 170\,\text{mA}$$

20. **Problem**
When a battery with an emf of $2.5\,\mathrm{V}$ supplies a $0.39\,\mathrm{A}$ current, its terminal voltage is $1.2\,\mathrm{V}$. What is the internal resistance of the battery?

   a. $2.5\,\Omega$
   b. $6.5\,\Omega$
   c. $4.2\,\Omega$
   d. $3.3\,\Omega$

**Solution**
The terminal resistance is related to the emf by $V_{terminal} = \mathcal{E} - Ir$. Therefore,

$$r = \frac{\mathcal{E} - V_{terminal}}{I} = 3.3\,\Omega$$