1. A battery with EMF of 4.5 volts has an internal resistance of 0.450 Ω. What is the terminal voltage when 0.26 A of current flows through the battery?

$$V_{term} = \mathcal{E} - Ir$$
$$= 4.5V - 0.26A \times 0.450\Omega$$
$$= 4.383V$$
$$\approx 4.4V$$

2. A battery with EMF of 2.9 volts has terminal voltage of 2.6 volts when 0.85 A of current flows through the battery. What is the internal resistance of the battery?

$$V_{term} = \mathcal{E} - Ir$$

$$\frac{V_{term} - \mathcal{E}}{-I} = r$$

$$\frac{2.6V - 2.9V}{-0.85A} = 0.3529\Omega \approx 0.35\Omega$$

3. A battery has internal resistance of 1.3 Ω terminal voltage of 6.8 volts. What is the EMF? $I = 1.2$

$$V_{term} + Ir = \mathcal{E}$$

$$6.8V + (1.2A \times 1.3\Omega) = 8.36V$$
$$\approx 8.4V$$

4. A load with resistance of 13.2 Ω, is connected to a battery with EMF of 12.0 V and internal resistance of 0.963 Ω.

   a. What is the total resistance of the circuit?

$$13.2\,\Omega + 0.963\,\Omega = 14.163\,\Omega \approx 14.2\,\Omega$$

   b. What is the total current of the circuit?

$$I = \frac{V}{R} = \frac{12.0\,V}{14.163\,\Omega} = 0.848896\,A \approx 0.849\,A$$

   c. What is the terminal voltage of the battery?

$$V_{term} = \mathcal{E} - Ir = 12.0\,V - 0.848896\,A \times 0.963 = 11.1825\,V \approx 11.2\,V$$

   d. How much power does the load draw?

$$P = VI = (11.1825\,V)(0.849\,A) = 9.49 \text{ watts}$$

5. A load with resistance of 22.5 Ω, is connected to a battery with terminal voltage of 4.5 V and EMF of 4.7 V.

   a. What is the current of the circuit?

$$I = \frac{V}{R} = \frac{4.5\,V}{22.5\,\Omega} = 0.20\,A$$

   b. What is the internal resistance of the battery?

$$r = \frac{V_{term} - \mathcal{E}}{-I} = \frac{4.5\,V - 4.7\,V}{-0.20\,A} = 1.0\,\Omega$$

0.085 A ↙

6. An electrical device has resistance of 24 Ω and requires a current of 85 mA to operate. It is connected to a battery with EMF of 3.0 volts. What is the maximum internal resistance the battery can have before the device stops working?

What V_{term} is required?

$$V = Ir$$
$$= (0.085A)(24\Omega)$$
$$= 2.04 V$$

What is r?

$$r = \frac{V_{term} - \mathcal{E}}{-I} = \frac{2.04V - 3.0V}{-0.085A} = 11.29\Omega$$
$$\approx 11\Omega$$

7. An electrical light draws 85 watts of power ~~from a 12 volt battery.~~ The internal resistance of the battery is 2.3 Ω. ~~What is the terminal voltage of the battery?~~ Current is 2.1A EMF?

$$P = VI$$

$$\frac{P}{I} = V_{term}$$

$$\frac{85W}{2.1A} = 40.48V \leftarrow V_{term}$$

$$\mathcal{E} = V_{term} + Ir$$
$$= 40.48 + 2.1A \times 2.3\Omega$$
$$= 45.31V$$
$$\approx 45V$$

8. A battery is connected to a 45 Ω load and the terminal voltage is 7.5 V. What will the terminal voltage be if it is connected instead to a 15 Ω load?

$r = 0.75\,\Omega$

$$I = \frac{V_{term}}{R_{ext}} = \frac{7.5\,V}{45\,\Omega} = 0.1666667\,A$$

$$\mathcal{E} = V_{term} + Ir = 7.5 + 0.1666667\,A \times 0.75\,\Omega$$
$$= 7.625\,V$$

$$I = \frac{V_{total}}{R_{total}} = \frac{7.625\,V}{15.75\,\Omega} = 0.4841\,A$$

$$V_{term} = \mathcal{E} - Ir = 7.625\,V - 0.4841\,A \times 0.75\,\Omega = \boxed{7.3\,V}$$

~~9. An electrical appliance draws 28 watts of power when connected to a battery with EMF of 22.5 volts and internal resistance of 2.5Ω. What is the resistance of the appliance?~~

~~$P = VI$~~