

Electrical Instruments

Galvanometer – measures current

Voltmeter – measures potential difference

Ammeter – measures current

Ohmmeter – measures resistance

---

---

---

---

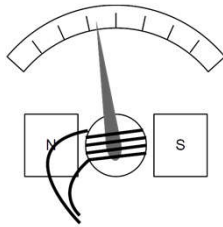
---

---

---

Electrical Instruments

Galvanometer – Current through coil creates a magnetic field that interacts with field due to other magnets. Needle deflection is proportional to current.



---

---

---

---

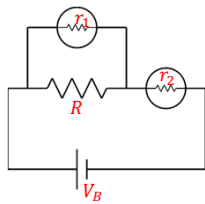
---

---

---

Electrical Instruments

Adding an instrument changes the circuit. The measurement is of the circuit with the instrument and not of the original circuit.



---

---

---

---

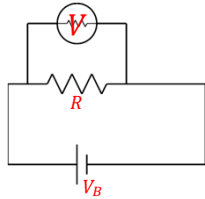
---

---

---

Voltmeter

- Voltmeter connected in parallel to measure potential difference between two points.
- $r_V$  must be large to minimize change from original circuit.




---

---

---

---

---

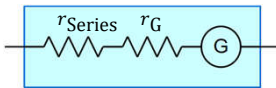
---

---

---

Voltmeter

Creating a voltmeter from a galvanometer



$$r_V = r_{Series} + r_G$$

Given that  $I_{max}$  creates a full-scale deflection, select  $r_{Series}$  such that  $V_{max}$  produces  $I_{max}$  through the galvanometer.

---

---

---

---

---

---

---

---

Example: A galvanometer has an internal resistance of  $12\Omega$  and experiences full deflection with a current of  $0.4A$ . Design a voltmeter using the galvanometer that will read full scale at  $20V$ .

---

---

---

---

---

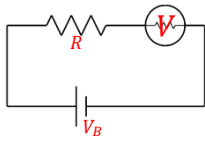
---

---

---

### Voltmeter

What happens if a voltmeter is connected in series?




---



---



---



---



---

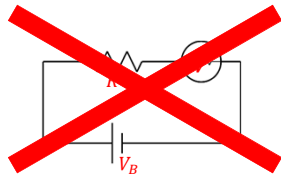


---

### Voltmeter

What happens if a voltmeter is connected in series?

- Circuit is drastically changed.
- Very little current flows.




---



---



---



---



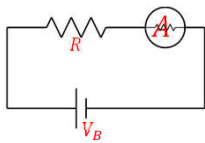
---



---

### Ammeter

- Ammeter connected in series to measure current through resistor.
- $r_A$  must be small to minimize change from original circuit.




---



---



---



---



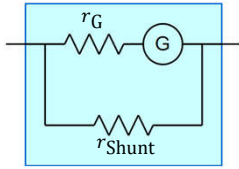
---



---

Ammeter

Creating an ammeter from a galvanometer



$$\frac{1}{r_A} = \frac{1}{r_{Shunt}} + \frac{1}{r_G}$$

Select  $r_{Shunt}$  such that  $I_{A-max}$  produces  $I_{G-max}$  through the galvanometer.

---

---

---

---

---

---

---

---

Example: A galvanometer has an internal resistance of  $12\Omega$  and experiences full deflection with a current of  $0.4A$ . Design an ammeter using the galvanometer that will read full scale at  $10A$ .

---

---

---

---

---

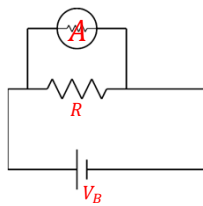
---

---

---

Ammeter

What happens if an ammeter is connected in parallel?



---

---

---

---

---

---

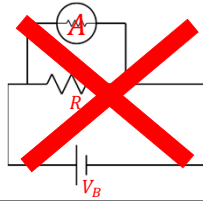
---

---

Ammeter

What happens if an ammeter is connected in parallel?

- Circuit is drastically changed.
- Massive current flows.
- Flash
- Noise
- Smoke
- Smell
- Loss of ammeter
- Angry instructor




---

---

---

---

---

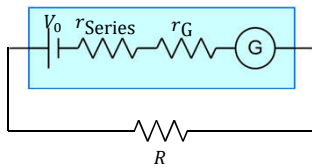
---

---

---

Ohmmeter

Creating an ohmmeter from a galvanometer. Connected to a resistor in isolation, the ohmmeter forms a circuit with the unknown resistor.




---

---

---

---

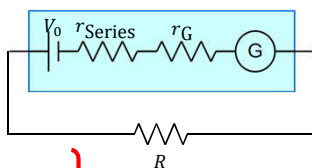
---

---

---

---

Ohmmeter



$$R_T = \frac{V_0}{I}$$

$$R_T = r_{Series} + r_G + R$$

$$R = \frac{V_0}{I} - r_{Series} - r_G$$

---

---

---

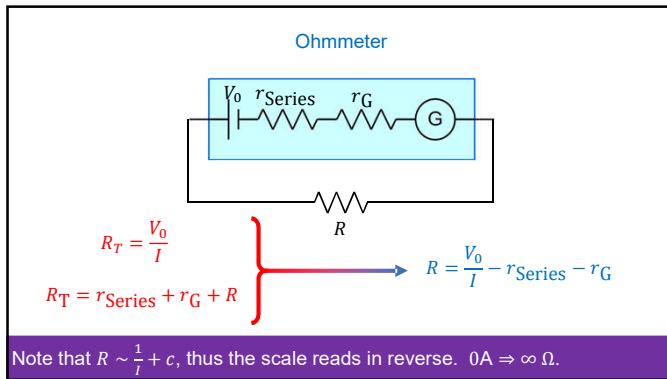
---

---

---

---

---




---



---



---



---



---



---