مراجعة عامة وفق الهيكل الوزاري

مراجعة لهيكل الفيزياء ثاني عشر متقدم

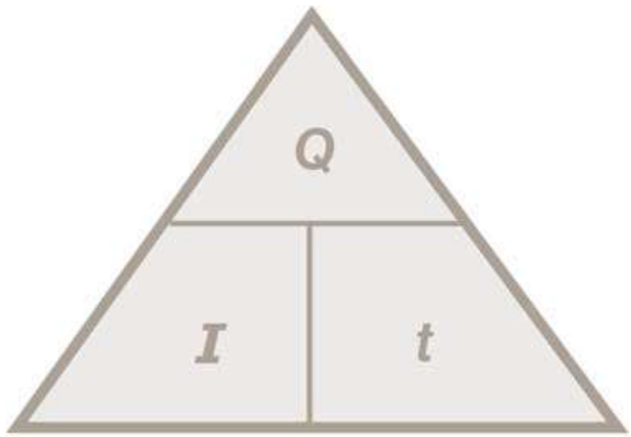
الاستاذ: محمد جمال ابومحفوظ

اهداء

لله الحمد في البداية والختام....له الحمد في السراء والضراء وفي كل وقت وحين ...نحمد الله على هذا الفضل ونرجو رضاه اما بعد اهدي هذا العمل البسيط الى كل من يسعى جاهدا في طلب العلم ولم يستسلم للظروف او للفشل .... الى من سهرت لراحتي الى سيدتي الاولى والاخيرة امي الى صاحب الفضل والسيادة والدي صاحب البهجة والسعادة الى الى عائلتي والاهل والاصدقاء اهدي لكم كلماتي وجهدي واجتهادي لكم خالص شكري وارجو لكم من الله التوفيق والعلم والعمل نضع بين ايديكم هذا العمل نفعنا الله واياكم بما فيه من علم

وقل رب زدني علما

electric current: I, is the net charge passing a given point in a given time, divided by that time.



Q: charge in coulomb "c"

Note: Total charge is conserved, implying that charge flowing in a conductor is never lost. Therefore, the same amount of charge flows into one end of a conductor as emerges from the other end.

I: current in ampere "A"

t: time in second "s"

Example 1: Calculate the current through a wire in which the charge pass through it is 15 micro coulomb in 3s?

ENG: MOHAMMAD JAMAL
+962 7 8769 5012
+971 50 727 0623

Current density “J”: the current per unit area flowing through the conductor at that point.

- The direction of J is defined as the direction of the velocity of the positive charges (or opposite to the direction of negative charges)
- Current density can be expressed as:

$$J = \frac{i}{A}.$$

electromotive force: The potential difference, supplied by a battery or other device.

- (Electromotive force is not a force at all, but rather a potential difference.)
- The potential difference created by the emf device is represented as Vemf
- Solar cells convert light energy from the Sun to electric energy. If you examine a battery, you will find its potential difference (sometimes colloquially called “voltage”) written on it. This “voltage” is the potential difference (emf) that the battery can provide to a circuit.
- Rechargeable batteries also display a rating in mAh (milliampere-hour), which provides information on the total charge the battery can deliver when fully charged. The mAh is another unit of charge:

$$1 \text{ mAh} = (10^{-3} \text{ A})(3600 \text{ s}) = 3.6 \text{ As} = 3.6 \text{ C}.$$

_At least one component must be a source of emf because the potential difference created by the emf device is what drives the current through the circuit.

_An electric circuit starts and ends at an emf device.

_ positive current leaves the device at the higher potential of its positive terminal and enters its negative terminal at a lower potential.

_ This lower potential is conventionally set to zero.

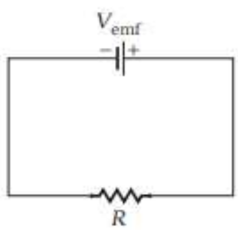
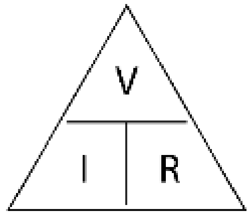


FIGURE 5.10 Simple circuit containing a source of emf and a resistor.

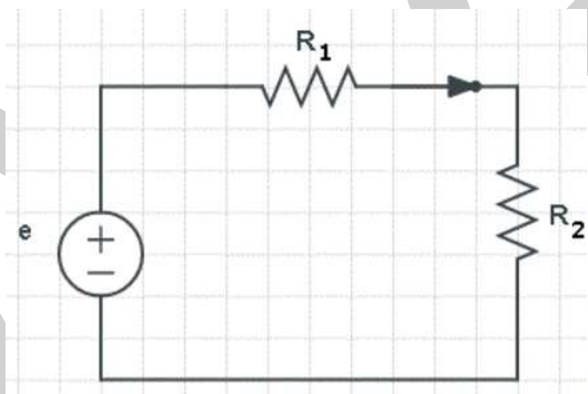
ENG: MOHAMMAD JAMAL
+962 7 8769 5012
+971 50 727 0623

Ohm’s Law



V: potential difference “volt”(v)
I: current “ampere”(A)
R : resistance in ohms()

Example: In the circuit below resistors R1 and R2 are in series and have resistances of 5 Ω and 10 Ω, respectively. The voltage across resistor R1 is equal to 4 V. Find the current passing through resistor R2 and the voltage across the same resistor.



A.Z physics

ENG: MOHAMMAD JAMAL
+962 7 8769 5012
+971 50 727 0623

resistivity, ρ: is a measure of how strongly a material opposes the flow of electric current.

- the resistivity depends on the direction in which the current is flowing.
- the resistivity of a material characterizes how much it opposes the flow of current.
- The resistivity is defined in terms of the magnitude of the applied electric field, E, and the magnitude of the resulting current density, J:

$$\rho = \frac{E}{J}.$$

- The units of resistivity are:

$$[\rho] = \frac{[E]}{[J]} = \frac{\text{V/m}}{\text{A/m}^2} = \frac{\text{V m}}{\text{A}} = \Omega \text{ m}.$$

resistance, R: is a material's opposition to the flow of electric current.

$$R = \frac{\Delta V}{i}. \qquad R = \rho \frac{L}{A}.$$

- resistance of a device depends on the material of which the device is made as well as its geometry.

_The units of resistance are volts per ampere, a combination that was given the name ohm and the symbol Ω

$$1\ \Omega = \frac{1\text{ V}}{1\text{ A}}.$$

ENG: MOHAMMAD JAMAL
+962 7 8769 5012
+971 50 727 0623

conductance, G:

$$G = \frac{i}{\Delta V} = \frac{1}{R}.$$

_ Conductance has the SI derived unit of siemens (S),

$$1\ \text{S} = \frac{1\ \text{A}}{1\ \text{V}} = \frac{1}{1\ \Omega}.$$

conductivity, σ:

$$\sigma = \frac{1}{\rho}.$$

- The units of conductivity are $(\Omega\ \text{m})^{-1}$.

PROBLEM

What is the resistance of the 100.0 m standard 12 gauge copper wire that is typically used in wiring household electrical outlets?

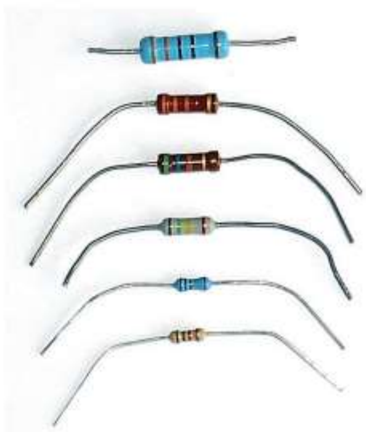
A 12 gauge copper wire has a diameter of 2.053 mm (see Table 5.2). Its cross-sectional area is then

$$A = 3.31\ \text{mm}^2.$$

ENG: MOHAMMAD JAMAL
+962 7 8769 5012
+971 50 727 0623

Resistor Codes

Resistors are commonly made of carbon enclosed in a plastic cover that looks like a medicine capsule, with wires sticking out at the ends for electrical connection. The value of the resistance is indicated by three- or four-color bands on the plastic covering.



(a)

- The values of resistivity and resistance vary with temperature.
- The resistance of both the conductors increases as the temperature of such conductors rises. As a result, we can conclude that resistance and temperature are directly related. Similarly, as the resistance of a conductor is reduced, the temperature is reduced.
- An empirical relationship for the temperature dependence of the resistivity of a metal is

$$\rho - \rho_0 = \rho_0 \alpha (T - T_0),$$

ρ is the resistivity at temperature T.

ρ0 is the resistivity at temperature T0.

α is the temperature coefficient of electric resistivity for the conductor.

- the temperature dependence of the resistance of a conductor can be approximated as

$$R - R_0 = R_0 \alpha (T - T_0).$$

R is the resistance at temperature T.

R0 is the resistance at temperature T0.

α is the temperature coefficient of electric resistivity for the conductor.

ENG: MOHAMMAD JAMAL
+962 7 8769 5012
+971 50 727 0623

- Super conductors: At very low temperatures, the resistivity of some materials goes to exactly zero

- The resistance of some semiconducting materials decreases as the temperature increases, which implies a negative temperature coefficient of electric resistivity.

- A thermistor: is a semiconductor whose resistance depends strongly on temperature.
  _ Thermistors are used to measure temperature.

  in Figure 5.9a. Here you can see that the resistance of a thermistor falls with increasing temperature. This drop contrasts with the increase in resistance of a copper wire over the same temperature range, shown in Figure 5.9b.

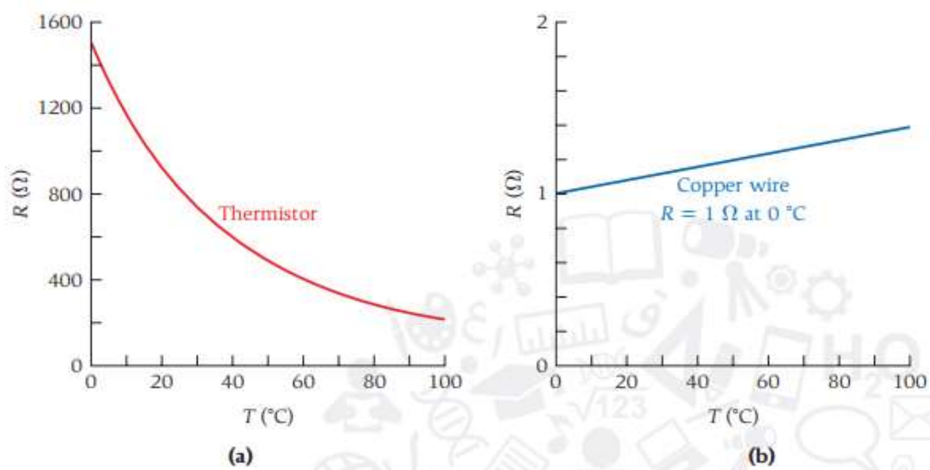


FIGURE 5.9 (a) The temperature dependence of the resistance of a thermistor. (b) The temperature dependence of the resistance of a copper wire that has a resistance of 1 Ω at $T = 0$ °C.

A.Z physics

ENG: MOHAMMAD JAMAL
+962 7 8769 5012
+971 50 727 0623

_Energy and Power in Electric Circuits:

$$P = i\Delta V = i^2R = \frac{(\Delta V)^2}{R}.$$

Example:

A 100-W light bulb is connected in series to a source of emf with $V_{emf} = 100$ V. When the light bulb is lit, the temperature of its tungsten filament is 2520 °C.

PROBLEM

What is the resistance of the light bulb's tungsten filament at room temperature (20 °C)?

_temperature coefficient of resistivity for tungsten from Table 5.1 = $(4.5 \cdot 10^{-3}\ °C^{-1})$

ENG: MOHAMMAD JAMAL
+962 7 8769 5012
+971 50 727 0623

Series Circuits

series circuit: "A circuit such as this, in which there is only one path for the current".

- Current has to be the same everywhere along a wire, and also in a resistor, because charge is conserved everywhere. No charge is lost or gained along the wire, and so the current is the same everywhere around the loop

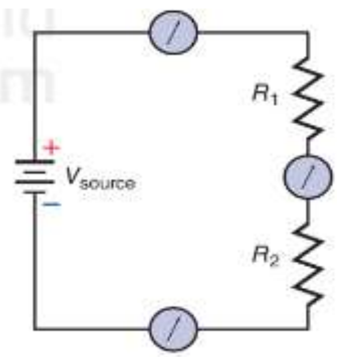
In Series Circuits:

$$\Delta V_{source} = \Delta V_1 + \Delta V_2.$$

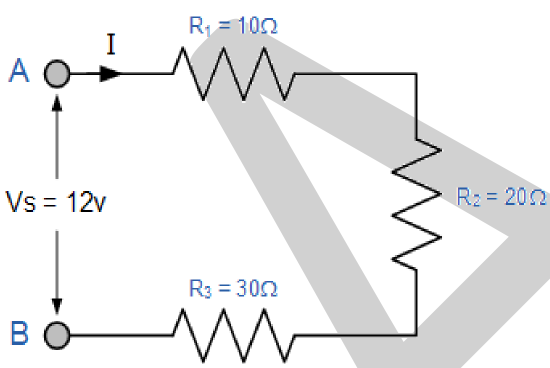
$$I_{source} = I_1 = I_2$$

$$R_{eq} = R_1 + R_2$$

$$P = I\Delta V \text{.....(POWER)}$$



Example:



Find:

1-Req.

2-Potential difference for each resistance.

3-what happened to Req and current if we remove R2?

ENG: MOHAMMAD JAMAL
+962 7 8769 5012
+971 50 727 0623

Parallel Circuits

Parallel Circuits: A circuit in which there are several current paths is called a parallel circuit.

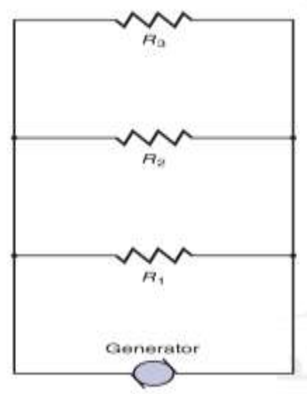
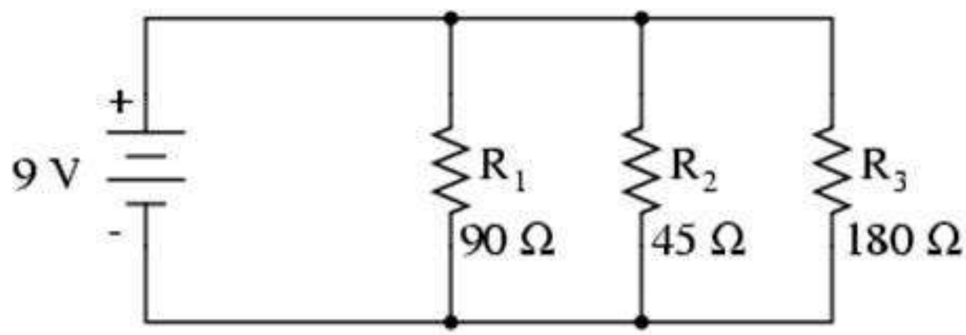


Figure 6 The parallel paths for current in this diagram are analogous to the multiple paths that a river might take down a mountain.

- The three resistors are connected in parallel; both ends of the three paths are connected together.
- Current in a parallel circuit:
- $I = I_1 + I_2 + I_3.$
- Voltage in a parallel circuit:
- $V_S = V_1 = V_2 = V_3 = ...$
- EQUIVALENT RESISTANCE FOR RESISTORS IN PARALLEL:
- $$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + ...$$

ENG: MOHAMMAD JAMAL
+962 7 8769 5012
+971 50 727 0623

Example:



Find:

1-Req.

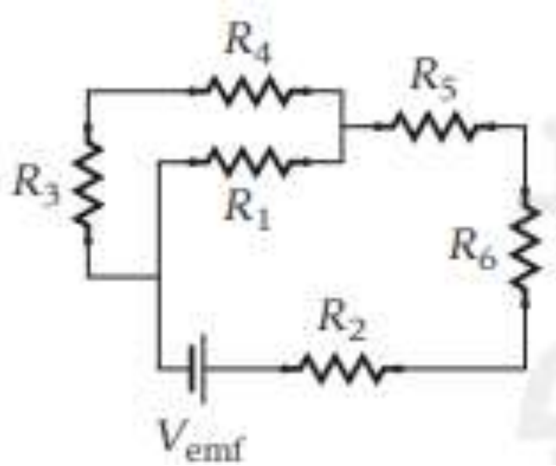
2-current for each resistance.

3-what happened to current and Req if we remove R2?

Example:

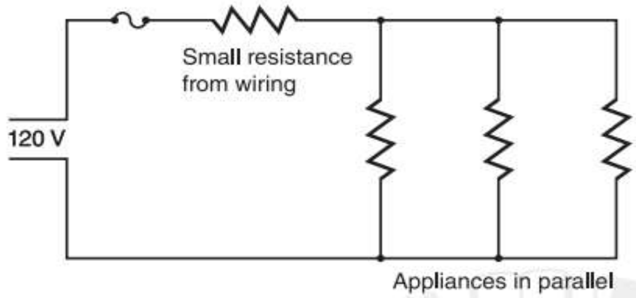
R1=3,R2=2,R3=1,R4=3,R5=6,R6=1

Find Req



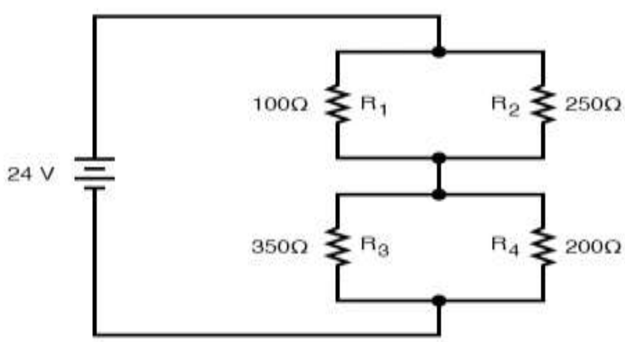
ENG: MOHAMMAD JAMAL
+962 7 8769 5012
+971 50 727 0623

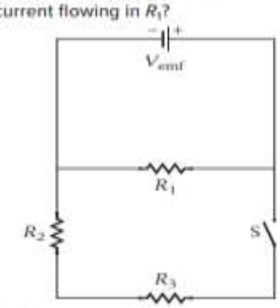
- **Combined Series-Parallel Circuits:** Circuits that contain series and parallel branches are called combination series-parallel circuits.



Example:

A series-parallel combination circuit




In the circuit in the figure, there are three identical resistors. The switch, S, is initially open. When the switch is closed, what happens to the current flowing in R_1?

a) The current in R_1 decreases.

b) The current in R_1 increases.

c) The current in R_1 stays the same.

Find:

1-Req

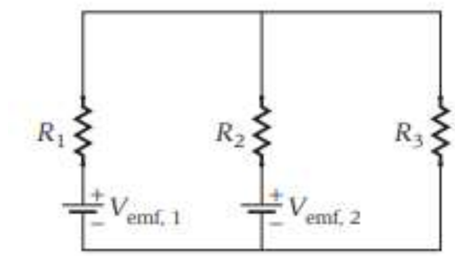
2-Is

3-V1

ENG: MOHAMMAD JAMAL
+962 7 8769 5012
+971 50 727 0623

Kirchhoff’s Junction Rule (***conservation of charge***): The sum of the currents entering a junction must equal the sum of the currents leaving the junction.

- A junction is a place in a circuit where three or more wires are connected to each other.
- Each connection between two junctions in a circuit is called a branch
- A branch can contain any number of different circuit elements and the wires between them.
- them. Each branch can have a current flowing, and this current is the same everywhere in the branch.



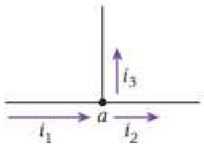
_With a positive sign assigned (arbitrarily) to currents entering the junction and a negative sign to those exiting the junction, Kirchhoff’s Junction Rule is expressed mathematically as:

$$\text{Junction: } \sum_{k=1}^{n} i_k = 0.$$

$$\sum |I_{in}| = \sum |I_{out}|$$

ENG: MOHAMMAD JAMAL
+962 7 8769 5012
+971 50 727 0623

Example:

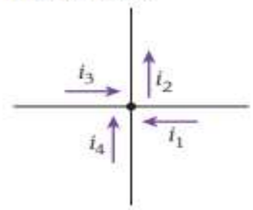


solution by Kirchhoff’s Junction Rule:

$$i_1 = i_2 + i_3.$$

Concept Check 6.1

For the junction shown in the figure, which equation correctly expresses the sum of the currents?



a) $i_1 + i_2 + i_3 + i_4 = 0$

b) $i_1 - i_2 + i_3 + i_4 = 0$

c) $-i_1 + i_2 + i_3 - i_4 = 0$

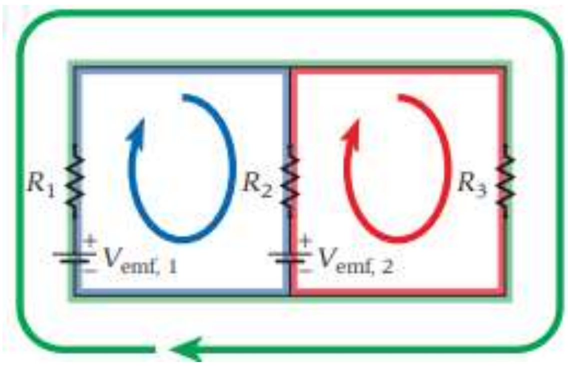
d) $i_1 - i_2 - i_3 - i_4 = 0$

e) $i_1 + i_2 - i_3 - i_4 = 0$

ENG: MOHAMMAD JAMAL
+962 7 8769 5012
+971 50 727 0623

Kirchhoff’s Loop Rule (conservation of energy): The potential difference around a complete circuit loop must sum to zero.

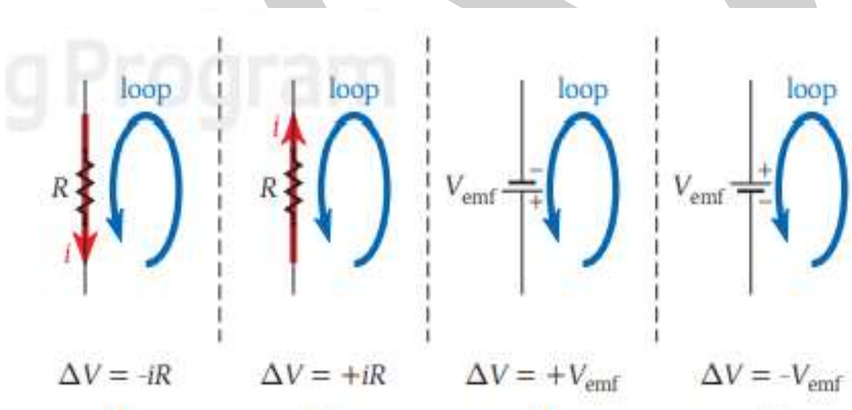
Q: how much loop in the circuit?



_Kirchhoff’s Loop Rule is written in mathematical form as:

$$\text{Closed loop:} \quad \sum_{j=1}^{m} V_{emf,j} - \sum_{k=1}^{n} i_k R_k = 0.$$

save in your mind:



ENG: MOHAMMAD JAMAL
+962 7 8769 5012
+971 50 727 0623

Single-Loop Circuits

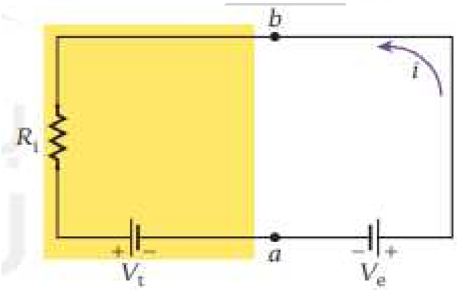
- In the single-loop circuit, there are no junctions, and so the entire circuit consists of a single branch "The current is the same everywhere in the loop".

SOLVED PROBLEM 6.1 **Charging a Battery**

A 12.0 V battery with internal resistance $R_i = 0.200\ \Omega$ is being charged by a battery charger that is capable of delivering a current of magnitude $i = 6.00$ A.

PROBLEM

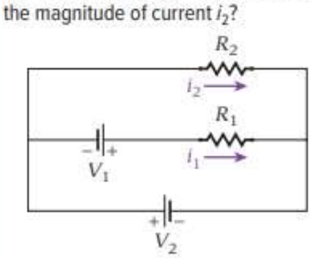
What is the minimum emf the battery charger must supply to be able to charge the battery?



Multiloop Circuits

Concept Check 6.3

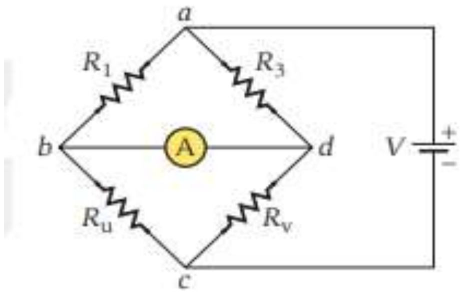
In the multiloop circuit shown in the figure, $V_1 = 6.00$ V, $V_2 = 12.0$ V, $R_1 = 10.0\ \Omega$, and $R_2 = 12.0$ V. What is the magnitude of current i_2?



a) 0.500 A
b) 0.750 A
c) 1.00 A
d) 1.25 A
e) 1.50 A

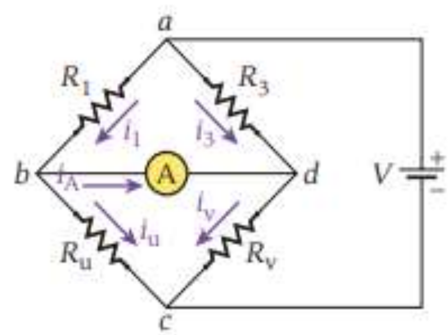
ENG: MOHAMMAD JAMAL
+962 7 8769 5012
+971 50 727 0623

==The Wheatstone bridge:== is a particular circuit used to measure unknown resistances.



- This circuit consists of three known resistances, R1, R3, and a variable resistor, Rv, as well as an unknown resistance, Ru. A source of emf, V, is connected across junctions a and c.
- A sensitive ammeter (a device used to measure current, is connected between junctions b and d.
- The Wheatstone bridge is used to determine Ru by varying Rv until the ammeter between b and d shows no current flowing.
- When the ammeter reads zero, the bridge is said to be balanced.

PROBLEM Determine the unknown resistance, Ru, in the Wheatstone bridge shown in Figure. The known resistances are R1 = 100.0 Ω and R3 = 110.0 Ω, and Rv = 15.63 Ω when the current through the ammeter is zero, indicating that the bridge is balanced.



ENG: MOHAMMAD JAMAL
+962 7 8769 5012
+971 50 727 0623

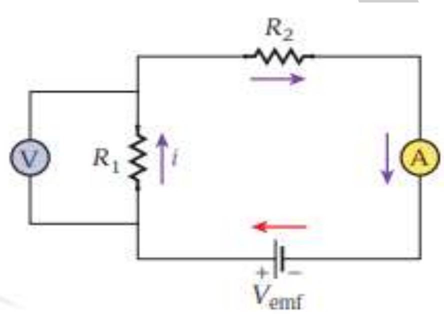
Ammeters and Voltmeters

Ammeter: A device used to measure current.

- an ammeter must be wired in a circuit in series.
- ammeters are designed to have as low a resistance as possible, usually on the order of 1 Ω, so they do not have an appreciable effect on the currents they measure.

Voltmeter: A device used to measure potential difference.

- a voltmeter must be wired in parallel with the component across which the potential difference is to be measured.
- voltmeters are designed to have as high a resistance as possible, usually on the order of 10 MΩ (107 Ω), so they have a negligible effect on the potential differences they are measuring.



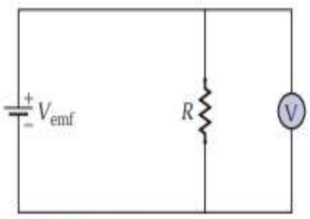
Ohmmeter: A device used to measure the resistance of a circuit component.

digital multimeter: a device that can switch between functioning as an ammeter and functioning as a voltmeter.

ENG: MOHAMMAD JAMAL
+962 7 8769 5012
+971 50 727 0623

EXAMPLE 6.2 Voltmeter in a Simple Circuit

Consider a simple circuit consisting of a source of emf with voltage $V_{emf} = 150.$ V and a resistor with resistance $R = 100.$ kΩ (Figure 6.18). A voltmeter with resistance $R_V = 10.0$ MΩ is connected across the resistor.



PROBLEM 1

What is the current in the circuit before the voltmeter is connected?

PROBLEM 2

What is the current in the circuit when the voltmeter is connected across the resistor?

- An ammeter can be used to measure different ranges of current by adding a current divider in the form of a shunt resistor connected in parallel with the ammeter.
- A shunt resistor is simply a resistor with a very small resistance.
- Its name arises from the fact that when it is connected in parallel with the ammeter, whose resistance is larger, most of the current is shunted through it, bypassing the meter. The sensitivity of the ammeter is therefore decreased allowing it to measure larger currents.

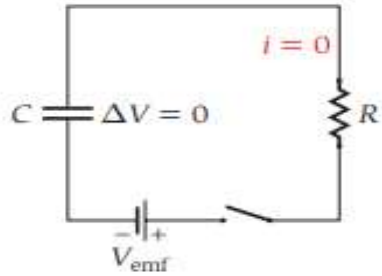
shunt resistor can be calculated by the equation:

$$R_s = R_i \frac{i_{int}}{i_{max} - i_{int}}$$

Q: Suppose an ammeter produces a full-scale reading when a current of i int = 5.10 mA passes through it. The ammeter has an internal resistance of Ri = 16.8 Ω. To use this ammeter to measure a maximum current of i max = 20.2 A, what should be the resistance of the shunt resistor, Rs, connected in parallel with the ammeter?

ENG: MOHAMMAD JAMAL
+962 7 8769 5012
+971 50 727 0623

RC circuits: circuits that contain capacitors, as well as sources of emf and resistors.



- these circuits have currents that do vary with time.
- The simplest circuit operations that involve time-dependent currents are the charging and discharging of a capacitor.

Charging a Capacitor

_Equation of Charging a Capacitor:

$$q(t) = q_{max}\left(1 - e^{-t/\tau}\right),$$

_time constant of RC circuit:

$$\tau = RC.$$

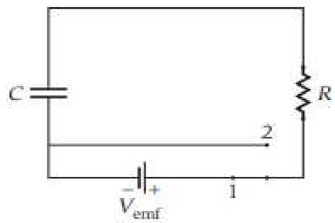
- A large time constant means that it takes a long time to charge the capacitor.
- a small time constant means that it takes a short time to charge the capacitor.

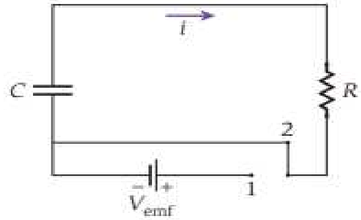
$$q_{max} = CV_{emf}.$$

$$i = \frac{dq}{dt} = \left(\frac{V_{emf}}{R}\right)e^{-t/RC}.$$

ENG: MOHAMMAD JAMAL
+962 7 8769 5012
+971 50 727 0623

Discharging a Capacitor





_Equation of Discharging a Capacitor:

$$q(t) = q_{max} e^{-t/RC}.$$

$$i(t) = \frac{dq}{dt} = -\left(\frac{q_{max}}{RC}\right) e^{-t/RC}$$

EXAMPLE 6.3 **Time Required to Charge a Capacitor**

Consider a circuit consisting of a 12.0 V battery, a 50.0 Ω resistor, and a 100.0 μF capacitor wired in series. The capacitor is initially completely discharged.

PROBLEM

How long after the circuit is closed will it take to charge the capacitor to 90% of its maximum charge?

Concept Check 6.5

To discharge a capacitor in an RC circuit very quickly, what should the values of the resistance and the capacitance be?

a) Both should be as large as possible.

b) Resistance should be as large as possible, and capacitance as small as possible.

c) Resistance should be as small as possible, and capacitance as large as possible.

d) Both should be as small as possible.

ENG: MOHAMMAD JAMAL
+962 7 8769 5012
+971 50 727 0623

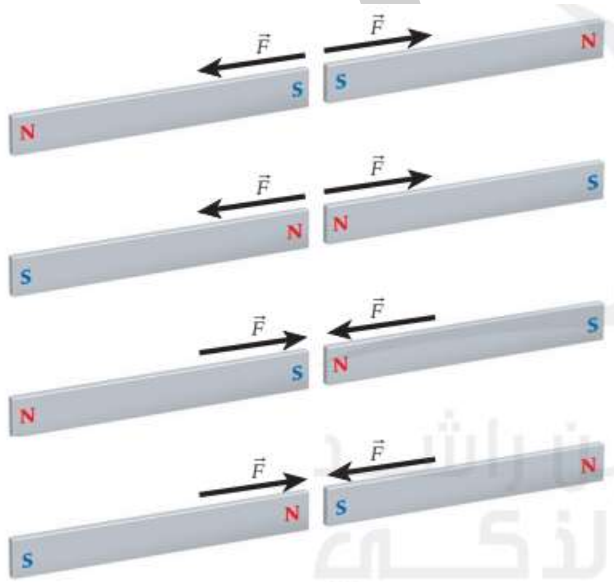
Magnetism

- Magnets have two opposite ends, called **poles.(** magnets are polarized)

north magnetic pole: The end of the magnet that points north .

south magnetic pole: The end of the magnet that points south.

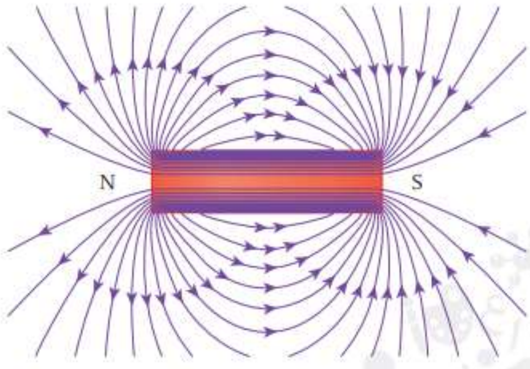
- Like magnetic poles repel
- unlike magnetic poles attract.



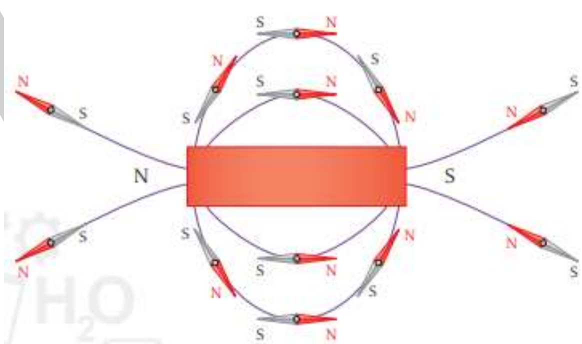
- **Poles repel or attract:** forces between two magnets differ depending on how you orient the magnets." Like poles repel; unlike poles attract"

ENG: MOHAMMAD JAMAL
+962 7 8769 5012
+971 50 727 0623

- magnetic field is represented using field lines.
- The magnetic field vector is always tangent to the magnetic field lines.
- As with electric field lines, closer spacing between lines indicates higher field strength.



- The direction of the magnetic field is established in terms of the direction in which a compass needle points.
- A compass needle, with a north pole and a south pole, will orient itself so that its north pole points in the direction of the magnetic field.



ENG: MOHAMMAD JAMAL
+962 7 8769 5012
+971 50 727 0623

- **a magnet always has two poles**: No matter how you cut or break a magnet, a magnet always has two poles. There have been many searches for objects, called mono poles, with only a north pole or only a south pole, but no monopole has ever been found.

Magnetic Force

The magnetic force exerted by a magnetic field on a moving charged particle with charge q moving with velocity v is given by:

$$F_B = |q| vB\sin\theta,$$

FB: force in newton(N)

q: charge is measured in coulombs (C)

V: velocity in meters per second (m/s)

B: magnetic field strength in teslas (T)

Θ: angle between velocity& magnetic field

_ The direction of the force on a charged particle is perpendicular to that particle's velocity and to the magnetic field.

- for the field strength and inserting the units of the other quantities gives:

$$[F_B] = [q][v][B] \Rightarrow [B] = \frac{[F_B]}{[q][v]} = \frac{\text{N s}}{\text{C m}}$$

- A tesla is a rather large amount of magnetic field strength. Sometimes magnetic field strength is given in gauss (G), which is not an SI unit:

$$1\ \text{G} = 10^{-4}\ \text{T}.$$

ENG: MOHAMMAD JAMAL
+962 7 8769 5012
+971 50 727 0623