PHYSICS II

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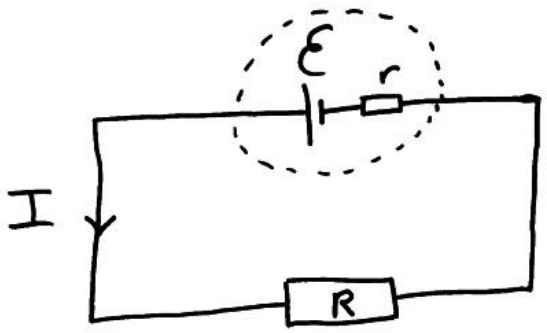
- EMF and Terminal Voltage
- Resistors in Series and in Parallel
- Test solutions related to electric charges

EMF and Terminal Voltage

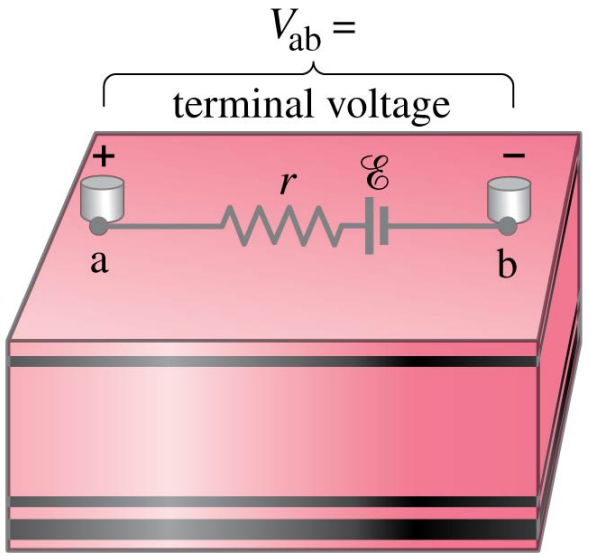
- Electric circuit needs battery or generator to produce current—these are called sources of electromotive force (e.m.f.).
- It is equal to the potential difference across the terminals of the cell when no current is flowing.
- Battery is a nearly constant voltage source, but does have a small internal resistance, which reduces the actual voltage from the ideal emf:

$$V_{ab} = \mathscr{E} - Ir.$$



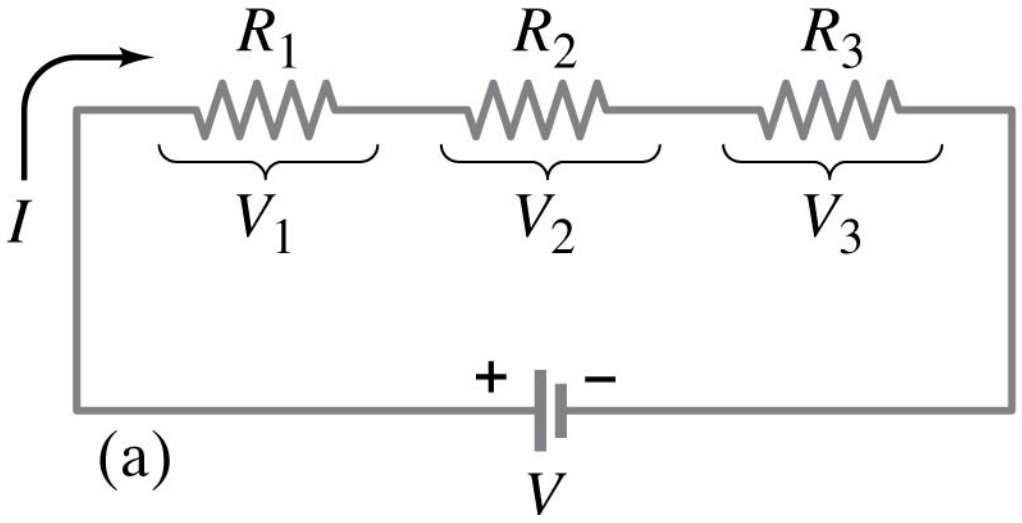
EMF and Terminal Voltage

- This resistance behaves as though it were in series with the emf. (V_{ab}: potential difference: voltage between a and b poles.)
- The maximum potential difference q power source can have is called the emf.
- The term is not actually a force, simply the amount of energy per charge (J/C or V).



Resistors in Series

A series connection has a single path from the battery, through each circuit element in turn, then back to the battery.



Resistors in Series

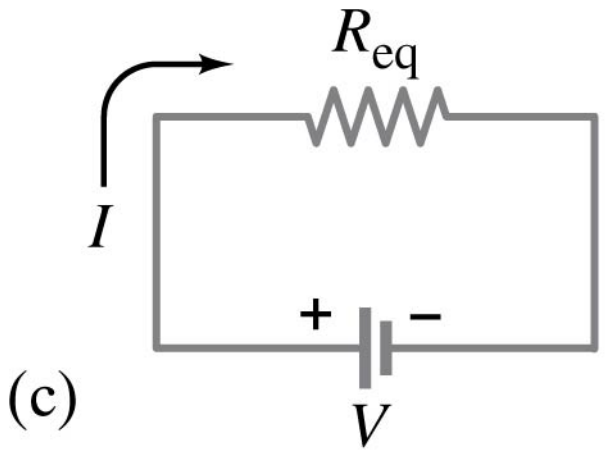
The current through each resistor is the same; the voltage depends on the resistance. The sum of the voltage drops across the resistors equals the battery voltage.

$$V = V_1 + V_2 + V_3 = IR_1 + IR_2 + IR_3$$

Resistors in Series

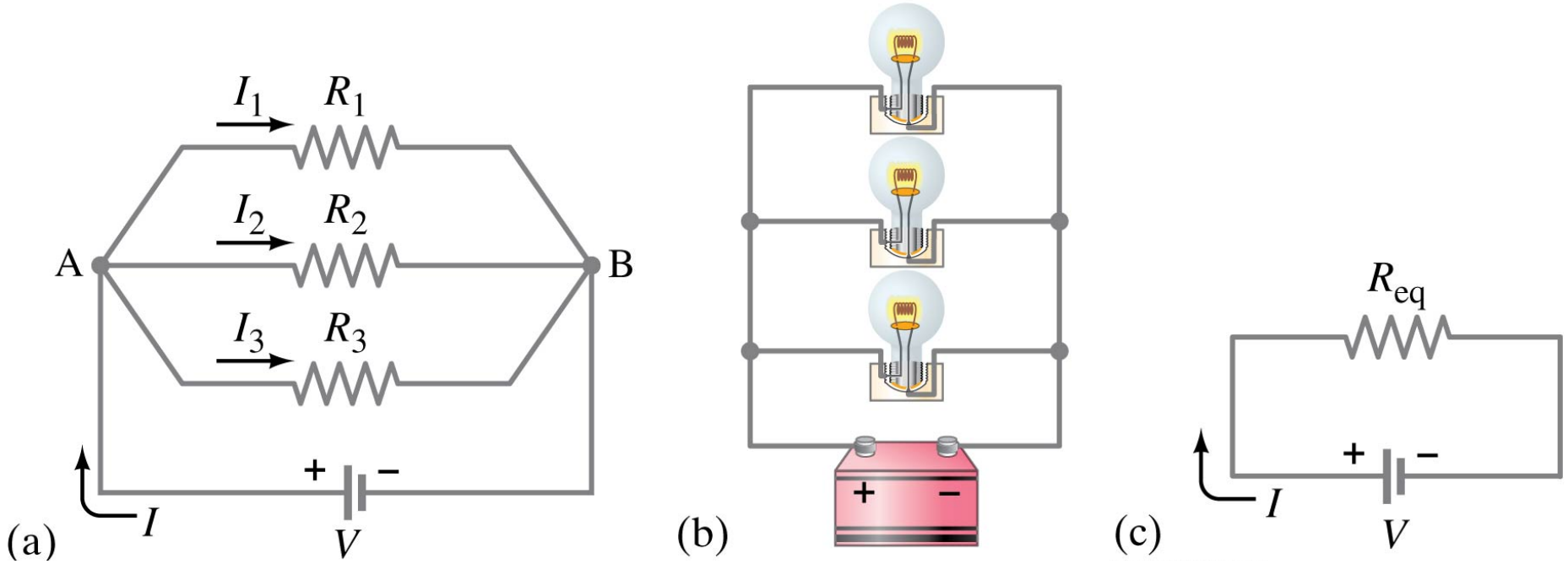
From this we get the equivalent resistance (that single resistance that gives the same current in the circuit).

$$R_{eq} = R_1 + R_2 + R_3.$$



Resistors in Parallel

A parallel connection splits the current; the voltage across each resistor is the same:



Resistors in Parallel

The total current is the sum of the currents across each resistor:

$$I = \frac{V}{R_{\text{eq}}}$$

$$I = I_1 + I_2 + I_3,$$

$$\frac{V}{R_{\text{eq}}} = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3}$$

Resistors in Parallel

This gives the reciprocal of the equivalent resistance:

$$\frac{1}{R_{\text{eq}}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}.$$

Question solutions related to electric charges

1. Which one of the following statements concerning the electric force is true?

a) Two charged objects with identical charges will exert an attractive force on one another.

b) It is possible for a small negatively-charged particle to float above a negatively charged surface.

c) A positively-charged object is attracted toward another positively-charged object.

d) The electric force cannot alter the motion of an object.

e) Newton's third law of motion does not apply to the electrostatic force.

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2. Which one of the following scientists is credited with assigning the "-" and "+" signs used to describe the two kinds of charge?

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b) Isaac Newton

c) James Watt

d) Leonardo Da Vinci

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3. Complete the following sentence: When wool is rubbed along a copper rod,

a) the copper becomes positively charged and the wool becomes negatively charged.

b) the copper and the wool become positively charged.

c) the copper becomes negatively charged and the wool becomes positively charged.

d) the copper and the wool become negatively charged.

e) the copper becomes negatively charged and the wool remains electrically neutral.

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4. Complete the following sentence: an electric insulator has

a) the ability to easily conduct electricity, but does not easily conduct heat.

b) few electrons available to conduct electricity.

c) the ability to easily conduct electricity and heat.

d) no ability to conduct electricity.

e) many free electrons available to conduct electricity.

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5. Which one of the following statements concerning electrical conductors is false?

a) Rubber is an excellent electrical conductor.

b) A material that is a good electrical conductor has many free electrons that can easily move around inside the material.

c) When a positively-charged object is moved into contact with an electrical conductor, electrons move toward the object.

d) Materials that are good thermal conductors are often good electrical conductors.

e) Most metals are very good electrical conductors.

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6. Which of the following terms is used to describe a material that does not allow electrons to easily move through it?

a) conductor

b) resistor

c) insulator

d) transformer

e) inductor

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7. Which of the following statements describes an object as having an induced charge?

a) A glass rod is rubbed with silk.

b) A negatively-charged object is brought into contact with an initially uncharged conductor. When they are separated, both objects are negatively charged.

c) A rubber rod is rubbed with animal fur.

d) A positively-charged object is brought near with an initially uncharged insulator. The surface of the insulator becomes slightly negatively charged.

e) As you grab a door knob in the winter time, you feel a slight electric spark.

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8. Silicon is an example of what type of material?

a) metal

b) insulator

c) semiconductor

d) superconductor

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9. Two positively charged particles are separated by a distance r. The force on particle 1 is F due to particle 2. The force on particle 2 is $2F$ due to particle 1. Is the previous sentence true or false? Explain why this is the case.

a) The sentence is true, if the net charge of particle 1 is twice that of particle 2.

b) The sentence is false because the forces on each of the two objects are equal in magnitude, but opposite in direction.

c) The sentence is true since the particles are separated by a distance r.

d) The sentence is false because two positively charged particles cannot exert a force on each other.

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10. Two positively charged particles are separated by a distance r. Which of the following statements concerning the electrostatic force between acting on each particle due to the presence of the other is true?

a) The electrostatic force may be calculated using Faraday's law.

b) The electrostatic force depends on the masses of the two particles.

c) The electrostatic force depends on r^2.

d) The electrostatic force increases as r is increased.

e) The electrostatic force is on each particle is directed toward the other particle.

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11. The unit of electrical current is the ampere (A). Which one of the combinations of units is equivalent to the ampere?

a) $C \cdot s$

b) C/s

c) $N \cdot m/s$

d) $J \cdot s$

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12. Which one of the following statements is false?

a) The total number of positive and negative charges within a system may change.

b) Electric charge is quantized.

c) Electric charge is conserved.

d) A system may have a charge that is equal to two-thirds of the charge on an electron.

e) The convention is to consider the electron as having a negative charge.

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13. Which one of the following statements is a consequence of charge being conserved?

a) The difference between the number of positive and negative charges does not change for a given system.

b) If you examine a system at different times, the total number of charges will change.

c) Energy within the system is also conserved.

d) The positive and negative charges within a system must be quantized.

e) The numbers of electrons and protons for a given system cannot change.

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14. When an electron (charge -1.60×10^{-19} C) and a positron (charge $+1.60 \times 10^{-19}$ C) come together, they annihilate one another. Two particles of light (photons) are emitted from the annihilation. This is an example of what type of physical phenomena?

a) charge quantization

b) charge separation

c) Coulomb force

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References for this lecture:

- Giancoli, Physics
- Halliday&Resnick&Walker, Fundamentals of Physics