Electromagnetism Checklist

Elementary Charge and Conservation of Charge

4.1.1A – Convert from elementary charge to charge in coulombs ☐

What is the charge in coulombs on an object with an elementary charge of +4?

An object contains 35 electrons and 75 protons. What is its charge in coulombs?

4.1.1B – Convert from charge in coulombs to elementary charge ☐

An object has a charge of -6.4×10^{-17} coulombs. What is its elementary charge?

Which set of elementary charges would produce a charge of $+3.2 \times 10^{-18}$ C?

(1) 400 electron and 200 protons
(2) 40 electrons and 20 protons
(3) 200 electrons and 400 protons
(4) 20 electrons and 40 protons

4.1.1C – Determine whether or not a particular charge can exist on a 'real world' object ☐

Which charges could ***not*** exist on a real-world object?

(1) 3.2×10^{-19} C
(2) 6.5 C
(3) -20 *e*
(4) 1.2×10^{2} *e*
(5) 0.5×10^{-19} C
(6) 3.2×10^{-21} C
(7) 3.5 *e*
(8) 1.6×10^{-19} *e*

4.1.1D – Determine how charge will distribute in conservation of charge problems ☐

Object A begins with a charge of +3.0 coulombs; object B begins with a charge of -6.0 coulombs; and object C begins with no charge. Object A is brought into contact with object B then removed. Object B is then brought into contact with object C and removed. What are the final charges on the three objects?

4.1.1E – Determine the direction of electron flow in conservation of charge problems ☐

In which direction will electrons flow in each case?

a. -3C -6C

b. -4C +5C

c. +3C -6C

d. +8C +2C

Charging and Charge Transfer

4.1.2A – Explain the processes of conduction, induction, and 'charging by induction' ☐

Object A is negatively charged and is used to charge object B by conduction. What is the final charge on objects A and B?

Object A is negatively charged and is brought near neutral object B without touching it. What is the final charge on objects A and B?

Object A is negatively charged and is used to charge object B by induction. What is the final charge on objects A and B?

4.1.2B – Explain the rules for testing an object to determine its charge ☐

A small object is tested to determine its charge. What test could be used to prove that the object is positively charged? What test could be used to prove that the object is not charged?

4.1.3A – Explain how a neutral electroscope will react to the presence of a charged object

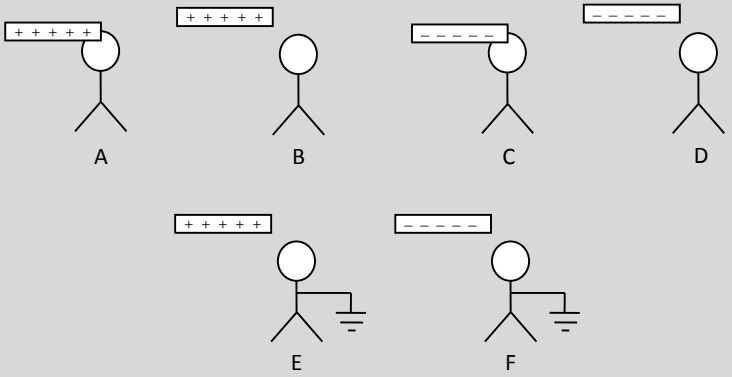
A negatively charged rod is brought near a neutral electroscope then removed, what is the reaction of the electroscope leaves?

4.1.3B – Explain how an electroscope can become charged

Which of the following shows an electroscope being charged negatively by conduction?

Which of the following electroscopes could be charged positively by induction?

In which of the following are the leaves of the electroscope negatively charged?



4.1.3C – Explain how a charged electroscope is tested to determine charge

A negatively charged rod is brought near a charged electroscope causing its leaves to converge. What is the charge on the electroscope?

A negatively charged rod is brought near a charged electroscope causing its leaves to diverge. What is the charge on the electroscope?

Coulomb's Law

4.1.4A – Use equation to determine electrostatic force; charge; or distance

What is the electrostatic force that a +4.0 coulombcharge exerts on a -6.0 coulomb charge if they are separated by a distance of 2.0 meters?

4.1.4B – Determine the effects on electrostatic force when changing the amount of charge and/or distance between charges

Two charged objects are attracted to one another by an electrostatic force of 5.0 newtons. What would this force become if the charge on both objects were doubled?

An electrostatic force F acts between two objects with charges +q and +q when they are a distance R apart. If the distance between the objects is halved, the electrostatic force would become

(1) F/2 (2) F/4 (3) 2F (4) 4F

Electric Fields

4.1.5A – Use equation to determine: electric field strength; force; or charge.

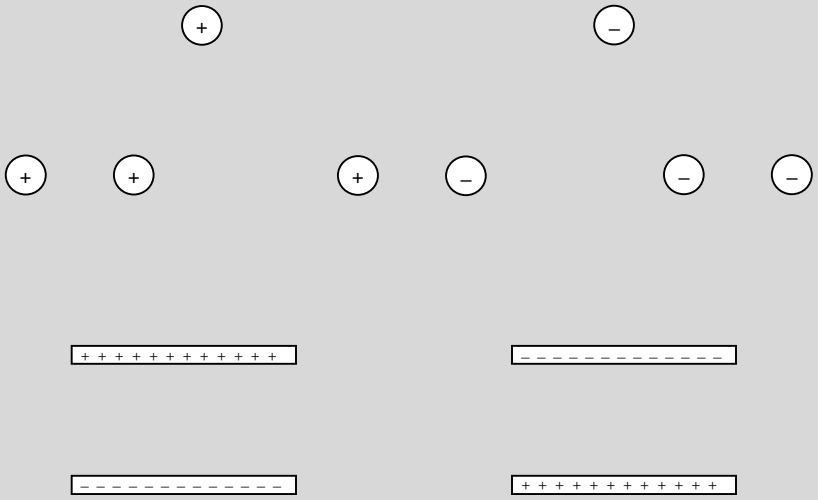
A +2.0 coulomb charge experiences a force of 10 newtons while in an electric field. What is the strength of the electric field?

What force will a 3.0 coulomb charge experience if place in an electric field with a strength of 15 newtons per coulomb?

What is the charge on an object that experiences a force of 20 newtons when it is placed in an electric field with a strength of 4.0 newtons per coulomb?

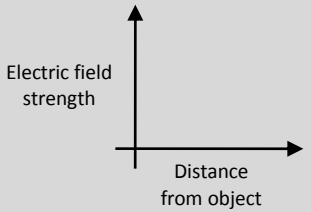
4.1.5B – Map electric field in the region near a point charge or near a system of point charges

Sketch the electric field in the area around each point charge, set of point charges, and set of parallel plates.



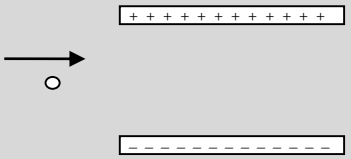
4..1.5C – Explain how electric field strength relates to distance from a point charge

Sketch a graph that shows the relationship between the distance from an object and the strength of the electric field that it produces.



4.1.5D – Explain the effect of charged, parallel plates on electric field strength, force on charge between the plates, and acceleration of charges between the plates.

An electron is fired into the space between two parallel, oppositely charged plates that produce an electric field of strength 2.0×10^{-11} newtons per coulomb.



Sketch the path of the electron as it passes between the plates.

Determine the amount of force exerted on the electron.

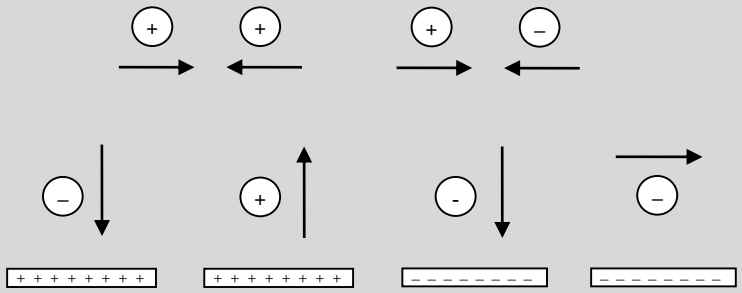
Determine the acceleration of the electron.

What is important to know about the field strength, force on the charge, and acceleration of the charged object between the charged plates?

Electrical Potential

4.1.6A – Explain how electrical potential relates to the distance between charged objects'

In which of the cases below is the electrical potential energy increasing? In which cases is the electrical potential energy decreasing? In which cases is the electrical potential energy remaining constant?



4.1.6B – Use equation to determine: electrical potential/voltage; work/energy; or charge

What is the electrical potential generated when 15.0 joules of work are done in moving a 5.0 coulomb charge through an electric field?

What is the amount of work needed to increase the electrical potential of a 2.0 coulomb charge by 8.0 volts?

What is the charge on an object that requires 6.4×10^{-19} joules of work to be moved through an electrical potential of 2.0 volts?

4.1.6C – Convert from electron-volts to joules and joules to electron-volts

Convert 3.2×10^{-19} joules into electron-volts.

Convert 6.4 electron-volts into joules.

4.1.6D – Explain when it is appropriate to express energy in units of electron-volts

What is the amount of energy needed to move an electron through an electrical potential of 3.0 volts? Express this energy in both joules and electron-volts.

An object with a 4.0 coulomb charge is accelerated through an electrical potential of 12.0 volts. What amount of kinetic energy does the object gain? Express this energy in both joules and electron-volts.

Electrical Current

4.2.1A – Use equation to determine electrical current; charge; or time

What is the amount of electrical current passing through a wire if 35 coulombs of charge flow through it in 5.0 seconds?

If a 2.5 ampere current is flowing through a given point on a wire, how long would it take for 100 coulombs of charge to pass this point?

How much charge passes through a wire if a current of 10 ampere flows through it for 30 seconds?

4.2.1B – Determine the number of electrons flowing through a system based on current or current based on number of electrons through a given point

How many electrons per second are flowing through a point in a wire that has 5.0 amperes of current passing through it?

6.4×10^{14} electrons pass through a given point every second. What amount of electrical current does this represent?

Electrical Resistance

4.2.2A – Use equation to determine resistance; resistivity; length; or cross-sectional area. Determine composition of a wire.

What is the resistance of a copper wire with a cross-sectional area of 2.0×10^{-6} meter^2 and a length of 50 meters?

What is the length of an aluminum wire with a resistance of 25 ohms if it has a cross-sectional area of 4.0×10^{-4} meter^2?

What is the composition of a wire with a resistance of 8.13 ohms if its cross-sectional area is 3×10^{-6} meter^2 and its length is 1000 meters?

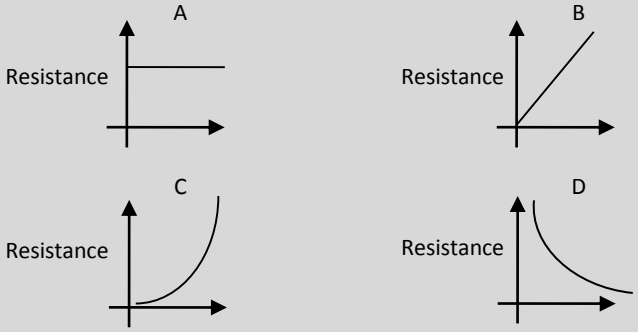
4.2.2B – Explain the relationship between electrical resistance, length, resistivity, cross-sectional area, radius, and/or temperature of a conductor

What is the difference between resistance and resistivity?

Which graph best represents the relationship between the following variables?

resistance and resistivity ____ resistance and length ____

resistance and area _____ resistance and temperature _____



Ohm's Law, Power Law, and Circuit Elements

4.2.3A – Use equations to determine current; voltage; resistance; or electrical power

How much current will pass through a 30 ohm resistor when it is connected to a 90 volt source of electrical potential?

What is the resistance of a heater that allows 12 amperes of current to flow through it when it is connected to a 120 volt source?

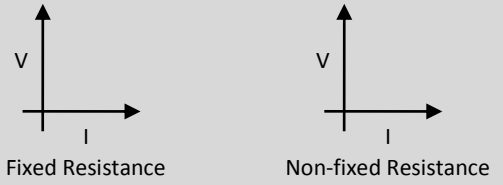
How much power is generated by a light bulb that draws 0.2 ampere of current when connected to a 6.0 volt battery?

How much current is drawn by a 4400 watt motor if it is operated at an electrical potential of 220 volts?

What is the resistance of a component that generates 300 watts of power while allowing 0.5 ampere of current to pass through it?

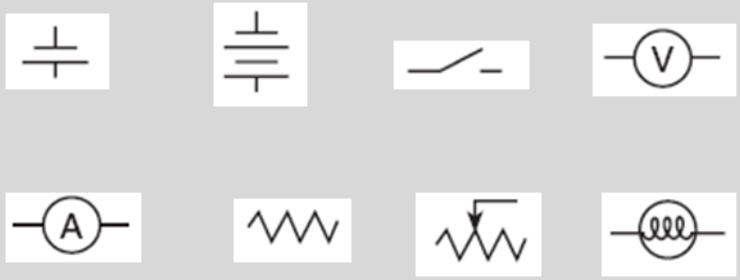
4.2.3B – Explain the relationship between current and voltage with fixed and non-fixed resistances

Sketch a graph of current vs. voltage for a fixed resistance. Explain what the slope of this graph represents. Sketch a graph of current vs. voltage for a non-fixed resistance that does NOT obey Ohm's Law.



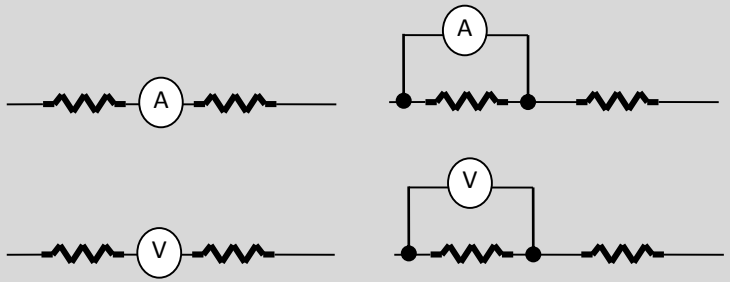
4.2.3C – Recognize and sketch circuit elements: resistor; ammeter; voltmeter; etc.

Name the circuit elements shown below



4.2.3D – Explain the proper way to connect an ammeter and/or voltmeter to a circuit

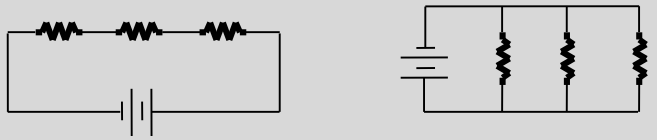
In which instances is the meter connected improperly?



Series and Parallel Circuits

4.2.4A – Explain the differences between how series and parallel circuits are constructed

Which is a series circuit? Which is a parallel circuit?



4.2.4B – Explain the rule for current in each type of circuit

A 30 ohm resistor and a 20 ohm resistor are connected in series with a 100 volt battery. The electrical current that would pass through the 20 ohm resistor is

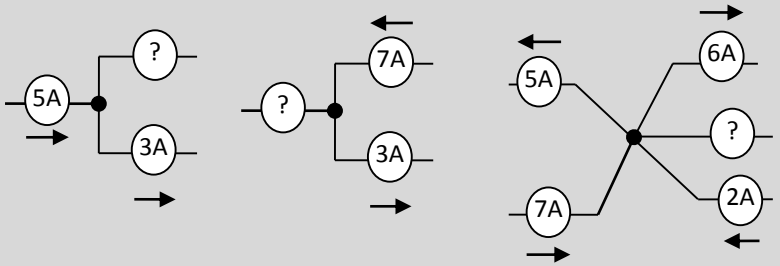
(1) 5 A (2) 2 A (3) 7 A

A 30 ohm resistor and a 20 ohm resistor are connected in parallel with a 100 volt battery. The electrical current that would pass through the 20 ohm resistor is

(1) 5 A (2) 2 A (3) 7 A

4.2.4C – Use the junction rule to determine the current flowing into/out of a circuit junction

Determine the unknown current and its direction in each diagram.



4.2.4D – Explain the rule for voltage in each type of circuit

A 30 ohm resistor and a 20 ohm resistor are connected in series with a 100 volt battery. The electrical potential that is measured across the 30 ohm resistor in this circuit would be:

(1) < 100 V (2) 100 V (3) > 100 V

A 30 ohm resistor and a 20 ohm resistor are connected in parallel with a 100 volt battery. The electrical potential that is measured across the 30 ohm resistor in this circuit would be:

(1) < 100 V (2) 100 V (3) > 100 V

Determine the equivalent resistance of…

a. three 90 ohm resistors in series
b. three 90 ohm resistors in parallel
c. a 10 ohm resistor and 20 ohm resistor in series
d. a 10 ohm resistor and 20 ohm resistor in parallel
e. 5, 10, and 40 ohm resistors in series
f. 20, 30, and 40 ohm resistors in parallel
g. 120, 142, and 312 ohm resistors in series
h. 311, 416, and 520 ohm resistors in parallel

Which has the least resistance?

(1) four 8 ohm resistors connected in parallel
(2) two 8 ohm resistors connected in series
(3) a single 8 ohm resistor
(4) a pair of 2 ohm resistors connected in series

4.2.4E – Explain how equivalent resistance is found for each type of circuit

4.2.4F – Explain how altering a series or parallel circuit changes current; voltage; and/or equivalent resistance

A 10 ohm and 20 ohm resistor are connected in series to an 80 volt battery. If a third 20 ohm resistor is added to this circuit in series:

a. The circuit's R_{eq} will (INCREASE/DECREASE/NOT CHANGE)
b. The total current will (INCREASE/DECREASE/NOT CHANGE)
c. The total voltage will (INCREASE/DECREASE/NOT CHANGE)
d. The total power output will (INCREASE/DECREASE/NOT CHANGE)
e. The voltage measured across the 10 ohm resistor will (INCREASE/DECREASE/NOT CHANGE)

A 10 ohm and 20 ohm resistor are connected in parallel to an 80 volt battery. If a third 20 ohm resistor is added to this circuit in parallel:

a. The circuit's R_{eq} will (INCREASE/DECREASE/NOT CHANGE)
b. The total current will (INCREASE/DECREASE/NOT CHANGE)
c. The total voltage will (INCREASE/DECREASE/NOT CHANGE)
d. The total power output will (INCREASE/DECREASE/NOT CHANGE)
e. The voltage measured across the 10 ohm resistor will (INCREASE/DECREASE/NOT CHANGE)

A set of three light-bulbs are connected in series to a battery. If one light-bulb is removed from the circuit, what happens to the current in the rest of the circuit?

A set of three light-bulbs are connected in parallel to a battery. If one light-bulb is removed from the circuit, what happens to the current in the rest of the circuit?