Electricity & Magnetism Problems Solved on Youtube

Electrostatics

Electric Field of point charges

Two charges are held fixed on a horizontal plane: q1 (1.00 μC) is at (-1.00; 3.00) cm, and q2 (-2.00 μC) is at the origin.
Find the net electric field at point P3 (2.00; 1.00) cm
You Tube: http://youtu.be/4xuM8HN6Vms

Motion of a charged particle in an electric field

In a poorly aligned cathode ray tube, electrons enter a vertical uniform electric field with a velocity of 5.00×10^7 m/s at 20.0° above the horizontal.
The electrons hit the top plate, 1.00 cm up and 2.00 cm to the right from the place where they entered the electric field.
What is the magnitude of the electric field, and in which direction does it point?
YouTube: http://youtu.be/4aRUcVEgIAM

Drawing field lines, example 1

A positive charge 2.5Q is held on a horizontal plane and a positive charge of Q is held above (North) of it.
Sketch the electric field lines to represent the electric field around these 2 charges.
You Tube: http://youtu.be/LBr63hA4mww

Drawing field lines, example 2

A positive charge 2Q is held on a horizontal plane and a negative charge -Q is held left of it.
Sketch the electric field lines to represent the electric field around these 2 charges.
You Tube: http://youtu.be/mjQ6MJss_oI

Drawing equipotential surfaces, example 1

A positive charge 2.5Q is held on a horizontal plane and a positive charge of Q is held above (North) of it.
Sketch the equipotential surfaces around these 2 charges.
You Tube: http://youtu.be/64Pz33c8-sc

Drawing equipotential surfaces, example 2

A positive charge 2Q is held on a horizontal plane and a negative charge -Q is held left of it.
Sketch the equipotential surfaces around these 2 charges.
You Tube: http://youtu.be/nQEgkZ8WyFs

Potential energy of point charges, example 1

A positive charge 2.00μC is held on a horizontal plane, a charge of -1.00μC is held 5.00 cm North of it, and a charge of 3.00μC is held 5.00 cm West of it.
a) What is the total potential energy of the system?
b) What is the potential energy of the 3.00μC charge?
c) If the 2.00μC charge is released (let's say the object has mass 1.00 gram), what is its speed when it is far, far away from the other 2 charges?
You Tube: http://youtu.be/jnzbv0oSY78

Potential energy of point charges, example 2

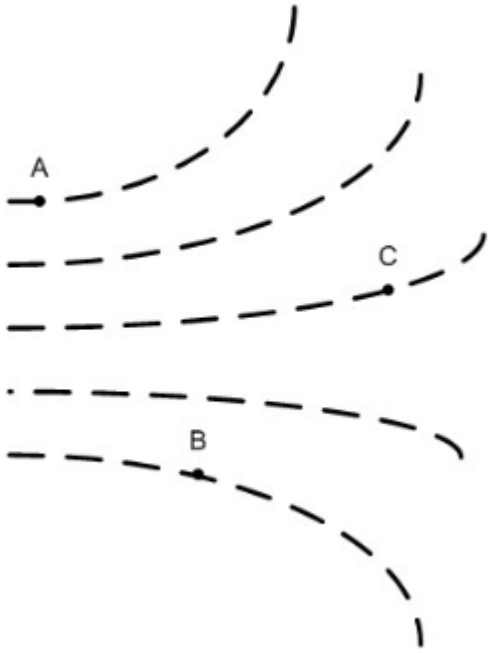
A small sphere carrying an unknown charge q1 is held fixed in space. A second small sphere of mass 1.00 mg, carrying charge q2 = 5.00 μC is projected toward q1. When q2 is 1.00 m from q1, its kinetic energy is 0.500 J. When q2 is 0.500 m from q1, its kinetic energy is 0.250 J.
Does q2 stop and turn around, or does it hit q1?
YouTube: http://youtu.be/bEnmo3qPdnI

Electric potential and potential energy of point charges, example 1

Charge q1 (-10.0 μC) is placed at the origin and charge q2 (1.00 μC) is at (3.00; -1.00) cm.
a) What is the electric potential at point P (3.00; 2.00) cm ?
b) Compare the potential energy of a 10.0 μC charge at point P with that of a -10.0 μC charge at point P.
You Tube: http://youtu.be/TXzS1NksFhQ

Electric potential and potential energy of point charges, example 2

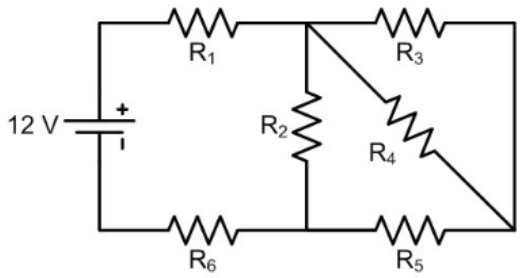
A small object with mass 1.00 mg carries 3.125×10^{12} extra electrons. When it passes point A, it is moving at 14.15 m/s, and when it passes point B, it is moving at 10.0 m/s. Electric forces
are the only ones acting on it.
a) Sketch electric field vectors at points A and B, and sketch an electric field line through point C.
b) What is the potential difference between points B and A (V_B-V_A)?
c) If A is at 25.0 V What is the electric potential at B?
YouTube: http://youtu.be/Af7ZCXqtqzo



DC Circuits

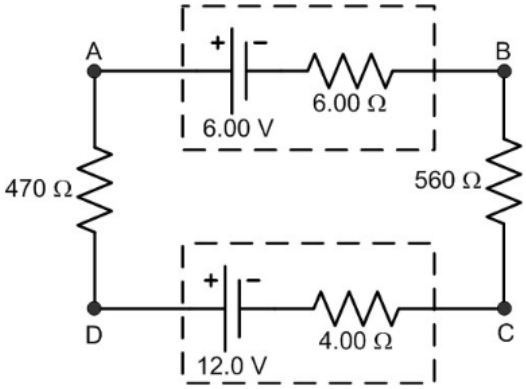
Resistors in series and in parallel

Consider the circuit below. All resistors are 20 Ω.
a) What is the equivalent resistance of this circuit?
b) Find the potential difference across all resistors, and the current through all resistors
You Tube: http://youtu.be/YsvAtGHHHWI



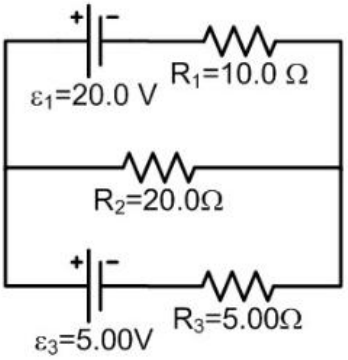
Circuits, example 1

Consider the following circuit:
a) What is the current in this circuit?
b) What is the power used by the resistors?
c) What is the power provided by or used by the batteries?
d) What is the potential difference between A and C (V_A-V_C)?
YouTube: http://youtu.be/CfoCqhdVpaU



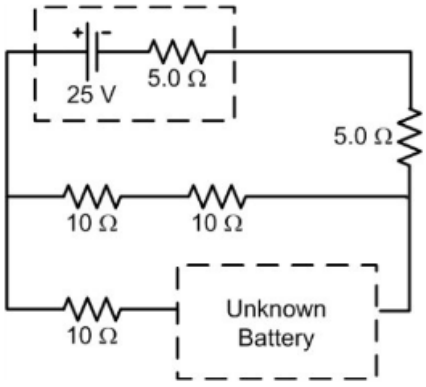
Multi-loop circuit

Consider the circuit below. Find all the currents in the circuit.
You Tube: http://youtu.be/0vwe1XLZsCo



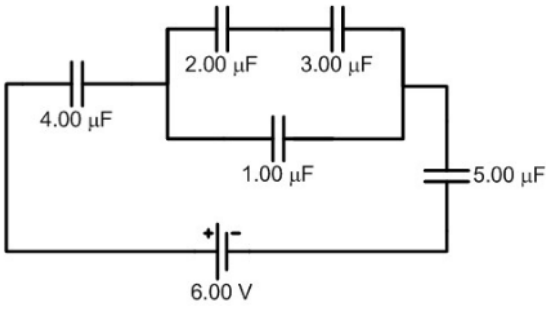
Multi-loop circuit and power in an electric circuit

The following circuit contains a battery with an emf of 25 V that delivers 25 W of power. The battery delivers an unknown amount of current that is less than 2.0 A.
How much power does the unknown battery deliver or use?
YouTube: http://youtu.be/YWAuoy_qleU



Capacitors

Capacitors in series and in parallel



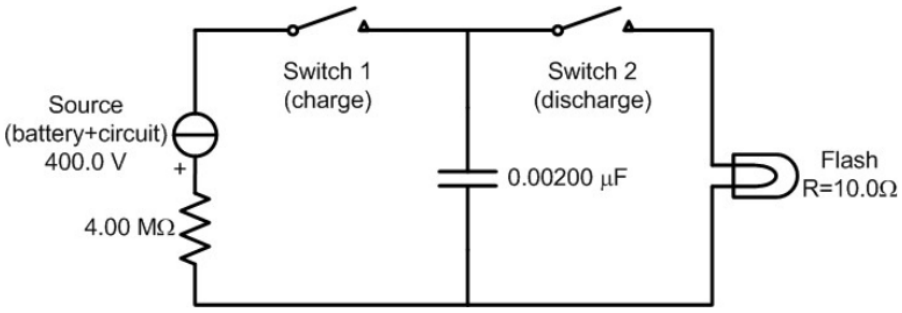
Consider the following arrangement of capacitors.
a) Find the total capacitance of the circuit.
b) Find the charge on each capacitor as well as the potential difference across each capacitor
YouTube: http://youtu.be/CfloCOQ2_1U

Reconnected capacitors

A 5.00 μF capacitor is charged to 10.0 V, and a 10.0 μF capacitor is charged 5.00 V.
a) How much energy is lost or gained when the capacitors are reconnected positive plate to positive plate?
b) How much energy is lost or gained when the capacitors are reconnected positive plate to negative plate?
YouTube: http://youtu.be/3iH5vs-2rN0

Capacitors in circuits

The following circuit diagram is a simplified version of the flash circuit inside a disposable camera. The user charges the capacitor by pressing on a button (switch 1), and when the user snaps a picture, the shutter presses switch 2 which allows the capacitor to discharge quickly through the flash bulb.



a) What is the time constant of the circuit when the capacitor is charging?
b) What is the potential difference across the capacitor after one time constant?
c) The flash bulb requires an initial potential difference of 350V in order to 'flash'. How much time does it take to accumulate this potential difference across the capacitor?
d) What is the time constant of the circuit when the capacitor is discharging?
e) What is the potential difference across the flash bulb after one time constant?
f) How long does it take for the potential difference across the capacitor to drop to 10.0V?
YouTube: http://youtu.be/9fRIW6ZN6n0

RC Circuit

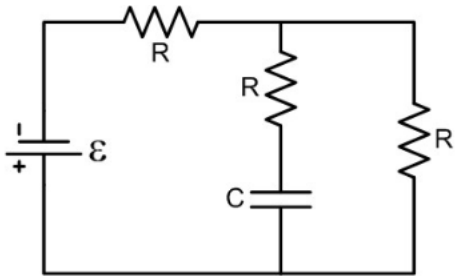
Consider the following circuit (the capacitor is initially uncharged):

a) What is the initial current through the circuit?

b) After a long, long time what is the current through the circuit?

c) What is the maximum potential difference across the capacitor?

YouTube: http://youtu.be/C1zmDdPvzcM



Magnetism

Magnetic force on a moving charged particle

An alpha particle (2 protons and 2 neutrons) is traveling with a velocity of $\vec{v} = (0.500\hat{\imath} + 1.00\hat{\jmath} + 1.00\hat{k}) \times 10^6\ m/s$ in a magnetic field $\vec{B} = (-0.500\hat{\imath} + 0.300\hat{\jmath} + 0.800\hat{k}) \times 10^{-3}\ T$.

a) What is the force on the alpha particle?

b) What is the angle between the velocity and the magnetic field?

c) Briefly describe the trajectory of the alpha particle in the magnetic field.

YouTube: http://youtu.be/NA9qxFbTqQA

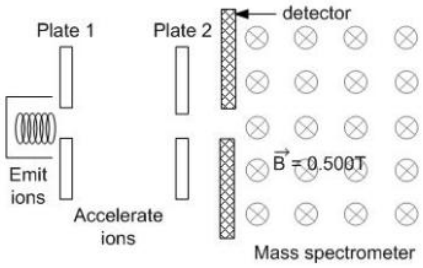
Accelerated particles and mass spectrometer

Negative, singly ionized atoms of carbon-12 and carbon-14 are accelerated through a potential difference of 5.74 kV. They are then deflected in a magnetic field of 0.500 T.

a) Do they hit the top plate or the bottom plate of the detector?

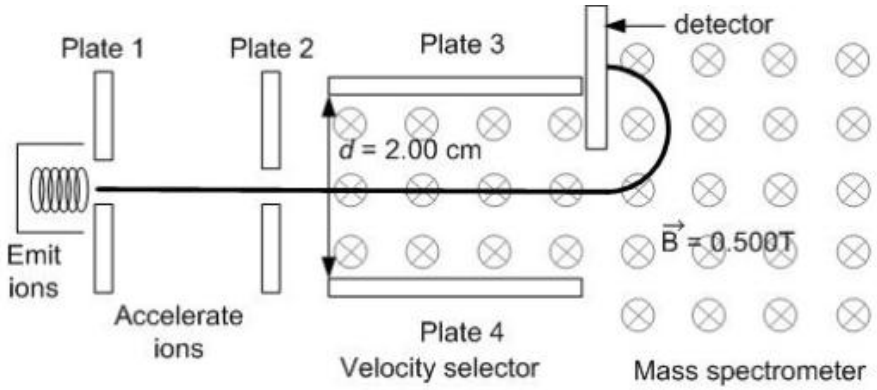
b) How far apart are the carbon-12 and the carbon-14 ions at the detector?

YouTube: http://youtu.be/c2GdOSFMNkg



Mass spectrometer

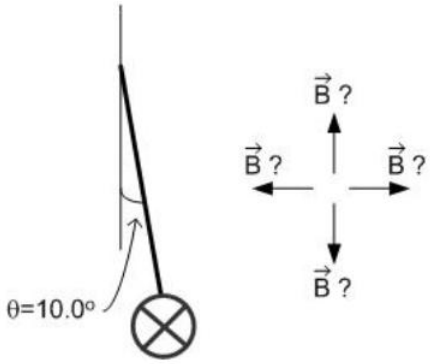
An accelerator, velocity selector and mass spectrometer are used to analyze the carbon-12 and Carbon-14 content of a sample. The carbon is positively, singly ionized. The magnetic field in the velocity selector and mass spectrometer is 0.500 T.



a) You want the distance between the carbon-12 and carbon-14 at the detector to be 1 inch (2.54 cm). With what speed must the particles enter the magnetic field of the mass spectrometer?
b) What accelerating voltage is required to accelerate the carbon-12 to the correct speed, and what accelerating voltage is required to accelerate the carbon-14 to the correct speed?
c) What voltage is required across the plates of the velocity selector? Does it need to be readjusted carbon-14?
YouTube: http://youtu.be/YCNi1J2Mdso

Force on a wire in a magnetic field

A copper rod with mass per unit of length λ=0.954 kg/m carries a current of 15.0 A into the page. The rod is in a uniform magnetic field and hangs at an angle of 10.0° from the vertical.
a) What is the direction of the magnetic field? (it can only be in one of the 4 directions on the pictures)
b) What is the magnitude of the magnetic field?
YouTube: http://youtu.be/w3JIkTO6g2I



Magnetic field of long wires

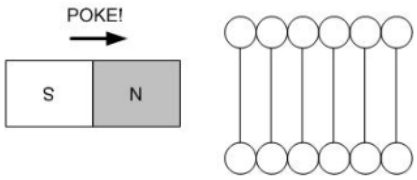
A very long wire carries a current of 5.00 A in the +z-direction (out of the page). Another very long wire, 3.00 cm to the right of the first wire, carries a current of 10.0 A in the +z-direction. What is the net magnetic field (magnitude and direction) 2.00 cm above the first wire?
YouTube: http://youtu.be/NsIeoG_TbEI

Magnetic forces between current-carrying wires

Wire 1 carries a current of 15.0 A from the bottom to the top of the page.
Wire 2, parallel to wire 1, is placed 5.00 cm to the right of wire 1, and carries a current of 5.00 A in the opposite direction (from the top to the bottom of the page).
Wire 3 carries a current in the same direction as wire 1. The net force on wire 3 is zero.
Where is wire located? (Hint: do you actually need the know current in Wire 3 to answer?)
YouTube: http://youtu.be/epLI3u9mJqw

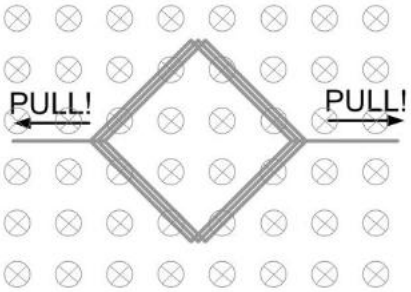
Induced current

A magnet is poked north pole first into a solenoid.
Determine the direction in which the induced current flows and whether the magnet and the solenoid attract each other or repel each other.
YouTube: http://youtu.be/Q_7ZjZqrN0k



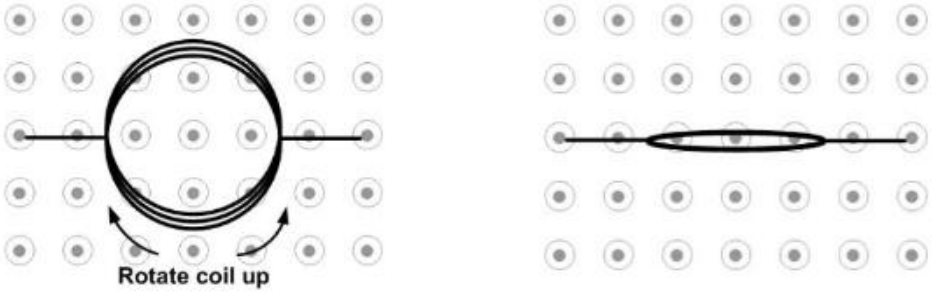
Induced current

A square coil is made of 10.0 turns and has a side of length 10.0 cm and a resistance is 10.0Ω. The coil lies in a 1.00T-magnetic field that points into the page as shown. The coil is flattened by pulling the sides in 0.200 s.
What is the magnitude and the direction of the induced current?
YouTube: http://youtu.be/RJZ67-aBND8



Induced emf

A circular, 20.0-turn coil has a diameter 7.50 cm. It lies in a uniform magnetic field of 0.100 T that points out of the page. The coil is rotated ¼ turn, from perpendicular until it is parallel to the field.
a) How quickly must this be done for the average emf to be 1.50V, and which way does the induced current flow?
b) You have a power supply that can deliver a maximum of 5.00 A. Design an apparatus that can produce the uniform magnetic field in this problem.



YouTube: http://youtu.be/mubvkqPjWUA