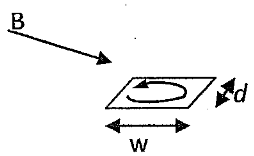


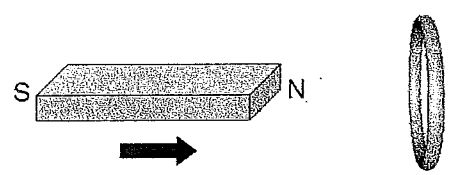
Question. A rectangular coil, 65 turns, carries current in the direction shown. The current is I = 14 A. There is a B-field B = 0.2 T making a 27° angle with the plane of the coils. The width of the coil is w = 0.15 m and the depth is d = 0.09 m.

What is the torque on the coil (magnitude and direction)?

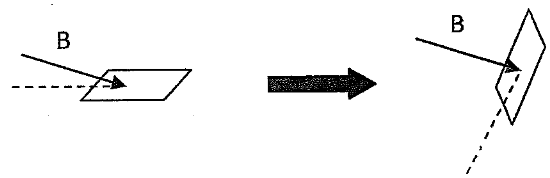
Question. What is the radius of the orbit of a proton traveling perpendicular to the Earth's Magnetic field? The mass of the proton is $m_p = 1.67 \times 10^{-27}$ kg, the velocity is 5×10^{8} m/s, and the magnetic field of the earth is $B = 5.5 \times 10^{-5}$ T.

Question. Name the four basic components of every motor, and explain what each component does.

Question. The North end of a magnet rapidly moves right toward the copper ring. a. What is the direction of the current induced in the ring? b. Is there a force on the ring, and if so, what is the direction?



Question. A magnetic field B = .077 T is pointing at a 30° angle to the plane of a coil. The coil has 650 turns, and an area of 35 cm^2. Suddenly, in 0.004s, the coil rotates so that it is perpendicular to the B-field.

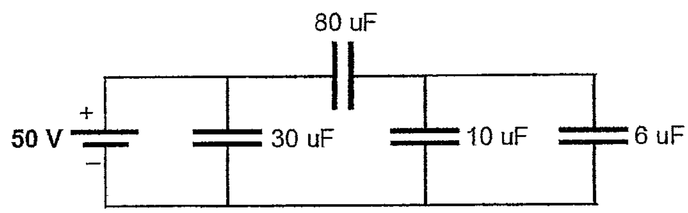


a. What is the voltage induced in the coil?

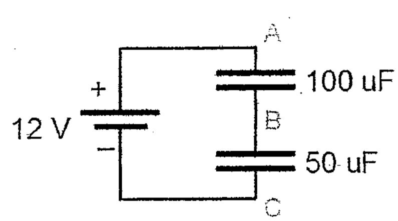
b. If the resistance of the coil is 10 Ω, what current flows in the coil?

c. Use an arrow to show the direction of the induced current

Question. a. What is the total capacitance as seen by the battery in the circuit below? b. How much charge flows from the battery when it is initially connected to the circuit?

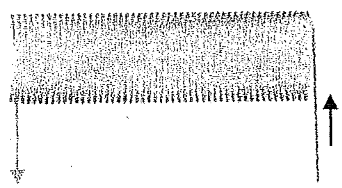


Question. a. What is the total capacitance as seen by the battery in the circuit below? b. How much charge is on each capacitor? c. Which two nodes should you connect to a voltmeter to get a reading of 8 Volts? d. How much energy is stored in each capacitor?



Question. 50 turns of wire are wrapped tightly in a cylindrical coil that is 8.5 cm in length and 1.05 cm in diameter. A current of 5.9 A passes through the wire.

a. What is the value of the magnetic field produced by this solenoid –Inside the coil? Outside the coil?



b. Draw the magnetic lines of force inside and outside the coil. Their density should indicate the relative strength of the field at each location. Assume the current is going upward on the wire that is near you on the right.

c. In the above drawing, where are the lines very uniform?

Very non-uniform?

Very sparse?

d. A cylindrical steel rod is fitted tightly inside the coil. The value of μ for the steel rod is 14. What is the magnetic field produced by the solenoid now?

Question. In ferromagnetism, what role is played by domains?

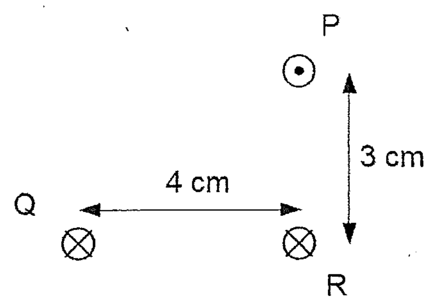
by Fe Co and Ni?

by rare earths such as Nd, Dy, Eu, and Sm?

by iron atoms, as distinguished from domains?

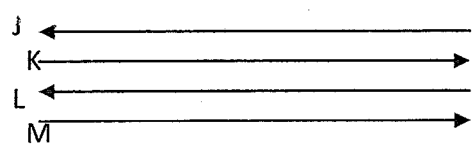
Question. Three wires are 50 m long and are arranged as shown in the drawing. Current P and Q are 40 A. Current R is 60 A.

a. What is the force on wire R (magnitude and direction)?



b. What is the B-field experienced by R, due to P and Q?

Question. Wires J, K, L and M are parallel and separated, each from the next, by 20 cm. They are 17 m long and each carries 25 A in the direction indicated. What is the net force on wire K?



Coulomb force Mini Lab

You can measure the force between a charged object and a metal sphere. Then use the force and distance between the two to estimate the charge using Coulomb's Law.

Procedure:
Use the scales that are accurate to 0.01 gram. Place the aluminum ball on the balance. Press the 'tare' button on the balance to zero the reading with the ball on the scale. Now any changes in the force on the ball will show up as mass deviations from this new zero.

1. Determination of Charge:
Rub the fur or wool on the plastic pipe. Bring rubbed end of the pipe to about 2 cm above the aluminum ball. The charge on the sphere is approximately equal and opposite to the charge on the plastic rod. The distance between the two charges is R, where R is 2 cm converted to meters. The 'unknown' charges are $\pm Q$. The force has a value $F = \Delta m \cdot g$, where Δm is the mass change of the ball converted to kg, then multiplied by g to give the electric force in Newtons.

F = ___________N.

To find out what Q has to be in order to give the force found above, use Coulomb's Law:

$F = 9 \times 10^9 \cdot \frac{Q * (-Q)}{R^2}$. Solve this equation for Q:

Q = __________C

2. Inverse square law:
Rub the fur or wool on the plastic pipe. Bring rubbed end of the pipe to about 4 cm above the aluminum ball. Take a reading of the scale, then move to about 2 cm above the aluminum ball, and take another reading of the scale.

- Is the scale reading stronger as you get closer to the ball?
- Rub the rod again, and repeat the experiment 3 times, writing down the two scale readings in grams each time.

reading @ 2 cm:	_______ gm	_______ gm	_______ gm
reading @ 4 cm:	_______ gm	_______ gm	_______ gm
ratio near/far :	_______ gm	_______ gm	_______ gm

- **Prediction**: What would you predict for the ratio between the two readings, (near ÷ twice as far), based upon Coulomb's Law, an inverse square law?

Ratio = ______

W6

Electrostatic Force Interactions

Charged Objects and Newton's Laws

Suppose that the two point objects below have identical mass but that object A has twice as much excess positive charge as object B. The two objects are in empty space where there is no gravity. The objects are placed as shown and then released from rest.

Questions

Do the objects move after they are released? If so, in which directions? Explain your reasoning. (Q1)

Do the objects speed up, slow down or move at constant speed

just after they are released? (Q2a)

a short time after they are released? (Q2b)

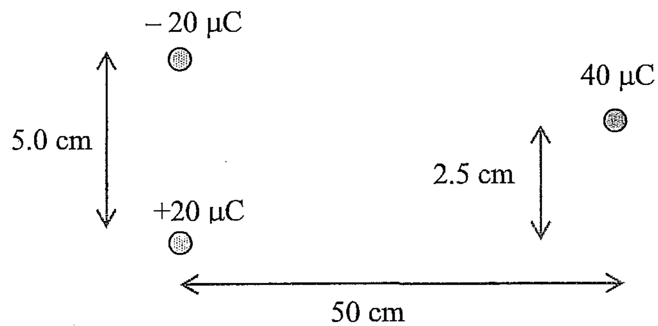
a long time after they are released? (Q2c)

Questions

At any instant in time, how does the speed of object A compare with the speed of object B? Explain (Q13)
Draw arrows to show the net force on each object.
At any instant in time, how does the force that object A exerts on object B compare with the force that object B exerts on object A? What law governs these two forces (Q15)

Coulombs Law Dipole

a. Draw arrows to show the Coulomb force on the 40 μC charge due to the +20 μC and the -20 μC charges. Draw another arrow to show the net, combined force on the 40 μC charge.



b. Find the x- and y- components and the magnitude of the net force on the 40 μC charge.

W10

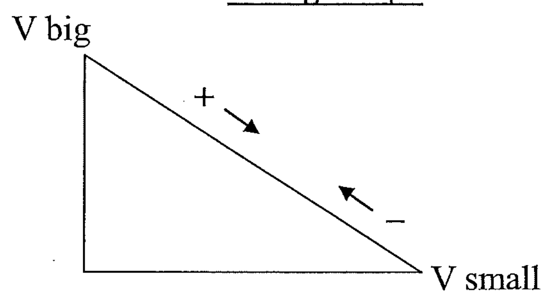
Energy and Voltage Worksheet

Use one or both of the following nomograms:

Sign of ΔV

	Q+	Q–
KE ↓ PE ↑	+	–
KE ↑ PE ↓	–	+

+ and – on a Voltage Slope



Example problem. An electron flying from plate A to plate B speeds up from 1.0 $\times 10^6$ m/s to 5.0 $\times 10^6$ m/s. What is the change in voltage from A to B?

a. Draw a diagram of the situation described above. Either an incline or + and – plates.

b. Is this a case of KE increasing, or a case of KE decreasing?

c. What is the sign of ΔV?

d. What is the kinetic energy change?

$\Delta KE =$

e. What is ΔV (including the correct sign)?

$\Delta V =$

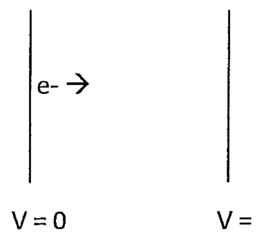
Charge and Volts

1. When a free electron and a free proton join up to form a hydrogen atom, the voltage experienced by the electron changes by $|\Delta V| = 13.6$ Volts. Energy is converted from potential energy into ultraviolet light.

a. As the electron gets closer to the proton, it experiences a positive negative change in voltage (circle one and explain why?)

b. What is the amount of energy in emitted UV light when the electron and proton join to form a hydrogen atom? (the electronic charge is $e = 1.6 \times 10^{-19}$ C)

2. Each time an electron circulates around the ring of an electron synchrotron (atom smasher), it passes through and RF voltage section and it gains kinetic energy 1.12×10^{-13} J. If it starts at a voltage of V = 0, what voltage V must it reach in order to pick up this energy?



"RF voltage section" of synchrotron

3. It takes about 200 C of charge from a 12 Volt battery to start a car.

a. How much energy is required to start the car?

b. Do electrons flow from the negative positive terminal (circle one), through the starting motor, and back to the battery?

Lemon Batteries **Minilab**

Objective: Measure lemon batteries in series and parallel.

Building the battery

Pierce the side of the lemon with the galvanized steel strap, leaving some room for the copper terminal. ("Glavanized" means it is plated with zinc.) Stick the pointy end of the copper flashing into the lemon. Don't let it touch the galvanized steel strap at any point.

1. Measure the voltage between the copper and the zinc electrodes.

V =

Which is the positive and which is the negative terminal of the lemon battery?

2. Change the multimeter to current measurement. You will probably need to use a scale that can measure in uA (10^{-6} A).

A =

3. Hook up the red LED to the battery. The positive end of the LED is the longer wire.

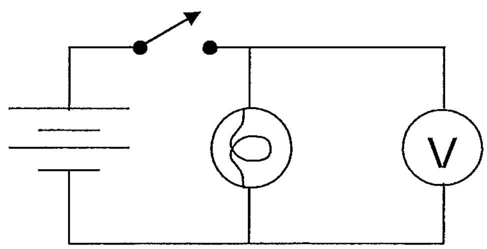
4. Since there is not enough voltage in one battery to light the red LED, connect two batteries in such a way as to light the light (it will be very dim, so turn the light on and off to see the light).

Lamp Circuit and Measurement **Minilab**

The purpose is to familiarize you with some simple circuit facts and tools. Hook up a lamp and battery and get it to light. Make measurements of voltage and current using the multimeter and the clip-on meter.

Materials:
2 batteries, battery holder, and 1 2.5 Volt lamp w/ socket, clip lead wires, multimeter, clip-on meter (there are only 2 of these, so please share).

1. Lighting the lamp and measuring the voltage
The following circuit shows two D-cells in series, the lamp, switch and the multimeter:



Create the circuit with just the lamp and the batteries, and get the lamp to light. Show that the switch makes the lamp go on and off because it can interrupt the current through the battery – lamp circuit. While the lamp is lit, measure the voltage across the lamp using the multimeter. The lamp and the meter need to be 'in parallel' when measuring voltage. The 'voltage' is a measure of the energy the batteries give to the electrons that go through the lamp (more about this next week.)

Voltage across the lighted lamp = ____________V.

Is the voltage you measure greater than the voltage rating of the lamp – ie, 2.5 V? Y or N (circle one) It should be if the batteries are fresh, and that is why the lamp is very bright!

2. Measuring the current in the lamp
Disconnect the multimeter from the circuit, leaving and close the switch so the lamp is lit. Now open up the switch and attach the meter for measuring current. Attaching the current meter will cause the light to light, if you attach the meter so it provides a current path that circumvents the open switch.

- Note: you need the meter to measure DC current, which is symbolized ---- on the multimeter. Use the maximum current scale – namely 2 Amps maximum.
- You may need to change the sockets where the leads go into the multimeter, so you can measure current.

- You must wire it so all the current that goes through the lamp also goes through the meter like a daisy chain. This is called putting the meter and the lamp 'in series'.

Current through the lighted lamp = ____________Ampere.

The ampere is the electrical measurement of electric current flow in a device. If you think of the voltage as being similar to the pressure forcing water through a pipe, the current is analogous to the the fluid flowing through the pipe.

3. Finding the power in the lamp

The power in the lamp is the product of current and voltage applied to the lamp. Find the power in the lamp when lit:

Power = Current * Voltage = ____________ Watts

4. Measuring current with the clip-on meter

Familiarize yourself with the clip-on meter by using it to measure the current in the lamp when lit. You will have to set the meter to DC Current, and then zero the meter so it measures no current when there is no wire going through the clip.

Clip the meter around the wire while the lamp is lit.

a. Current = _____________ Ampere

Now try looping the wire a couple of times around one of the jaws of the clip.

b. Current (multi-turn) = ____________ Amperes

What is the difference between Current (a) and the quotient of Current (b) divided by the number of loops N?

a) – (b/N) = _____________ Amps

W16

Simulate Electric Field

Aktiv Physics

Introduction

Use the AktivPhysics simulations to visualize the Electric Field and Voltage field for various charge geometries.

Material

Use Internet Explorer if Firefox doesn't work on the Java simulations.
Google www.Aktivphysics.com
You want to go to a Pearson website. Then find the home, and use the pulldown menu to find electromagnetism. Here is the URL:

http://wps.aw.com/aw_young_physics_11/13/3510/898593.cw/index.html

I. Dipole Field

Predict the appearance of a dipole electric field:

\+ −

A. Turn on the simulation of the electric dipole (11.5 #2). Redraw the field using this information:

\+ −

What happens when you increase the amount of charge in each of the charges?

B. What is the direction the E-fields point in the vicinity of the + charge?

C. What is the direction the E-fields point in the vicinity of the – (negative) charge?

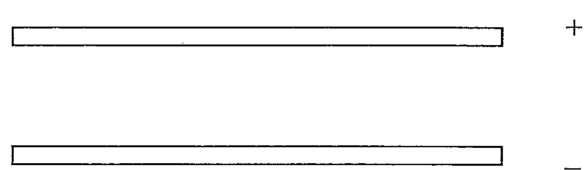
D. Turn on the potential field. Describe how the equipotentials are arranged around a single charge:

E. Does the potential (voltage) change more or less rapidly as you get closer to the charge?

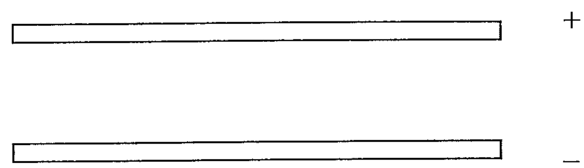
F. As one moves toward a positive charge, what happens to the voltage?

II. Parallel plate configuration

A. Predict the electric field in and around two parallel plates:



B. Turn on the simulation of the parallel plates (11.12 #3). Redraw the field using this information:



C. What happens to the number of E-lines as the charge on the plates is increased?

D. What happens to the number of Voltage equipotentials as the charge on the plates increases?

E. What happens to the density of the electric field lines near the edges of the plates? Comment on this – why does this happen?

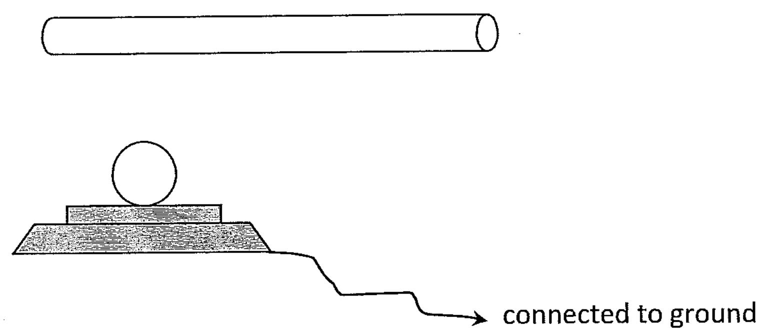
F. How can you tell that the E-field in between the plates is uniform, and what does that mean?

G. As you go from toward the positive plate, does the voltage increase or decrease?

W22

E-field between two charged spheres

3. <u>What Does the E-Field Look Like?:</u>
Below is a diagram of the plastic pipe held over the aluminized ball on the scale. Complete this diagram by showing the charges present, the electric field lines of force between and around the objects, and the direction of the electric field.



4. <u>E-field Magnitude and Direction at the ball</u>
a. You know the charge on the plastic rod from part #1 above. When the distance between the rod and the ball is 2 cm, what is the electric field experienced by the ball, due to the charge on the plastic rod?
Charge on rod =

E-field on ball, magnitude =

E-field on ball, direction, is ___________.

b. Under the same conditions as part a), what is the electric Force and the E-field experienced by the rod, due to the charge on the ball?
Charge on ball =

E-field on rod, magnitude =

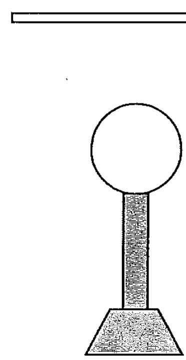
E-field on rod, direction, is ___________.

c. Is the force in part a) equal to the force in part b) and why or why not?

5. E-field & Dielectric Breakdown

The instructor or a brave student will hold a metal plate near the van der Graaf. Other brave students will measure the maximum distance at which a spark jumps from the van der Graaf to the metal plate.

a. Complete the diagram at below by showing the charges present, the electric field lines of force between and around the objects, and the direction of the electric field.



What is the longest spark achieved between the plate and the sphere?

d = ________m

What is the electric field needed for breakdown in dry air?

E_{BD} = __________ V/m

Find the Voltage on the vdG sphere, based on the above distance and E_{BD}:

$| V_{BD} | = E*d$

Sign of voltage on the vdG = _______

6. Coulomb Force between vdG and plate

Assume the vdG has a charge of 400 nC when breakdown occurs in part 5) above. What is the Coulomb force on the plate due to the electric field and the charge on the plate? (assume the charge on the plate is equal and opposite to that on the vdG):

F = ___________N . Is this force consistent with what the student holding the plate felt?

Explain:

Coulomb's Law Components

1. A 1.0 C charge is 5.0 m away from a 2.0 C charge.

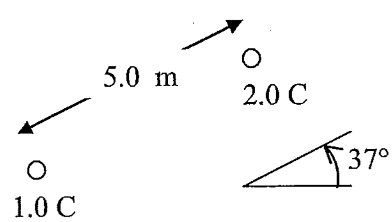
a. Draw an arrow from the 2.0 C charge to show the E-field experienced by the 2.0 C charge, due to the 1.0 C charge; and label it showing the magnitude of the E-field.

$|E_{2\to1}| =$ ○   ○ $|E_{1\to2}| =$

1.0 C   2.0 C

b. Draw an arrow to show the E-field on the 1.0 C charge, and label it with the value of the magnitude. Are the E-fields equal and opposite?

2. The 2.0 C charge is now 37° above the horizontal, as shown:



a. Draw arrows to show the x- and y- components $E_{1\to2}$.

b. Calculate the x- and y- components:

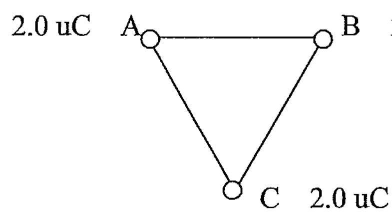
$E_{1\to2\,x} =$

$E_{1\to2\,y} =$

c. Find the magnitude of the $E_{1\to2}$, using the Pythagorean theorem.

Adding up E-fields – Equilateral Triangle

1. Three 2.0 μC charges are arranged in an equilateral triangle as shown. The side of the triangle is 3.0 cm.



a. Draw an arrow on charge C showing $E_{A\rightarrow C}$, the E-field of charge A acting on charge C. Find the magnitude of this E-field.

$E_{A\rightarrow C}$ =

b. Calculate the x- and y- components of $E_{A\rightarrow C}$:

$E_{A\rightarrow C\ x}$ =

$E_{A\rightarrow C\ y}$ =

c. Find the E-field due at point C due to the other charges by adding the E-fields due to A and B at point C:

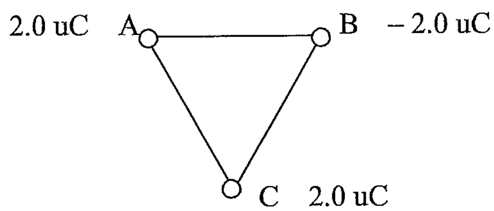
$E_x = E_{A\rightarrow C\ x} + E_{B\rightarrow C\ x}$ =

$E_y = E_{A\rightarrow C\ y} + E_{B\rightarrow C\ y}$ =

W27

Adding up E-fields – Another Equilateral Triangle

1. Two 2.0 μC charges and a – 2.0 μC charge are arranged in an equilateral triangle as shown. The side of the triangle is 6.0 cm.



a. Draw an arrow on charge C showing the E-field due to charge A at point C. Find the magnitude of this E-field.

$E_{A \to C} =$

b. Calculate the x- and y- components of $E_{A \to C}$:

$E_{A \to C\,x} =$

$E_{A \to C\,y} =$

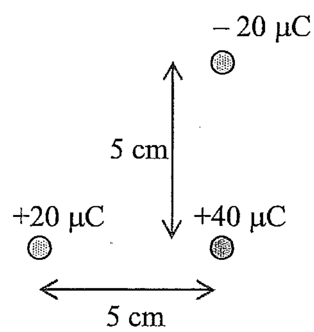
c. Find the E-field at charge C by adding the fields due to A and B:

$E_x = E_{A \to C\,x} + E_{B \to C\,x} =$

$E_y = E_{A \to C\,y} + E_{B \to C\,y} =$

Physics 112 **E-field Vectors**

a. Draw an arrow to show the net E-field on the 40 μC charge due to the other two charges.



b. Find the x- and y- components and the magnitude of E at the 40 μC charge.

Gauss's Law Exercise

1. a. A charge of 4 μC is enclosed by an imaginary sphere of radius 2.5 meters. What is the product of E*A, where A is the area of the sphere and E is the electric field at its surface?

E =

A =

E*A =

b. The 4 μC charge now is enclosed by an imaginary sphere of radius .25 m. What is the E-field at the new radius? What is the area at this new radius? What is the new product E*A?

E =

A =

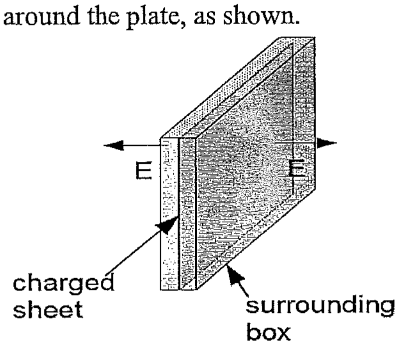
E*A =

c. Can you make a generalization about the product of an imaginary area A enclosing charge Q and the E-field penetrating the area?

E*A =

[ans. 4πkQ]

3. A square plate has area A and carries a charge Q spread over it. An imaginary box is placed around the plate, as shown.



Assume all the E-field lines of force come through the broad faces of the box. Use E = 4πkq/A to find the E-field near the charged sheet.

a. What is the area of the imaginary box around the plate (consider only the two large faces of the box) area =

b. What is the charge inside the box?

charge =

c. Previous results show that area*E = $4\pi k$ * charge. Use this fact to find the value of E emanating from the charged sheet:

E =

4. Example: A 4 μC charge is spread uniformly over a square sheet that is 0.2 m x 0.2 m. What is the value of E-field near the surface of the square sheet?

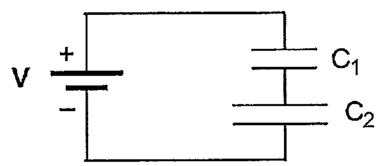
5. Important Example: A 10 μC charge is spread uniformly over a spherical shell that is 0.2 m in radius.

a. What is the E-field outside the sphere a distance R from the center of the sphere? [hint: would it make any difference whether the charge is on the surface of the sphere or all located at the center of the sphere?]

b. What is the E-field **inside** the sphere a distance 0.1 m from the center of the sphere? [hint: would it make any difference whether the 10 μC charge is spread over the surface of the sphere or is all located at the center of the sphere?]

Capacitors in Series and Parallel

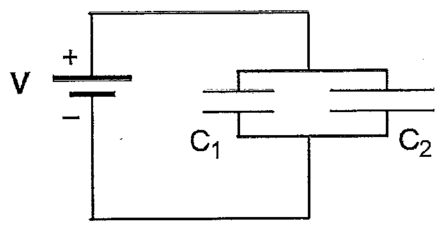
1. Two capacitors in series



$$\frac{1}{C_T}=\frac{1}{C_1}+\frac{1}{C_2}$$

Problem: Suppose C_1 is 12 uF and C_2 is 24 uF. What is C_T?

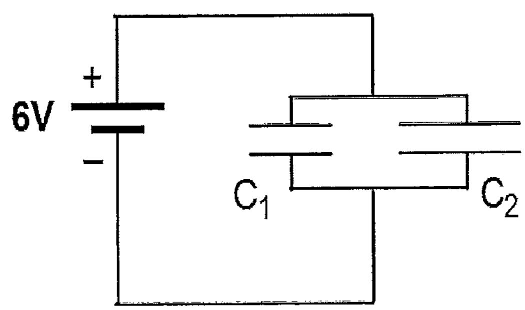
2. Capacitors in parallel



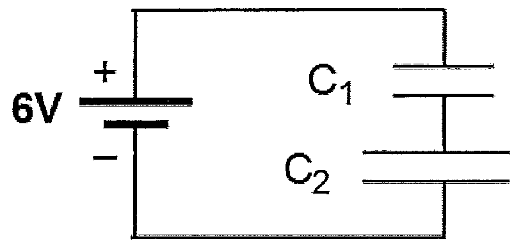
$$C_T = C_1 + C_2$$

Problem: Suppose C_1 is 12 uF and C_2 is 24 uF. What is C_T?

3. Charge Storage



If V = 6 Volts, mark each capacitor plate with the charge there. C_1 is 3 uF and C_2 is 6 uF. What is the total charge stored?



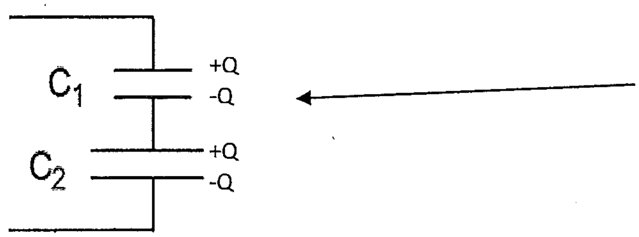
C_1 is 3 uF and C_2 is 6 uF. What is C_T?

C_T = ____________

a. If V = 6 Volts, what is the charge stored?

$Q = C_T*V$ = ____________

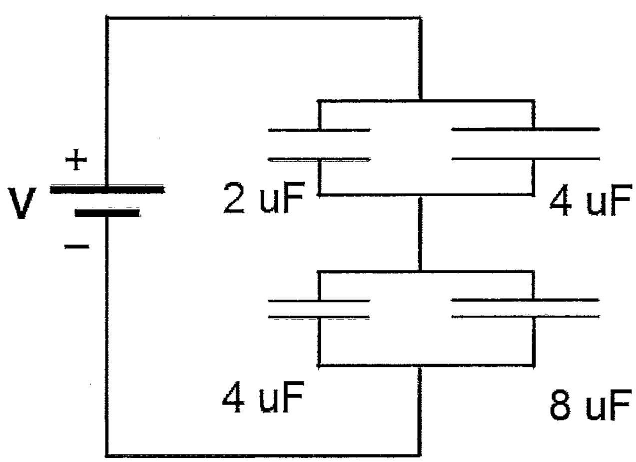
b. Mark each capacitor plate with the charge stored there.



(Hint: Every plate of C_1 and C_2 must hold the same charge ±Q found in part a) above. The node in between the two capacitors must have zero net charge.)

c. Use Q = CV to find the voltage on each capacitor.

V_1 = ________ V_2 = ________



What is the total capacitance of this circuit?

Resistivity

- R = ρL/A Resistance of object with intrinsic resistivity ρ, length L, and area A

1. An aluminum power line is 1" = 2.54 cm in diameter and 16,000 m long. The resistivity of aluminum is 2.82×10^{-8} Ω-m. What is the resistance of the power line?

2. A fine wire in a loudspeaker is $1.0 \times 10^{-7}\,m^2$ area in cross section and the resistance of the wire is 3.2 Ω. It is made of copper, which has a resistivity $\rho = 1.68\times10^{-8}$ Ω-m. How long is the wire?

3. A spool of wire has 61 meters of wire that is $10^{-6}\,m^2$ area in cross section. The resistance of this wire is 1.6 Ω. A second spool has wire with an area that is 10× **smaller**, but the length is 10× **longer**. What is the resistance of this spool of wire?

Pair of Wires - Demo

Exercise in resistance, current and magnetic force

The wire is a single loop of copper wire that is 2.0 m long and .025 inches in diameter.

1. What is the resistance of the loop? (Use resistivity of Cu $\rho_{Cu} = 1.7 \times 10^{-8}\ \Omega\text{-m}$, resistance of the wire is $R = \rho_{Cu}\ L/A$, cross-sectional area of the wire is $A = \pi\ d^2/4$, where d is the diameter)

R =

2. The voltage applied is V = ____________ V. Therefore the current in the wire is

I = V/R =

3. The wires are about 1.0 cm apart. The force between the wires is

F =

4. A 10 cm length of the wires is 1.0 mm apart. The force between the two wires in this segment is

F =

5. The magnetic field 1.0 cm away from one of the wires is

B =

Magnetic force on Current MiniLab

Summary: Examine magnetic force by putting the north pole of a magnet up to a wire carrying a current. Use the force F, current I, and the length of wire L that crosses in front of the magnetic pole, to calculate the magnetic field B coming from the magnet. For B and I at right angles, $F = B*I*L$. Try one or multiple magnets. (Careful, these magnets are powerful and can pinch you!)

Procedure:

1. The **B-field** emanates from the North pole of a magnet. Identify the north pole of your magnet by bringing a compass from far away toward one end of the magnet. When you find the North pole, mark it by sticking on a small piece of tape.
2. Place the wire mounted on a block onto the balance and zero the balance.
3. The battery consists of 2 or 3 small cells that supply about 5 amperes to the wire. The red lead from the battery holder is positive, the black lead is negative. Connect the big copper wire to the battery and quickly make the following observations (before the battery dies). Disconnect the battery whenever you are not making observations.

Current, I: Quick measurement of current – easy to do with the clip on meter.

Magnitude and Direction of the Magnetic field and Magnetic force

1. With the current going from your left to your right, the magnet horizontal, point the North pole perpendicular to the wire. The reading of the balance in grams is _________

Force in Newtons _________N Direction of the force __________

Current I in the Wire ________A B-field from the magnet ________

Draw a 3-D sketch of the wire and magnet configuration, showing B, I and F directions:

2. Keeping the magnet in the same location, and the current direction the same, flip the magnet over so its South pole faces the wire. This reverses the magnetic field. The reading of the balance in grams is _________

Force in Newtons _________N   Direction of the force __________

3. Now keep everything the same as 2) above, flip the wire 180° so the current flows right to left instead of left to right. The reading of the balance in grams is _________

Force in Newtons _________N   Direction of the force __________

4. Point the North pole downward on the wire from above. The reading of the balance in grams is _________

Force in Newtons _________N   Direction of the force __________

5. Put the North pole at the corner of the wire and point it parallel to the horizontal segment of the wire. The reading of the balance in grams is _________

Force in Newtons _________N   Direction of the force __________

Now that you are done making measurements, check the wire current again, to see that the battery is not dead, but still delivering a current of at least a few Amps

I = ________ A

Questions:

a) What is the angle between a current and a magnet that gives maximum force?

b) Extend proposition (a) above to apply to a moving charge and a magnetic field:

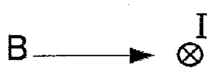
c) If a current and a magnetic field are aligned parallel, what is the force on the current?

d) If a current I points along the x-axis, and a B-field points along the y-axis, what is the direction of the force F on the current?

W44

Right Hand Rule Practice

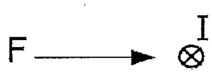
1. Find the direction of the Force on the wire with the current I.

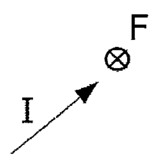


B is North
I is down

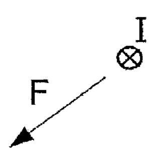
B is +y-direction
I is +x-direction

2. Find the direction of the magnetic field given current I and force F. Assume B is at right angles to I.



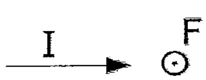


F is West
I is down

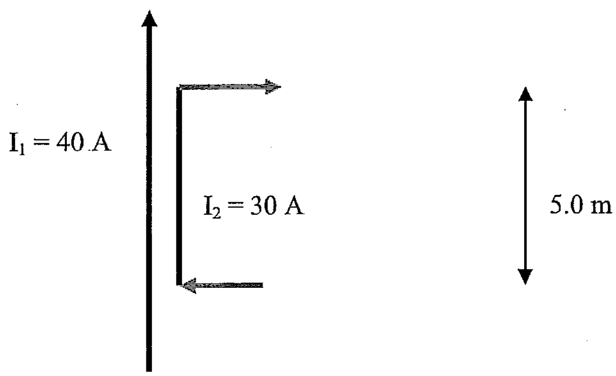


F is +z-direction
I is +x-direction

3. Draw B assuming B is at 45° angle to I:



Physics 112 **Force between currents**



1. Wire 1 and wire 2 are separated by 1.0 cm. They are parallel for a distance of 5.0 m.
a. What is the magnitude and direction of the B-field due to wire 1 at the location of I_2?

$B_{1\rightarrow 2} =$

Give both magnitude and direction

b. What is the force on wire 2 due to $B_{1\rightarrow 2}$ found in 1a) ?

2. a. What is the magnitude and direction of the B-field due to wire 2 at the location of I_1?

$B_{2\rightarrow 1} =$

Give both magnitude and direction

b. What is the force on wire 1 due to $B_{2\rightarrow 1}$ found in 2a) ?

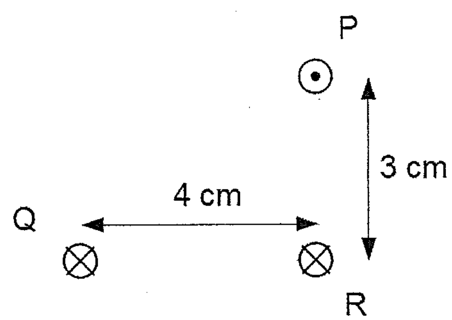
W47

Question 1. In ferromagnetism:
What happens to domains if a rebar is wrapped with many turns of a coil and a large current goes through the coil?

What happens to the domains if the above current is turned off?

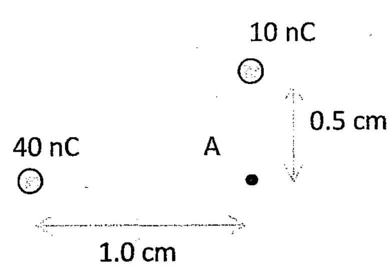
What happens to the domains if the current is switched back and forth: 6A , -5A, +4A, -3A, +2A, -1A, +.5A, -.25A, 0A.

Question 2. Three wires are 50 m long and are arranged as shown in the drawing. Current P and Q are 40 A. Current R is 60 A.
a. What is the force on wire R (magnitude and direction)?



b. What is the B-field experienced by R, due to P and Q?

Question 3. Find the Electric field at the point A, including magnitude and direction:



If a 1.1 μC charge is placed at A, what is the magnitude of the force on it?

Question 4. a. Two parallel plates are separated by 2.0 mm. The voltage between the plates is 120 V. What is the electric field, E, between the plates?

b. A proton moves freely from the 120 V plate to the 0 V plate. What is the force on the proton?

|F| = direction =

c. What is the change in potential energy of the proton?

Question 5. Create a circuit with a 1000 V battery that uses resistors to divide the voltage so that it can be measured with a Voltmeter having a 10 volt scale. Set up an RIVP table to prove your circuit works.

W49

Capacitor problems

1. a. Find the capacitance of a pair of flat metal plates that are 1000 m^2 each, separated by 1 mm, if the capacitor is filled with air.

b. The voltage applied to the capacitor is 150 V. What is the charge stored?

c. Redo parts a and b of the above problem if the space between the plates is filled with a dielectric having dielectric constant 3.2.

2. a. A capacitor consists of two metal plates that are 30 cm x 110 cm. In between is a piece of mylar ($\kappa = 3.6$) What is the capacitance?

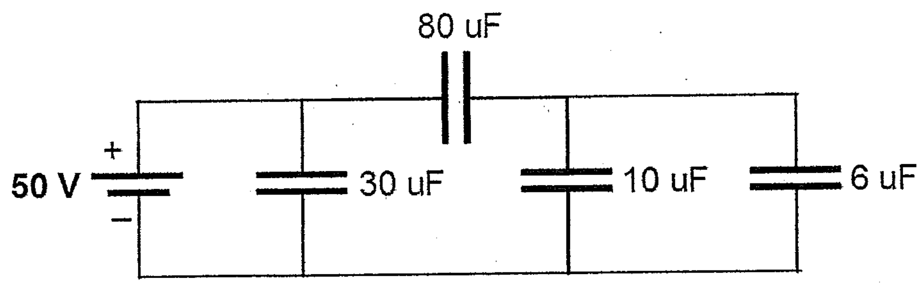
b. A stack is made of plate1 / mylar/ plate2/ mylar/ plate3. The plates and mylar have the same dimensions as in part a. What is the capacitance between plate 2 and the parallel combination of plates 1 and 3?

3. An air capacitor with a 0.1 mm plate separation has a capacitance of 150 pF. What is the maximum charge that can be stored before the electric field causes breakdown of the air between the plates?

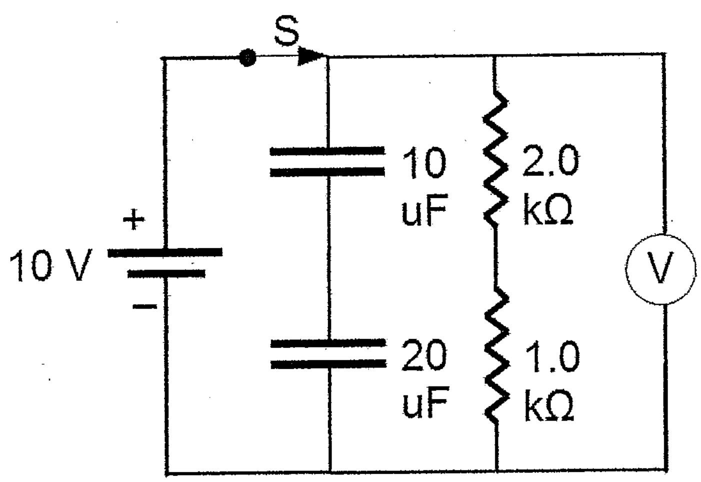
WSO

Capacitor Circuits

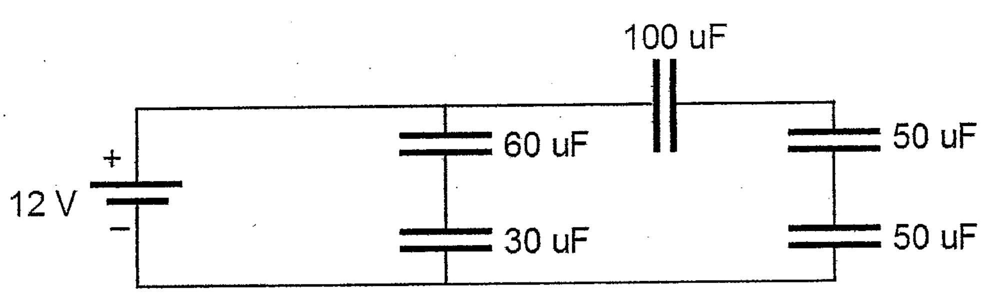
1. Find the total capacitance. Then find the charge stored. Then find the energy stored.



2. The switch S is initially closed, the capacitors are fully charged, and V = 10 Volts. When S is opened, charge will leak through the resistors. What is the time constant for V to reach 3.7 Volts?



3. What is the total capacitance in the circuit:



WS1

House Transformer

A transformer has 1100 turns on the primary and 25 turns on the secondary. It is used to supply house current to the local neighborhood of houses.

a. The output voltage is 120 VAC. What is the input voltage? [Ans. 5,280 V]

b. The current supplied by the secondary goes to 7 houses, for a total maximum current of 750 Arms. Under full current conditions, what is the current in the primary? [Ans. 17.0 Arms]

c. How much power is the transformer handling under these conditions? [Ans. 89,760 W]

d. Is this a step-up or step-down transformer?

W52

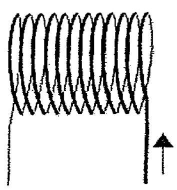
Solenoid Worksheet

The formula for the magnetic field inside a solenoid is

$$B = \mu_0 I \, N_{TPM}$$

We had a formula for μ_0 /(2π) = 2 x 10^{-7} , so since 2π is just a number, you can solve the equation and find out what μ_0 is. I is the current. Also, N_{TPM} is the number of turns per meter. That is, how many coils are there per meter of length.

1. Problem: A solenoid has 10 amperes going through it. The solenoid has length of .15 meter. It has 80 turns in its entire length.

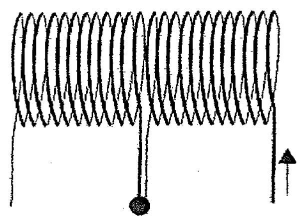


a. What is the magnetic field inside the solenoid?

b. What is the magnetic field outside the solenoid?

c. What is the direction of the magnetic field inside the solenoid?

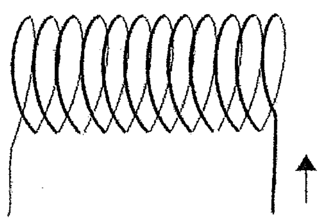
W53



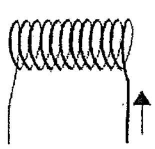
(previous)

2. Two solenoids that are identical to the one above are aligned and placed end to end. They are hooked up in series, and the same current, 10.0 A goes through each. What is the magnetic field inside this new, combined solenoid?

3. Now the original solenoid, carrying the same 10 Amperes, is stretched out to twice its original length. What is the B-field inside the solenoid now?



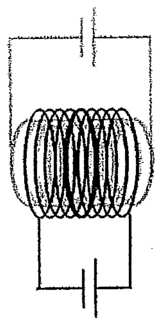
4. Now the original solenoid, carrying the same 10 A, is shrunk in diameter from its original 0.04 m to 0.02 m. The length is kept the same. What is the B-field inside the solenoid now?



W 54

5. Two solenoids are placed one inside the other. They both carry current in the same direction. The outer solenoid is 0.62 m long, has 10,000 turns, and carries a current of 1.23 A. The inner solenoid is 0.93 m long, has 8,000 turns, and carries a current of 0.85 A. (Hint: think of Gauss Law!!)

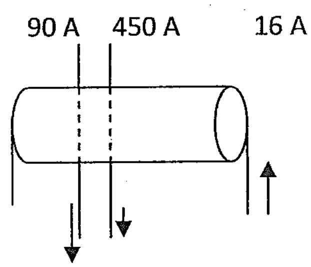
a. What is the B-field at the center of the inner solenoid?



b. What is the B-field in the annular region that is inside the outer coil, but outside the inner coil? (Hint: think of Gauss Law again)

Complicated Force on a Wire

1. A long solenoid has 500 turns on a 0.12 m diameter and a length of 0.40 m. It carries a current of 16 A. Two wires pass through it, separated by 1.0 cm. One wire carries a current of 90 A, the other 450 A. What is the net force on the segment of 90 A wire that is inside the solenoid (magnitude and direction) ?



2. A proton is moving to the right at a speed of 3×10^6 m/s. There is a uniform magnetic field pointed into the page, and a uniform electric field pointed downward. The two resulting forces – electric and magnetic – cancel out and the proton travels in a straight line. If the magnetic field has a value of 0.055 T, what is the value of the electric field?