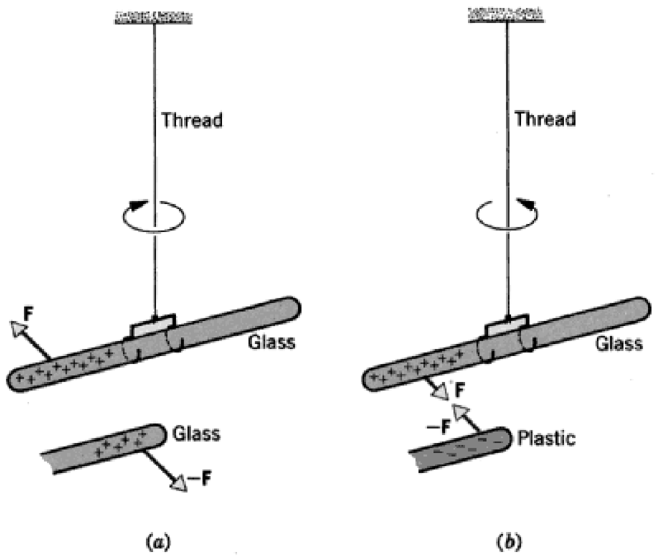
Physics 12
Section 16.1
Rules of Static Electricity, Conservation of Electric Charge



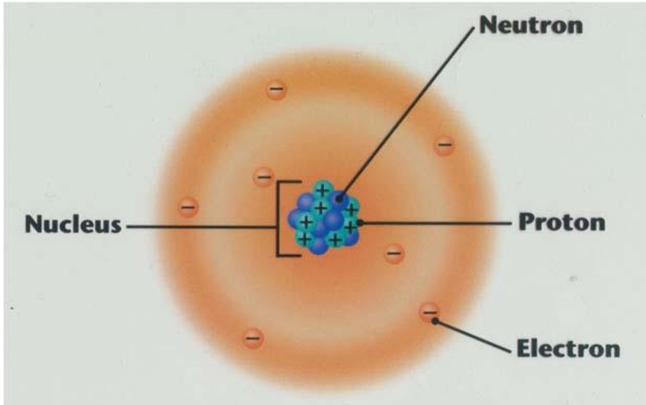
1. **Rules of Static Charge:**

2. **There are two types of charge**

3. **Benjamin Franklin first assigned these charges to objects. He assigned the positive charge to a glass rod as a result of rubbing it with a cloth.**

4. **The Law of Conservation of Electric Charge states that**

Physics 12
Section 16-2
Electric Charge in the Atom



1. We now know that the

2. When an atom loses

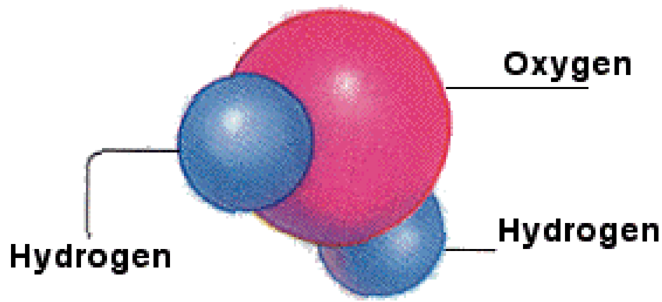
3. A plastic ruler becomes negative when you rub it with paper towel.

4. In liquids and gases charged molecules can move as well as electrons.

5. Water is a polar molecule. The result is that the once charged object is now neutral or has less charge imbalance.

Water Molecule

Negative End (-)



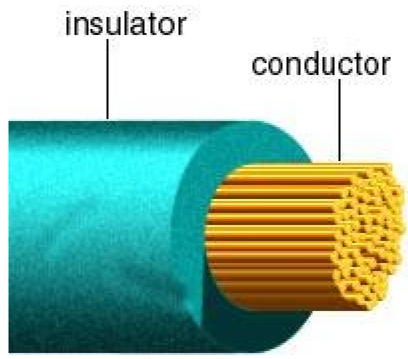
Positive End (+)

Physics 12
Section 16-3
Insulators and Conductors

1. A material that allows electric charge to move freely through it is said to be

2. An insulator

Most materials are insulators.



3. Another classification of material is the

category. Silicon, Germanium and Carbon are some common semiconductors.

4. The electron plays a key role in distinguishing the above three categories.

Physics 12
Section 16-3
Insulators and Conductors

1. A material that allows electric charge to move freely through it is said to be

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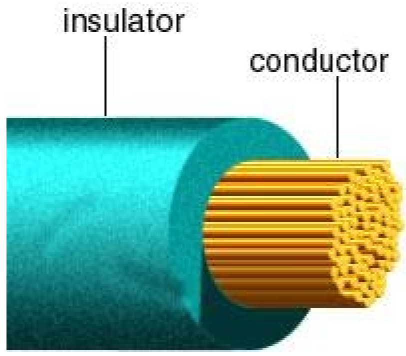


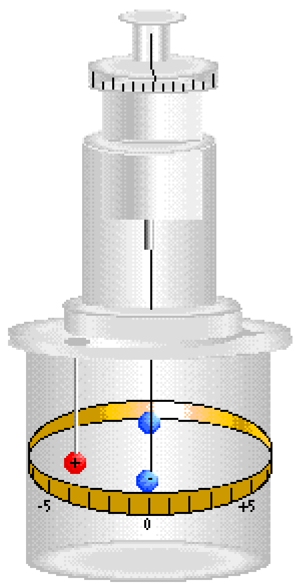
3. Another classification of material is the

   category. Silicon, Germanium and Carbon are some common semiconductors.

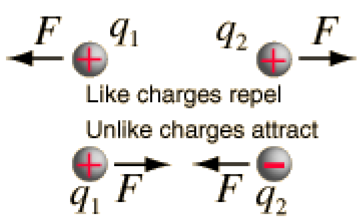
4. The electron plays a key role in distinguishing the above three categories.

Physics 12
Section 16-5
Coulomb's Law

1. **Charles Coulomb (1736-1806) studied forces**



2. **Coulomb used the above device to determine his equation, which is:**



$$F = \frac{kq_1q_2}{r^2} = \frac{q_1q_2}{4\pi\varepsilon_0 r^2}$$ *Coulomb's Law*

$$k = \frac{1}{4\pi\varepsilon_0} \approx 9x10^9 N \cdot m^2/C^2 = \text{Coulomb's constant}$$

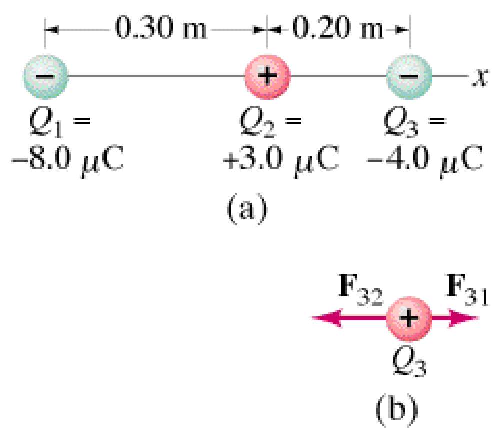
Example 16-1 page 483 Determine the magnitude of the electric force on the electron of a hydrogen atom exerted by the single proton that is its nucleus. The electron orbits the nucleus at a distance of 0.53 x 10^{-10}m.

$$F = \frac{k\, q_1 q_2}{r^2}$$

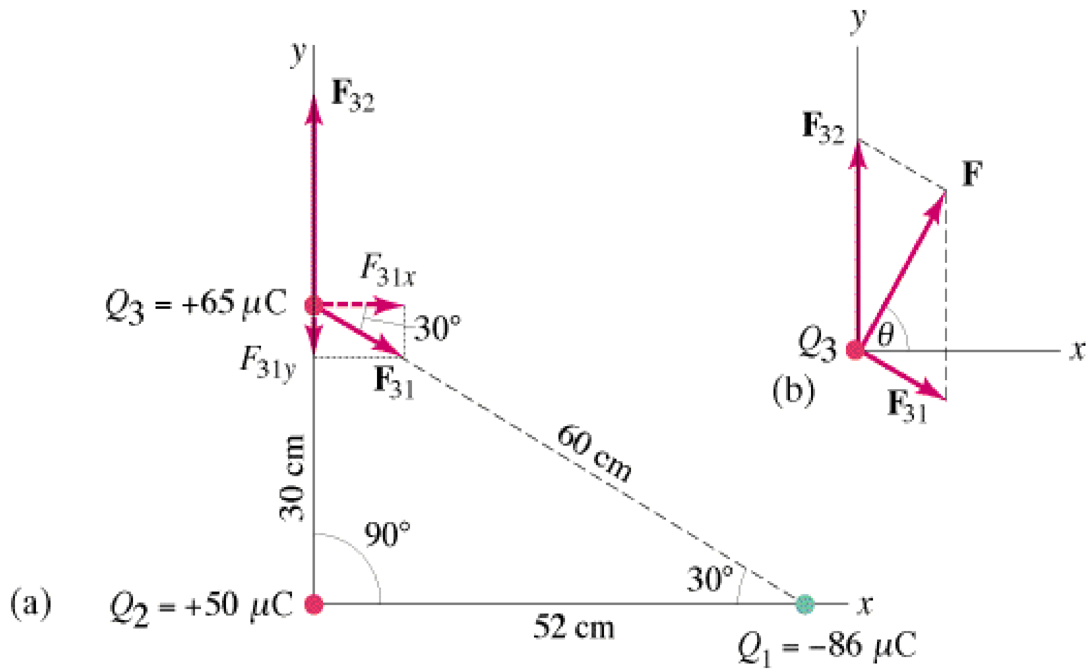
$$F = 8.2 \times 10^{-8} N$$

This is an attractive force since the charges are opposite.

Example 16-3 page 484: Three charged particles are in a line, as shown in fig 16-18a. Calculate the net electrostatic force on particle 3 due to the other two charges.



Example 16-4 page 485: Electric force using vector components. Calculate the net electrostatic force on charge Q_3 due to the charges Q_1 and Q_2.

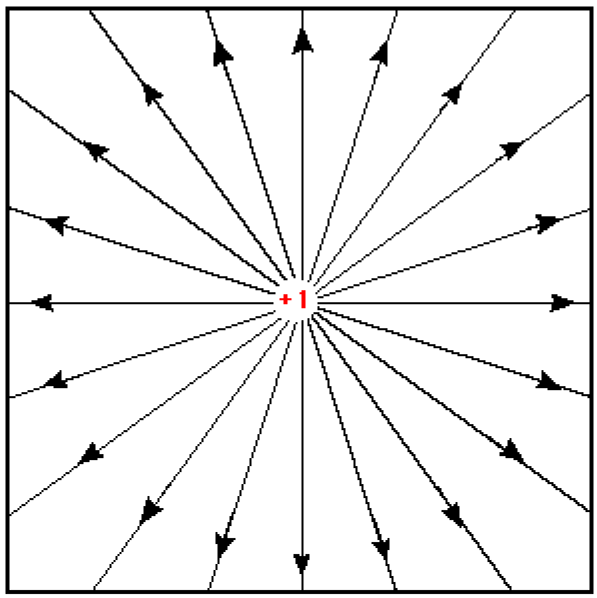


Do numbers 6,7,11,12,15 page 497-498

Physics 12
Section 16-7
The Electric Field

1. A field is

2. Electric charges have electric fields around them.



3. Electric fields

4. The strength of the electric field can be determined by:

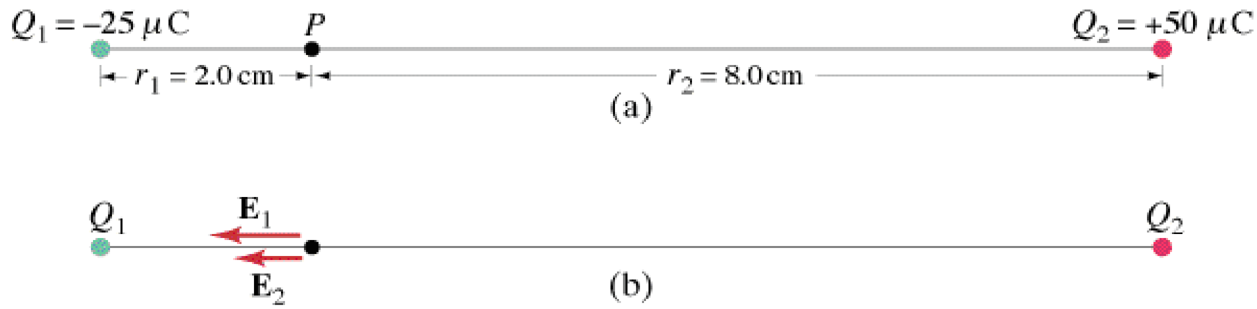
5. The electric field at any point in space can be determined by the following:

This is Coulomb's Law, the force on the charges q and Q

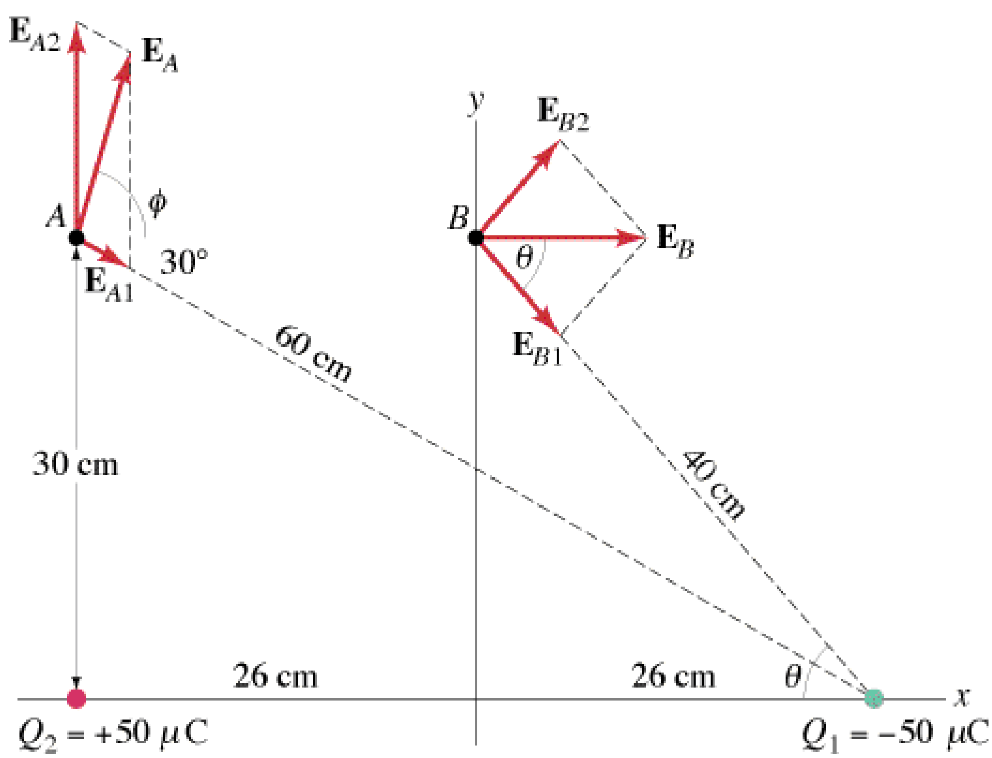
Example 16-6 page 487: Calculate the magnitude and direction of the electric field at a point P which is 30cm to the right of a point charge Q = -3.0 x 10-6C

Example 16-7 page 488: Two point charges are separated by a distance of 10.0cm. One has a charge of –25uC and the other +50uC. What is the direction and magnitude of the electric field at a point P in between them, that is 2.0cm from the negative charge?

If an electron is placed at point P, what will its acceleration be initially?



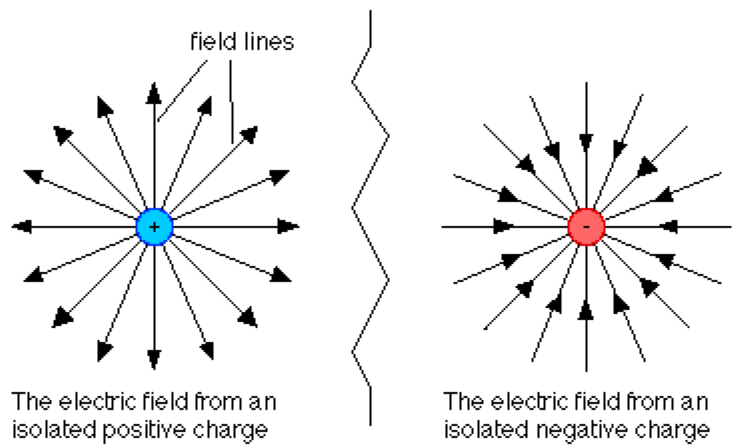
Example 16-8 page 489: Calculate the total electric field at point A and at point B due to both charges Q_1 and Q_2.



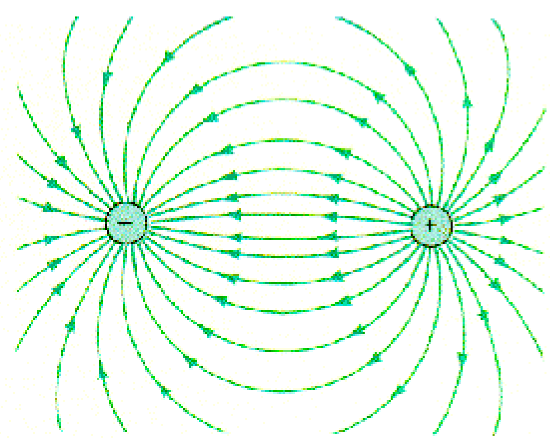
DO # 21,22,23,25,26,27 page 498

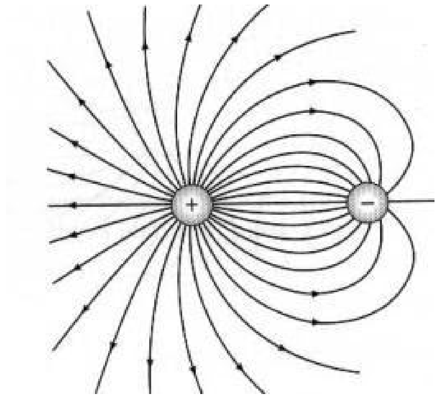
Physics 12
Section 16-8
Field Lines

1. **Electric fields radiate around a point charge.**



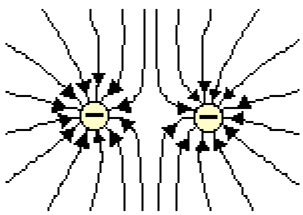
2. **The concentration of lines indicates field strength.**



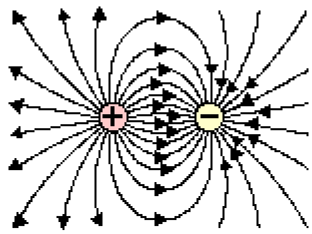


The positive charge is twice the size of the negative charge

Other Charge Configurations

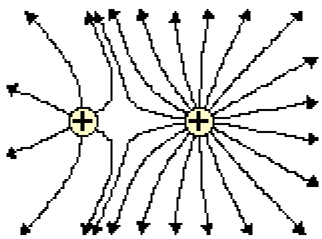


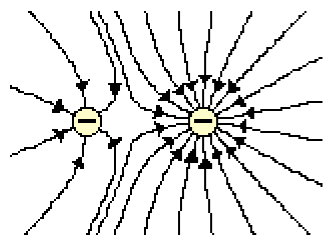
Two Negatively-Charged Objects

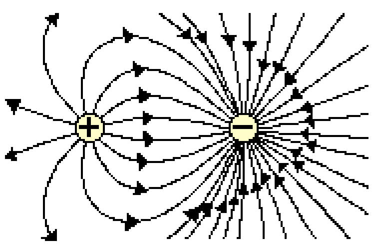


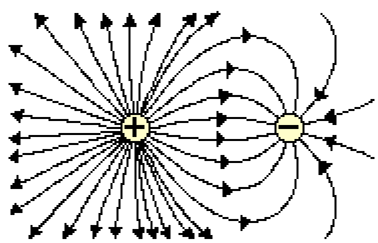
A Positively and a Negatively-Charged Object

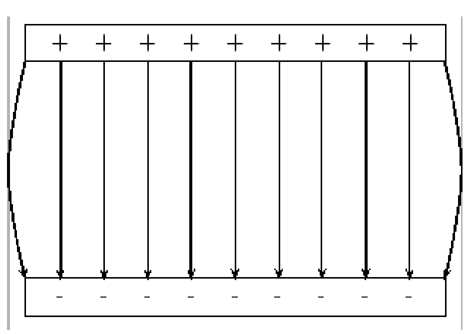
Electric Field Line Patterns for Objects with Unequal Amounts of Charge







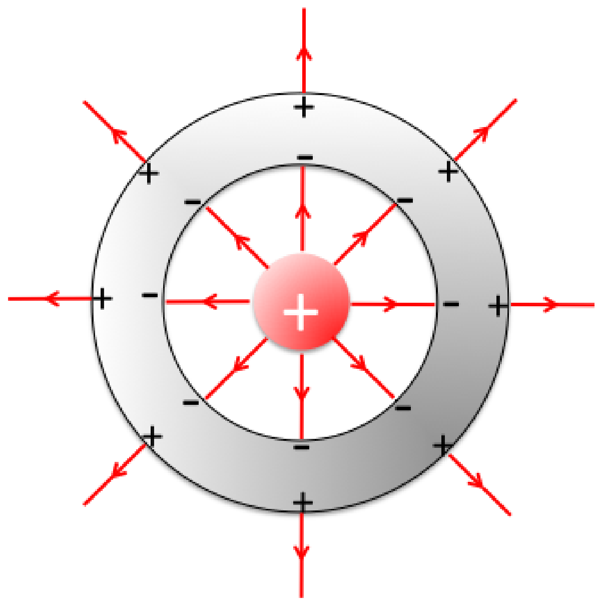




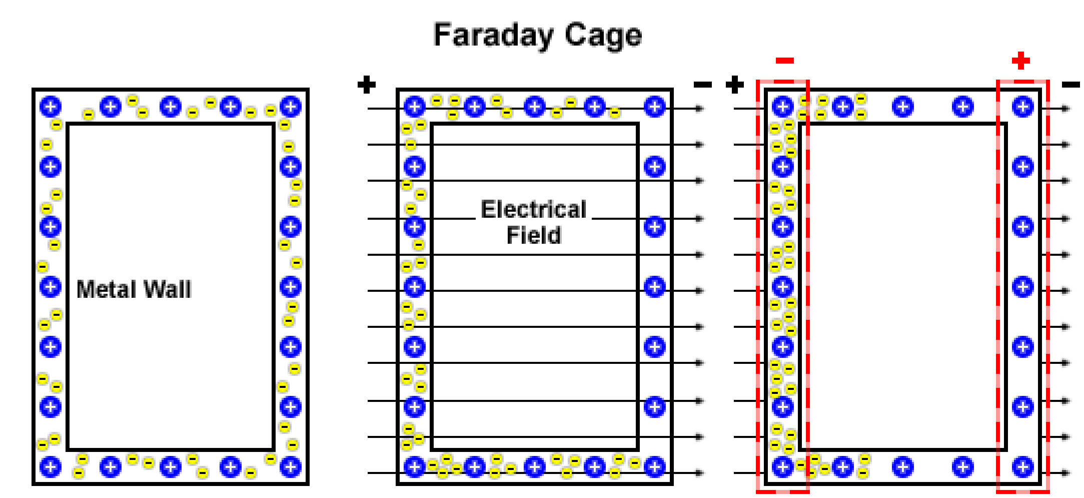
Between two parallel plates Do # 34 page 499

Section 16.9
Electrical Fields and Conductors

1. Within a conductor   If an external electric field is
encountered by the conductor



2. There is no electric field within the conductor itself.



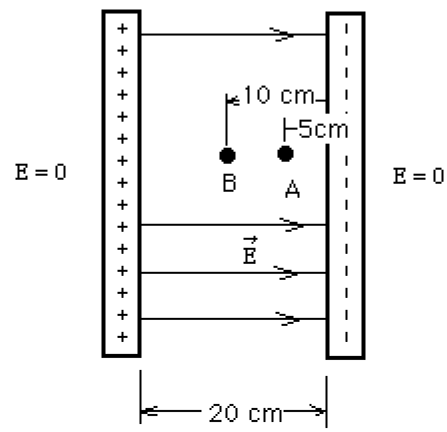
Faraday Cage in the absence of an electrical field.

The charged particles in the wall of the Faraday cage respond to an applied electrical field.

Electrical fields generated inside the wall cancel out the applied field, neutralizing the interior of the cage.

Physics 12
Section 17-1
Electric Potential and Potential Difference.

1. Charges in an electric field have a certain amount of



2. If a charge were at position B

3. If a charge were at position A

4. The (V_A), at location A, can be defined to be the

5. Differences in electric potentials can be calculated using:

$$\Delta Ep = Ep_2 - Ep_1$$

This is equal to the negative of the work done by the field moving the charge from location 1 to 2.

$$\Delta Ep = -W$$

Example 17-1 page 505: Suppose an electron in the picture tube of a television set is accelerated from rest through a potential difference of 5000V. What is the change in potential energy of the electron?

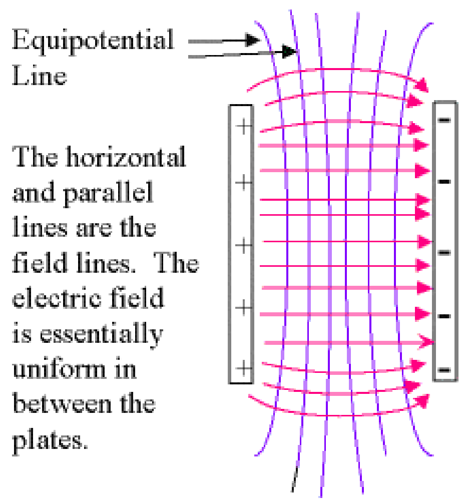
What is the speed of the electron as a result of the acceleration?

Repeat for a proton accelerating through a potential difference of –5000V

Do # 1-4 page 522

Physics 12
Section 17-2
Electric Potential and Electric Field

1. **The electric field between two parallel**

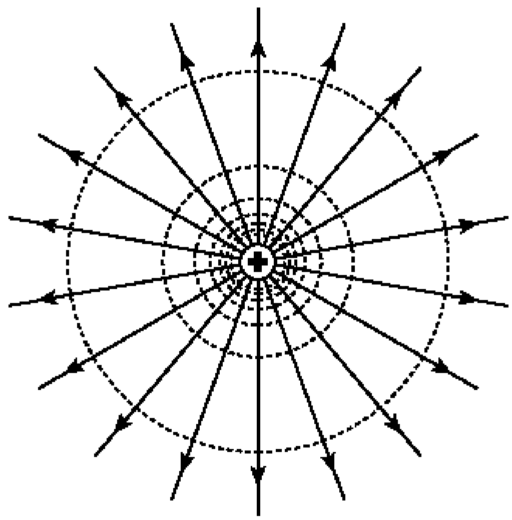


2. **The relationship between the potential difference and the electric field in between is the following:**

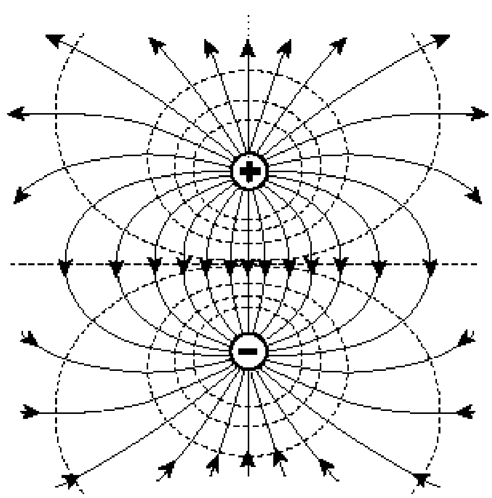
Example 17-2 page 506: Two parallel plates are charged to a voltage of 50V. If the separation between the plates is 0.050m, calculate the electric field between them.

Do # 5,6,7,8 page 522-523

Physics 12
Section 17-3
Equipotential Lines



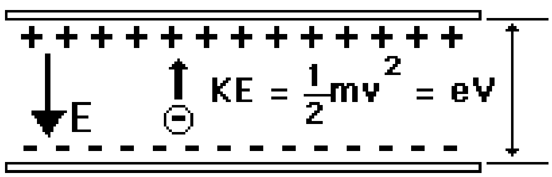
2. The doted lines are equipotential lines.



Physics 12
Section 17-4
The Electron Volt, a Unit of Energy

1. When an electron is

2. 1 electron volt (eV) is



e = electron charge = 1.6×10^{-19} C
V = voltage

$E = qV = (1.6 \times 10^{-19}\ C)(1\ \frac{J}{C})$

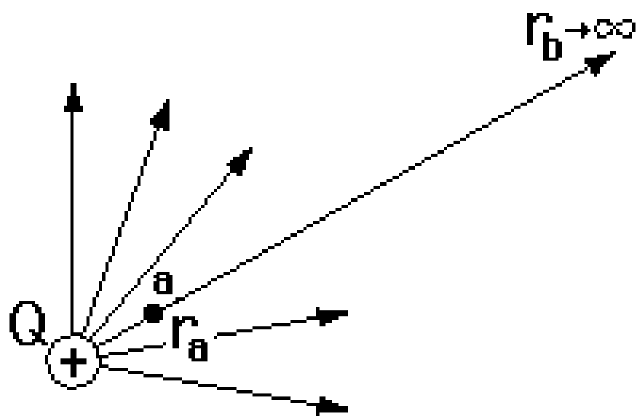
1 electron volt $= 1.6 \times 10^{-19}$ J

Do # 9, 10, 11, 12 page 522

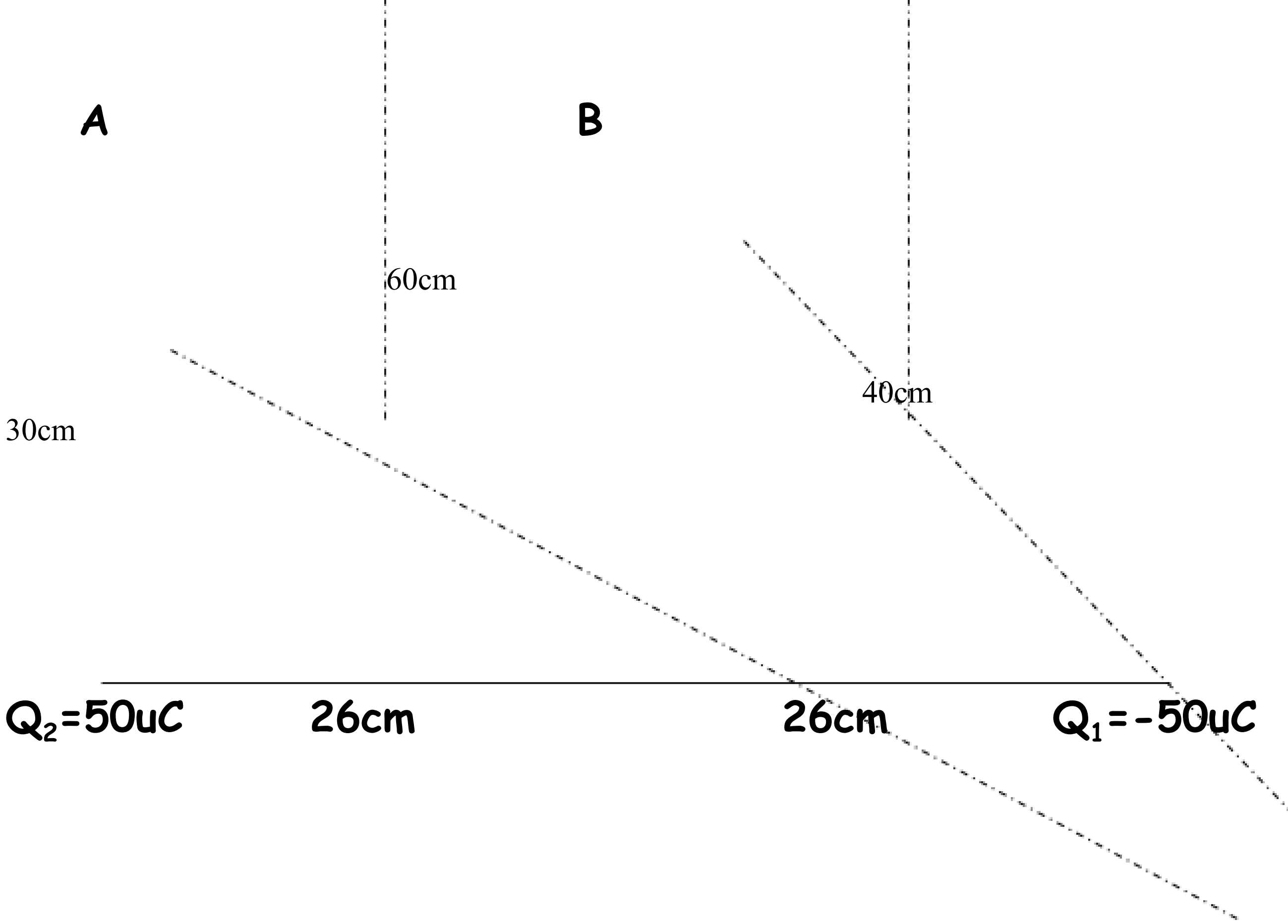
Physics 12
Section 17-5
Electric Potential Due to Point Charges

1. **The electric potential due to a single point charge can be calculated using the following equation:**

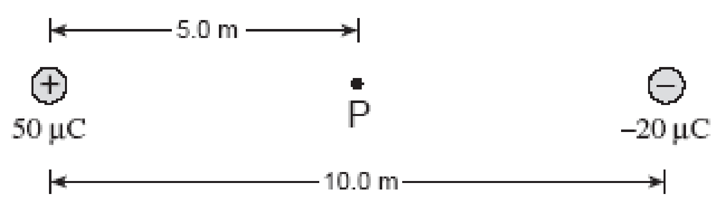
$$V_a - V_b = kQ\left[\frac{1}{r_a} - \frac{1}{r_b}\right]$$



Example 17-4 page 510: Calculate the electric potential at points A and B due to the two charges shown.



5. a) Determine the electric potential, relative to zero at infinity, at point P, midway between the two charges, shown below. **(5 marks)**



b) How much work would it take to move a −15 μC charge from point P to a position infinitely far away? (2 marks)

2. **The electric potential energy of an object can be calculated by combining the following:**

$$\Delta Ep = q\Delta V \text{ from 17-1}$$

and

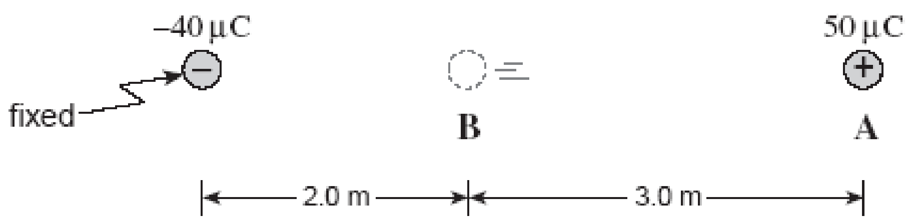
$$V = kQ/r \text{ from 17-5}$$

But r_2 is the current location and r_1 is at infinity so the electric potential at r_1 is zero.

To form:

Example:

5. A 1.0×10^{-3} kg styrofoam ball carrying 50 μC of charge is released from rest from position **A** as shown in the diagram below. ($1\ \mu C = 1 \times 10^{-6}$ C)



a) Determine the change in electric potential energy, ΔE_p, of the ball as it moves from position **A** to position **B**. **(5 marks)**

Physics 12 Cathode Ray Tubes
Section 17.10

1. The cathode ray tube is the basis for the first type of television.

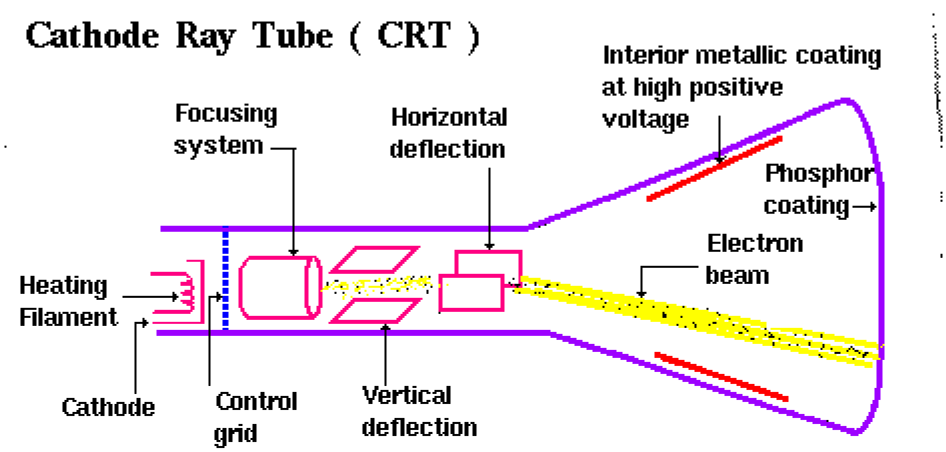
2.

The result is a visible glow.

3.

through a potential difference of 5000 – 50000V.

4.



Physics 12 Section 18-1 to 18-3
The Electric Cell, Current, and Ohm's Law

1. A simple cell consists of two

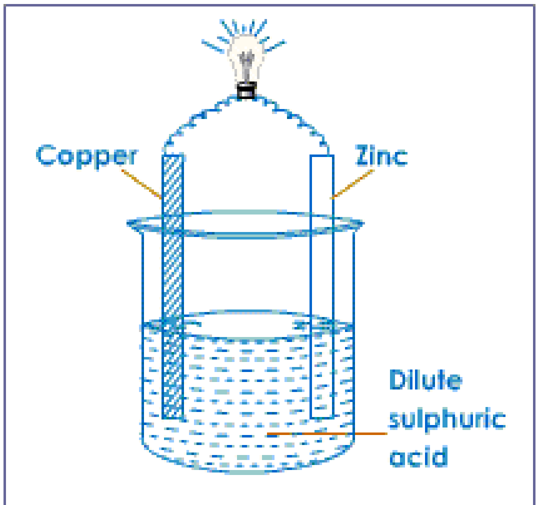
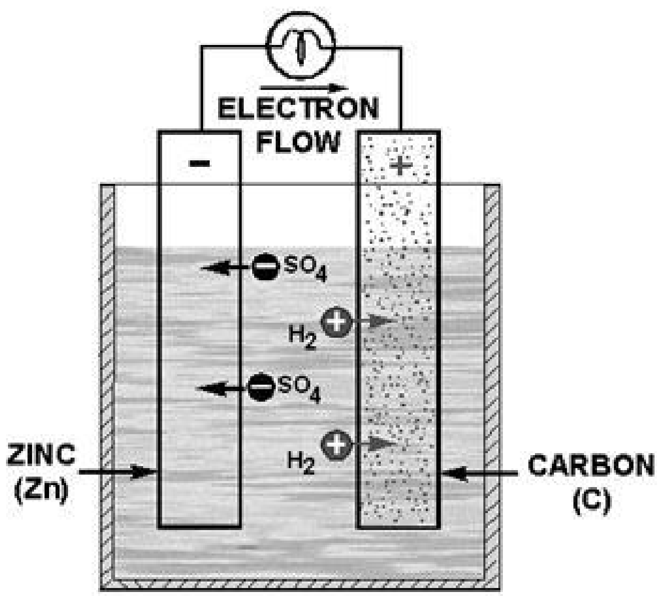


Fig. 4.7. Simple voltaic cell

2. The zinc in this case acquires

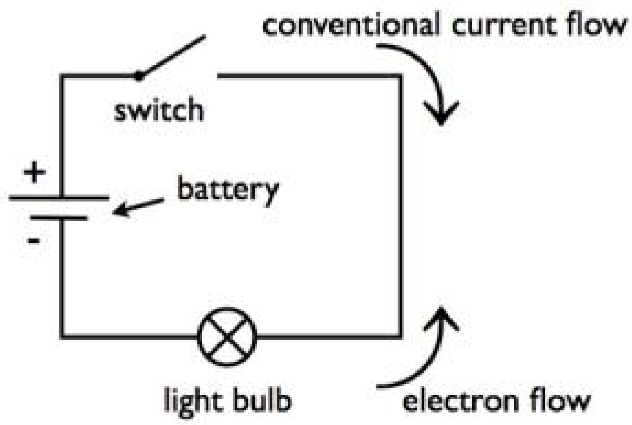


3. The result is

4. The potential difference results in a current flow

5. Current

6. Conventional current



7. From grade 9 we have ohm's law:

Example 18-3 p533. A small flash light bulb draws 300mA from its 1.5V battery. What is the resistance of the bulb? If the voltage dropped to 1.2V, how would the current change?

Second part:

Physics 12 Section 18-6
Electric Power

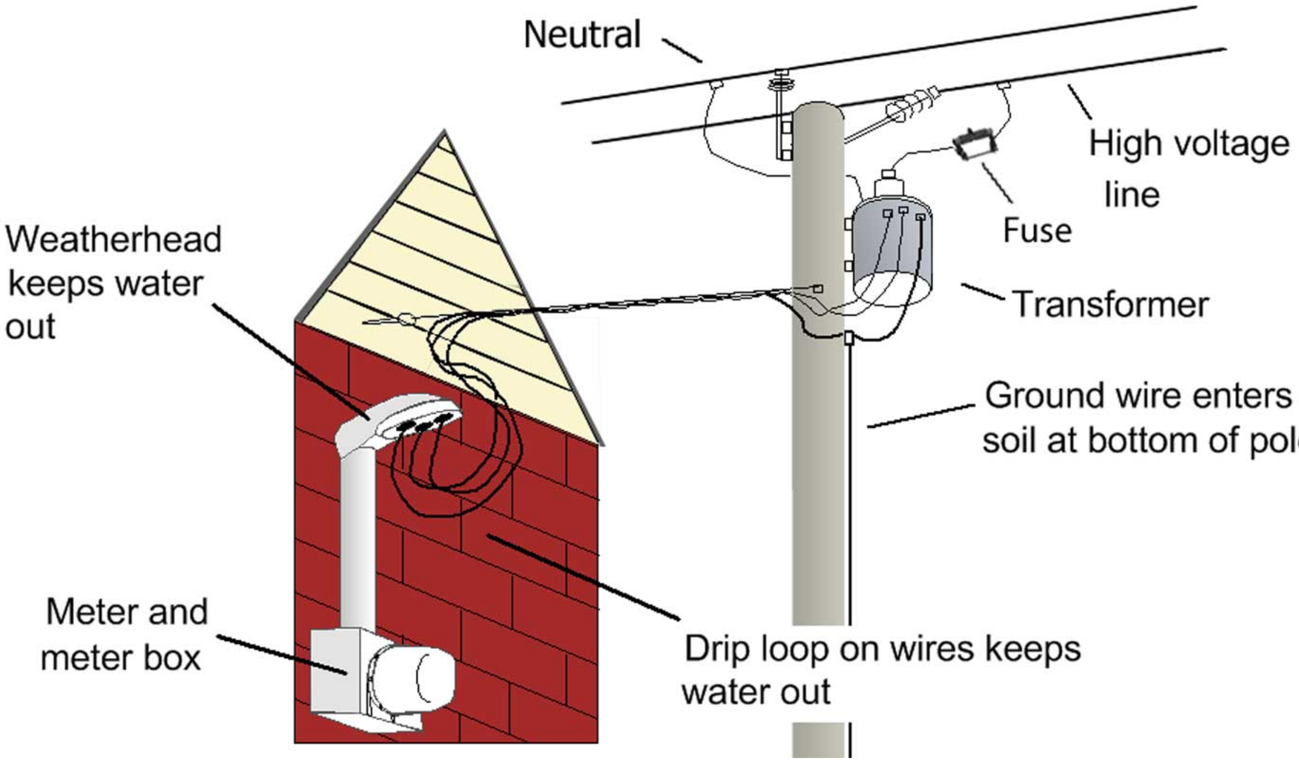
1. Power is the rate at which work is done or energy is used.

2. Ohm's Law $V = IR$ can be combined with $P = IV$ to produce two additional equations.

Do 23-25, 27-29, 33, 34, and 36 on page 552.

Section 18.7 Household Circuits

1. Your house



2. One of the hot wires is at a

3. Electricity is distributed throughout your home in individual circuits.

4. A circuit current capacity can be exceeded

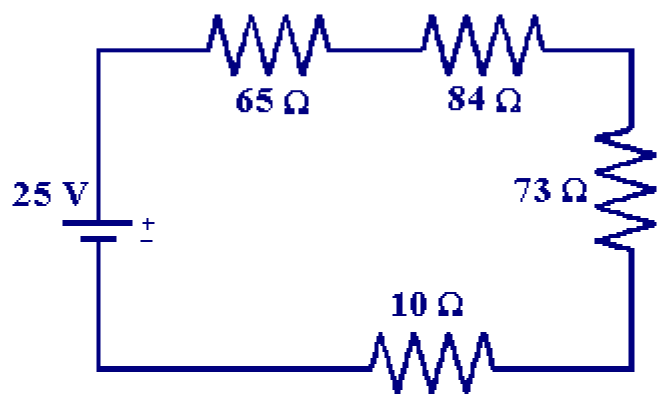
5. The circuit wire will

6. Ground fault circuit interrupter (GFCI) are very

Physics 12
Section 19-1
Resistors in Series and Parallel

1. From Science 9 we have

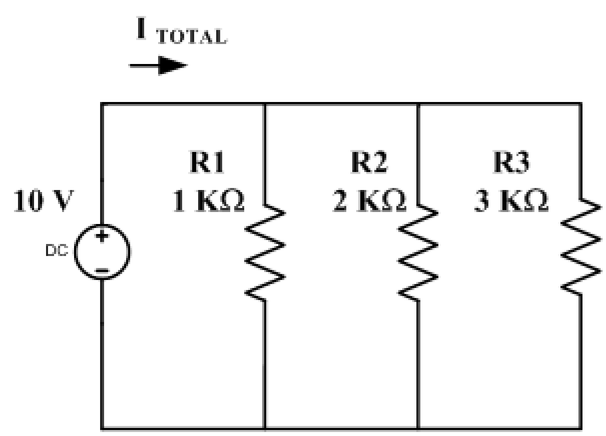
2. To find the total resistance in a series circuit you add the individual resistors.



3. The total resistance in the above circuit is:

$$R_t = 65\Omega + 84\Omega + 73\Omega + 10\Omega = 232\Omega$$

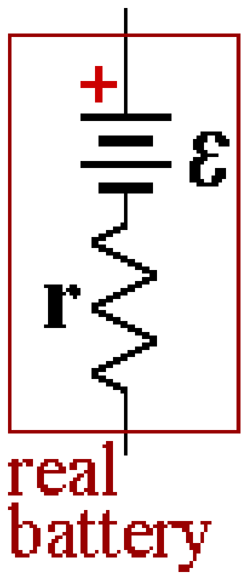
4. The total resistance in parallel is calculated by the following:



Physics 12
Section 19-2
EMF and Terminal Voltage

1. A device like a battery or generator is called a source of

   The emf a device can produce can be measured by using a voltmeter on the device between the two terminals.



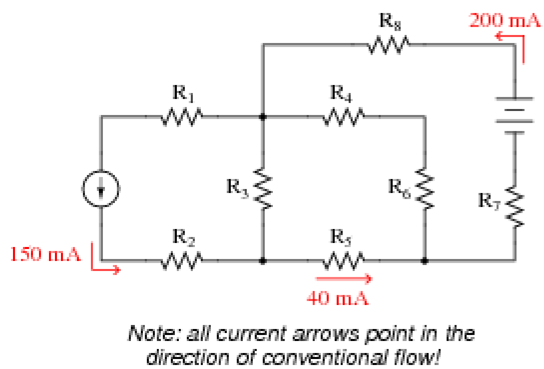
$$V_{ab} = E - Ir$$

Example 19-7 page 563: A 9.0V battery whose internal resistance r is 0.50Ω is connected in the circuit shown in Fig 19-10a. How much current is drawn from the battery? What is the terminal voltage of the battery? What is the current in the 6.0Ω resistor?

Physics 12 19-3 Kirchoff's Rules

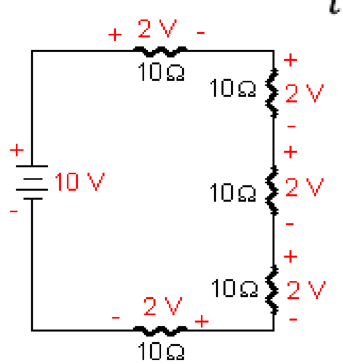
1. **Gustav Robert Kirchhoff** (12 March 1824 – 17 October 1887) was a German physicist who contributed to the fundamental understanding of electrical circuits spectroscopy, and the emission of black-body radiation by heated objects.

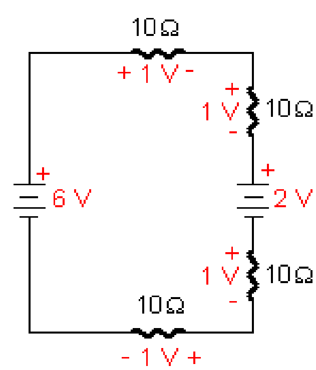
2. Kirchoff's first or junction rule:



3. Kirchoff's second or loop rule:

$$\sum_{loop} V = 0$$





Section 19.4
Circuit Analysis and Kirchoff's Rules

2.

Conventional current goes from + to -. If the current ends up being negative that means it was labeled incorrectly to begin with.

3. Apply kirchoff's loop rule to each loop. Use Ohm's law V = I x R.

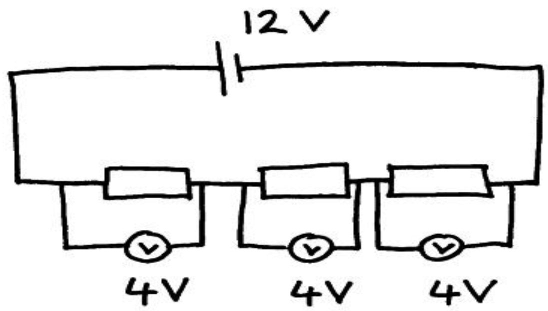
For a resistor the sign of the potential difference is negative if your chosen current is in the same direction as the loop direction.

4. For a battery, the sign of the

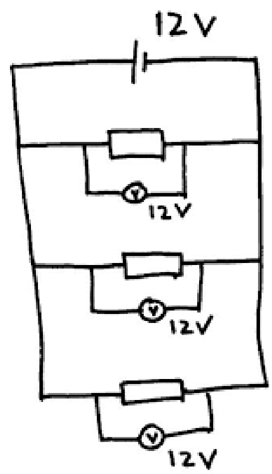
5. Solve the equations for the unknowns. The number of unknowns dictates the required number of equations.

Physics 12 Section 19.5
EMF in Series and Parallel

1. When two or more sources of EMF are connected in series the resulting voltage is



2. When two or more sources of EMF are connected in parallel the resulting voltage is the



3. If two batteries are connected in series and in such a way as to