Name: ___________________________________

1: _______/23 + ______ late

2: _______/14 + ______ late

3: _______/12 + ______ late

4: _______/12 + ______ late

Incorrect/incomplete: –______

Scaled score: ______/40

Unit 7 Learning Goals – Electrostatics

Goal Set 1:

Students will be able to analyze the nature of charge, including analyzing methods of charging conductors and insulators.

4.0	I can analyze complex problems involving the nature of charge and methods of charging conductors and insulators.
3.0	**I can analyze the nature of charge, including analyzing methods of charging conductors and insulators.** **This includes…** • Distinguish between conductors and insulators by analyzing the properties of both. • Distinguish between methods of charging based on material type, method, and result.
2.0	I can recognize, recall, and explain specific vocabulary and concepts including: • Charge, electrons, protons, systems, rule of charges, law of conservation of charge, conductors, insulators, conduction, friction, induction, polarization I am able to… • Discuss the nature of charge. • Explain the how the balance of electrons and protons results in objects becoming positively, negatively, or neutrally charged. • Distinguish objects from systems. • Identify that in closed systems charge is conserved. • Identify the nature of the interactions between charges based on charges being alike or opposite each other.
1.0	With help, partial success at 2.0 content

Check yourself:

<u>Level 2.0</u>

1.) Describe the nature of charge.

2.) Determine whether the objects below are positive, negative, or neutral.

   a. An object has an equal amount of protons, neutrons, and electrons.
      + - 0
   b. An object has an excess of electrons.
      + - 0
   c. An object has a shortage of electrons.
      + - 0
   d. An object has unpaired protons.
      + - 0
   e. An object that used to be neutral has gained electrons.
      + - 0
   f. An object that used to be neutral has lost electrons.
      + - 0

3.) List all of the conserved quantities you can remember are conserved in closed systems.

4.) Given a closed system made of two objects…

a. Two objects can exchange charge.	Truth!	Lies!	Broccoli!
b. The amount of charge in each object can change.	Truth!	Lies!	Broccoli!
c. The amount of charge in the system can change.	Truth!	Lies!	Broccoli!
d. The total amount of charge is conserved.	Truth!	Lies!	Broccoli!
e. What kind of vegetable looks like little green trees?	Truth!	Lies!	Broccoli!
f. If one object loses 5 electrons, the other object must gain them.	Truth!	Lies!	Broccoli!
g. If both objects start out neutral, and one becomes negatively charged, the other must become positively charged.	Truth!	Lies!	Broccoli!

5.) Two protons walk into a smoothie bar. Do they feel attracted to each other?

Yes No Maybe so

Two electrons walk into a smoothie bar. Do *they* feel attracted to each other?

Yes No Maybe so

A proton and an electron walk into a smoothie bar. Do *they* feel attracted to each other?

Yes No Maybe so

Level 3.0

1.) For each of the following, answer *conductors*, *insulators*, *both*, or *neither*.

a. A material made of one element has a lattice-like atomic or molecular structure that allows easy flow of outer electrons.

b. An element has all outer electrons paired, and the outer electron shell is full.

c. A molecule has all electrons covalently bonded.

d. A material accepts electrons easily.

e. A material does not accept electrons easily.

f. A material can become charged.

g. A material holds onto charge well.

h. A material can be charged by simple contact (without friction.)

i. A material can be charged by friction.

j. A material can be charged by induction.

k. A material can be charged by polarization.

2.) For the following, answer F for *friction*, C for *contact/conduction*, I for induction, and/or P for *polarization*. You can use more than one answer per question.

a. Some electrons move to one side of the surface molecules but do not leave the molecules.

b. Electrons jump a gap from a charged a negatively-charged material to a neutral material.

c. Electrons jump a gap from a neutral material to a positively-charged material.

d. Electrons transfer from one neutral material to another neutral material.

e. A charged object is brought near to a neutral conductor but does not touch the neutral conductor. There is a redistribution of charge in the neutral conductor.

f. A charged object is brought near to a neutral insulator but does not touch the neutral insulator. There is a redistribution of charge in the neutral insulator.

g. A charged insulator is brought near a neutral insulator. The two are attracted toward each other.

Level 4.0

A person walks across a carpet and attains a negative charge due to friction between her feet and the carpet. The person then comes to a door and brings her hand near a metal doorknob without touching it. (a) If no charge transfers, what happens to the charges in the doorknob? (b) Does this happen to all of the charges in the doorknob? (c) What method of charging is this? (d) Define the system and relate this scenario to conservation of charge. (e) Describe a scenario in which the charge of the system would not be conserved. (f) In your own words, compare and contrast this situation with one in which the person's hand came near an insulating material, such as the drywall on the wall next to the door

Goal Set 2:

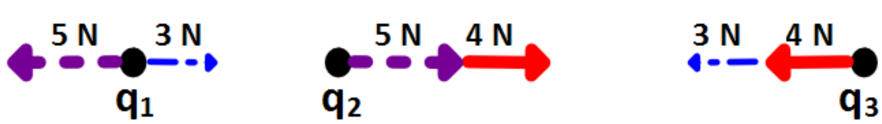
Students will be able to analyze electric force between charged particles.

4.0	I can analyze electric force among complex arrangements of charged particles.
3.0	**I can analyze electric force between charged particles.**
2.0	I can recognize, recall, and explain specific vocabulary and concepts including: • Force, charge, vector operations, Newton's second law, Newton's third law, Coulomb's law I am able to… • Perform vector operations. • Calculate the magnitude of electric force between two charges using Coulomb's law. • Analyze the direction of electric force on a charge. • Use Newton's second and third laws to analyze electric force on and accelerations of the objects in a system of charges.
1.0	With help, partial success at 2.0 content

Check yourself:

Level 2.0

Questions 1 - 6 refer to the following charge arrangement and electric forces in a three-charge system.



1.) In the system above, what is the net force on charge number 1?

2.) In the system above, what is the net force on charge number 2?

3.) In the system above, what is the net force on charge number 3?

4.) Notice that q1 and q2 each have 5N forces acting on them in opposite directions. What other two patterns do you notice about the forces acting on the charges in this system?

5.) Explain why the pattern you noted in question four occurs.

6.) If q1 is positive…

   a. What is the charge of q2?

   b. What is the charge of q3?

Questions 7 - 11 refer to the following system: An electron is 2.3 E-9 m directly to the left of a proton.

7.) What is the magnitude of the electric force on the electron?

8.) What is the direction of the electric force on the electron?

9.) What is the magnitude of the electric force on the proton?

10.) What is the direction of the electric force on the proton?

11.) The mass of an electron is 9.11E-31 kg, and the mass of a proton is 1.67E-27 kg.

   a. What will be the acceleration of the electron?

   b. Will the acceleration of the proton be greater than, less than, or the same as the acceleration of the electron?

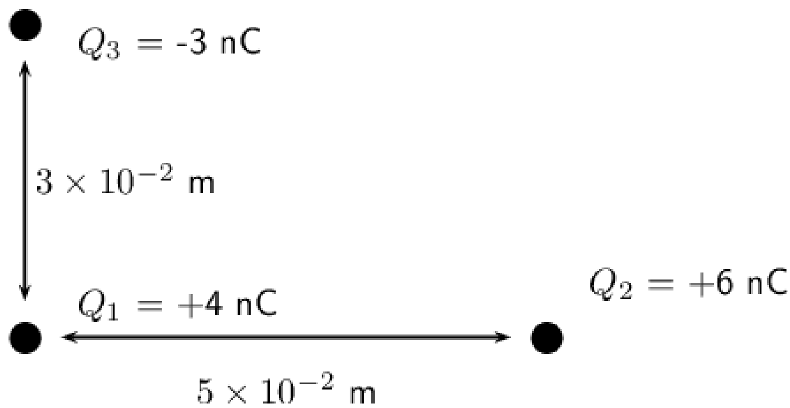
Level 3.0

A 3.7E-12 C charged particle (charge 1) is held at rest 1.2E-8 m to the left of a 2.4E-12 C charged particle (charge 2.) In addition, there is a -9.7E-11 C charged particle (charge 3) that is 5.6E-8m to the right of charge 2.

1.) What is the magnitude of the net force on charge 2?
2.) What is the direction of that net force?

Level 4.0

What is the net force on Q_1 in the arrangement of charges shown below? Note that nC stands for nanocoulomb, and the prefix *nano* equals 1E-9 (or one billionth.)



Goal Set 3:

Students will be able to analyze electric fields qualitatively and quantitatively.

4.0	I can analyze electric fields created by complex arrangements of charges.
3.0	**I can analyze electric fields qualitatively and quantitatively.**
2.0	I can recognize, recall, and explain specific vocabulary including: • Force, field, charge, electric field I am able to… • Calculate the magnitude of the electric field around one charged object. • Analyze by creating or interpreting an electric field diagram the direction of the electric field created around multiple charged objects.
1.0	With help, partial success at 2.0 content

Check yourself:

Level 2.0

1.) Define electric field in your own words.

2.) What is the electric field 2.5E-2 m away from an object whose charge is 3.0E-9 C?

3.) Draw the electric field diagram for the region around the charge noted in question 2.

Level 3.0

1.) Draw the electric field diagram around the following combinations of charges.

   a. A positive charge is to the right of a negative charge. The negative charge is twice as strongly charged as the positive charge.

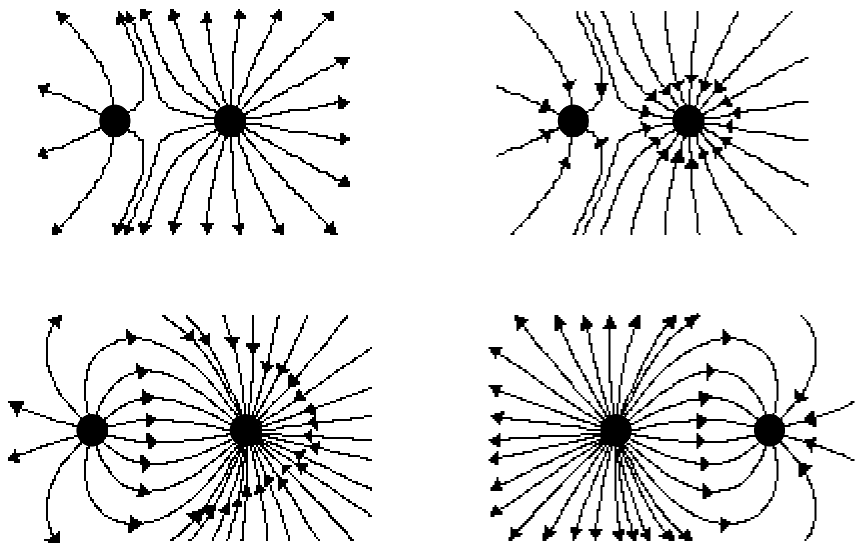
   b. A positive charge is to the right of another positive charge. The positive charge on the right is twice as strongly charged as the charge on the left.

   c. Repeat question b with two negative charges.

   d. Three equally-charged negative charges form an equilateral triangle.

   e. Three equally-charged positive charges form an equilateral triangle.

2.) In the diagrams below, identify the charges of the objects as well as their charge ratio (meaning how strongly charged they are. For example, if the charge on the left is twice as strongly charged as the charge on the right, the ratio would be 2:1.) The diagrams are labeled A-B-C-D going from top left to top right to bottom left to bottom right.



a.) Left is _____, and right is _____. The charge ratio (left:right) is _____ : _____.

b.) Left is _____, and right is _____. The charge ratio (left:right) is _____ : _____.

c.) Left is _____, and right is _____. The charge ratio (left:right) is _____ : _____.

d.) Left is _____, and right is _____. The charge ratio (left:right) is _____ : _____.

Level 4.0

1.) Which of the diagrams in level 3.0 question 2 has/have a location where the magnitude of the electric field is zero?

2.) Let's imagine an electric field where two positive charges create the field. Charge one is 3.4E-9 C, and the field is zero at a position that is 7.4E-3m from charge one. This position is also 1.6E-3m from charge two. What is the magnitude of charge 2?

Goal Set 4:

Students will be able to analyze energy in systems of charges, including electric potential energy, electric potential, and potential difference.

4.0	I can analyze complex problems electric potential energy, electric potential, and potential difference.
3.0	**I can analyze energy in systems of charges, including electric potential energy, electric potential, and potential difference.**
2.0	I can recognize, recall, and explain specific vocabulary and concepts including: • Energy, electric potential energy, electric potential, potential, potential difference, voltage I am able to… • Distinguish between electric potential energy, electric potential, and potential difference. • Perform calculations involving electric potential energy, electric potential, and potential difference. • Explain the conditions under which electric potential energy, electric potential, and potential difference can occur.
1.0	With help, partial success at 2.0 content

Check yourself:

Level 2.0

1.) In what ways is the concept of electric potential energy similar to the concept of gravitational potential energy?

2.) Explain how the concept of electric potential energy is different from the concept of electric potential. State as many differences as you can.

3.) Explain how the concept of electric potential is different from the concept of potential difference. State as many differences as you can.

4.) Circle the synonyms for electric potential:

electric potential energy   potential   potential difference   voltage

5.) Circle the synonyms for potential difference

electric potential energy   electric potential   voltage

6.) What is it about a battery that makes a battery have electric potential?

7.) An electron orbits 70 pm (picometeters, which is 70E-12m) from a nucleus with 6 protons.

   a. At the distance of the electron, what is the electric field? (Remember that there are 6 protons creating the field.)

   b. What is the electric potential energy of the electron? (Remember that in the electric potential energy equation, we are focused on the charge of the object *in* the field. In this case, that is the electron.)

   c. What is the electric potential at the location of the electron?

      i. Solve using $V = \frac{PE_E}{q}$ where q is the charge of the electron.

      ii. Solve using $V = k\frac{q}{r}$ where q is the charge of the six protons in the nucleus.

Level 3.0

1.) The charge at the negative end of a battery is negative. The charge at the positive end of a battery is positive.

   a. What is the sign of the voltage near the negative end? + - neutral

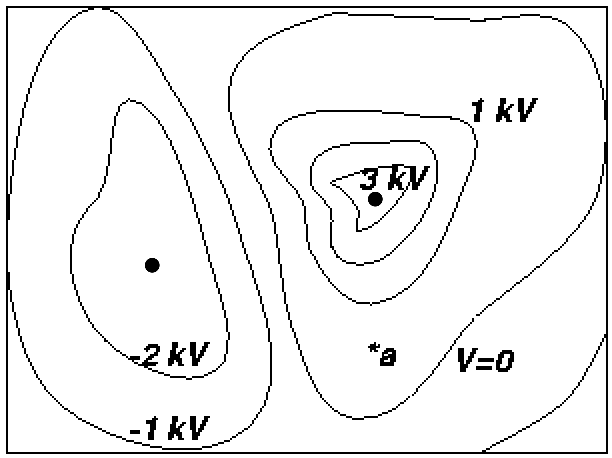
   b. What is the sign of the voltage near the positive end? + - neutral

   c. If the battery says that it's a 1.5 Volt battery, what does that mean in terms of the potential difference between the two ends of the battery?

2.) Two charges are creating an electric field around an object. Charge 1 lies 4.1E-2m from the object. Charge 2 lies 5.6E-2m from the object. The charges are: q_1 = 6.2E-6C and q_2 = -3.8E-6C. What is the voltage at the location of the object?

Level 4.0

The diagram below shows something called equipotential lines. These lines represent regions of equal voltage around charged objects. For example, the voltage anywhere along the middle line marked V=0 is zero Volts.

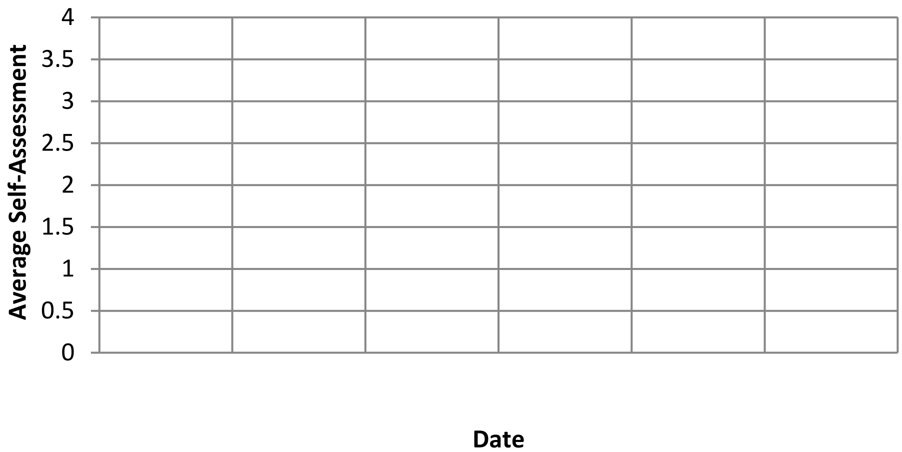


1.) What is the sign of the charge on the left? + - neutral
2.) What is the sign of the charge on the right? + - neutral
3.) Explain how there could be an equipotential line with zero voltage even though there are two charges nearby.

4.) Now draw the electric field lines on top of the diagram. A general rule with this is that electric field lines always cross equipotential lines at right angles.
5.) Based on your electric field lines, do you think a charged object would move or would not move if it were located on the zero equipotential line? (We'll discuss the meaning of this in class.)

Chart your Progress

Goals Set 1



Goals Set 2


Goals Set 3
4
3.5
3
2.5
2
1.5
1
0.5
0
Average Self-Assessment
Date


Goals Set 4
4
3.5
3
2.5
2
1.5
1
0.5
0
Average Self-Assessment
Date