

Charge

Read from **Lesson 1** of the **Static Electricity** chapter at **The Physics Classroom**:

<http://www.physicsclassroom.com/Class/estatics/u8l1a.html>

<http://www.physicsclassroom.com/Class/estatics/u8l1b.html>

MOP Connection: Static Electricity: sublevel 1

Introduction:

It all begins with atoms. An understanding of static electricity begins with an understanding of the atom. Matter is made of atoms and if any sample of matter is charged, becomes charged or loses a charge, then the explanation of what happened demands that one understand matter at the *particle level*.

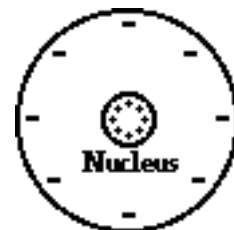
1. In the space at the right, draw a picture of your understanding of the structure of an atom. What does it look like? What is inside of it? Express what you know using a well-labeled diagram.
 2. The charged parts of the atom are the _____ and the _____. The _____ are positively charged and the _____ are negatively charged. The _____ are not charged and thus will not be of importance in this unit.
 3. An electrically neutral atom is an atom which _____.
 - a. does not have any protons or electrons
 - b. has more neutrons than the sum of all its protons and electrons
 - c. has a balance of protons and electrons (the same number of each)
 - d. has a balance of neutrons and electrons (the same number of each)
 - e. has a balance of protons, electrons and neutrons (the same number of each)
 4. An electrically charged atom (sometimes referred to as an ion) can be distinguished from an electrically neutral atom in that the charged atom (ion) _____.
 - a. does not have any neutrons
 - b. has lost one or more of its neutrons
 - c. either has a proton or an electron present somewhere within it
 - d. has a different number of neutrons than the sum of its electrons and protons
 - e. has an imbalance of protons and electrons (unequal numbers of these)

Structure of the Atom

Physics Fact:

Protons (and neutrons) are located in the *interior* of an atom - in the nucleus. They are tightly bound and unable to leave the atom except through nuclear processes. On the other hand, electrons are on the *exterior* of an atom. They are exposed to other atoms and to forces that are capable of *ejecting* them or *stripping* them of the atom.

5. The diagram at the right depicts the eight electrons and eight protons in an oxygen atom.
 - a. Explain what must happen in order for an oxygen atom to become negatively charged.
 - b. Explain what must happen in order for an oxygen atom to become positively charged.



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6. What is true of atoms in terms of being neutral, negatively charged, and positively charged is also true of objects. An object that is negatively charged must have _____ (more, less, the same number of) electrons compared to its protons. An object that is positively charged must have _____ (more, less, the same number of) electrons compared to its protons. An object that is electrically neutral must have _____ (more, less, the same number of) electrons compared to its protons.

Summarize these verbal statements by inserting $>$, $<$ or $=$ symbols into the blanks below:

Negatively Charged
of e^- _____ # of p^+

Positively Charged
of e^- _____ # of p^+

Electrically Neutral
of e^- _____ # of p^+

7. An object becomes charged due to an excess or deficiency (shortage) of electrons. Knowing the exact number of excess or deficient electrons in an object allows one to determine the object's charge. The charge of one electron is 1.6×10^{-19} C. Use this to determine the charge of the following objects.

Object	# of Excess or Deficient Electrons	Quantity and Kind of Charge (Q) on Object in Coulombs (C)
A	1.0×10^3 excess electrons	
B	1.0×10^6 deficient electrons	
C	2.0×10^9 excess electrons	
D	2.5×10^8 deficient electrons	
E	6.82×10^{12} excess electrons	

8. During a physics lab, a plastic strip was rubbed with cotton and became positively charged. The correct explanation for why the plastic strip becomes positively charged is that ...
- the plastic strip acquired extra protons from the cotton.
 - the plastic strip acquired extra protons from the charging process.
 - protons were created as the result of the charging process.
 - the plastic strip lost electrons to the cotton during the charging process.
9. Miss Chiff, the seventh-grade science teacher, greets her students in an unusual manner. She stands at the door of her classroom, scuffing her feet back and forth on the carpet. As she does so, electrons move from the carpet to her shoes to her body. Miss Chiff is now charged with a _____ (positive, negative) type of charge.
- Then, Miss Chiff reaches out and touches her students on the nose as they enter the classroom. As she does, some electrons leave Miss Chiff and move onto her students. Miss Chiff is now _____ (more, less) negatively charged than before the contact with the student. And the student is now charged with a _____ (positive, negative) type of charge.
10. In a lab report during the Static Electricity unit, Aaron Agin suggests that a sample of wool became positively charged by gaining protons from the rubber balloon that it rubbed. Explain what is wrong with Aaron's statement.

Charge Interactions

Read from **Lesson 1** of the **Static Electricity** chapter at **The Physics Classroom**:

<http://www.physicsclassroom.com/Class/estatics/u8l1c.html>

MOP Connection: Static Electricity: sublevel 2

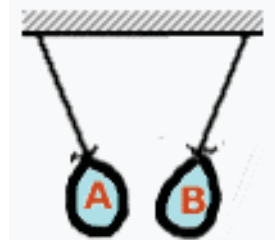
1. **Review:** Fill in the following blanks with the words **electrons** or **protons**.

_____ are negatively charged and _____ are positively charged. As an object begins to gain or lose electrons from its atoms, it becomes positively or negatively charged. A negatively charged object has more _____ than _____. A positively charged object has more _____ than _____.

2. Charged objects interact with one another. One can observe the interactions and infer information about the type of charge present on an object. Complete the following statements to illustrate your understanding of the three types of charge interactions:

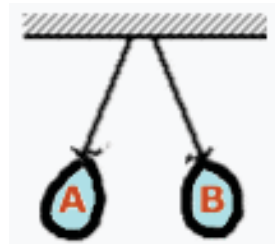
- a. Oppositely-charged objects _____.
- b. Like-charged objects _____.
- c. A charged object and a neutral object will _____.

3. Your physics teacher has prepared the room for the class's entry by suspending several inflated balloons from the ceiling. Upon entering the physics room, you observe two balloons being drawn towards each other as shown at the right. The attraction of these balloons for one another provides evidence that _____.



- a. both balloons are charged with the same type of charge
- b. both balloons are charged with the opposite type of charge
- c. both balloons are charged - either with the same type or opposite type of charge
- d. only one of the balloons is charged; the other is neutral
- e. at least one of the balloons is charged; the other is either charged or neutral

4. As you look around the room, you observe two other balloons being pushed away from each other as shown at the right. The repulsion of these balloons from one another provides evidence that _____.



- a. both balloons are charged with the same type of charge
- b. both balloons are charged with the opposite type of charge
- c. both balloons are charged - either with the same type or opposite type of charge
- d. only one of the balloons is charged; the other is neutral
- e. at least one of the balloons is charged; the other is either charged or neutral

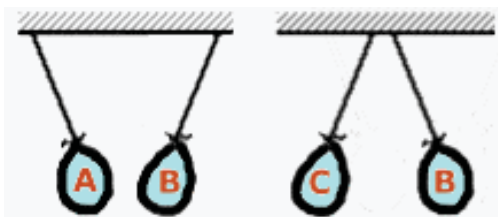
5. In one part of the room, there are two balloons - one hanging straight down and the other being attracted to it. This is evidence that _____.

- a. balloon A is charged and balloon B is neutral
- b. balloon B is charged and balloon A is neutral
- c. balloon A is neutral and balloon B is negative
- d. balloon A is neutral and balloon B is positive
- e. ... nonsense! This would never happen if the balloons are identical and simply suspended by strings. They will attract each other and both be deflected from a vertical orientation.

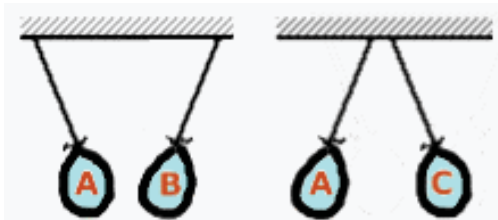


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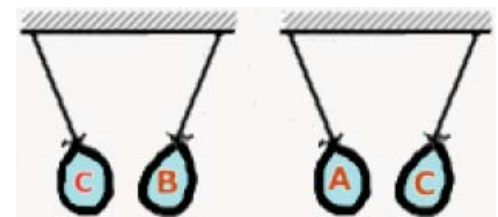
6. Anna Litical is performing a physics lab in which she charges a variety of materials and tests to determine their charge by bringing them near a negatively charged balloon and near some neutral paper bits at rest on the table. Help Anna draw conclusions from her observations by entering +, -, neutral (or a combination of these if absolute conclusiveness is not possible).
- Object A is observed to attract the paper bits; object A must be _____.
 - Object B is observed to attract the balloon; object B must be _____.
 - Object C is observed to repel the balloon; object C must be _____.
 - Object D is observed to attract both the paper bits and the balloon; object D must be _____.
 - Object E is observed to attract the paper bits and repel the balloon; object E must be _____.
7. On three occasions, the following charge interactions between balloons A, B and C are observed. In each case, it is known that balloon B is charged negatively. Based on these observations, what can you conclusively confirm about the charge on balloon A and C for each situation.



Balloon	Conclusive evidence to conclude that the charge is +, -, neutral
A	
B	negative
C	



Balloon	Conclusive evidence to conclude that the charge is +, -, neutral
A	
B	negative
C	



Balloon	Conclusive evidence to conclude that the charge is +, -, neutral
A	
B	negative
C	

8. Jean Yuss is investigating the charge on several objects and makes the following findings.

Object C
attracts B

Object D
repels C

Object E
attracts D
repels F

Object F
attracts A

Jean knows that object A is negatively charged and object B is electrically neutral. What can Jean Yuss definitively conclude about the charge on objects C, D, E, and F? Explain.