The application of tutorial based worksheets to enhance student understanding of static electricity and magnetism at lower and upper second level education

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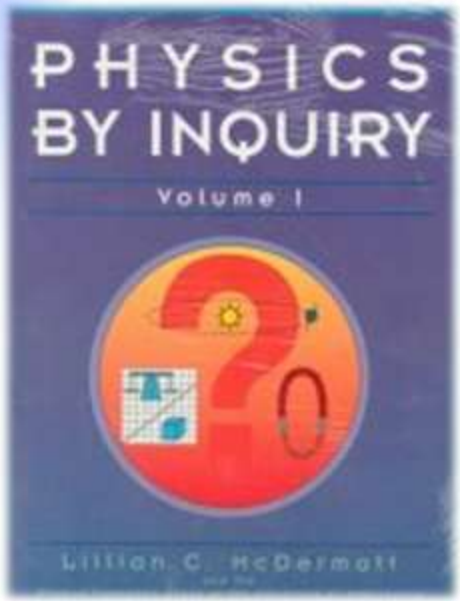
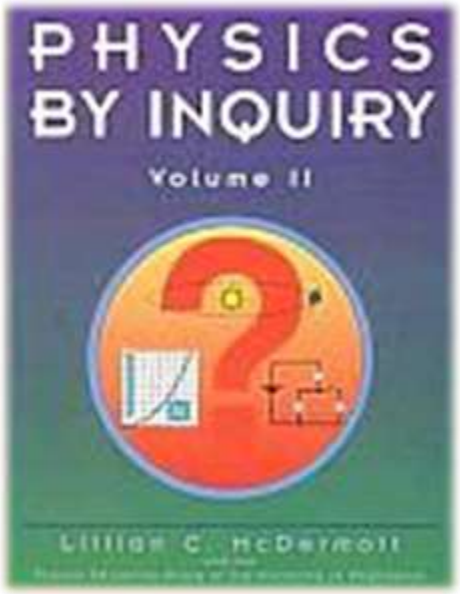
Where did I start.

- Should I use guided inquiry or open inquiry?

- Should I focus on improving conceptual understanding or improving student skill?

Starting influences.



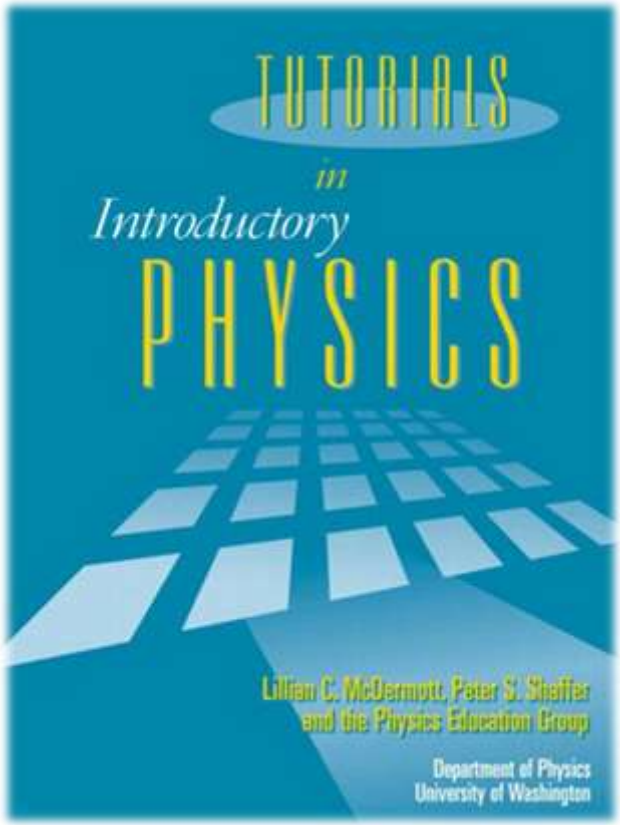


- Physics By Inquiry. Vol I & II.
- Lillian C McDermott & Physics Education Group the University of Washington.

Starting influences.

- Tutorials in Introductory Physics.

- Lillian C McDermott, Peter S Shaffer & Physics Education Group the University of Washington.



What Topics?

- Static Electricity (Lower and Upper)
- Magnetism (Lower)

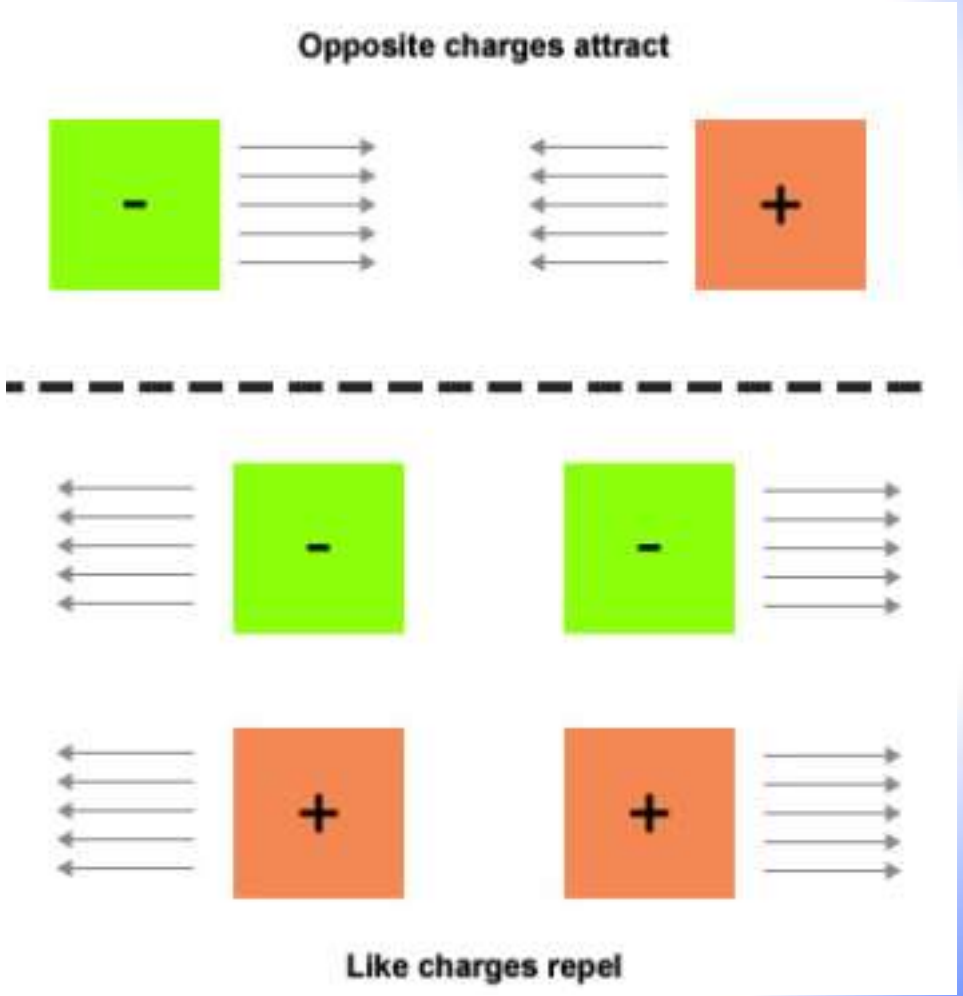
Why pick Static Electricity?

1. Students and teachers think it is easy.

2. Literature shows lots of misconceptions developed in this topic.

Charges vs Charged Objects.

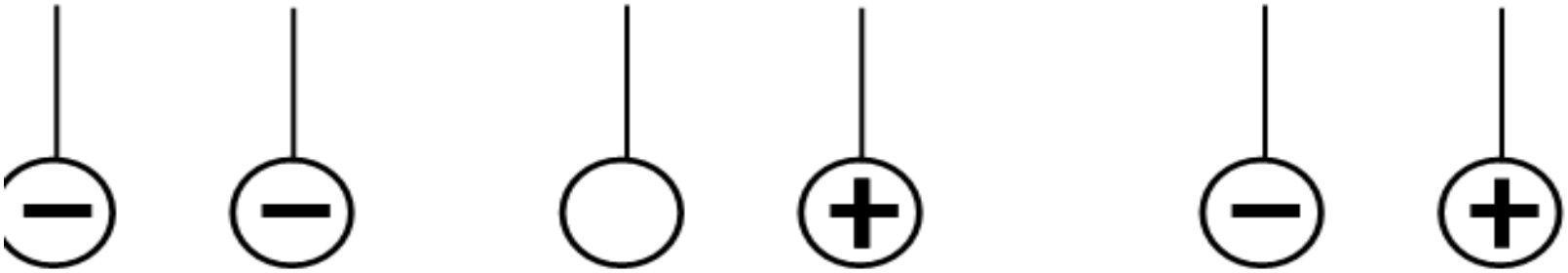
- Typically, this is what students are taught about charges.
- Develops a misconception that neutral objects will not react to a charged object.



Pre – Test Question

1. In the following question, a circle with a (+) sign represents a positively charged ball, a circle with a (-) sign dome represents a negatively charged ball and a circle with no symbol in it represents a neutrally charged ball. Each ball is hanging from a string and is free to move.

   In which of the three setups, will we see a force of *attraction*, a force of *repulsion* or no force?

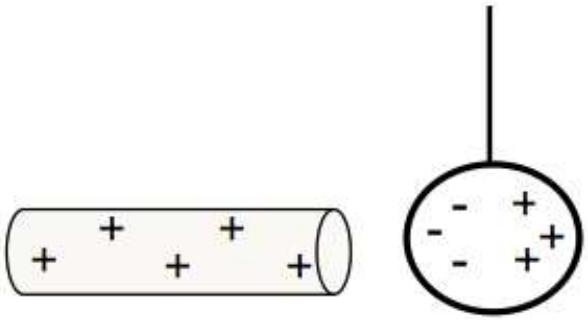


(i) (ii) (iii)

In each case, explain why you think you will see a force of attraction, a force of repulsion or no force.

Challenging student models.

Attraction, Repulsion and Distribution of Charge.



If we take the neutral dome at the end, and bring a positively charged rod close to it, we see the charge on the dome spread itself in the manner shown to the left.

How many + and – charges are on the conductor?

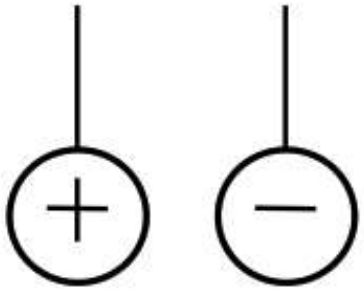
What is the *overall charge* on the conductor? Explain.

Why did the rod pull the – charges to the left side of the dome?

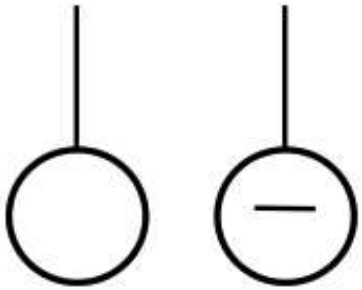
Challenging student models.

What type of *force* do be observe, if any, in the following three pairs of conductors. Explain why you chose the type of force and if there is none, explain why there is none.

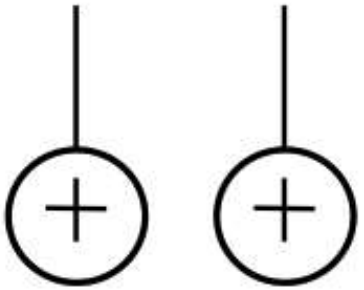
(i)



(ii)



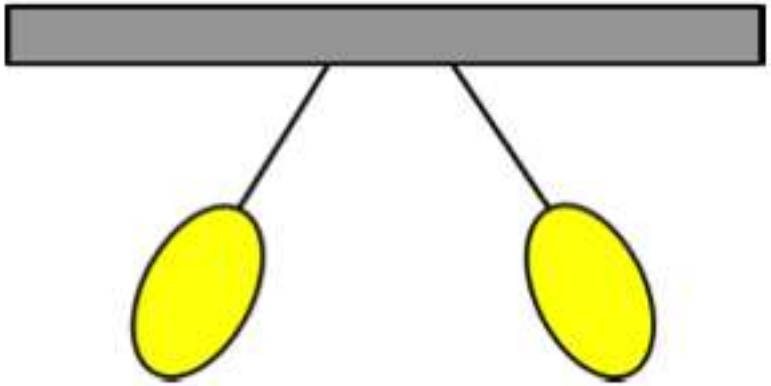
(iii)



From what you've covered here and in section one, do both objects need to be charged in order to see attraction? Explain.

Post –Test Question.

Two balloons are charged and hung from an insulated post as shown.



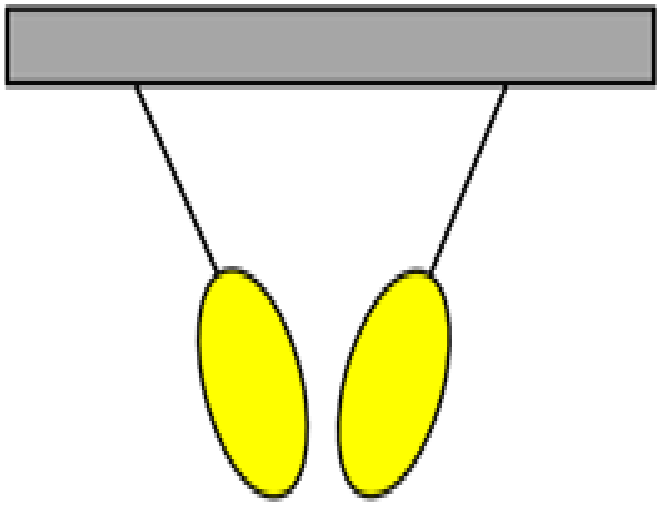
traction or repulsion?

n you conclude about the charges on both balloon? Explain.

sible to tell what charges are on the balloons? If so, do and explain. If not, why?

Post –Test Question.

Q8. Two different balloons are hung from an insulated post and behave as shown.



Is this attraction or repulsion?

What combination(s) of charges could cause this to happen? Briefly explain how each one cause attraction.

What were the challenges?

1. Length and time of exposure.

2. Abstract nature of the material.

3. Explicit experience of attraction between charged and neutral objects must occur.

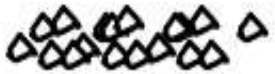
Revised Edition.

1. Balloons and paper.

Take a piece of paper and tear it into small pieces of paper. Take a plastic biro and rub it in your hair.

(i) Predict what you will observe if you hold the pen over the paper.

(ii) What do you observe?



(iii) Which object did you charge in this experiment? Which object was neutral in this experiment?

Revised Edition.

2. Balloons and Jumpers.

You are going to rub one balloon in your hair and hold it to your jumper. Predict what you will observe when you let go of the jumper.

(i) What do you observe?

(ii) Which object did you charge in this experiment? Which object was neutral in this experiment?

(iv) Do your findings in this section agree with what you learned in section I of this worksheet. Explain.

Revised Edition.

What have you learned about how positively charged objects (the biro) react with neutral objects?

What have you learned about how negatively charged objects (the balloon) react with neutral objects?

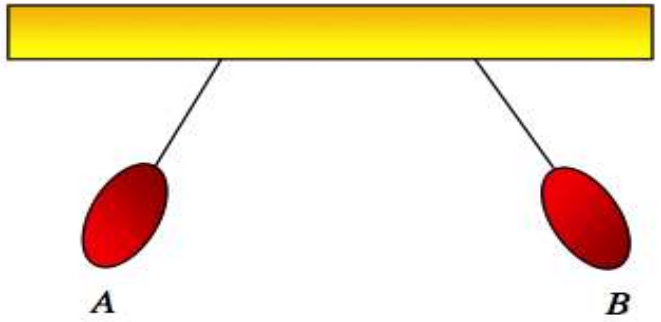
Revised Edition.

1. Two charged balloons are hanging from a wooden support, as shown.

(a) Is this attraction or repulsion

(b) What combinations of charges give the reaction as shown to the right?

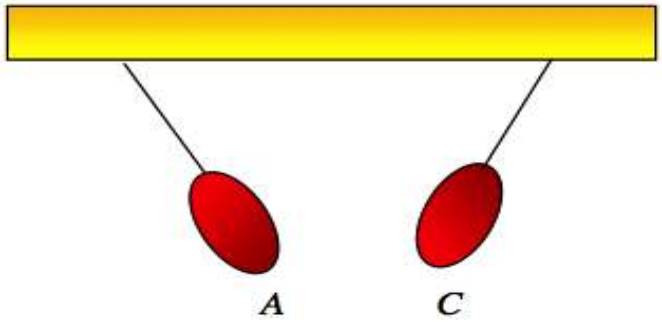
(c) Is it possible to identify the charge on balloon A or balloon B? Explain



2. Balloon B is replaced with another charged balloon, balloon C.

(a) Is this attraction or repulsion

(b) What combinations of charges give the reaction as shown to the right?

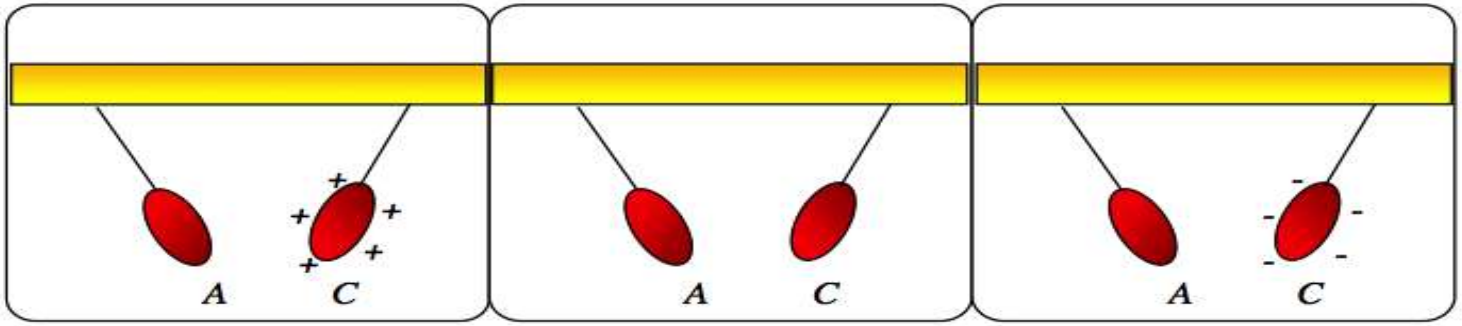


Revised Edition.

3. The charge on balloon B was identified as positively charged.

   From this, what is the charge on balloon A. Explain.

Using this information, work out which of the following three set ups ***cannot*** represent the charge that is on balloon C. Explain, in as much detail as you can, why not all of the following set ups can be correct.



(i) *C is positively charged.*

(ii) *C is neutrally charged.*

(iii) *C is negatively charged.*

Incorrect diagram(s):

Reason.

What else are we going with this?

- Lower level Static:
  1. Interaction of charges
  2. Interaction of charged objects and neutral objects.
  3. Conservation of charge: Micro vs Macro.
  4. Applications of grounding.

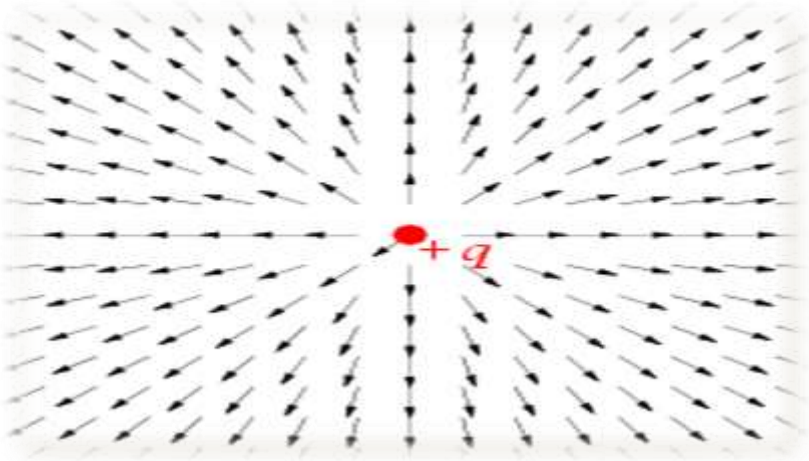
What else are we going with this?

- Lower level magnetism:
  1. Magnets with magnets, magnetisable metals and plastics.
  2. Properties of magnetic fields.
  3. Attraction and Repulsion – Experience & Field pattern.
  4. Magnetic field of the earth.

Where else are we going with this?

- Upper level Electrostatics

1. Coulomb's Law.
2. Electric Field, vectors and fields.
3. Potential Difference, static concept and setting up a circuit.
4. Capacitance, static concept and setting up a capacitor.



Thanks for listening

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