

Physics Education Laboratory Lecture 12 Content Knowledge for Electricity

Francesco Longo - 29/11/22





Electric Field, Electric Field Lines and Direction

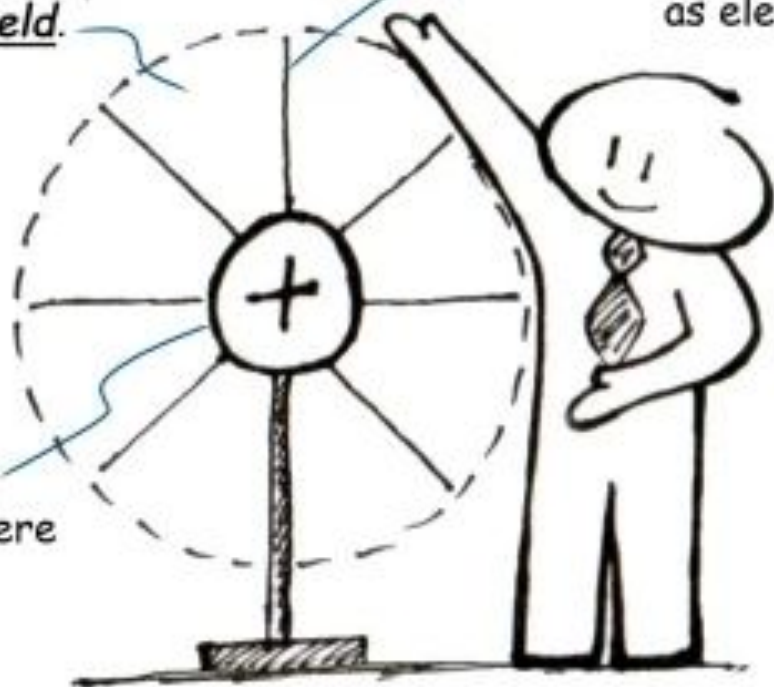
The space or region around the positive charged sphere is known as electric field.

The lines around the sphere/particle are known as electric field lines.

The denser the lines (closer/more lines) the stronger the electric field strength.

But how to remember what is the direction of the electric field lines?

A positively charged sphere



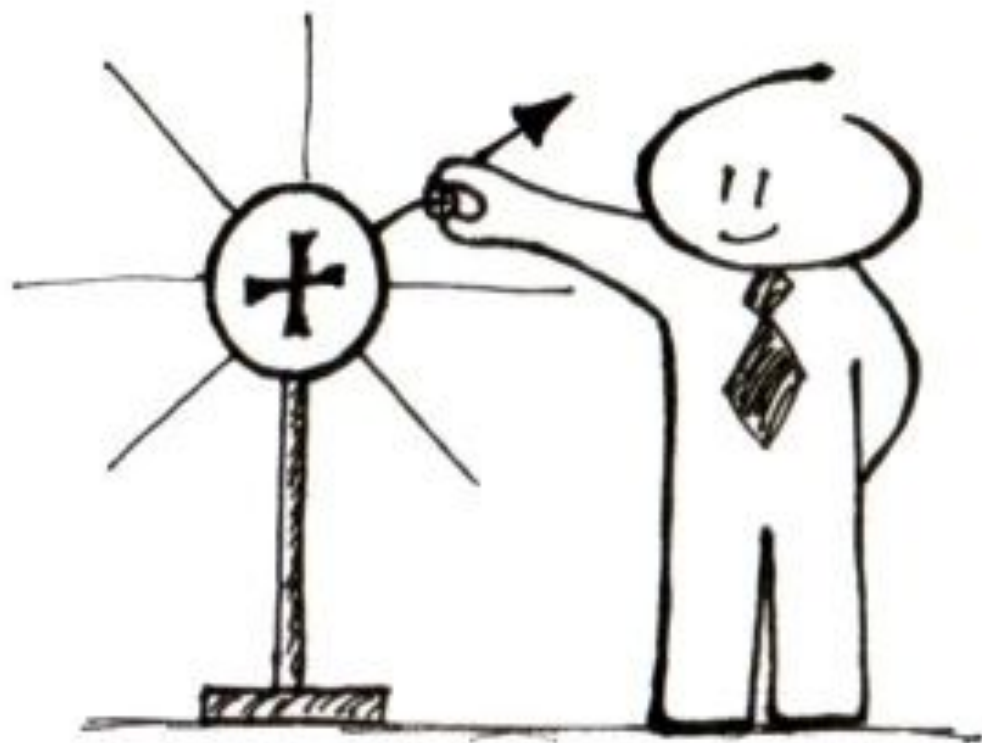
To know the direction of
the electric field lines ...

Just imagine you always
have a tiny
positive charge
in your pocket ...

... and recall the
Laws of Electrostatic
- *Like charges repel*
- *Unlike charges attract*



How to remember it is positive?
Just remember that you want
to be a 'positive' person!



Using the positive test charge, place it in the electric field of the positive sphere in this case.

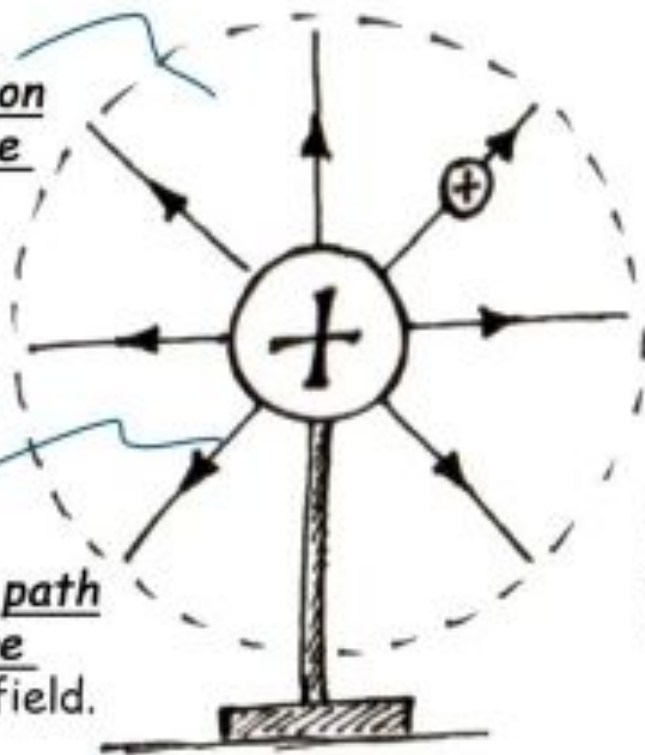
As like charges repel, the positive charge will be repelled by the positive sphere. Hence it will move outwards.

The direction of the force experienced by the positive charge indicates the direction of the field lines.

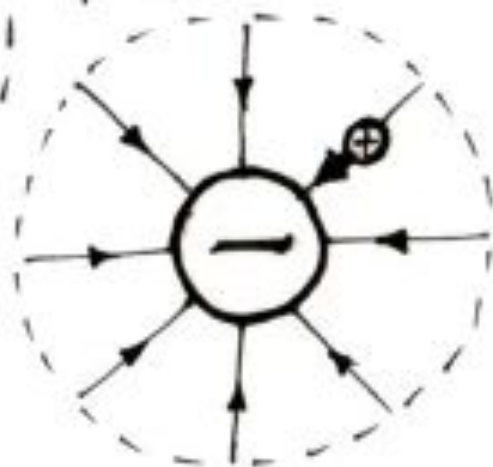
Definition of the terms...

Electric field is the region in which an electric charge experiences a force (attraction or repulsion).

Electric field line is the path in which a positive charge would take in an electric field.

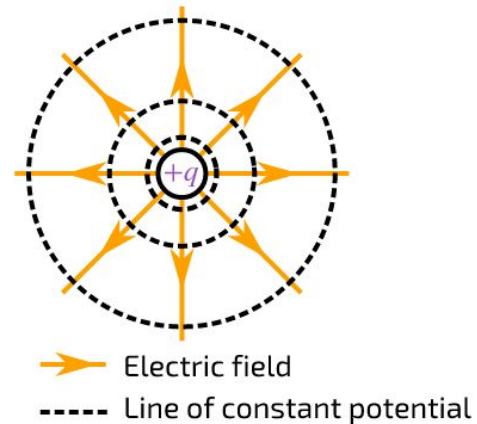


Concepts apply for electric field around a negatively charged sphere.



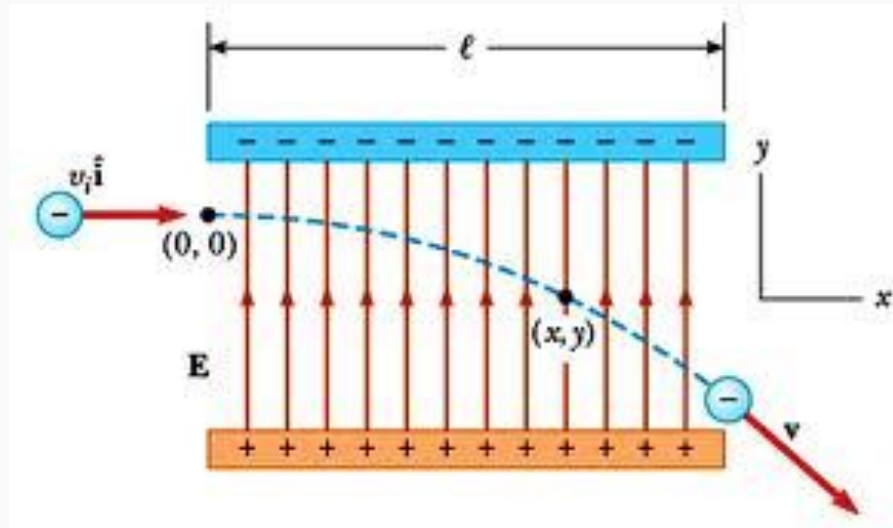
Key concepts in Electrostatics

- The electric charge (with opposite signs)
- The Coulomb law
- The Electric field
- The Electric potential



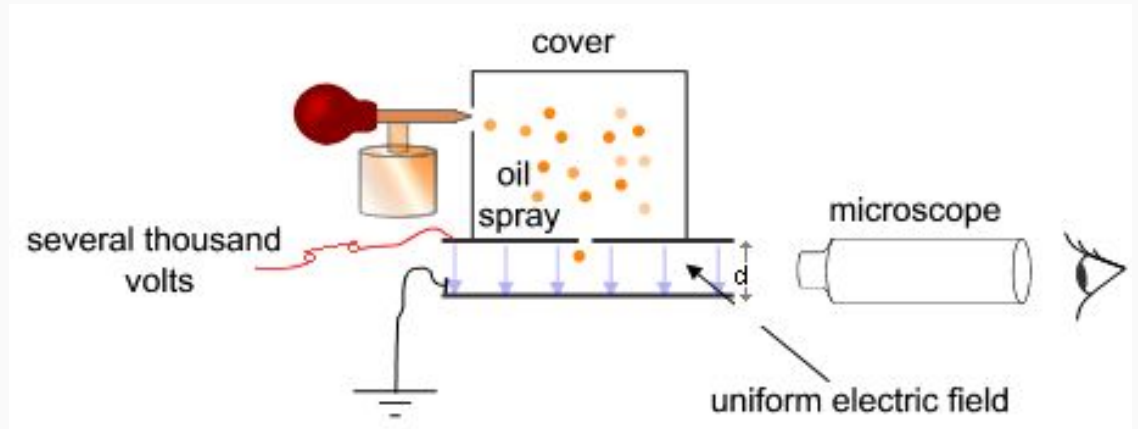
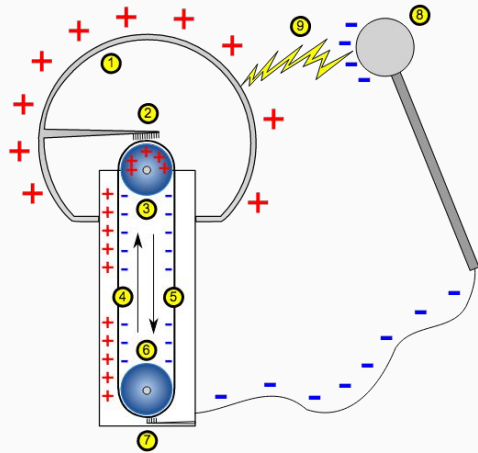
Key concepts in Electrostatics

- Motion of particles in Electric field



Key concepts in Electrostatics

- The electric charge



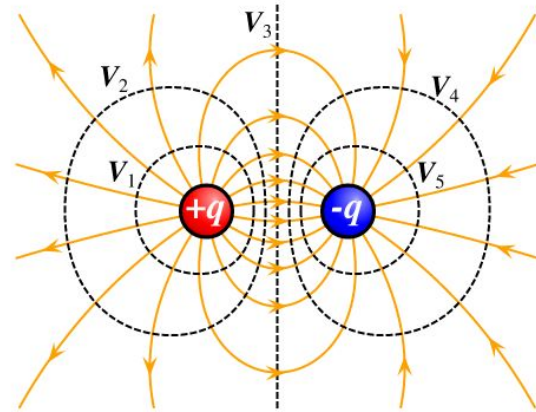
Key concepts in Electrostatics

- The electric charge



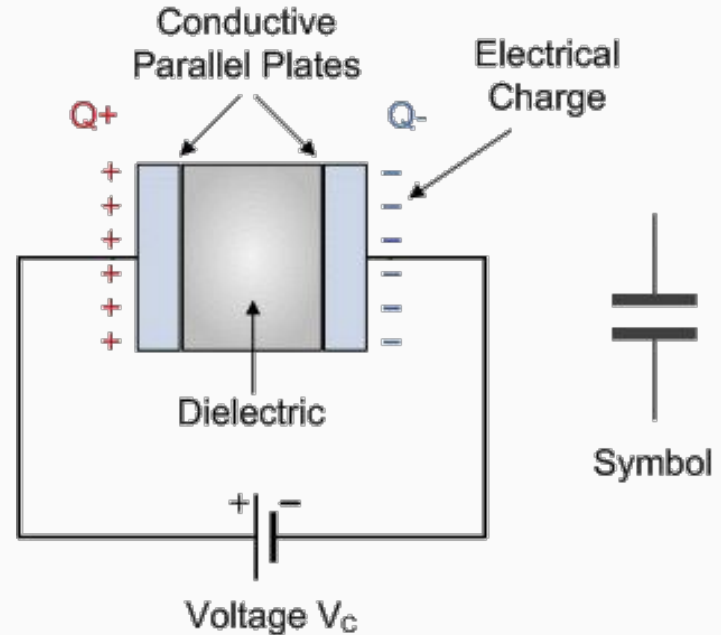
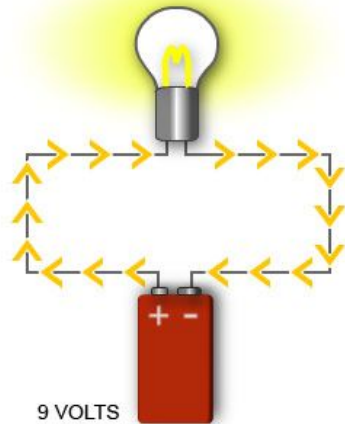
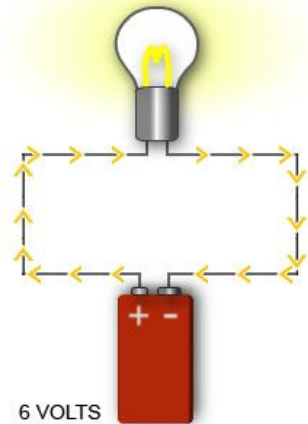
Key concepts in Electrostatics

- The Electric field as a vector
- The Potential as a scalar field
- How to “see” them?



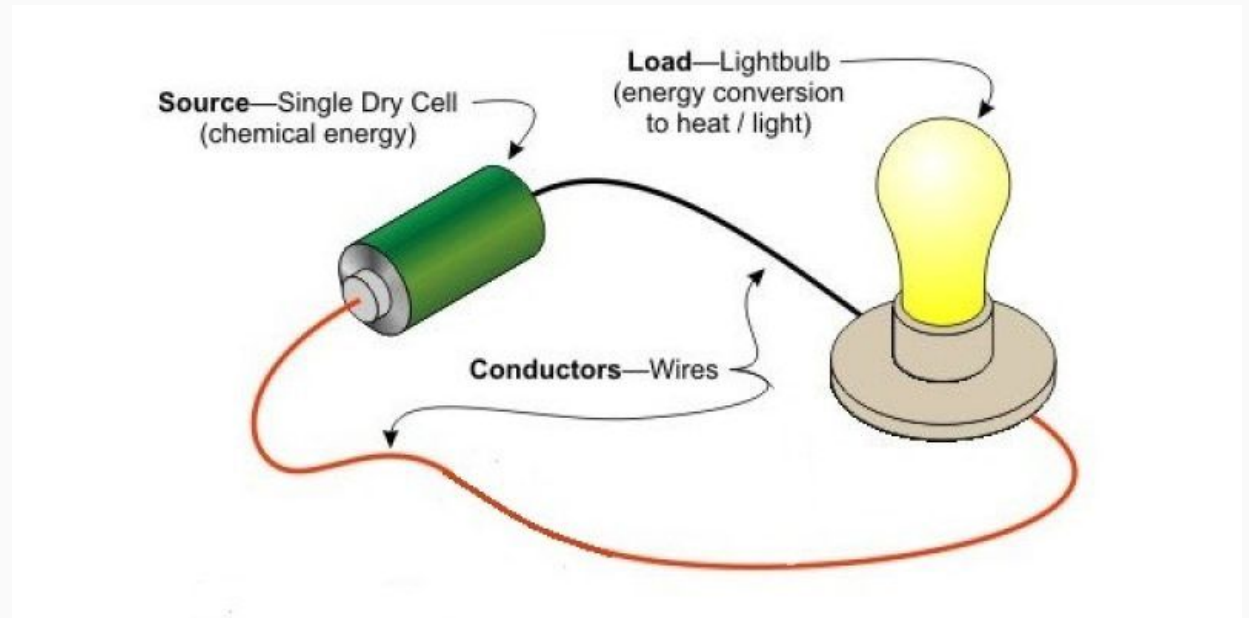
Key concepts in Electrostatics

- Concept of “Voltage”
- Voltage and currents
- Voltage and capacitors



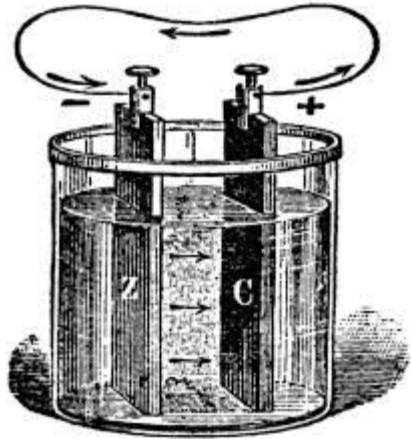
Key concepts in Electrostatics

- The electric current
- Electric resistance
- Circuits in CC
- Ohm's law
- Batteries



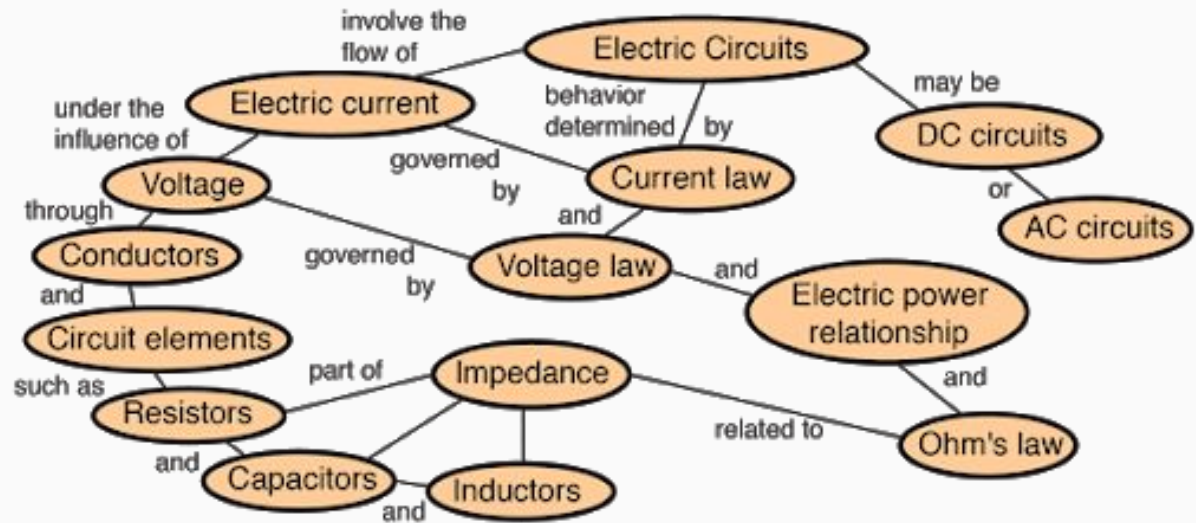
Key concepts in Electrostatics

- Batteries



Key concepts in Electrostatics

- Electric circuits



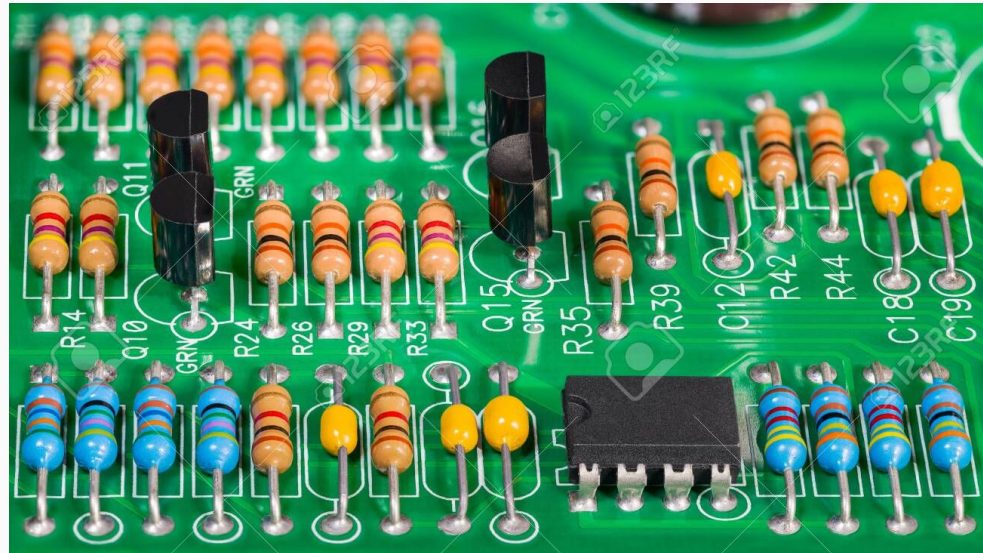
Key concepts in Electrostatics

- The Ohm's law

Ohm's law formulas www.ohmlaw.com		To Calculate			
		Voltage (V)	Current (I)	Resistance (R)	Power (P)
Given parameters	Current & Resistance	$V = IR$	---	---	$P = I^2R$
	Current & Power	$V = \frac{P}{I}$	---	$R = \frac{P}{I^2}$	---
	Voltage & Current	---	---	$R = \frac{V}{I}$	$P = VI$
	Voltage & Resistance	---	$I = \frac{V}{R}$	---	$P = \frac{V^2}{R}$
	Voltage & Power	---	$I = \frac{P}{V}$	$R = \frac{V^2}{P}$	---
	Power & Resistance	$V = \sqrt{P \cdot R}$	$I = \sqrt{P/R}$	---	---

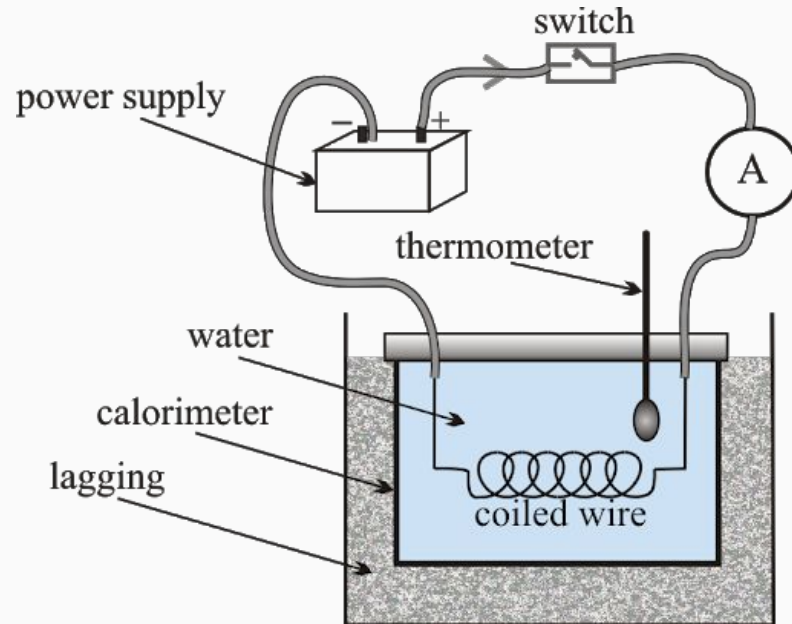
Key concepts in Electrostatics

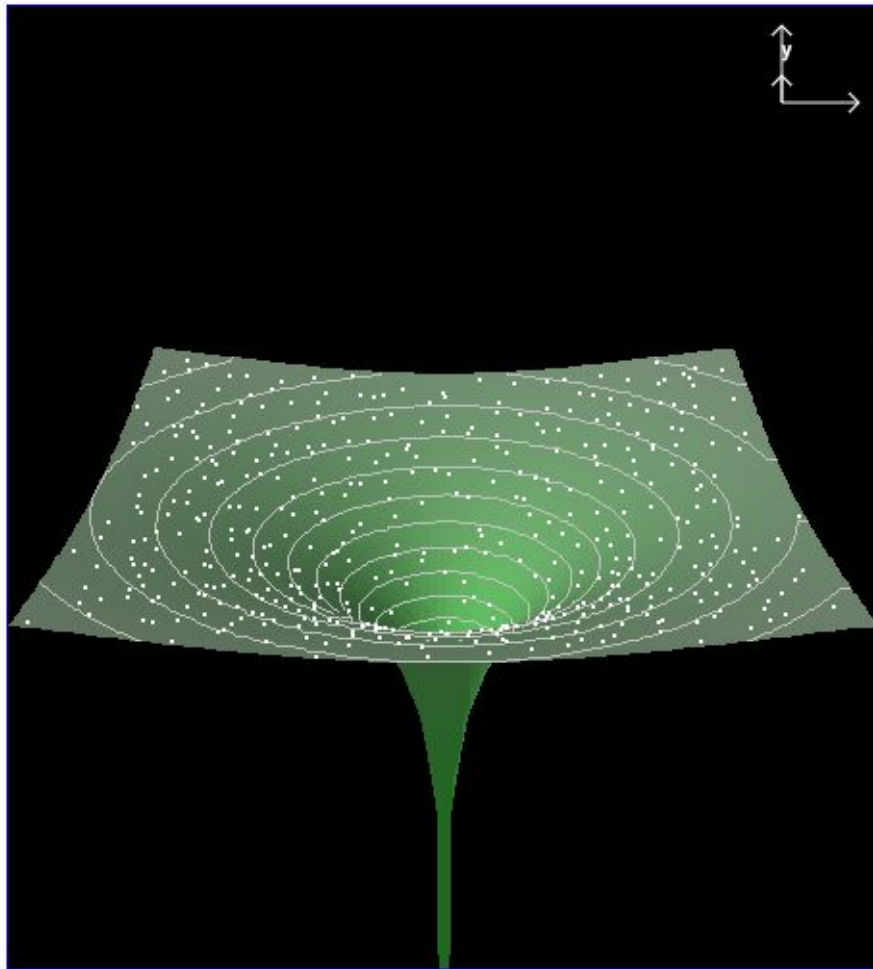
- The resistors



Key concepts in Electrostatics

- The power in Electric fields





Setup: charged line

Color: field magnitude

Floor: equipotentials

Flat View

Display: Particles (Vel.)

Mouse = Adjust Angle

Stopped

Reverse

Reset

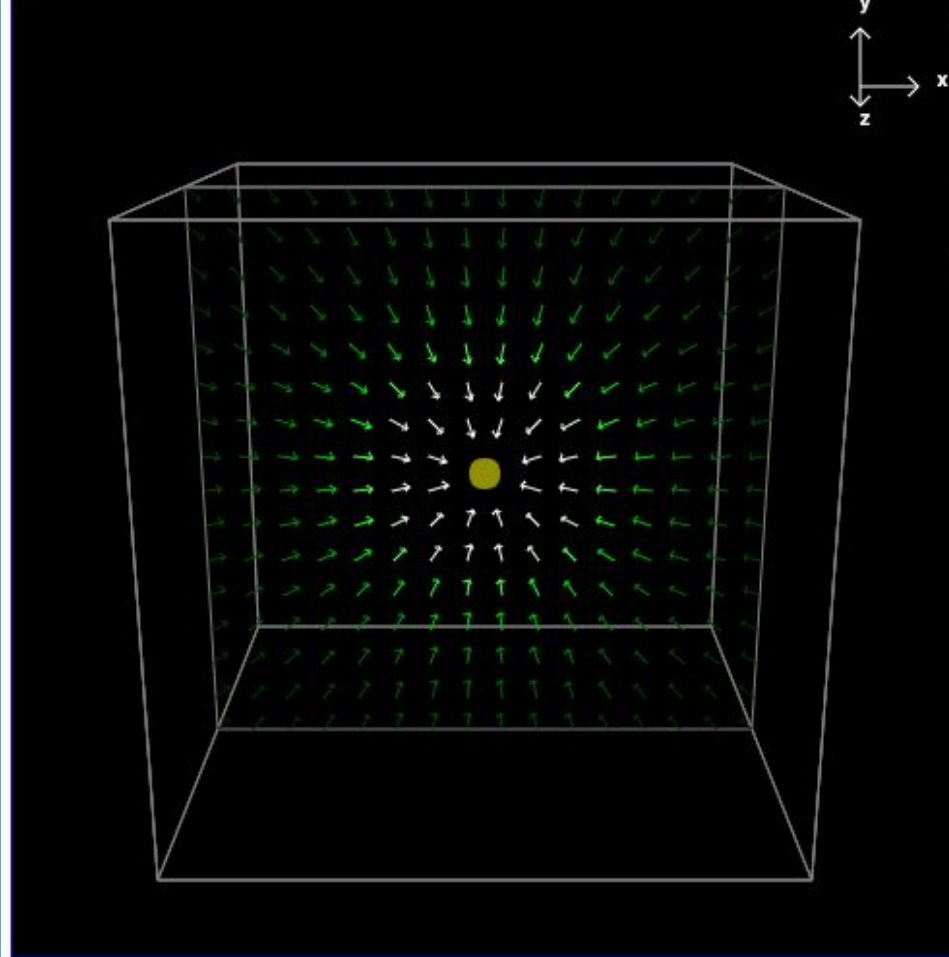
Kick

Field Strength

Number of Particles

<http://www.falstad.com>

<http://www.falstad.com/vector2de/>



Field selection:
point charge

Display: Field Vectors

Mouse = Adjust Angle

Show Z Slice

Stopped

Reverse

Reset

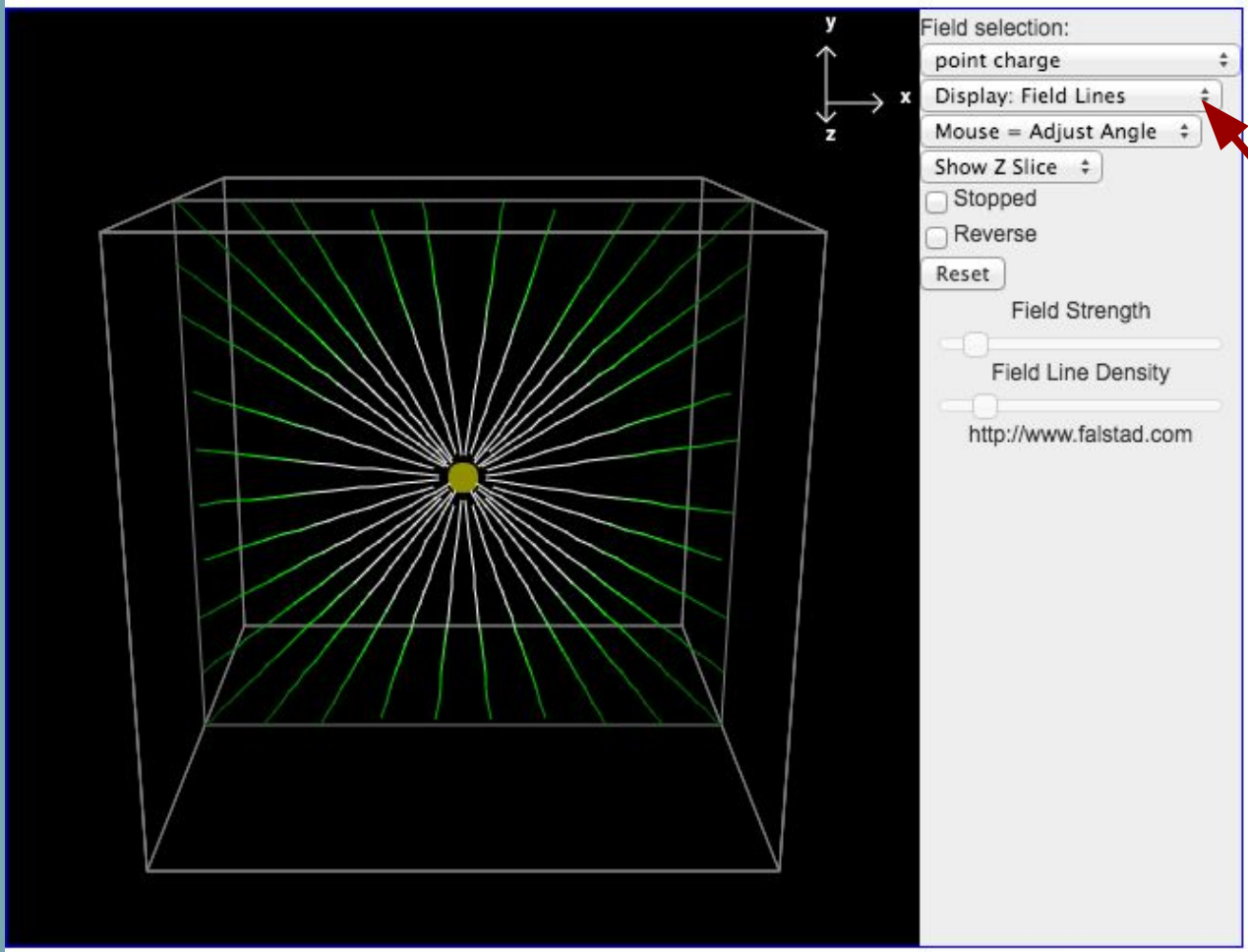
Field Strength

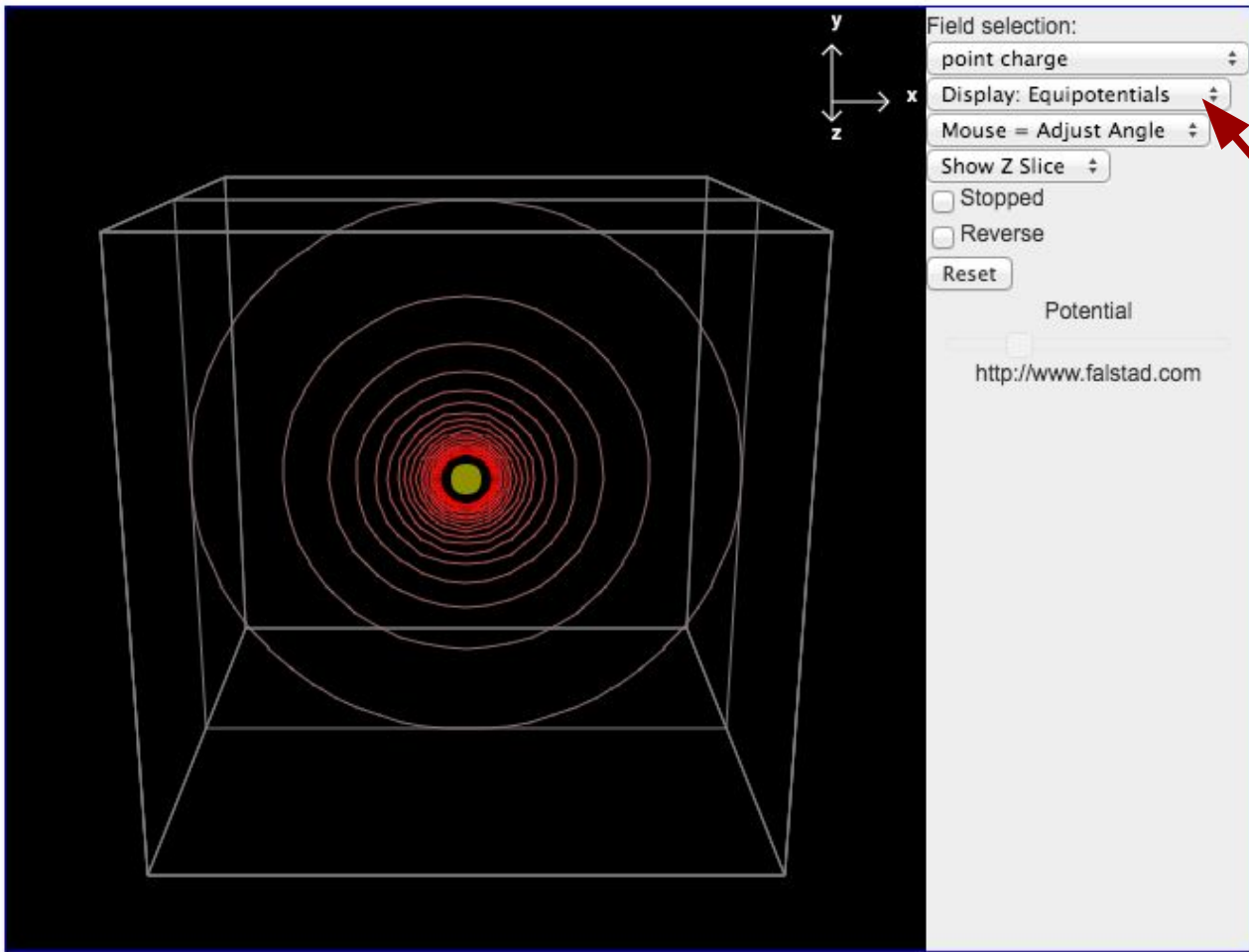
Vector Density

<http://www.falstad.com>



<http://www.falstad.com/vector3de/>






Misconceptions in Electrostatics

- Current flows in one direction and charges move in the other one
- Electric field is a scalar field
- Potential field is a vector field -- which relation to electric field ?
- The elementary charge
- Neutrality of matter and electricity ...
- Potential and Potential energy
- Capacitors treatment - Voltage and charge relationships
- Potential - Voltage
- Ohm law inversion

Inquiry Based
Science Education
(IBSE approach)



Inquiry is a multifaceted activity that involves: making observations; posing questions; examining books and other sources of information to see what is already known; planning investigations; reviewing what is already known in light of experimental evidence; using tools to gather, analyze, and interpret data; proposing answers, explanations, and predictions; and communicating the results. Inquiry requires identification of assumptions, use of critical and logical thinking, and consideration of alternative explanations.

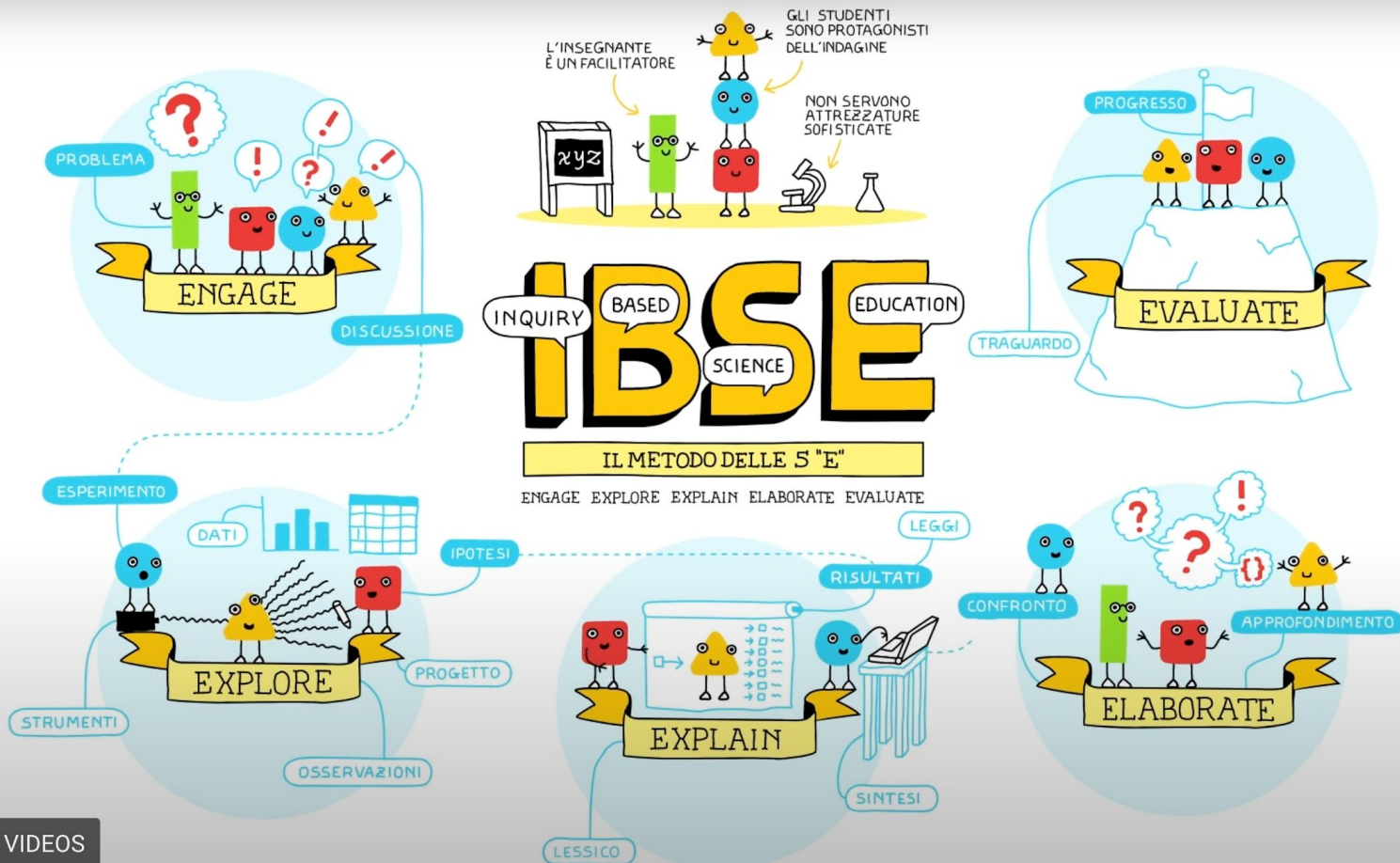
(National Research Council, 1996)

What is Inquiry-Based Learning?

<https://www.youtube.com/watch?v=QlwkerwaV2E&list=RDCMU CRmWJULBr4CIP5xUucVg0vw&index=1>

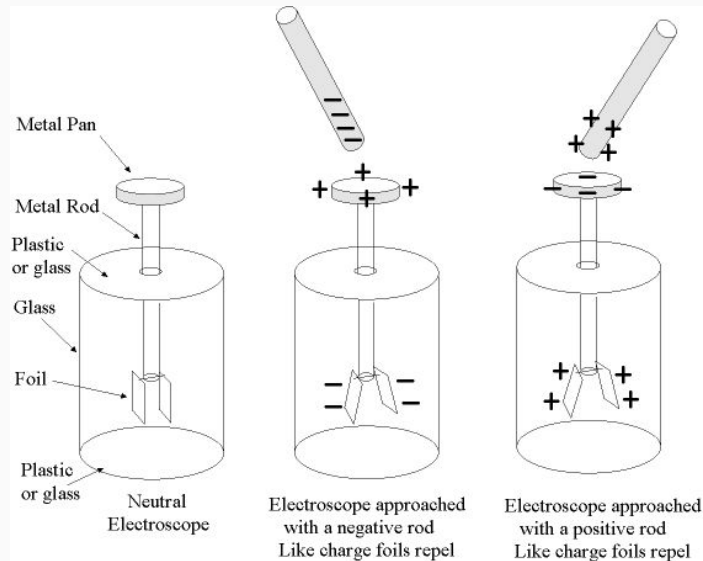
<https://www.youtube.com/watch?v=kYap39FNFv8>

IBSE DESCRIPTION



IBSE example for Electrostatics

- ENGAGE students in Electrostatics : find few examples ...



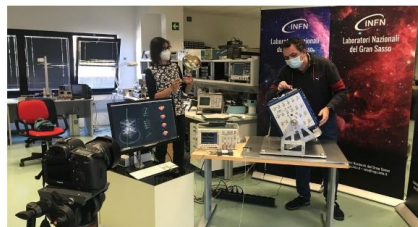
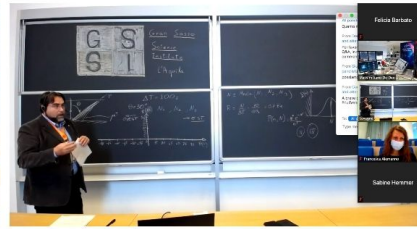
IBSE example for Electrostatics

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IBSE example for Electrostatics

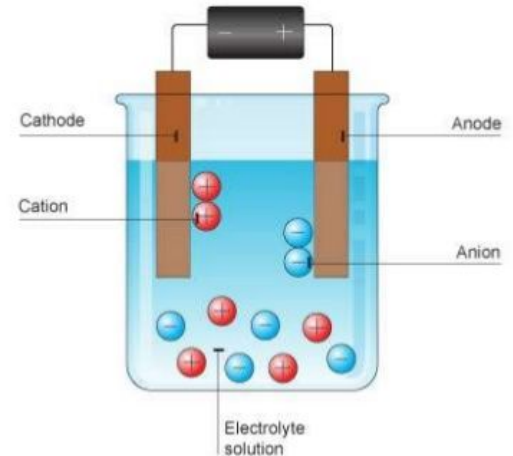
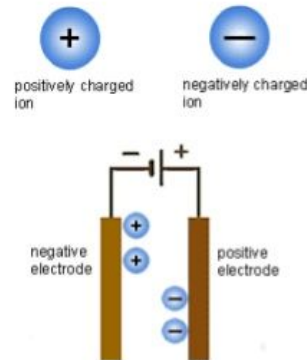
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IBSE example for Electrostatics

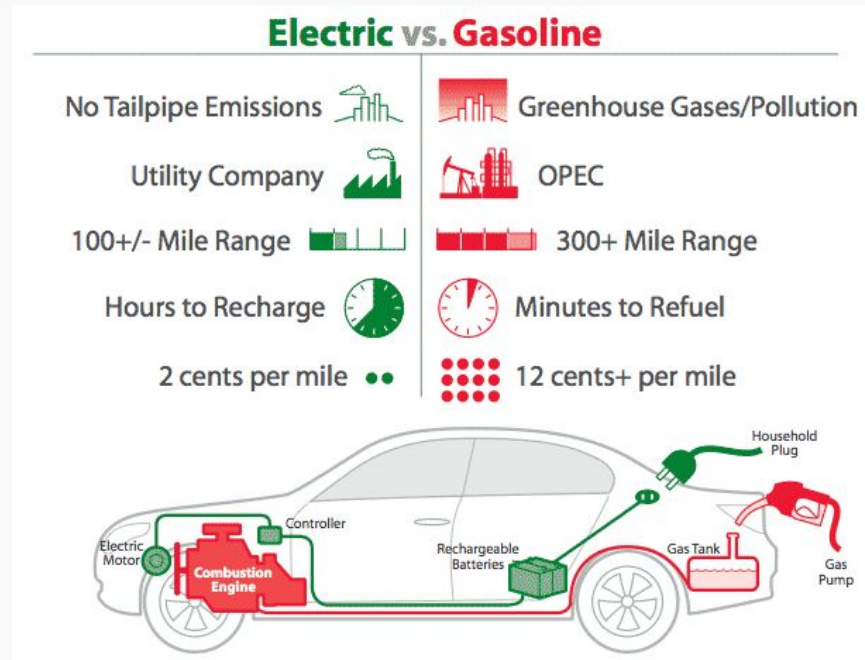
- ENGAGE students in Electrostatics find few examples ...

Don't **PANIC** - **P**ositive is **A**node, **N**egative is **C**athode.



IBSE example for Electrostatics

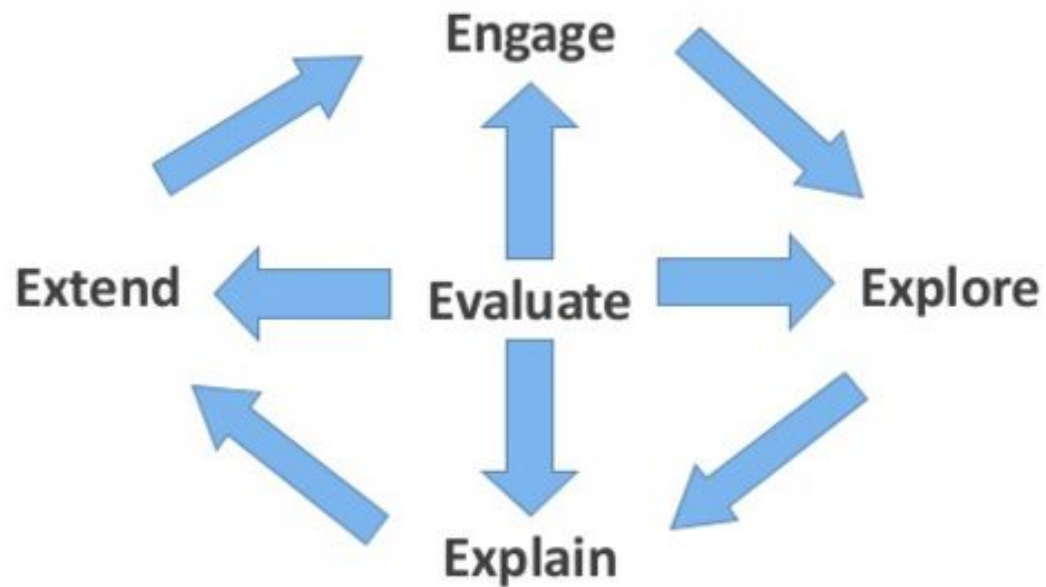
- ENGAGE students in Electrostatics :
find few examples ...



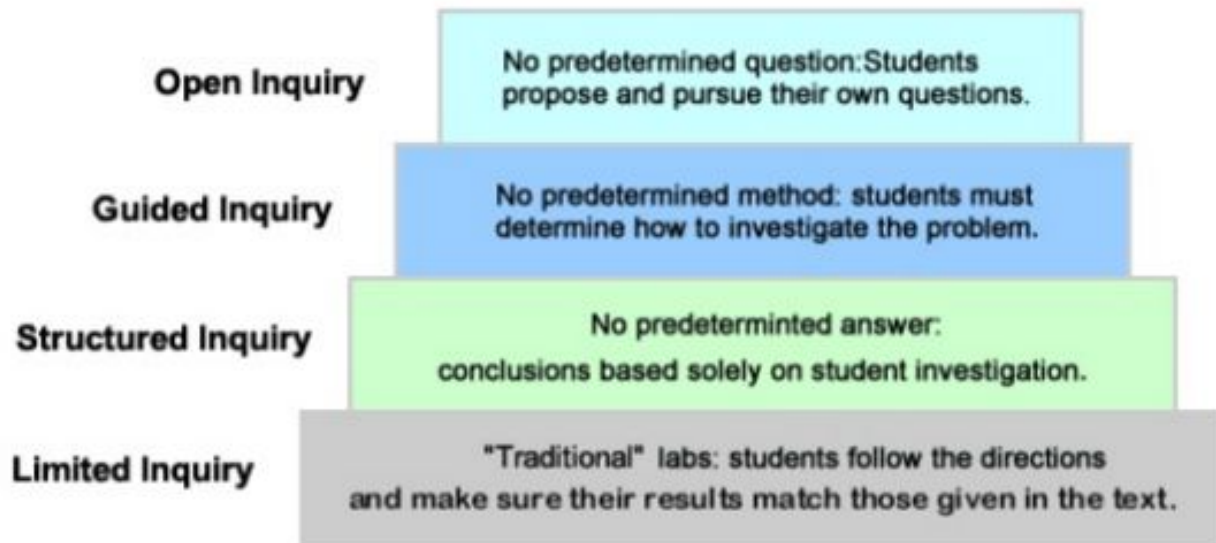
Engage examples

- Carica cellulare - Wifi - Piastra induzione
- Fulmine in Auto
- Scossa in giornate secche
- La scossa
- Display pixel
- Carica e scarica batteria

Learning Cycle



Inquiry Levels



Confirmation inquiry

It is based on confirmation or verification of laws and theories. Confirmatory inquiry is appropriate at the beginning of IBSE implementation, when the teacher aims to develop observational, experimental and analytical skills of the students. When conducting experiments, students follow teacher's detailed instructions under his/her guidance.

Structured inquiry

The teacher significantly influences the inquiry at this level and helps students by asking questions and providing guidance. Students look for solutions (answers) through their inquiry and provide an explanation based on the evidence they have collected. A detailed procedure of experiments is defined by the teacher, but the results are not known in advance. Students show their creativity in discovering laws. However, they are conducted by teacher's instructions in the research. This level of inquiry is very important for developing students' abilities to perform high-level inquiry.

Guided inquiry

The third level of IBSE changes the role of the teacher dramatically. The teacher becomes a students' guide. He/she cooperates with students in defining research questions (problems) and gives advice on procedures and implementation. Students themselves suggest procedures to verify the inquiry questions and their subsequent solutions. Students are encouraged by the teacher much less than in the previous two levels, which radically increases their level of independence. Students should have previous experience of lower levels to be able to work independently.

Open inquiry

This highest level of IBSE builds on previous three inquiry levels and it resembles a real scientific research. Students should be able to set up their inquiry questions, methods and procedures of research, record and analyze data and draw conclusions from evidence. This requires a high level of scientific thinking and places high cognitive demands on students, so it is applicable for the oldest and/or gifted students.

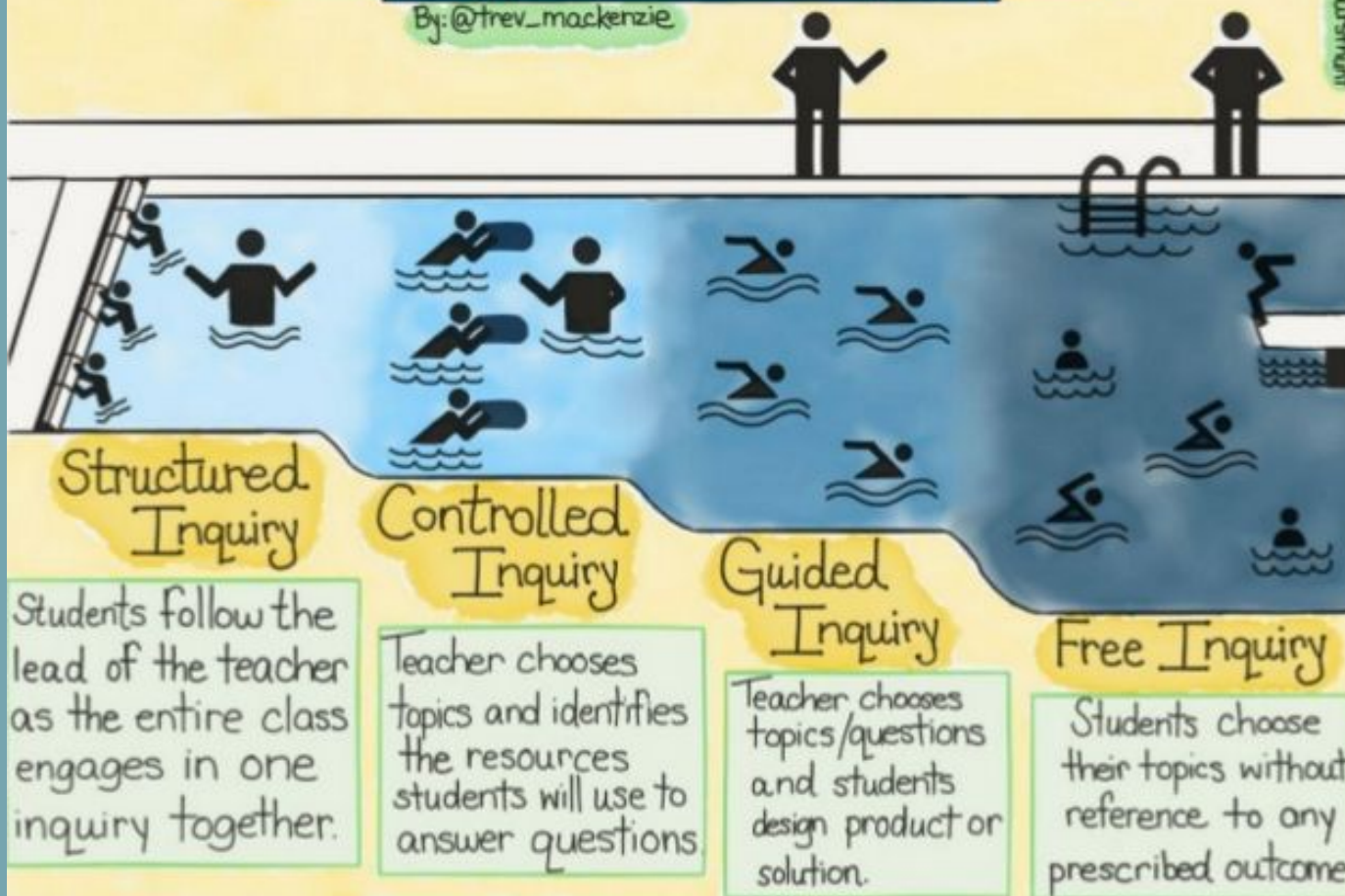
Inquiry Levels

	Traditional Hands-on	Structured Inquiry	Guided Inquiry	Student Directed Inquiry	Student Research Inquiry
Topic	Teacher	Teacher	Teacher	Teacher	Teacher/Student
Question	Teacher	Teacher	Teacher	Teacher/Student	Student
Materials	Teacher	Teacher	Teacher	Student	Student
Procedures/ Design	Teacher	Teacher	Teacher/Student	Student	Student
Results/ Analysis	Teacher	Teacher/Student	Student	Student	Student
Conclusions	Teacher	Student	Student	Student	Student

Types of Student Inquiry

By: @trev_mackenzie

@trev_mackenzie



<http://www.establish-fp7.eu/resources/units/direct-current-electricity.html>