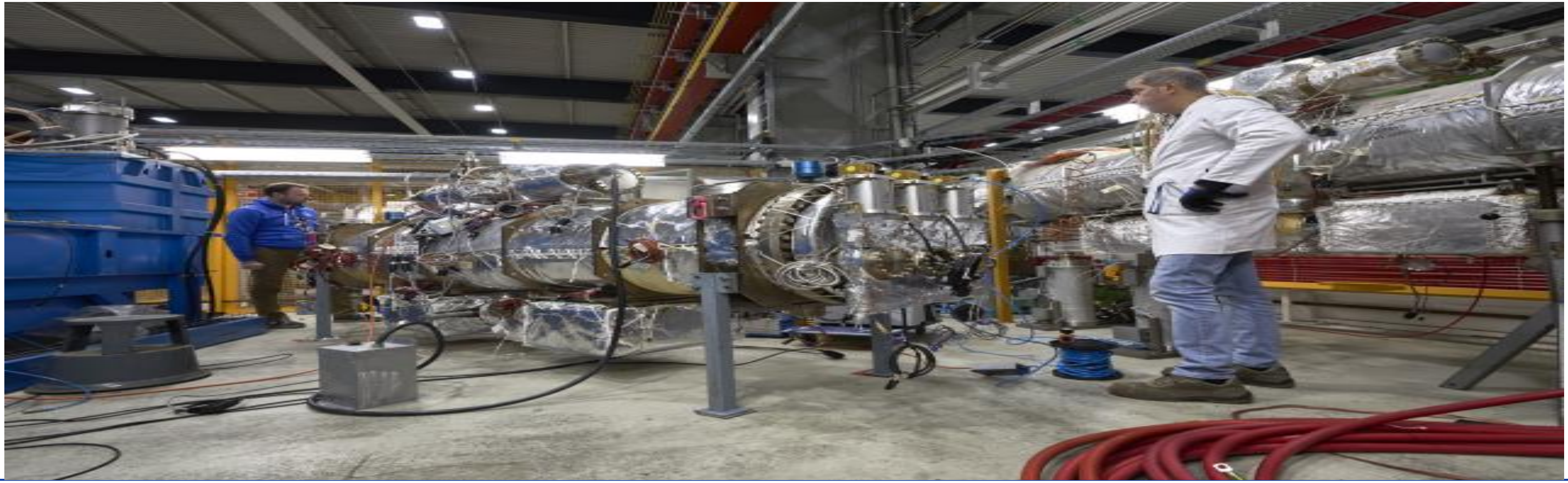
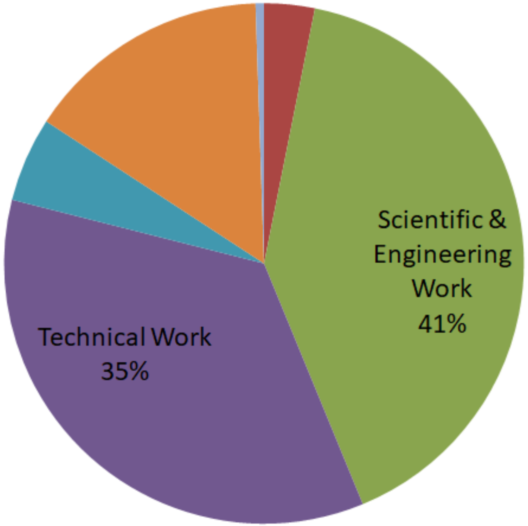
Engineering at CERN

ITW2024 Study Group 4



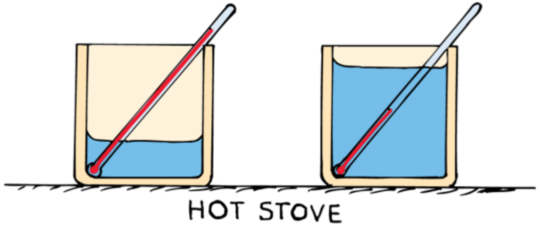
Key Ideas

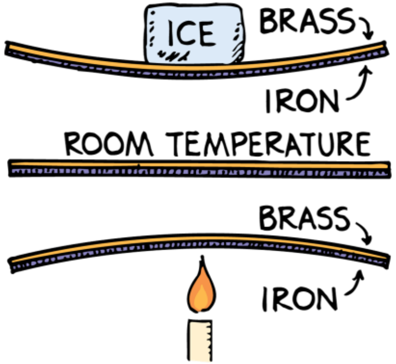
Superconducting magnets
Heavy handling
Data acquisition
Underground civil structures
Grid computing
Ultra-high vacuum
Micro-Electronics
Data visualisation
Network infrastructure
Cryogenics
Databases
Cooling and ventilation
AI



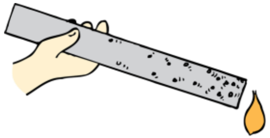
Curriculum & Classroom Connections I

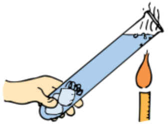
Temperature, Heat, and Thermal Expansion

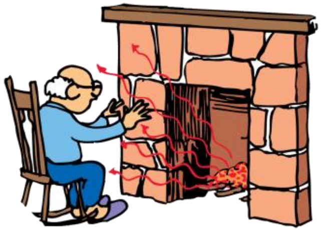




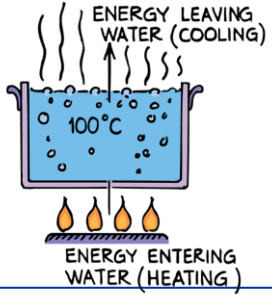
Heat Transfer: Conduction, Convection, and Radiation.



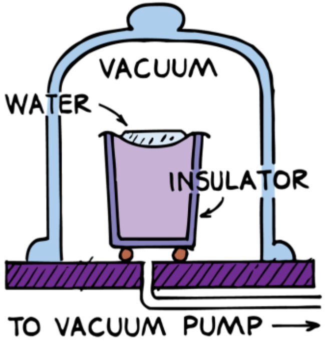




Change of Phase

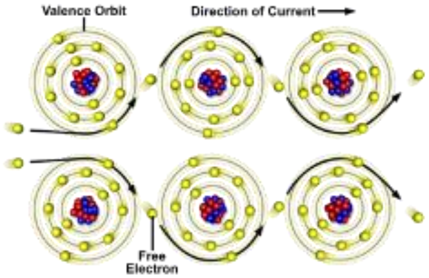


Boiling and freezing at the same time

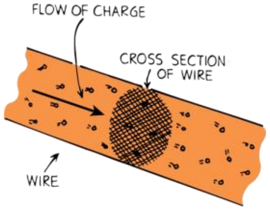


Curriculum & Classroom Connections II

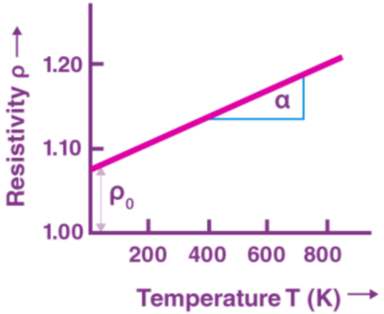
Atoms and Valence Electrons



Electric current,Drift velocity, Voltage Sources,

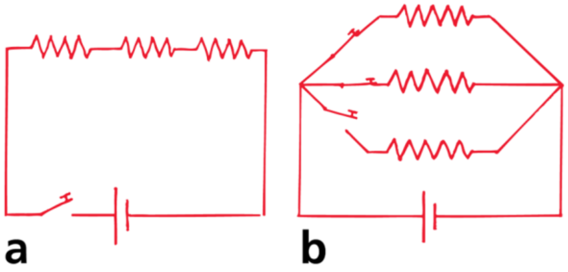


Electrical Resistance, Ohm’s Law, Dependence of Resistivity from Temperature



DC and AC, Electric Power

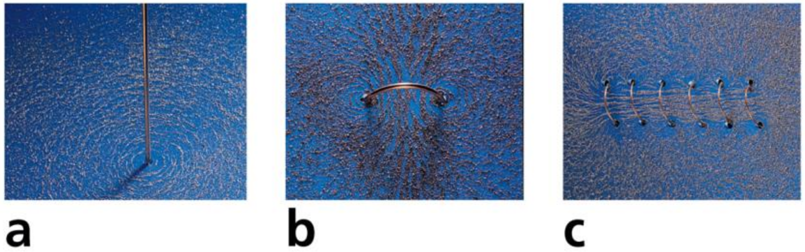
Circuit Diagrams



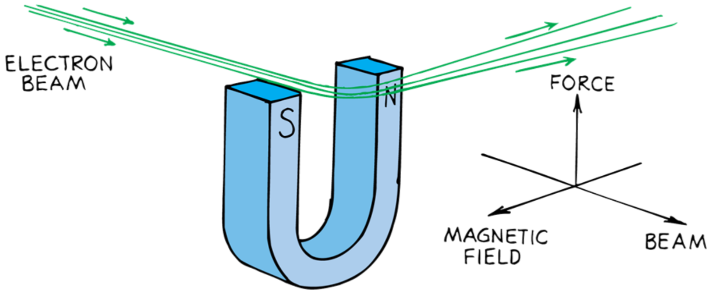
Curriculum & Classroom Connections III

Magnetism, Ferromagnetic Materials

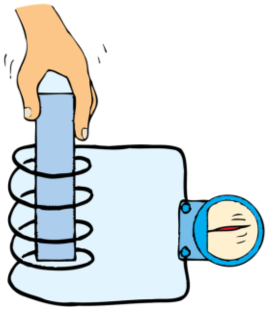
Electric Currents and Magnetic Fields

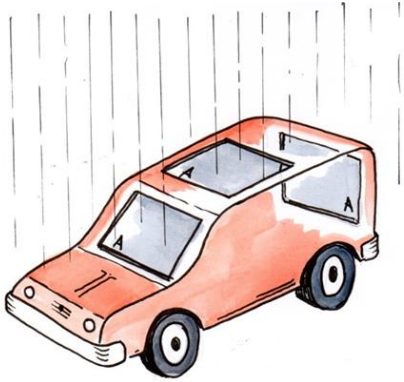


Magnetic Force on Moving Charges



Electromagnetic Induction

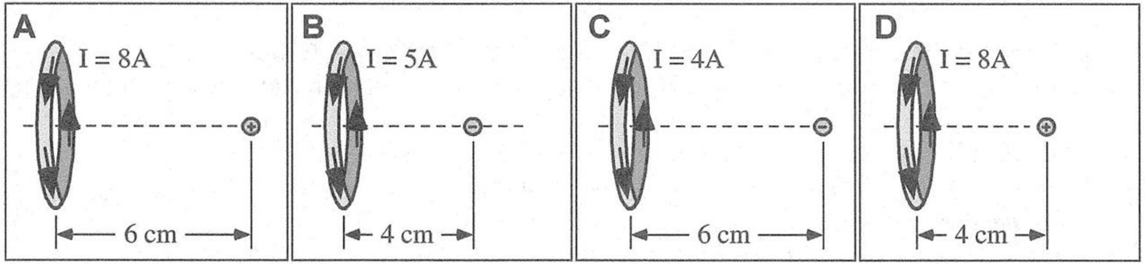




Potential Students’ Conceptions & Challenges

D3-QRT34: Charge near a Circular Current Loop—Magnetic Force Direction

An electrically charged particle is placed at rest near a circular current-carrying loop of wire, along the centerline of the loop. All of the charges have the same magnitude. In Cases A and D, the particle is positively charged, while in Cases B and C they are negative. The currents in all the loops are in the same direction.



For these situations, draw the direction of the magnetic force exerted on the charged particle and on the current loop in the chart below.

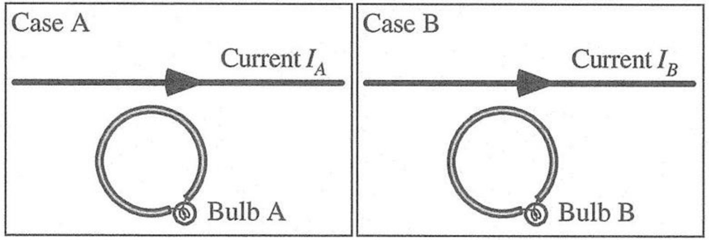
	Direction of force on the current loop	Direction of force on the particle
Case A	none	none
Case B	none	none
Case C	none	none
Case D	none	none

Explain your reasoning.

Potential Students' Conceptions & Challenges

D3-SCT41: CHANGING CURRENT IN LONG WIRE—BULB BRIGHTNESS IN NEARBY LOOP

A circular loop of wire with a small bulb in it is placed beside a long straight current-carrying wire. In both cases below, these loops are the same distance away from the current-carrying wire. Bulb A is brighter than Bulb B. The wire loops, bulbs, and long straight wires are identical for the two situations.



Three students discussing this arrangement contend:

Adela: *"Bulb A is brighter than Bulb B because the long wire next to the brighter bulb has a larger current in it."*

Bryce: *"No, Bulb A is brighter than Bulb B because the current in the long wire next to it is increasing at a faster rate than the current in the other wire."*

Consuelo: *"We don't know that. The current in the long wire must be changing at a faster rate, but it could also be decreasing."*

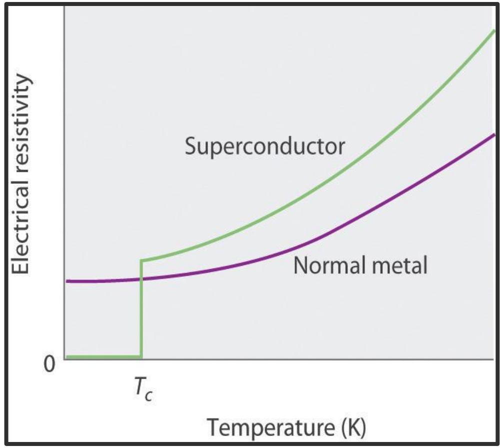
With which of these students do you agree?

Adela _____ Bryce _____ Consuelo _____ None of these students _____

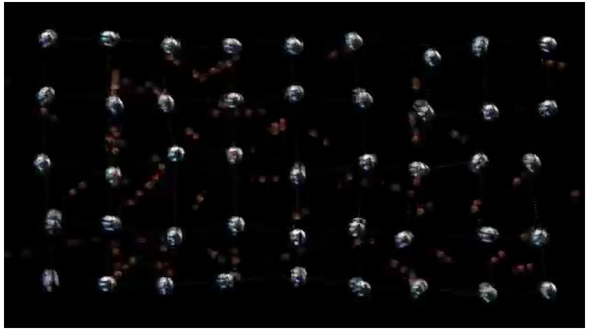
Explain your reasoning.

Super conductivity

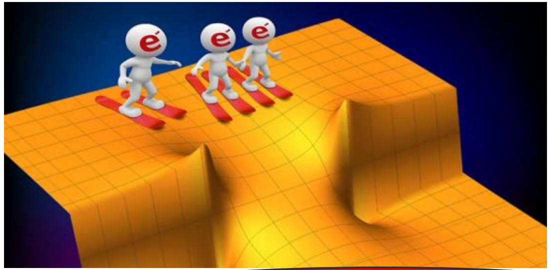
Playing with Electromagnets



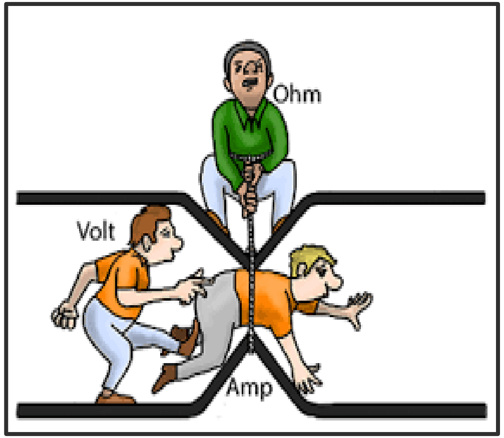
How resistance of a super conductor becomes zero?



Source: https://youtu.be/vruYFOlM1-Q



Why resistance become zero in super conductor ? What happens at atomic level ?



Superconductivity & Engineering at CERN

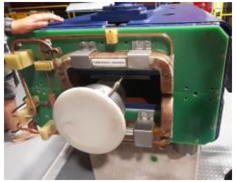
1.Powerful electromagnets bend & focus the path of charged particles in LHC.

2.The electromagnets carry currents (12,000A) to produce magnetic fields of 8.3T which is 100000 times higher than magnetic field of Earth

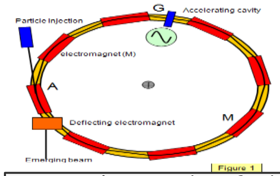
3.The electromagnets coils are made of Niobium-Titanium , a superconducting material

4.These coils are kept at very low temp (2.3k) to have no electrical resstance

5.So super conductors can maintain their electric currents indefinetly



Dipoles & Quardopoles magnets of CERN



Circular path of charged particle in LHC

Super conductors used in CERN

Useful Material & Resources

1. https://home.cern/resources/image/engineering/engineering-images-gallery
2. https://www.vedantu.com/evs/how-to-make-an-electromagnet
3. https://nationalmaglab.org/magnet-academy/try-this-at-home/making-electromagnets/
4. https://www.youtube.com/watch?v=Vpb7IQ2Ib_Y
5. https://scoollab.web.cern.ch/content/preparation-superconductivity-workshops
6. https://home.cern/science/engineering/cryogenics-low-temperatures-high-performance
7. https://javalab.org/en/conduction_2_en/
8. https://www.cryogenicsociety.org
9. doi:10.1088/1742-6596/1317/1/012203

ITW2024 Study Group 4

Diana (Canada/Bulgaria), Mahmoud (Egypt), Rinku (India), Roberto (Italy)

One way in which our thinking has changed…

- **Particle physics can be part of the high-school curriculum, as long as lessons and classroom activities are adapted to the audience**
- **The greatest achievements come from the collaboration of people with different skills**
- **Students should dare asking the big questions (What are we? Where do we come from? Where are we going?)**
- **… we now feel more confident supporting them searching for an answer!**

Highlights, snapshots, final words…