Electronic Air Cleaners

Question:

A woman rubs her feet on the carpet and gives a shock to her identical twin. If the twin also rubs her feet on the carpet before being touched, the shock will be

1. larger.
2. smaller.
3. the same size.

Observations About Air Cleaners

- Dust doesn't settle quickly on its own
- Mechanical filters gradually plug up
- Dust clings to things with static electricity
- Air cleaners could be based on static electricity

Air Resistance

- Different from buoyancy
- Opposes the relative motion of air and object
- Acts to bring both to one velocity
- Consists of a matched pair of forces:
  - The air pushes on the object
  - The object pushes on the air
  - Forces have equal magnitudes, opposite directions
- Increases with relative speed and cross section

Terminal Velocity

- A real falling object experiences two forces:
  - Weight downward
  - Air resistance upward (while dropping in still air)
- Air resistance affects descent
  - Object accelerates downward initially
  - Upward air resistance gradually increases
  - Terminal velocity occurs when net force is zero
- Small objects have small terminal velocities

Electric Charge 1

- Two types: positive & negative
- Like charges repel, opposites attract
  - Forces consist of a matched pair:
    - Each charge pushes or pulls on the other
    - Forces have equal magnitudes, opposite directions
  - Forces increase with decreasing separation
- Charge is measured in coulombs

Electric Charge 2

- Charge is conserved
- Charge is quantized
  - One fundamental charge is $1.6 \cdot 10^{-19}$ coulomb
- Charge is an intrinsic property of matter
  - Electrons are negatively charged
  - Protons are positively charged
  - Each has one fundamental charge

Net Charge

- Net charge is the sum of an object's charges
- Most objects have zero net charge (neutral)
- Neutral objects contain equal + & – charges

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Voltage

- Charge has electrostatic potential energy (EPS)
- Voltage measures the EPS per unit of charge
  - Raising the voltage of positive charge takes work
  - Lowering the voltage of negative charge takes work
- Voltage is measured in joules/coulomb or volts

Charging Objects

- Like charge separate whenever possible
  - They disperse on the outside of a conductor
  - They accumulate on an outside point or thin wire
- Charging is limited by charge escape
  - Severe repulsion leads to corona discharge
  - Charges leap onto air molecules and escape
  - Air molecules often glow during corona discharge
- If ionization occurs, a spark or arc forms

Polarizing Objects

- Nearby charges can shift an object's charges
- When negatively charged dust nears a wall,
  - the wall's positive charges move toward dust
  - the wall's negative charges move away from dust
  - the wall becomes electrically polarized
- Charged dust clings to walls and surfaces