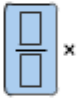
You have four identical conducting spheres: A, B, C, and D. In each scenario below, sphere A starts with a charge of +*Q*, while B, C, and D start out with no net charge, and then the spheres are touched to each other and separated in the order described. Any spheres not in contact are held very far away. For each scenario, give the final charge of sphere C as a **whole number fraction** of *Q*. For example, if you decide that the final charge of sphere C is *Q*/7, enter "1" in the numerator and "7" in the denominator.

Remember! Before each scenario begins, spheres A, B, C, and D are reset to charges of +*Q*, 0, 0, and 0 again.

Scenario 1: A and B touch and are separated, then A and C touch and are separated, then A and D touch and are separated.

$Q_C =$  $\times Q$

Scenario 2: A and B touch and are separated, then B and C touch and are separated, then C and D touch and are separated.

$Q_C =$  $\times Q$

Scenario 3: A and D touch and are separated, then D and C touch and are separated, then D and A touch and are separated, then A and B touch and are separated.

$Q_C =$  $\times Q$

A physicist has developed a device that generates a beam of alpha particles (each of which is a helium nucleus, consisting of two protons, two neutrons, and no electrons). The device ejects a steady stream of 5930 alpha particles per second.

You are testing different shielding materials for a test chamber that will house the alpha particle generator. You prepare a sheet of one potential material in an electrically neutral state, mount it on a perfectly insulating stand, and fire the alpha particle device at it for 22.3 seconds.

Afterward, you measure that the charge of the sheet is 8.21×10^{-15} coulombs. Assume that none of the alpha particles bounced back from the sheet, meaning that the alpha particles either were captured by the shielding or penetrated completely through the shielding. What percentage of the alpha particles penetrated completely through the shielding material?

Number

□ %

You venture out on a cold winter morning to warm up your vehicle. You have layers of cotton/polyester blend clothes on and from walking on carpeting you have accumulated a net negative charge. Your car is considered a neutral conductor. As you place your hand near the door handle (without touching it) what happens to the charges of your car?

- Nothing, the charges are too cold to deliver any response.
- There is a localization of negative charge near the door handle.
- Nothing, since your hand is not touching the car it cannot transfer any charge.
- There is a localization of positive charge near the door handle.

Two particles, one with charge -7.13×10^{-6} C and one with charge 4.39×10^{-6} C, are 0.0809 meters apart. What is the magnitude of the force that one particle exerts on the other?

Number

N

Two new particles, which have identical positive charge q_3, are placed the same 0.0809 meters apart, and the force between them is measured to be the same as that between the original particles. What is q_3?

Number

C

A pair of closely spaced parallel conducting plates, charged with equal and opposite electric charges, produces a uniform electric field in the region between them. In designing a cutting-edge device that will revolutionize the electronics industry, you set up such a pair of plates with a separation of 0.953 mm between them and charge them so that the direction of the electric field in their interior region is from plate A to plate B. Your idea requires that electrons, when released from rest at one of the plates, reach the other plate at the speed of 1.13% of the speed of light. (The speed of light is $c = 3.00 \times 10^8$ m/s.)

At which plate should the electrons be released?

- A
- B
- Either
- Cannot be determined

What must the strength of the electric field be?

Number

[ ] N/C

A nucleus of the boron-11 isotope consists of five protons and six neutrons. A particular ionized atom of boron-11, whose mass is 1.83×10^{-26} kg, lacks 2 electrons from its neutral state. Find the magnitude and direction of the electric field that will levitate this ion, exactly balancing its weight. Take $g = 9.81$ m/s^2.

Magnitude:

Number

N/C

Direction:

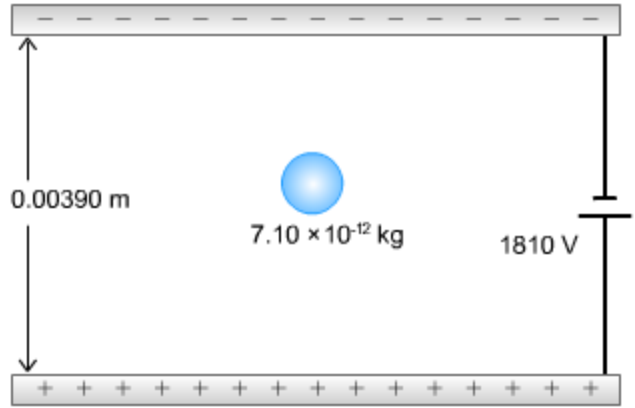
- Horizontal
- Upward
- Downward
- Cannot be determined

A small ball of mass, $m = 7.10 \times 10^{-12}$ kg, has acquired an excess charge. The ball is then placed between two parallel plates spaced $x = 0.00390$ m which have a potential difference of $V = 1810$ V applied across them. In this configuration the ball appears to be motionless or floating in between the plates. What is the overall charge on the ball? Calculate the number of electrons, n_e, the ball has either gained or lost. The acceleration due to gravity is $g = 9.81$ m/s^2, and the elementary unit of charge is $e = 1.60 \times 10^{-19}$ C.

The ball is charged:

- negatively
- neutrally
- positively

$n_e =$ Number



An electron and a proton are fixed at a separation distance of 881 nm. Find the magnitude and direction of the electric field at their midpoint.

Magnitude:

Number

N/C

Direction:

- Toward the electron
- Cannot be determined
- Toward the proton
- Perpendicular to the line of the particles

Two test charges are located in the x–y plane. If $q_1 = -4.25$ nC and is located at x = 0.00 m, y = 1.080 m and the second test charge has magnitude of $q_2 = 3.40$ nC and is located at x = 1.50 m, y = 0.550 m,

calculate the x and y components, E_x and E_y, of the electric field, $\vec{E}$, in component form at the origin, (0,0). The Coulomb Force constant is $1/(4\pi\epsilon_0) = 8.99 \times 10^9$ N· m^2/C^2.

$E_x =$ Number [ ] N/C

$E_y =$ Number [ ] N/C

A thin metallic spherical shell of radius 45.1 cm has a total charge of 7.45 μC uniformly distributed on it. At the center of the shell is placed a point charge of 4.53 μC. What is the electric field at a distance of 11.9 cm from the center of the spherical shell?

$E =$ Number [ ] N/C

- outward
- inward
- directionless