Static Electricity (Part I) pre-class assignment

Due: 11:59pm on Thursday, July 14, 2022

You will receive no credit for items you complete after the assignment is due. Grading Policy

The Sign of the Charge

Part A

A glass marble is rubbed against a piece of silk. As a result the piece of fabric acquires extra electrons. What happens to the glass marble?

Check all that apply.

Hint 1. How to approach the problem

The key concept in this problem is the fact that electric charge is never *created*, but it is simply *transferred* from one object to another. Therefore, if the piece of silk acquired extra electrons after the glass marble was rubbed against it, these electrons must have been taken from the glass marble, leaving the marble with a deficiency of electrons. Since electrons have a negative charge, this should give you an indication of the type of electric charge the marble has after the transfer.

Hint 2. Electrostatic interaction between charges

Two like charges, either both positive or both negative, repel each other. A positive and a negative charge attract each other.

ANSWER:

- [x] The marble has lost the same number of electrons acquired by the piece of silk.
- [ ] The marble has acquired the same number of electrons acquired by the piece of silk.
- [ ] The marble acquires a positive charge and repels the piece of silk.
- [x] The marble acquires a positive charge and attracts the piece of silk.
- [ ] The marble acquires a negative charge and attracts the piece of silk.
- [ ] The marble acquires a negative charge and repels the piece of silk.

Correct

This was a simple example of electrostatic interactions. When you rub a piece of glass against a piece of silk, the glass acquires a positive charge and the silk acquires a negative charge because some electrons were transferred from the glass to the silk in the rubbing process. The silk acquires the same net charge as the glass, but with the opposite sign. This charge distribution causes the silk and the glass marble to be attracted to one another.

Part B

Two glass marbles (1 and 2), each supported by a nylon thread, are rubbed against a piece of silk and then are placed near a third glass marble (3), also supported by a similar thread. Assuming that marble 3 has not been in contact with the piece of fabric, which of the following statements best describes the situation when the three marbles are brought together?

To keep things simple in this Tutorial, we will ignore the effects of polarization and just focus on the overall charge of each object.

Hint 1. How to approach the problem

As was stated in the previous part, glass marbles acquire a positive charge when they are rubbed against a piece of silk. Therefore, marbles 1 and 2 have both the same charge and repel each other. What charge does marble 3 have?

Hint 2. Charged and uncharged objects

When an object has an excess of electrons, it has a *negative* net charge. When an object has a deficiency of electrons, it has a *positive* net charge. When an object has the same number of electrons and protons, then it has a zero net charge and it is said to be *neutral*. Typically, uncharged or neutral objects do not interact with electrically charged objects. (Interactions between neutral and charged objects are observed when polarization occurs; however, this phenomenon is ignored in this problem.)

Most of the objects in everyday life are neutral; they acquire a nonzero net charge only if subjected to processes that involve a transfer of electrons. Rubbing a glass marble with a piece of silk is an example of such a process. Thus, both marbles 1 and 2 have a nonzero electric charge. Marble 3, which hasn't been in contact with the fabric, remains neutral.

ANSWER:

- ○ Marbles 1 and 2 attract each other, but no interaction occurs with marble 3.
- ○ Both marbles 1 and 2 attract marble 3.
- ○ The three marbles will repel each other.
- ◉ Marbles 1 and 2 repel each other, but no interaction occurs with marble 3.

Correct

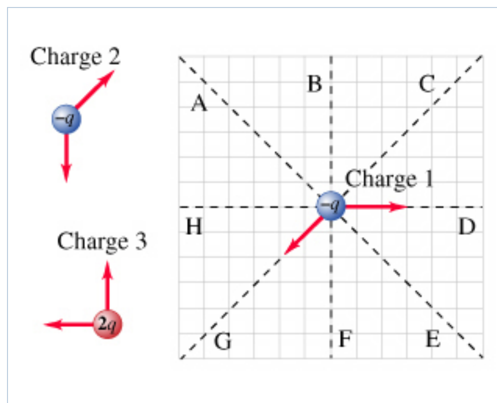
As you have seen here, electrostatic interactions occur between charged objects. Objects with like charges repel each other, whereas objects with opposite charges attract each other.

Placing Charges Conceptual Question

Below are free-body diagrams for three electric charges that lie in the same plane. Their relative positions are unknown.

Part A

Along which of the lines (A to H) in the figure should charge 2 be placed so that the free-body diagrams of charge 1 and charge 2 are consistent?



Hint 1. How to approach the problem

Newton's 3rd law states that the forces exerted by a pair of objects on each other are always equal in magnitude and opposite in direction. Identifying the forces that correspond to 3rd-law pairs in the free-body diagrams will enable you to place the particles in their proper relative position.

Hint 2. Placing charge 2

The two forces acting on charge 2 correspond to the forces exerted on it by charge 1 and charge 3. This means that one of these forces must pair with a force on charge 1 of equal magnitude and opposite direction and the other must pair with a force on charge 3 of equal magnitude and opposite direction. Also note that charge 2 should be repelled by charge 1, since both are negative. Therefore, the vector that represents the force of charge 1 on charge 2 must point away from charge 1. This information is all you need to place charge 2 in its correct position.

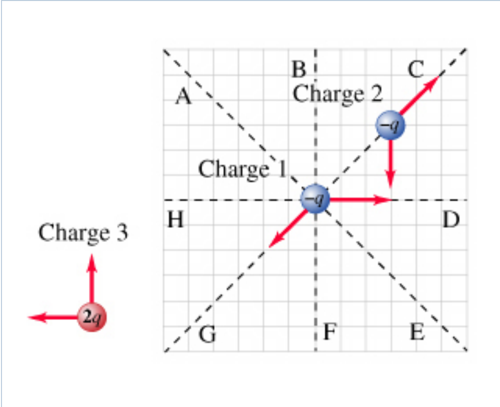
ANSWER:

C

Correct

Part B

Along which of the lines (A to H) in the figure should charge 3 be placed so that the free-body diagrams of charge 1, charge 2, and charge 3 are consistent?



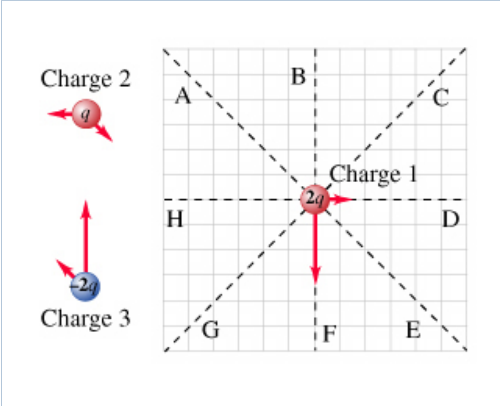
ANSWER:

D

Correct

Part C

Along which of the lines (A to H) in the figure should charge 2 be placed so that the free-body diagrams of charge 1 and charge 2 are consistent?



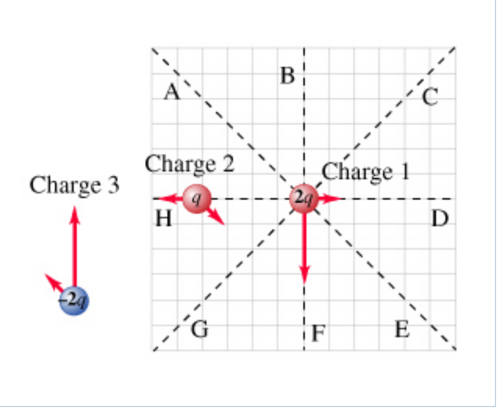
ANSWER:

H

Correct

Part D

Along which lines (A to H) in the figure should charge 3 be placed so that the free-body diagrams of charge 1, charge 2, and charge 3 are consistent?



ANSWER:

F

Correct

Charged Aluminum Spheres

Two small aluminum spheres, each of mass 0.0250 kilograms, are separated by 80.0 centimeters.

Part A

How many electrons does each sphere contain? (The atomic mass of aluminum is 26.982 grams per mole, and its atomic number is 13.)

Express your answer numerically.

Hint 1. The definition of mole and atomic number

In one mole (mol) of any material, there are approximately 6.023×10^{23} atoms present. The number of atoms per mole is called *Avogadro's number*. The atomic number of an element is the number of protons (and therefore also the number of electrons) in an atom of that element.

Hint 2. How many electrons per mole of aluminum?

How many electrons are there in a mole of aluminum?

Express your answer numerically.

ANSWER:

7.83×10^{24} $\mathrm{electrons/mol}$

Hint 3. How many electrons per kilogram of aluminum?

How many electrons are in a kilogram of aluminum?

Express your answer numerically.

ANSWER:

2.90×10^{26} $\mathrm{electrons/kg}$

ANSWER:

7.25×10^{24} electrons

Correct

Part B

How many electrons would have to be removed from one sphere and added to the other to cause an attractive force between the spheres of magnitude 1.00×10^4 N (roughly one ton)? Assume that the spheres may be treated as point charges.

Express your answer numerically.

Hint 1. How to approach the problem

Use Coulomb's law to find the charge needed to produce the given force. Then use the charge of an electron to determine the number of electrons necessary to produce the calculated charge.

Hint 2. Find the relationship between the charges of the spheres

Assume that after some electrons have been removed from it, the first sphere ends up with a net charge of q_1. What would be the charge on the other sphere, q_2, after these extra electrons are added to it?

Express your answer in terms of q_1 and any necessary constants.

ANSWER:

q_2 = $-q_1$ C

ANSWER:

5.27×10^{15} electrons

Correct

Part C

What fraction of all the electrons in one of the spheres does this represent?

Express your answer numerically.

ANSWER:

7.26×10^{-10}

Correct

A Test Charge Determines Charge on Insulating and Conducting Balls

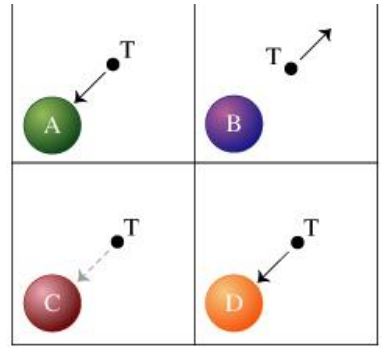
Learning Goal:
To understand the electric force between charged and uncharged conductors and insulators.

When a test charge is brought near a charged object, we know from Coulomb's law that it will experience a net force (either attractive or repulsive, depending on the nature of the object's charge). A test charge may also experience an electric force when brought near a *neutral* object. Any attraction of a neutral insulator or neutral conductor to a test charge must occur through induced polarization. In an insulator, the electrons are bound to their molecules. Though they cannot move freely throughout the insulator, they can shift slightly, creating a rather weak net attraction to a test charge that is brought close to the insulator's surface. In a conductor, free electrons will accumulate on the surface of the conductor nearest the positive test charge. This will create a strong attractive force if the test charge is placed very close to the conductor's surface.

Consider three plastic balls (A, B, and C), each carrying a uniformly distributed charge equal to either

$+Q$, $-Q$ or zero, and an uncharged copper ball (D). A positive test charge (T) experiences the forces shown in the figure when brought very near to the individual balls. The test charge T is strongly attracted to A, strongly repelled from B, *weakly* attracted to C, and strongly attracted to D.

Assume throughout this problem that the balls are brought very close together.



Part A

What is the nature of the force between balls A and B?

Hint 1. What is the net charge on ball A?

Since the test charge is positively charged, and there is a strongly attractive force between ball A and the test charge, what must be the nature of the net charge of ball A?

ANSWER:

- positive
- negative
- zero

Hint 2. What is the net charge on ball B?

Since the test charge is positively charged, and there is a strongly repulsive force between ball B and the test charge, what must be the nature of the net charge of ball B?

ANSWER:

- positive
- negative
- zero

ANSWER:

- strongly attractive
- strongly repulsive
- weakly attractive
- neither attractive nor repulsive

Correct

Part B

What is the nature of the force between balls A and C?

Hint 1. What is the charge on ball C?

Recall that ball C is composed of insulating material, which means that it can be polarized, but the charges inside are otherwise not free to move around inside the ball. Since the test charge experiences only a weak force due to ball C, if we compare to ball A we conclude that the charge on ball

C must be

ANSWER:

- ○ $+Q$
- ○ $-Q$
- ◉ zero

ANSWER:

- ○ strongly attractive
- ○ strongly repulsive
- ◉ weakly attractive
- ○ neither attractive nor repulsive

Correct

Recall that ball C is composed of insulating material, which can be polarized in the presence of an external charged object such as ball A. Once polarized, there will be a weak attraction between balls A and C, because the positive and negative charges in ball C are at slightly different average distances from ball A. If ball C had a very small negative charge the test charge would have the same response (weakly attractive) but it would have a weak repulsive interaction with ball A. However, a smaller negative charge is not one of the options.

Part C

What is the nature of the force between balls A and D?

Hint 1. What are the surface charges on ball D?

Recall that copper is a conductor, in which charges can freely flow. When ball D is brought close to ball A, what will be the nature of the surface charge density on the side of ball D that is closest to ball A?

ANSWER:

- ◉ positive
- ○ negative
- ○ zero

ANSWER:

- ◉ attractive
- ○ repulsive
- ○ neither attractive nor repulsive

Correct

Part D

What is the nature of the force between balls D and C?

ANSWER:

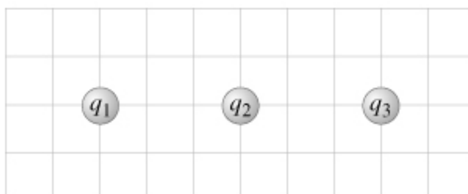
- attractive
- repulsive
- neither attractive nor repulsive

Correct

Because the test charge T is neither strongly attracted to nor repelled from ball C, ball C must have zero net charge. Since ball D also has zero net charge, there will not be any force between the two balls.

Electric Force of Three Collinear Points Ranking Task

In the diagram below, there are three collinear point charges: q_1, q_2, and q_3. The distance between q_1 and q_2 is the same as that between q_2 and q_3. You will be asked to rank the Coulomb force on q_1 due to q_2 and q_3.



Part A

Rank the six combinations of electric charges on the basis of the electric force acting on q_1. Define forces pointing to the right as positive and forces pointing to the left as negative. Rank positive forces as larger than negative forces.

Rank from largest to smallest, placing the largest on the left and the smallest on the right. To rank items as equivalent, overlap them.

Hint 1. Definition of electric force

The electric force between a pair of charges is proportional to the product of the charge magnitudes (q_1 and q_2) and inversely proportional to the square of the distance (r) between them. This result is summarized mathematically by Coulomb's law:

$$F = \frac{kq_1q_2}{r^2}.$$

The direction of the force is such that opposite charges attract and like charges repel each other.

Hint 2. Determine the net force for one combination of charges

For combination of charges ($q_1 = 1\ \mathrm{nC}$, $q_2 = -1\ \mathrm{nC}$, $q_3 = 1\ \mathrm{nC}$), what is the direction of the net electric force on q_1 due to the other charges?

Hint 1. Find the direction of the force on q_1 due to q_2

For combination of charges ($q_1 = 1\ \mathrm{nC}$, $q_2 = -1\ \mathrm{nC}$, $q_3 = 1\ \mathrm{nC}$), what is the direction of the electric force on q_1 due to q_2? Remember that like charges repel each other and opposite charges attract each other.

ANSWER:

- (selected) to the right
- to the left
- There is no force in any direction.

Hint 2. Determine the direction of the force on charge q_1 due to q_3

For combination of charges ($q_1 = 1 \text{ nC}, q_2 = -1 \text{ nC}, q_3 = 1 \text{ nC}$), what is the direction of the electric force on q_1 due to q_3?

ANSWER:

- to the right.
- (selected) to the left
- There is no force.

Hint 3. Find the magnitude of the net force on q_1

In combination of charges ($q_1 = 1 \text{ nC}, q_2 = -\ 1 \text{ nC}, q_3 = 1 \text{ nC}$), which of the two forces on q_1, that from q_2 or that from q_3, is larger in magnitude?

ANSWER:

- (selected) the force from q_2
- the force from q_3
- Neither; they are equal in magnitude.

ANSWER:

- (selected) to the right
- to the left
- There is no net force.

ANSWER:

Reset Help

largest

$q_1 = +1\,\mathrm{nC}$, $q_2 = -1\,\mathrm{nC}$, $q_3 = -1\,\mathrm{nC}$

$q_1 = -1\,\mathrm{nC}$, $q_2 = +1\mathrm{nC}$, $q_3 = +1\mathrm{nC}$

$q_1 = +1\,\mathrm{nC}$, $q_2 = -1\,\mathrm{nC}$, $q_3 = +1\,\mathrm{nC}$

$q_1 = +1\,\mathrm{nC}$, $q_2 = +1\,\mathrm{nC}$, $q_3 = -1\,\mathrm{nC}$

$q_1 = -1\,\mathrm{nC}$, $q_2 = -1\,\mathrm{nC}$, $q_3 = -1\,\mathrm{nC}$

$q_1 = +1\,\mathrm{nC}$, $q_2 = +1\,\mathrm{nC}$, $q_3 = +1\,\mathrm{nC}$

smallest

☐ The correct ranking cannot be determined.

Correct

Forces in a Three-Charge System

Coulomb's law for the magnitude of the force F between two particles with charges Q and Q' separated by a distance d is

$$|F| = K\frac{|QQ'|}{d^2},$$

where $K = \frac{1}{4\pi\epsilon_0}$, and $\epsilon_0 = 8.854\times10^{-12}\ \mathrm{C^2/(N\cdot m^2)}$ is the permittivity of free space.

Consider two point charges located on the *x* axis: one charge, q_1 = -16.5 nC , is located at x_1 = -1.705 m ; the second charge, q_2 = 38.0 nC , is at the origin $(x = 0.0000)$.

Part A

What is the net force exerted by these two charges on a third charge q_3 = 53.0 nC placed between q_1 and q_2 at x_3 = -1.065 m ?

Your answer may be positive or negative, depending on the direction of the force.

Express your answer numerically in newtons to three significant figures.

Hint 1. How to approach the problem

First, draw a diagram of the system. Next, find the magnitudes of the forces exerted on the third charge by each of the other charges. Then determine the direction of each of these forces. Finally, use vector addition to find the net force on the third charge.

Hint 2. Calculate the force on the third charge by the first charge

Calculate the magnitude $|F_1|$ of the force that the first charge exerts on the third charge.

Express your answer numerically in newtons to three significant figures.

Hint 1. Coulomb's law

Coulomb's law for the magnitude of the force F between two particles with charges q_1 and q_2 separated by a distance d is

$$|F| = \frac{1}{4\pi\epsilon_0}\frac{|q_1q_2|}{d^2},$$

where $\epsilon_0 = 8.854 \times 10^{-12}\ \mathrm{C^2/(N \cdot m^2)}$ is the permittivity of free space.

ANSWER:

$|F_1|$ = 1.92×10^{-5} N

Hint 3. Calculate the force on the third charge by the second charge

Calculate the magnitude $|F_2|$ of the force that the second charge exerts on the third charge.

Express your answer numerically in newtons to three significant figures.

Hint 1. Coulomb's law

Coulomb's law for the magnitude of the force F between two particles with charges q_1 and q_2 separated by a distance d is

$$|F| = \frac{1}{4\pi\epsilon_0}\frac{|q_1 q_2|}{d^2},$$

where $\epsilon_0 = 8.854 \times 10^{-12}\ \mathrm{C^2/(N \cdot m^2)}$ is the permittivity of free space.

ANSWER:

$|F_2|$ = 1.60×10^{-5} N

Hint 4. What are the directions of the forces?

In what directions do the forces on the third charge point in our system?
Note that since all the forces are in the *x* direction, you can drop the vector notation. Let F_1 be the force on q_3 due to q_1, and let F_2 be the force on q_3 due to q_2.

ANSWER:

- ○ F_1 and F_2 both point along the $+$ *x* direction.
- ◉ F_1 and F_2 both point along the $-$ *x* direction.
- ○ F_1 points along the $+$ *x* direction and F_2 points along the $-$ *x* direction.
- ○ F_1 points along the $-$ *x* direction and F_2 points along the $+$ *x* direction.

Hint 5. Relating the net force and the forces between pairs of charges

Since all the forces are in the *x* direction, you can drop the vector notation. Let F_{net} be the net force on q_3. Similarly, let F_1 be the force on q_3 due to q_1, and F_2 be the force on q_3 due to q_2. Then $F_{\mathrm{net}} = F_1 + F_2$.

ANSWER:

Force on q_3 = -3.51×10^{-5} N

Correct

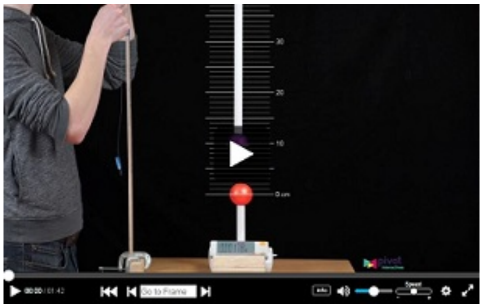
Direct Measurement Video: Electric Force vs. Distance

We will use a video to analyze the dependence of the magnitude of the Coulomb force between two electrically-charged spheres on the distance between the centers of the spheres. The electrical interaction is one of the fundamental forces of nature and acts between any pair of charged objects, therefore it is important to understand how precisely the separation distance affects the corresponding force between them.

Specifically, we will:

1. Study conceptually the nature of electric charge and force
2. Take measurements of the force exerted between two electrically-charged spheres as the distance between them is varied
3. Determine graphically the relationship between electric force and distance

Click play to watch the video below (text description of video) in its entirety, then go back to the beginning. Carefully observe the charging process. The metal disc, attached to a small insulating drinking cup is called an electrophorus. It is used to charge both spheres which are initially neutral. Assume that the electrophorus is charged *positively* before it touches each sphere.



Part A

Before you start taking measurements though, we'll first make sure you understand the underlying concepts involved. By what method is each of the spheres charged?

Select the best answer from the choices provided.

ANSWER:

- ○ induction
- ◉ conduction
- ○ rubbing
- ○ electrophorusization

Correct

The fact that the spheres can be charged by contact means that, just like the electrophorus, the spheres—or at least their surfaces—are made of a conducting material.

Part B

What happens as the positively-charged electrophorus touches the orange sphere?

Select the best answer from the choices provided.

Hint 1. Which particles can move?

The only particles that are able to move in this situation are electrons.

Hint 2. How do electrons interact?

Excessive electrons on the electrophorus repel each other.

ANSWER:

- the protons move from the electrophorus to the sphere.
- the protons move from the sphere to the electrophorus.
- the electrons move from the electrophorus to the sphere.
- (selected) the electrons move from the sphere to the electrophorus.
- the protons move to the electrophorus while the electrons move to the sphere.

Correct

Since the electrons are the mobile charge carriers, they will be the particles that are transferred. In this case, since the electrophorus is positively-charged, electrons from the sphere will be attracted to the electrophorus and thus transfer there.

Part C

Let us make sure that you can see the reading of the electronic balance clearly on your screen. What is the reading of the scale at the very first moment when the vertical “ruler” first appears on the screen? Use the “pause” and the “frame-by-frame-advance” buttons to navigate to that moment in the video.

Select the best answer from the choices provided.

ANSWER:

- $0.000031\ \mathrm{N}$
- (selected) $0.00031\ \mathrm{N}$
- $3.1\ \mathrm{N}$
- $31\ \mathrm{N}$

Correct

Note that at this point the scale reading is a bit high because, in addition to a force from the purple sphere, the orange sphere also experiences a force from the nearby electrophorus. As the electrophorus is moved away, the scale reading will go down.

Part D

Now let us see whether the ruler is working for you. What is the initial distance between the centers of the spheres (that is, at the moment when the ruler first appears on the screen)? Use the white "equators" on the spheres for the best estimate of the distance.

Express your answer in centimeters and use two significant figures.

Hint 1. How to approach the problem

Look at the positions of the white bands along the "equators" of the spheres. The orange sphere’s "equator" is at zero—what about the purple one?

ANSWER:

32 cm

Correct

Part E

We will now try to determine how the force between the spheres depends on the distance between them. A reasonable assumption is that the force increases as the distance decreases—but exactly how?

We will further assume that the force is described by the equation

$$F = \frac{B}{d^n}$$

where F is the magnitude of the force, B is a constant that depends on the charges of the spheres and the system of units, d is the distance between the centers of the spheres, and n is the power that will attempt to find using the measurements from the video. Which graph would be a straight line with the slope equal to constant B if the magnitude of the force between the spheres is described by the equation above?

Select the best answer from the choices provided.

Hint 1. How to approach the problem

If $y = mx$, then the graph y vs. x is a straight line with a slope of m. If F corresponds to y, then what corresponds to x?

ANSWER:

- ○ F vs. d
- ○ F vs. n
- ○ F vs. $1/d$
- ◉ F vs. $1/d^n$

Correct

In this case, F and d are not linearly related to each other, so a plot of F vs. d would not be linear. However, the technique of taking this kind of relationship, and "linearizing" it by relating not F and d, but rather F and $1/d$, is an important procedure in many fields (especially physics).

Part F

We will assume that, since the major laws of the Universe tend to have elegant and simple mathematical form, the exponent n is a small integer number: either 1 or 2 or 3.

Create a table with the following columns: F, d, $1/d$, $1/d^2$, $1/d^3$. The table should have at least five rows (that is, at least five values of d and the corresponding values of F). Consider only the values of $d > 8\ \mathrm{cm}$. Observe the moments in the video when the purple sphere is stopped, and record the values of F and d for those moments. Use three significant figures for both distance and force.

Just to get you started: your first data point should be 31.9 cm and 0.00016 N. After the table is filled, create the graphs F vs. $1/d$; F vs. $1/d^2$ and F vs. $1/d^3$. One of these graphs should be a lot more "linear" that the other two, showing that the magnitude of the force is inversely proportional to the distance raised to a certain power. Determine the value of n.

Express your answer as an integer.

ANSWER:

n = 2

Correct

Another, more elegant way to determine the value of n without making an initial assumption that it's either 1 or 2 or 3 is to take the natural logarithm of both sides of the expression

$$F = \frac{B}{d^n}$$

which would give

$$\ln F = \ln B - n \ln d$$

If you plot $\ln F$ vs. $\ln d$, you should obtain a straight line with the slope equal to $(-n)$ and a y-intercept equal to $\ln B$. Your instructor may ask you to create such a graph based on your data—see how close your slope gets to 2!

Part G

Now let's focus on the graph F vs. $1/d^2$. Let us add a few more data points now: Include two or three points for which $d < 8\ \mathrm{cm}$. You would notice that the data points deviate from the linear pattern more and more for the larger values of $1/d^2$, that is, for the *smaller* values of d.

For the smaller values of d, the measured values of d are ______________ than those predicted by the linear pattern.

Select the best answer from the choices provided.

Hint 1. Analyzing the graph

Are the data points for the larger values of $1/d^2$ above or below the trend line?

ANSWER:

- ○ greater
- ◉ smaller

Correct

The discrepancy should not be surprising. The mutual repulsion of the spheres causes the redistribution of charges on them, known as *polarization*. As the spheres are brought closer together, the effects of polarization become greater and greater, causing the deviation from the linear pattern. When the charge distribution on each sphere is far from spherically symmetrical, the effective distance between the charge distributions is *greater* than that between the geometric centers of the spheres, causing the value of F to fall below our predictions.

In general, the pattern that we have discovered is only applicable to either charged particles (objects that are much smaller than the distance between them) or spherically symmetrical charge distributions.

Part H

In reality, the magnitude of the force between the two spherically symmetrical charge distributions is described by *Coulomb's law*

$$F = \frac{kq_1q_2}{d^2}$$

where k is a constant equal to $8.99 \times 10^9 \ \mathrm{Nm^2/C^2}$, q_1 and q_2 are the magnitudes of the charges, and d is the distance between the centers of the spheres.

Assuming that both spheres have equal charges, estimate the charge on each sphere, using the first data point in your table. Remember that, for the calculations to be correct, both force and distance must be expressed in their respective SI units.

Express your answer in nanoCoulombs using two significant figures.

Hint 1. Unit conversions

Note that $1 \ \mathrm{nC} = 10^{-9} \ \mathrm{C}$.

Hint 2. The values for the first data point

The first suggested data point was 31.9 cm and 0.00016 N.

ANSWER:

q = 42.0 nC

Correct

In another DMV-based activity, you will be able to verify (or may have already verified!) that the Coulomb force between two charges is, indeed, directly proportional to the product of their magnitudes.

Coulomb's law is probably not the first inverse-square law that you have encountered. Newton's law of universal gravity, which describes the force between two spherical masses, has a very similar form:

$$F_g = \frac{Gm_1m_2}{d^2}$$

where G is the universal gravitational constant, m_1 and m_2 are the masses, and d is the distances between their centers.

Score Summary:

Your score on this assignment is 91.7%.
You received 91.67 out of a possible total of 100 points.