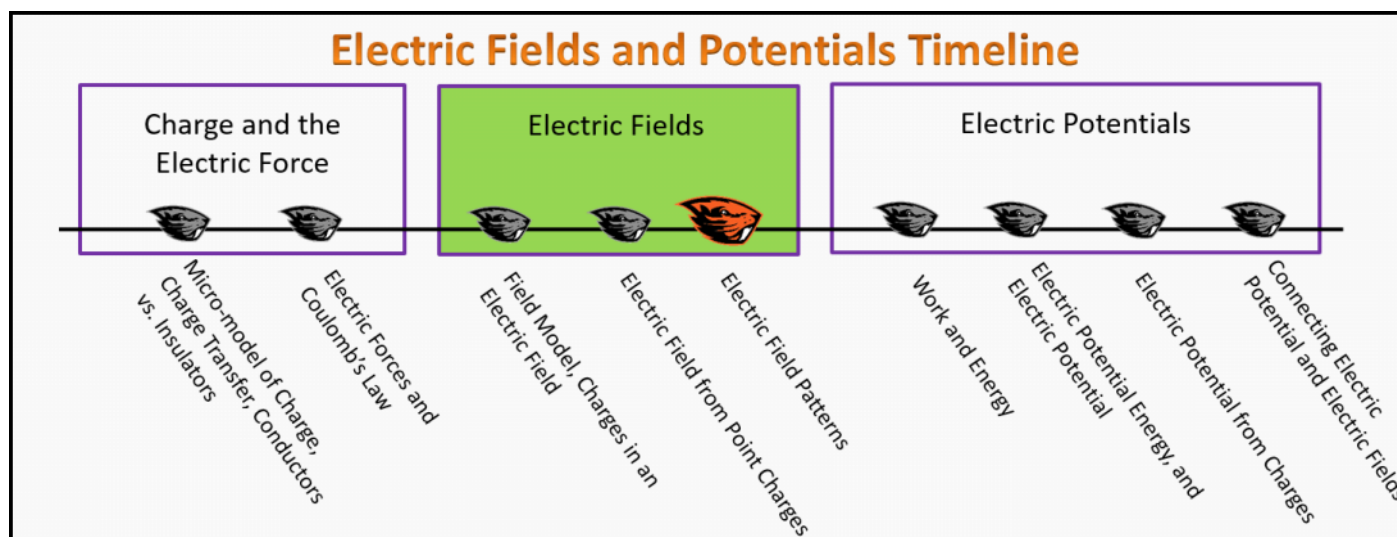


Electric Fields

Foundation Stage (EF.2.L3)

Lecture 3 Electric Field Patterns



Textbook Chapters (* Calculus version)

- **BoxSand** :: KC videos ([Electric Fields](#))
- **Knight** (College Physics : A strategic approach 3rd) :: 20.4 ; 20.5
- ***Knight** (Physics for Scientists and Engineers 4th) :: 22.5
- **Giancoli** (Physics Principles with Applications 7th) :: 16-7

Warm up

EF.2.L3-1:

Description: Given forces in the mathematical representation, calculate acceleration.

Learning Objectives: [?] - Can you identify the objectives from the previous lecture, and this lecture, that this question is relevant to?

Problem Statement: Three forces act on an object of mass 2 kg: $\vec{F}^1 = \langle 0,3 \rangle N$; $\vec{F}^2 = \langle 3, -6 \rangle N$; $\vec{F}^3 = \langle -1,2 \rangle N$. Calculate the acceleration of the object.

Selected Learning Objectives

1. Coming soon to a lecture template near you.

Key Terms

- Unit vector
- Charge distribution
- Continuous charge distribution

Key Equations

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Key Concepts

- Coming soon to a lecture template near you.

Questions

Act I: Rules and Regulations

EF.2.L3-2:

Description: Scaffolded question calculating the electric field from a single point charge. (1 minute + 2 minutes + 1 minute + 2 minutes + 1 minute + 4 minutes + 4 minutes + 3 minutes + 3 minutes + 2 minutes)

Learning Objectives: [?]

Problem Statement: Where can Electric field lines start from? (Assume statics)

(a) Where can Electric field lines start from?
(Assume statics)

- (1) Anywhere
- (2) Negative Charges

(b) Where can Electric field lines end at?
(Assume statics)

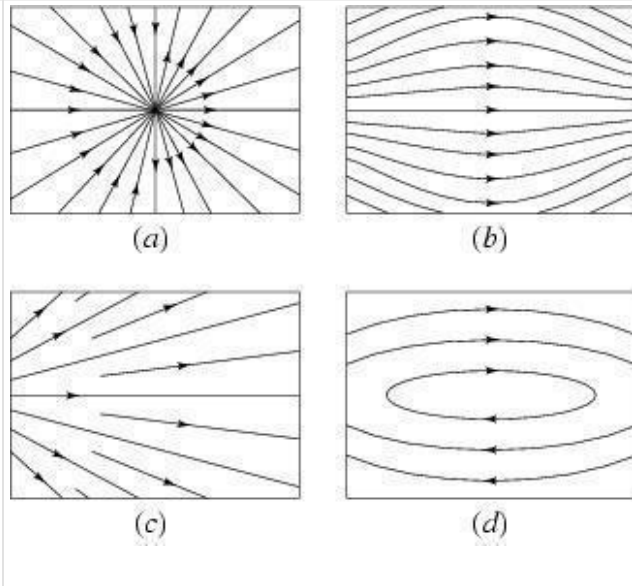
- (1) Anywhere
- (2) Negative Charges

(3) Positive Charges
(4) Infinity

(3) Positive Charges
(4) Infinity

(c) Consider the four field patterns shown below. Assuming there are no charges in the regions shown, which of the patterns represent(s) a possible electrostatic field?

- (1) A
- (2) B
- (3) C
- (4) D



EF.2.L3-3:

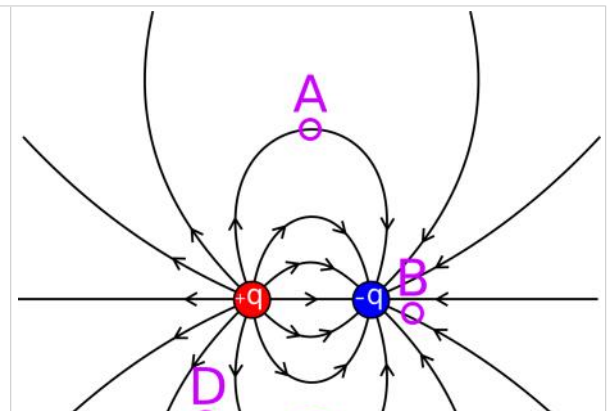
Description: Scaffolded question calculating the electric field from a single point charge. (1 minute + 2 minutes + 1 minute + 2 minutes + 1 minute + 4 minutes + 4 minutes + 3 minutes + 3 minutes + 2 minutes)

Learning Objectives: [?]

Problem Statement: Consider an electric field pattern shown below.

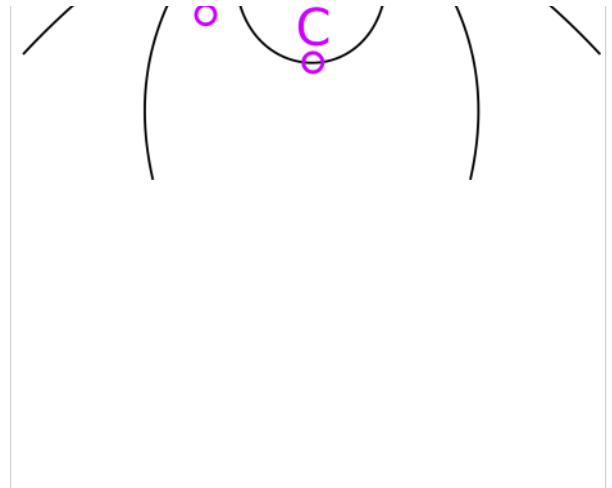
(a) Suppose a negatively charged particle is released from rest at the location labeled **A**. After release, the particle moves

- (1) along the same direction as the field line.
- (2) along the field line, but in the opposite direction.
- (3) straight towards the negatively charged particle.
- (4) straight towards the positively charged particle.
- (5) along some other trajectory.



(b) At what labeled location, **A** through **D**, would a test charge feel the largest force?

- (1) A
- (2) B
- (3) C
- (4) D



EF.2.L3-4:

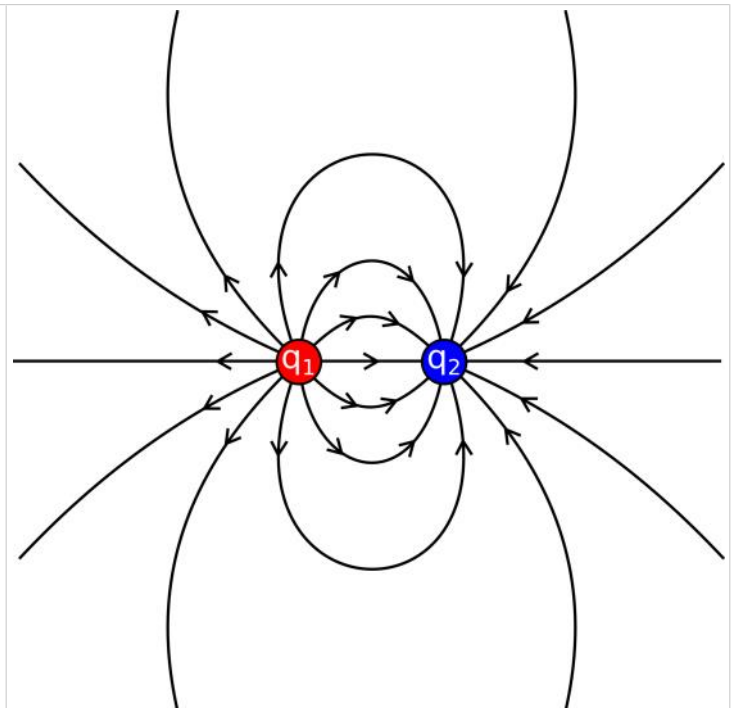
Description: Scaffolded question calculating the electric field from a single point charge. (1 minute + 2 minutes + 1 minute + 2 minutes + 1 minute + 4 minutes + 4 minutes + 3 minutes + 3 minutes + 2 minutes)

Learning Objectives: [?]

Problem Statement: Consider the charge distributions and their electric field shown below.

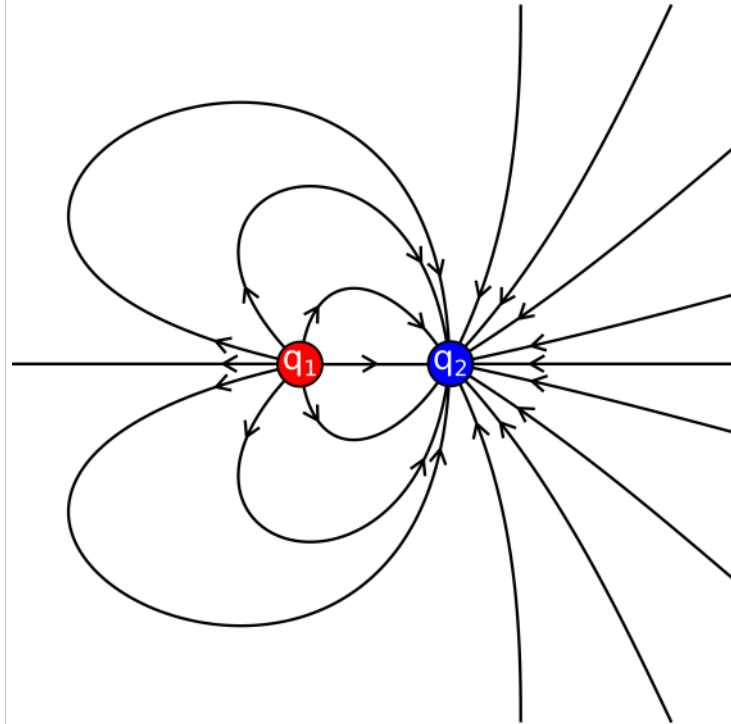
(a) The charge q_1 on the left is $q_1 = q$. What is the sign and magnitude of the charge q_2 on the right?

- (1) q
- (2) $-q$
- (3) $2q$
- (4) $-2q$
- (5) $q/2$
- (6) $-q/2$



(b) The charge q_1 on the left is $q_1 = q$. What is the sign and magnitude of the charge q_2 on the right?

- (1) q
- (2) $-q$
- (3) $2q$
- (4) $-2q$
- (5) $q/2$
- (6) $-q/2$



Act II: Symmetries

EF.2.L3-5:

Description: Calculate electric field from 4 point charges with symmetry. (4 minutes)

Learning Objectives: [?]

Problem Statement: Shown below are three charge distributions and their corresponding electric field patterns. Match each distribution of charge to the electric field pattern it produces.

IMG

EF.2.L3-6:

Description: Scaffolded question calculating the electric field from three point charges with symmetry. (4 minutes + 1 minute + 2 minutes + 1 minute + 2 minutes + 1 minute + 4 minutes + 4 minutes + 3 minutes + 3 minutes + 2 minutes)

Learning Objectives: [?]

Problem Statement: A hollow spherical shell of radius R has charge uniformly distributed across its 3-D surface. What direction is the electric field at the center inside the shell?

(1) Point's radially outwards towards the surface.	Maybe IMG
(2) Points' radially inwards away from the surface.	
(3) Left	
(4) Right	
(5) Up	
(6) Down	
(7) Zero	

EF.2.L3-7:

Description: Scaffolded question calculating the electric field from three point charges with symmetry. (4 minutes + 1 minute + 2 minutes + 1 minute + 2 minutes + 1 minute + 4 minutes + 4 minutes + 3 minutes + 3 minutes + 2 minutes)

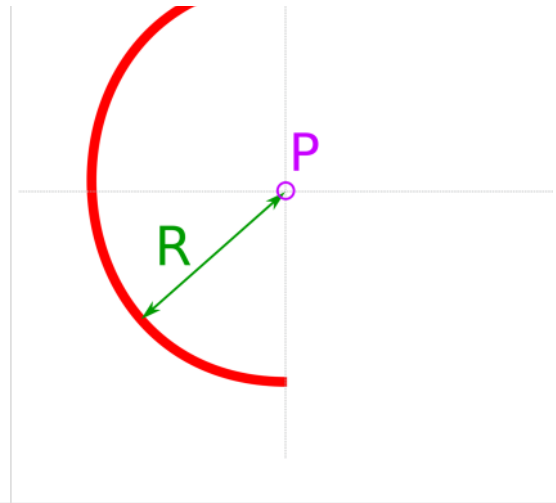
Learning Objectives: [?]

Problem Statement: A thin half-circular ring with radius R has charge uniformly distributed across its 2-D line.

(a) What direction is the electric field at the center, location P ?

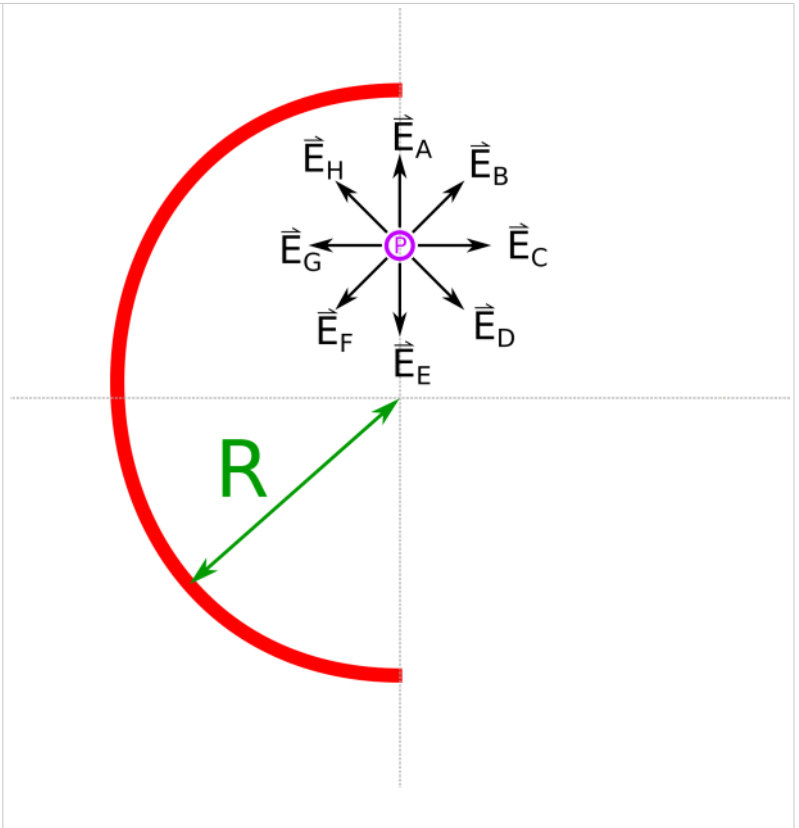


- (1) Left
- (2) Right
- (3) Up
- (4) Down
- (5) Zero



(b) What direction is the electric field a bit off the center, location **P**?

- (1) A
- (2) B
- (3) C
- (4) D
- (5) E
- (6) F
- (7) G
- (8) H



EF.2.L3-8:

Description: Scaffolded question calculating the electric field from three point charges with symmetry. (4 minutes + 1 minute + 2 minutes + 1 minute + 2 minutes + 1 minute + 4 minutes + 4 minutes + 3 minutes + 3 minutes + 2 minutes)

Learning Objectives: [?]

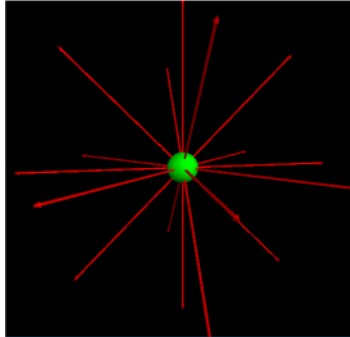
Problem Statement: Below is a perspective view of the electric field line representation of a point charge, infinite line of uniform charge, and an infinite sheet of uniform charge. Match these electric fields with their dependence on the distance r from the charge.

(1) Independent of r

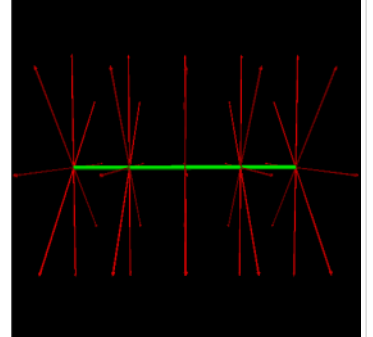
(2) like $1/r$

(3) like $1/r^2$

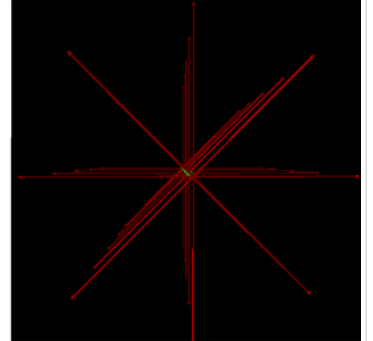
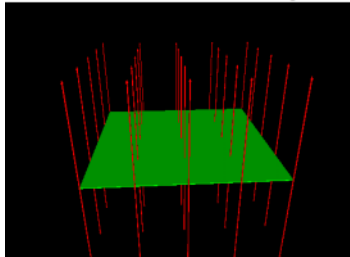
Point Charge



Infinite Line of Charge



Infinite Sheet of Charge



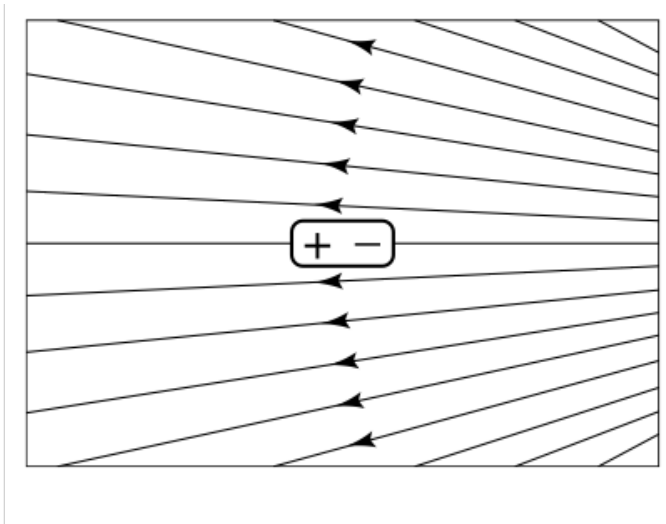
Act III: Dipoles

EF.2.L2-9:

Description: Estimate the direction of the electric field from given charge distributions. (3 minutes + 3 minutes + 3 minutes)

Learning Objectives: [?]

Problem Statement: Consider the electrically neutral dipole in an external electric field shown below. Sketch the direction of the acceleration of the dipole.



EF.2.L2-10:

Description: Estimate the direction of the electric field from given charge distributions. (4 minutes)

Learning Objectives: [?]

Problem Statement: Does a neutral object, such as a soda bottle, experience a force in an electric field?

- (1) No
- (2) Only in a uniform electric field.
- (3) Only in a non-uniform electric field.
- (4) In any electric field because the field polarizes the object.

EF.2.L2-11:

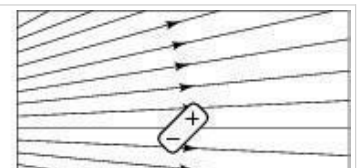
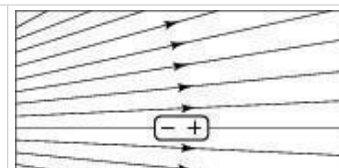
Description: Estimate the direction of the electric field from given charge distributions. (4 minutes)

Learning Objectives: [?]

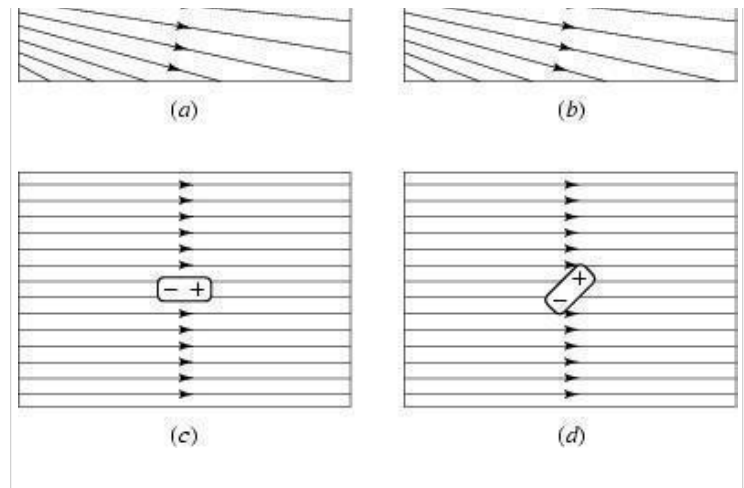
Problem Statement: Four identical electrically neutral dipoles are placed in external electric fields as shown below.

(a) In which situation is the net force on the dipole zero, and the net torque non-zero?

- (1) A



- (2) B
- (3) C
- (4) D



(b) If the dipole started at rest in the orientation shown in figure D above, what would the subsequent motion be?

- (1) Wobbles back and forth about its center of mass.
- (2) Moves to the left.
- (3) Moves to the right.
- (4) Rotates about its center of mass continuously.

Act IV: Conductors in Electric Fields

EF.2.L2-12:

Description: Estimate the direction of the electric field from given charge distributions. (4 minutes)

Learning Objectives: [?]

Problem Statement: A neutral tear-drop-shaped conductor is placed in an initially uniform external electric field. After placing this conductor in the external electric field, the net electric field is now found to have the pattern shown in the figure below. By studying the physical representation below, what can we conclude about conductors in electric fields? **Hint:** There are 4 correct conclusions below.

- (1) The free charges reside on the surface of the conductor.
- (2) The charge density is greater at sharp points.
- (3) The net electric field inside the conductor is zero.
- (4) The net electric field outside at the surface of the conductor is perpendicular to the surface.

- (5) The net electric field outside at the surface of the conductor is parallel to the surface.
- (6) Charges are uniformly distributed throughout the conductor.
- (7) The net electric field is strongest inside the conductor.

Act V: Measurements

EF.2.L2-13:

Description: Estimate the direction of the electric field from given charge distributions. (4 minutes)

Learning Objectives: [?]

Problem Statement: Three students are discussing the magnitude of the test charge on a force probe used for measurements of the electric field from a charge distribution. Which of the following statements do you like?

- (1) "I think the test charge on the probe should be quite large so that the response is much greater and thus can be measured more accurately".
- (2) "My only problem with that is that if you have a lot of charge on your test probe, it will affect the charges on the object that are creating the very field you are trying to measure and thus ruin your measurement".
- (3) "But if the charge is too small then you may not be able to get a reliable measurement, I mean as the test charge decreases, so does the response of the probe from the field".
- (4) "You all want to get some pizza for lunch"?

EF.2.L2-14:

Description: Estimate the direction of the electric field from given charge distributions. (4 minutes)

Learning Objectives: [?]

Problem Statement: A positively charged metal sphere creates an electric field \mathbf{E}_{ext} . You wish to measure this electric field by bringing a positive test charge q_0 to a point near the sphere and measuring the force on the test charge. The measured electric field \mathbf{E}_{ext} at point \mathbf{P} will be _____ the electric field \mathbf{E}_{ext} at point \mathbf{P} before the test charge was placed there.

- (1) less than
 - (2) greater than
 - (3) equal to
-
-

Conceptual questions for discussion

1. Coming soon to a lecture template near you.
-
-

Hints

EF.2.L2-1: No hints.

EF.2.L2-2: No hints.

EF.2.L2-3: No hints.

EF.2.L2-4: No hints.

EF.2.L2-5: No hints.

EF.2.L2-6: No hints.