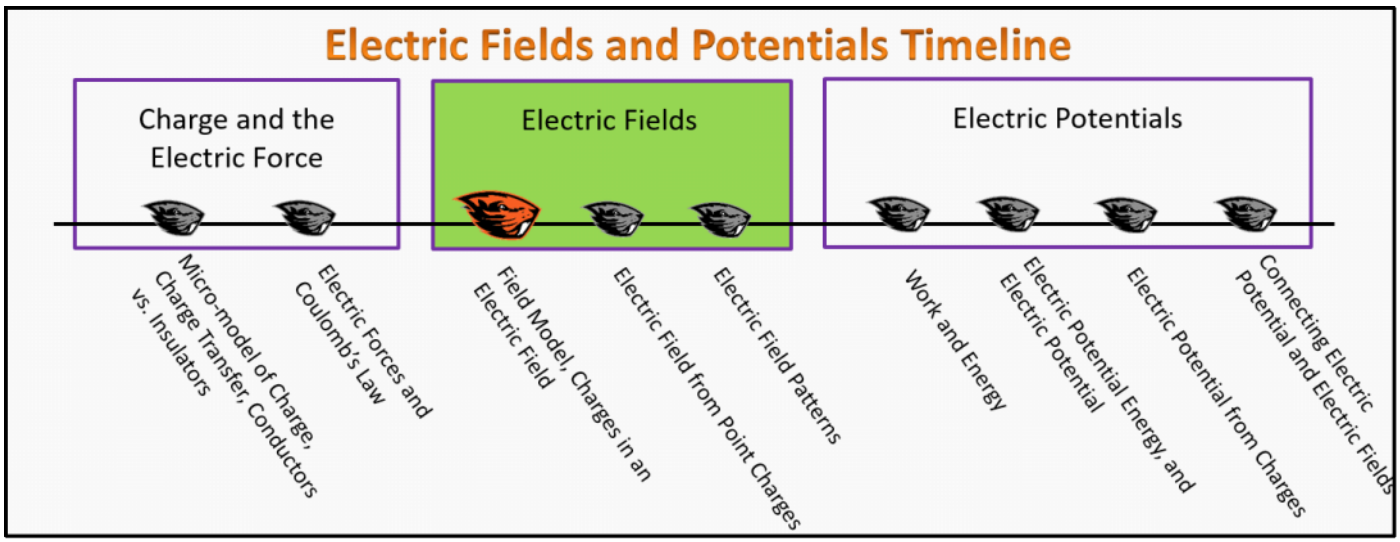
Friday, April 26, 2019 7:49 AM

Electric Fields

Foundation Stage (EF.L1.2)

Lecture 1
Field Model, Charges in an Electric Field



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 ; 16-8

Warm up

EF.2.L1-1:

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: $\vec{F}^1 =< 0,3 > N$; $\vec{F}^2 =< 3, -6 > N$; $\vec{F}^3 =< -1,2 > N$. Calculate the acceleration of the object.

Selected Learning Objectives

1. Coming soon to a lecture template near you.

Key Terms

- Fields
- Vector field
- Scalar field
- Electric field

Key Equations

Key Concepts

- Coming soon to a lecture template near you.

Questions

Act I: Field Model

EF.2.L1-2:

Description: Identify forces acting on an object. (3 minutes)

Learning Objectives: [?]

Problem Statement: Which of the following are properties of fields?

(1) A field is owned by something.
(2) It doesn't require an interaction to exist, like a force would.
(3) It is a map of how an object creating the field alters the region around it.
(4) It is abstract mathematical construct that helps describe interactions.
(5) It predicts how other particles will interact with it before the particles are there.

EF.2.L1-3:

Description: Conceptual question about functional dependence of electric force. (2 minutes)

Learning Objectives: [?]

Problem Statement: An alternative way to analyze a system is with fields.

(a) Which of the following are fields that could be used to analyze a system?

(1) Gravitational field

(2) Electric field
(3) Temperature field
(4) Velocity field
(5) Population field
(6) Happiness field

(b) Which of the following are vector fields?

(1) Gravitational field
(2) Electric field
(3) Temperature field
(4) Velocity field
(5) Population field
(6) Happiness field

EF.2.L1-4:

Description: Identify dominate forces given a system. (3 minutes)

Learning Objectives: [?]

Problem Statement: Electric fields are created by…

(1) Charge
(2) Mass
(3) Spin
(4) Magnets
(5) Brody
(6) UV
(7) Color
(8) Temperature

EF.2.L1-5:

Description: Conceptual question identifying features of charges. (4 minutes)

Learning Objectives: [?]

Problem Statement: Electrons feel...

(1) a force from their own electric field.
(2) a force from other charges.
(3) a force from the electric field created by other charges.

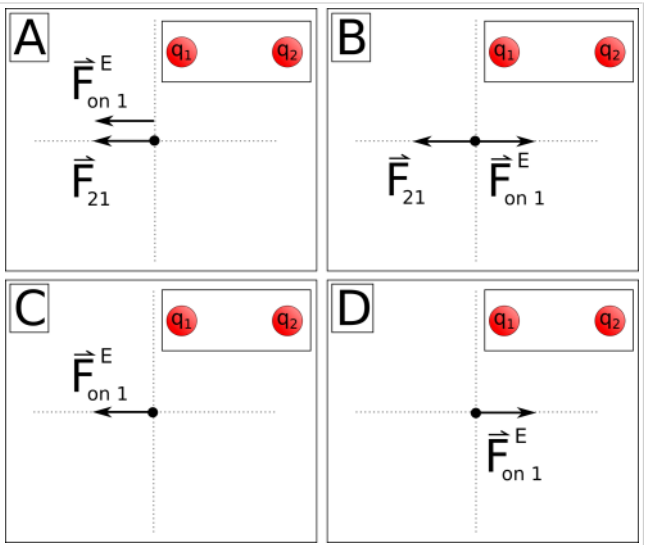
EF.2.L1-6:

Description: Rank net charge of systems containing electrons and protons. (4 minutes)

Learning Objectives: [?]

Problem Statement: Two charges, +$\mathbf{q_1}$ and +$\mathbf{q_2}$, are far away from all other objects in the universe. Which of the following free body diagrams best represents the forces acting on $\mathbf{q_1}$ from $\mathbf{q_2}$?

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



Act II: Representing Electric Fields

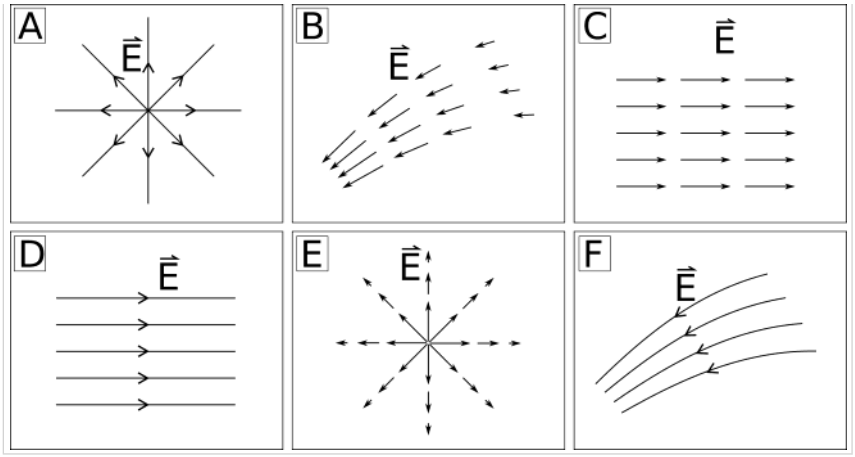
EF.2.L1-7:

Description: Calculate number of electrons in a system given net charge. (4 minutes)

Learning Objectives: [?]

Problem Statement: Electric fields can be represented in the physical representation with vectors or field lines.

(a) Below are 3 vector representations of electric fields and 3 field line representations of the same electric fields. Match the vector representations with the corresponding field representation.



(b) For a vector field representation, which of the following statements are true?	**(c)** For a field line representation, which is true?
(1) The length of the vector represents the magnitude of the electric field at that region. (2) There is an electric field everywhere, we just can't draw an infinite number of arrows	(1) The density of field lines represents the magnitude. (2) There is an electric field everywhere, we just can't draw an infinite number of lines.

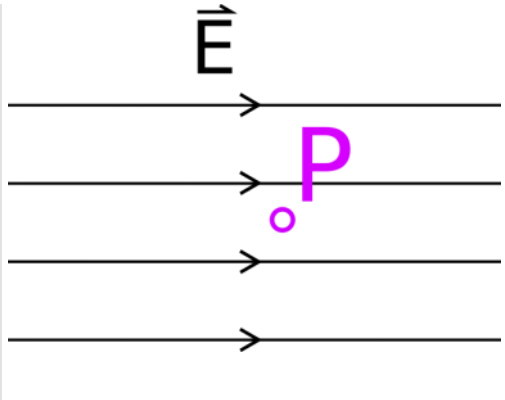
Act III: Forces on Charges in Electric Fields

EF.2.L1-8:

Description: Identify conductors and insulators. (3 minutes)

Learning Objectives: [?]

Problem Statement: An electron is placed at location **P** as seen in the figure below. Draw a vector to represent the direction of the force on the charge.



EF.2.L1-9:

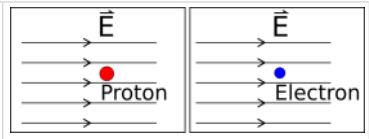
Description: Identify conductors and insulators. (3 minutes)

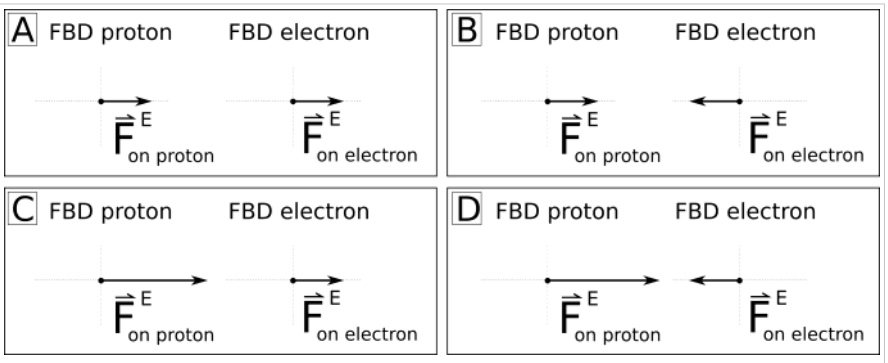
Learning Objectives: [?]

Problem Statement: Consider a uniform electric field as shown below.

(a) A proton is placed in the electric field and a FBD is drawn for it. The proton is then replaced with an electron, again the force is recorded on a FBD. Which set of FBD's represent the electric force acting on the proton and electron when they were in the electric field?

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

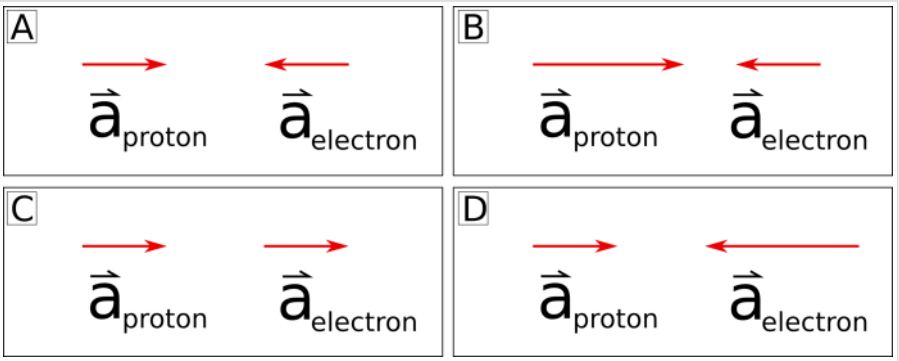




(b) Which of the following sets of vectors represent the acceleration of the proton and the electron when they were

in the electric field.

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



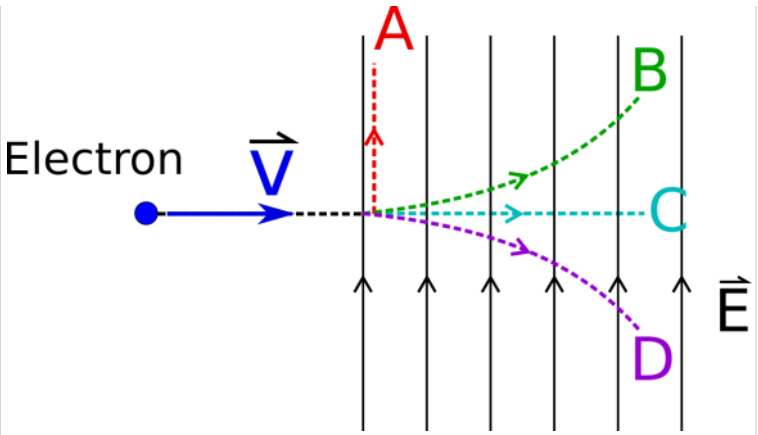
EF.2.L1-10:

Description: Identify conductors and insulators. (3 minutes)

Learning Objectives: [?]

Problem Statement: An electron is initially moving to the right when it enters a uniform electric field directed upwards. Which trajectory shown below will the electron follow?

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



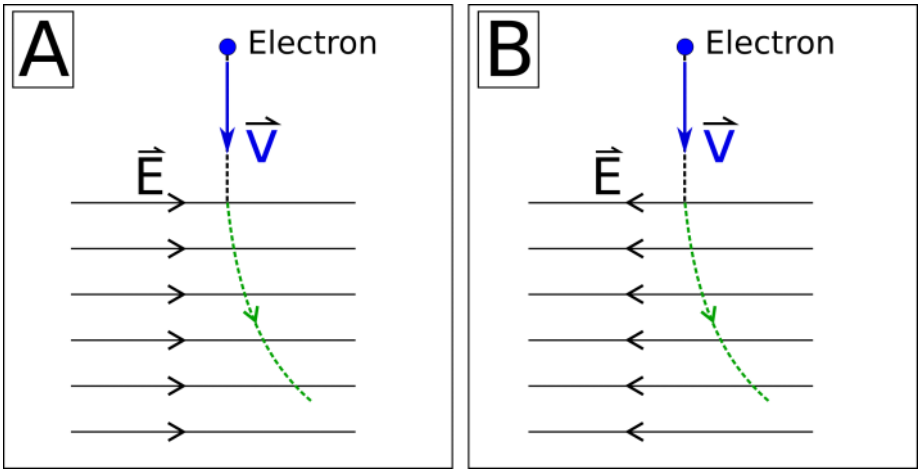
EF.2.L1-11:

Description: Identify conductors and insulators. (3 minutes)

Learning Objectives: [?]

Problem Statement: An electron enters a region with a uniform electric field from above, moving downwards with speed **v**. Which of the two electric field line diagrams shown below would produce the observed parabolic motion represented by the dashed green lines?

(1) Only **A**
(2) Only **B**
(3) Both **A** and **B**
(4) Neither **A** or **B**
(5) I have no idea.



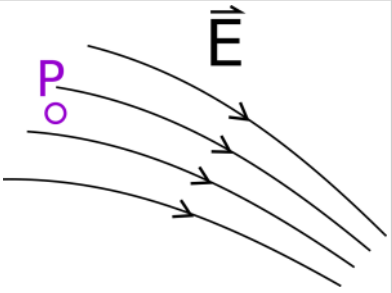
EF.2.L1-12:

Description: Identify conductors and insulators. (3 minutes)

Learning Objectives: [?]

Problem Statement: A proton starts at rest at point **P**. How will it move?

(1) Stays at rest.
(2) Follows a path between the field lines.
(3) It moves to the right, curving downwards but ultimately crossing a field line.

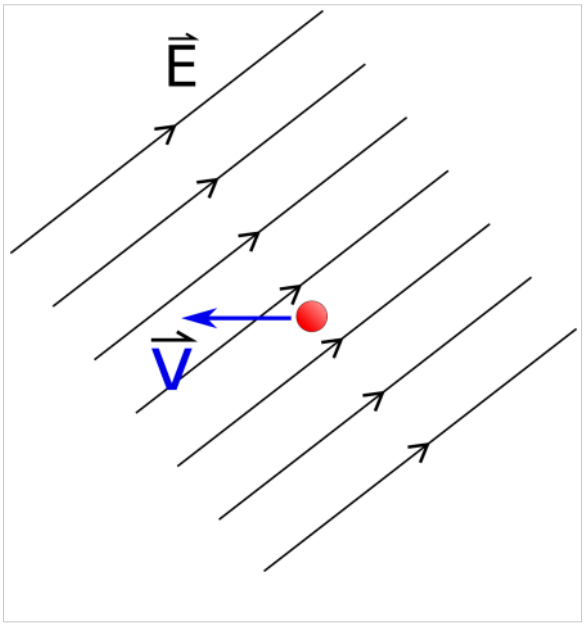


EF.2.L1-13:

Description: Identify conductors and insulators. (3 minutes)

Learning Objectives: [?]

Problem Statement: A proton, with initial speed $\mathbf{v_i}$, is placed at the position marked by the dot. Sketch the trajectory of the charge in this electric field.



EF.2.L1-14:

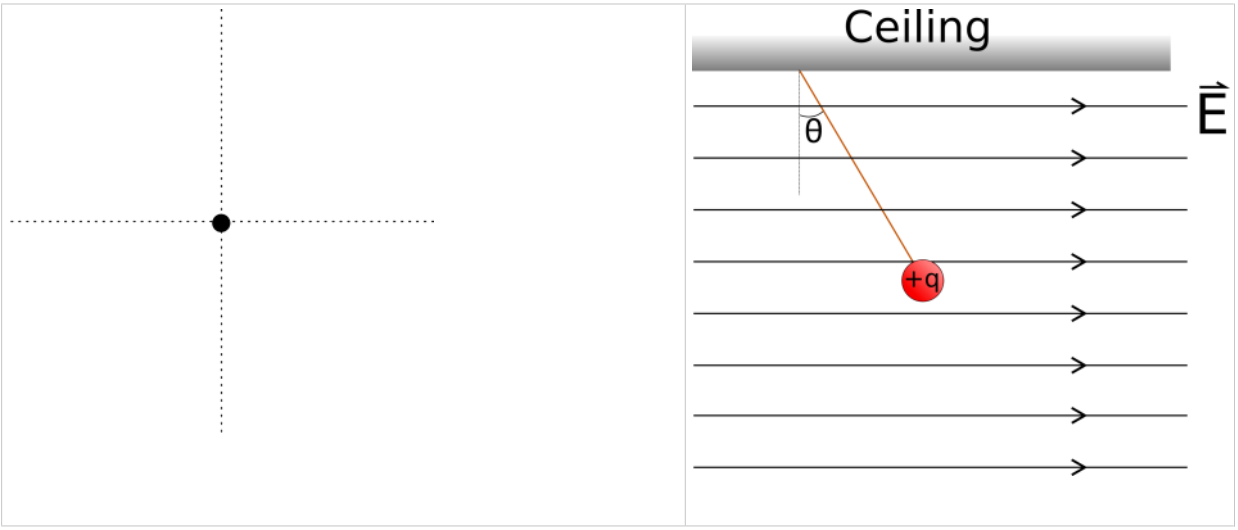
Description: Identify conductors and insulators. (3 minutes)

Learning Objectives: [?]

Problem Statement: A 0.25 kg object with a net charge of 0.015 C is hanging by an

thin insulating thread. The system is placed in a uniform electric field that points to the right and has a magnitude of 8.00 N/C as seen in the figure below. The system is in static equilibrium.

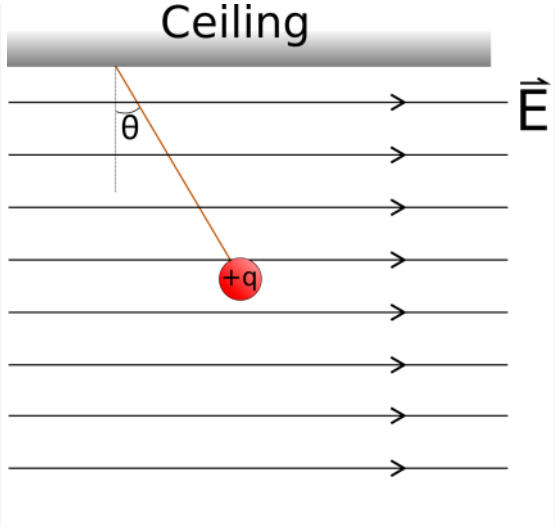
(a) Draw a free body diagram for the positively charged hanging object.



(b) Find the tension in the thread.

(c) Find the angle labeled **θ** in the figure.

(d) If the string is cut, sketch the resulting trajectory of the charged object.



EF.2.L1-15:

Description: Identify conductors and insulators. (3 minutes)

Learning Objectives: [?]

Problem Statement: An object having a mass of 10.0 g and a charge of 8.00 x 10^{-5} C is placed in a uniform electric field, $\vec{\mathbf{E}}$ (no gravitational field) where $\mathbf{E_x}$ = 3.00 x 10^{3} N/C, $\mathbf{E_y}$ = -600 N/C, and $\mathbf{E_z}$ = 100 N/C. What is the acceleration on the object?

(1) < 12, -6.2, 0.8 > m/s^2
(2) < 1.2, -4.2, 2.8 > m/s^2
(3) < 24, -3.8, 0.2 > m/s^2
(4) < 24, -4.8, 0.8 > m/s^2

EF.2.L1-16:

Description: Identify conductors and insulators. (3 minutes)

Learning Objectives: [?]

Problem Statement: An electron is placed in a constant electric field given by: $\vec{\mathbf{E}} = < -\mathbf{E_x}, \mathbf{E_y}, -\mathbf{E_z} >$. What is the acceleration of the electron?

(1) $-\frac{\mathbf{e}}{\mathbf{m_e}} < \mathbf{E_x}, \mathbf{E_y}, \mathbf{E_z} >$

(2) $\frac{\mathbf{e}}{\mathbf{m_e}} < \mathbf{E_x}, \mathbf{E_y}, \mathbf{E_z} >$

(3) $\frac{\mathbf{e}}{\mathbf{m_e}} < -\mathbf{E_x}, \mathbf{E_y}, -\mathbf{E_z} >$

(4) $-\frac{\mathbf{e}}{\mathbf{m_e}} < -\mathbf{E_x}, \mathbf{E_y}, -\mathbf{E_z} >$

Question about magnitude and acceleration

Conceptual questions for discussion

1. Coming soon to a lecture template near you.

Hints

EF.2.L1-1: No hints.

EF.2.L1-2: No hints.

EF.2.L1-3: No hints.

EF.2.L1-4: No hints.

EF.2.L1-5: No hints.

EF.2.L1-6: No hints.

EF.2.L1-7: No hints.

EF.2.L1-8: No hints.