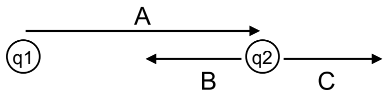
2.1

Coulomb's law: $\vec{\mathbf{F}}(\text{by 1 on 2}) = \dfrac{kq_1q_2}{\mathfrak{R}_{12}^2}\hat{\mathfrak{R}}_{12}$

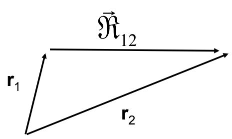
In the fig, q_1 and q_2 are 2 m apart.
Which arrow *can* represent $\hat{\mathfrak{R}}_{12}$?



D) More than one (or NONE) of the above
E) You can't decide until you know if q_1 and q_2 are the same or opposite signed charges

2.1b

How is the vector $\vec{\mathfrak{R}}_{12}$ related to $\mathbf{r}_1$ and $\mathbf{r}_2$?



A) $\vec{\mathfrak{R}}_{12} = \vec{r}_1 + \vec{r}_2$

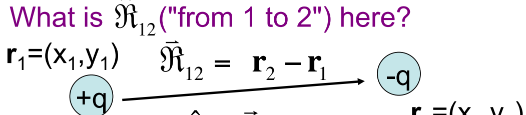
B) $\vec{\mathfrak{R}}_{12} = \vec{r}_1 - \vec{r}_2$

C) $\vec{\mathfrak{R}}_{12} = \vec{r}_2 - \vec{r}_1$

D) None of these

2.2

What is $\hat{\mathfrak{R}}_{12}$("from 1 to 2") here?



$\hat{A} = \vec{A}/|A|$

A) $(x - x_1,\ y - y_1)$ B) $(x_1 - x,\ y_1 - y)$

C) $\dfrac{(x - x_1,\ y - y_1)}{\sqrt{(x - x_1)^2 + (y - y_1)^2}}$ C) $\dfrac{(x_1 - x,\ y_1 - y)}{\sqrt{(x - x_1)^2 + (y - y_1)^2}}$

E) None of these

2.2

What is $\hat{\mathfrak{R}}_1$ (from r_1 to r)?

$\mathbf{r}_1=(x_1,y_1)$ $\quad \mathfrak{R}_1 = \mathbf{r} - \mathbf{r}_1$

q_1 $\quad$ $\mathbf{r} = (x,y)$

$\hat{A} = \vec{A} / |A|$

A) $(x-x_1, y-y_1)$ B) (x_1-x, y_1-y)

C) $\dfrac{(x-x_1, y-y_1)}{\sqrt{(x-x_1)^2+(y-y_1)^2}}$ D) $\dfrac{(x_1-x, y_1-y)}{\sqrt{(x-x_1)^2+(y-y_1)^2}}$

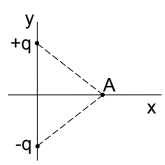
E) None of these/not sure/it depends...

Can I always use the Coulomb law in this form to calculate the force on a small charge at any point in vacuum if I know the location of all charges for all times? (Assume no conductors or dielectrics are present.)

A) Yes, of course! It's a law and laws are always true.
B) No. The coulomb law works only for specific situations.
C) I don't know and my neighbor has no clue either.

2.3

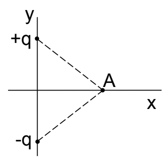
Two charges +q and -q are on the y-axis, symmetric about the origin.
The direction of the force on a test charge –q at point A is



A. Up
B. Down
C. Left
D. Right
E. Some other direction, or E = 0, or ambiguous

2.3

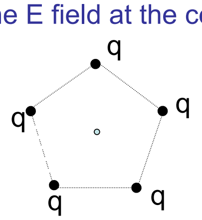
Two charges +q and -q are on the y-axis, symmetric about the origin.
Point A is an empty point in space on the x-axis. The direction of the E field at A is…



A. Up
B. Down
C. Left
D. Right
E. Some other direction, or E = 0, or ambiguous

2.5

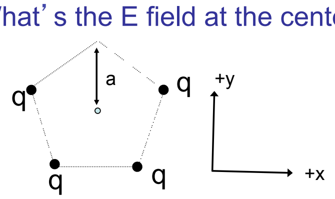
5 charges, q, are arranged in a regular pentagon, as shown.
What is the E field at the center?



A) Zero
B) Non-zero
C) Really need trig and a calculator to decide

2.6

1 of the 5 charges has been removed, as shown. What's the E field at the center?

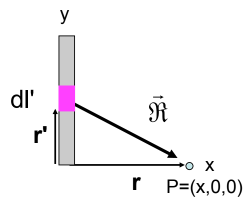


A) $+(kq/a^2)$ **j**
B) $-(kq/a^2)$ **j**
C) 0
D) Something entirely different!
E) This is a nasty problem which I need more time to solve

2.10 To find the E- field at P from a thin line (uniform linear charge density λ):

$$\mathbf{E} = \frac{1}{4\pi\varepsilon_0}\int \frac{1}{\mathfrak{R}^2}\hat{\mathfrak{R}}\ \lambda dl'$$

What is $\mathfrak{R} = |\vec{\mathfrak{R}}|$?



A) X B) y'

C) $\sqrt{dl'^2 + x^2}$ D) $\sqrt{x^2 + y'^2}$

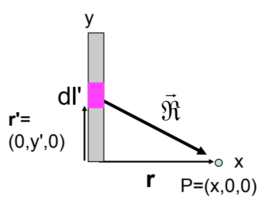
E) Something *completely* different!!

2.11

$$\vec{\mathbf{E}}(\vec{\mathbf{r}}) = \int \frac{\lambda\, dl'}{4\pi\varepsilon_0 \mathfrak{R}^3}\vec{\mathfrak{R}} \quad \text{,so} \quad \mathbf{E}_x(x,0,0) = \frac{\lambda}{4\pi\varepsilon_0}\int \ldots$$

$A)\ \int \frac{dy'\, x}{x^3}$

$B)\ \int \frac{dy'\, x}{(x^2 + y'^2)^{3/2}}$



$C)\ \int \frac{dy'\ y'}{x^3}$

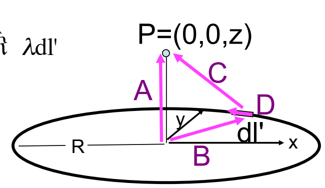
$D)\ \int \frac{dy'\ y'}{(x^2 + y'^2)^{3/2}}$ $\quad E)$ Something else

2.12

To find the E- field at P from a thin ring (radius R, uniform linear charge density λ):

$$\mathbf{E} = \frac{1}{4\pi\varepsilon_0}\int \frac{1}{\mathfrak{R}^2}\hat{\mathfrak{R}}\ \lambda dl'$$

what is $\vec{\mathfrak{R}}$?

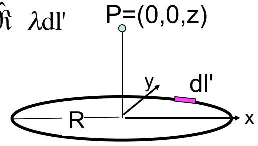


E) NONE of the arrows shown correctly represents $\vec{\mathfrak{R}}$

2.13

To find the E- field at P from a thin ring (radius R, uniform linear charge density λ):

$$\mathbf{E} = \frac{1}{4\pi\varepsilon_0}\int \frac{1}{\mathfrak{R}^2}\hat{\mathfrak{R}}\ \lambda \mathrm{dl}'$$



what is $\mathfrak{R}$?

A) $\sqrt{R^2 + z^2}$

B) R

C) $\sqrt{dl'^2 + z^2}$

D) z

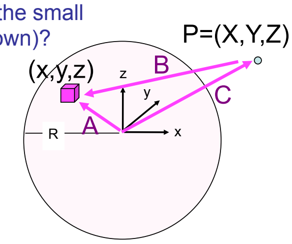
E) Something *completely* different!!

2.14

To find **E** at P from a negatively charged sphere (radius R, uniform volume charge density ρ) using

$$\mathbf{E} = \frac{1}{4\pi\varepsilon_0}\int \frac{1}{\mathfrak{R}^2}\hat{\mathfrak{R}}\ \rho\, \mathrm{d}\tau'$$

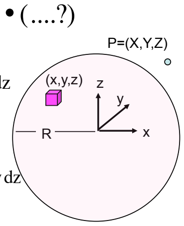
what is $\vec{\mathfrak{R}}$ (given the small volume element shown)?



D) None of these

2.15

$$\mathbf{E} = \frac{1}{4\pi\varepsilon_0}\int \frac{1}{\mathfrak{R}^2}\hat{\mathfrak{R}}\ \rho\, \mathrm{d}\tau \quad = \frac{1}{4\pi\varepsilon_0}\bullet(....?)$$



A) $\int \frac{(X,Y,Z)}{\left((X-x)^2+(Y-y)^2+(Z-z)^2\right)}\rho\, \mathrm{dx\, dy\, dz}$

B) $\int \frac{(X,Y,Z)}{\left((X-x)^2+(Y-y)^2+(Z-z)^2\right)^{3/2}}\rho\, \mathrm{dx\, dy\, dz}$

C) $\int \frac{(X-x,Y-y,Z-z)}{\left((X-x)^2+(Y-y)^2+(Z-z)^2\right)}\rho\, \mathrm{dx\, dy\, dz}$

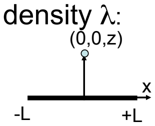
D) $\int \frac{(X-x,Y-y,Z-z)}{\left((X-x)^2+(Y-y)^2+(Z-z)^2\right)^{3/2}}\rho\, \mathrm{dx\, dy\, dz}$

E) None of these

2.16

Griffiths p. 63 finds E a distance z from a line segment with charge density λ:

$$\vec{\mathbf{E}} = \frac{1}{4\pi\varepsilon_0}\frac{2\lambda L}{z\sqrt{z^2+L^2}}\hat{\mathbf{k}}$$



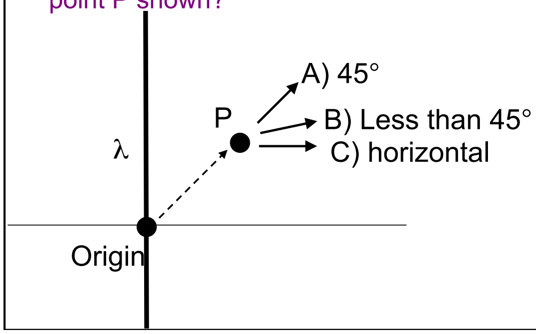
What is the approx. form for E, if z<<L?

$$E = \frac{2\lambda}{4\pi\varepsilon_0}\cdot(\ldots)$$

A) 0 B) 1 C) 1/z D) 1/z^2

E) None of these is remotely correct.

2.17 An infinite rod has uniform charge density λ. What is the direction of the E field at the point P shown?



2.19

Which of the following are vectors?

(I) Electric field

(II) Electric flux

(III) Electric charge

A) (I) only B) (I) and (II) only

C) (I) and (III) only

D) (II) and (III) only

E) (I), (II), and (III)

2.16b

A positive point charge +q is placed outside a closed cylindrical surface as shown. The closed surface consists of the flat end caps (labeled A and B) and the curved side surface (C). What is the sign of the electric flux through surface C?

(A) positive (B) negative (C) zero
(D) not enough information given to decide

2.23

A Gaussian surface which is *not* a sphere has a single charge (q) inside it, *not* at the center. There are more charges outside. What can we say about total electric flux through this surface $\oint \vec{E} \cdot d\vec{a}$?

A) It is q/ε0
B) We know what it is, but it is NOT q/ε0
C) Need more info/details to figure it out.

2.20

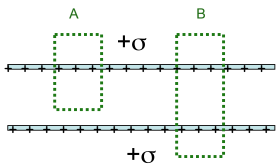
You have an E field given by
$\mathbf{E} = c\,\mathbf{r}/\varepsilon_0$, (Here c = constant, **r** = spherical radius vector)

What is the charge density ρ(r)?

A) c B) c r C) 3 c D) 3 c r^2
E) None of these is correct

SVC1

Given a pair of very large, flat, charged plates with surface charge densities $+\sigma$.
Using the two Gaussian surfaces shown (A and B), what is the E field in the region OUTSIDE the plates?



A) $\sigma/2\varepsilon_0$
B) σ/ε_0
C) $2\sigma/\varepsilon_0$
D) $4\sigma/\varepsilon_0$
E) It depends on the choice of surface

2.20

You have an E field given by
$\mathbf{E} = c\,\mathbf{r}/\varepsilon_0$, (Here c = constant, **r** = spherical radius vector)

What is the charge density $\rho(r)$?

A) c B) c r C) 3 c D) 3 c r^2
E) None of these is correct

2.21

Given $\mathbf{E} = c\,\mathbf{r}/\varepsilon_0$,
(c = constant, **r** = spherical radius vector)
We just found $\rho(r) = 3c$.
What is the total charge Q enclosed by an imaginary sphere centered on the origin, of radius R?

Hint: Can you find it two DIFFERENT ways?

A) (4/3) π c B) 4 π c
C) (4/3) π c R^3 D) 4 π c R^3
E) None of these is correct

What are the units of $\delta(x)$ if x is measured in meters?

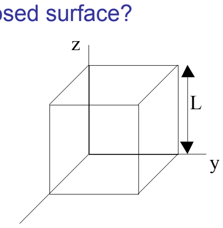
A) δ is dimension less ('no units')
B) [m]: Unit of length
C) [m^2]: Unit of length squared
D) [m^{-1}]: 1 / (unit of length)
E) [m^{-2}]: 1 / (unit of length squared)

What are the units of $\delta^3(\vec{\mathbf{r}})$ if the components of $\vec{\mathbf{r}}$ are measured in meters?

A) [m]: Unit of length
B) [m^2]: Unit of length squared
C) [m^{-1}]: 1 / (unit of length)
D) [m^{-2}]: 1 / (unit of length squared)
E) None of these.

2.22

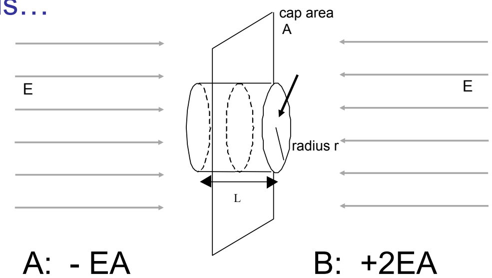
The space in and around a cubical box (edge length L) is filled with a constant uniform electric field, $\vec{E} = E\hat{y}$. What is the TOTAL electric flux $\oiint \vec{E} \cdot d\vec{a}$ through this closed surface?



A. Zero
B. EL^2
C. $2EL^2$
D. $6EL^2$
E. We don't know $\rho(r)$, so can't answer.

2.25

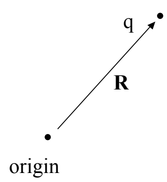
The flux through the pillbox surface is…



A: - EA
B: +2EA
C: $(-2A+L\pi r^2)\,E$
D: $L\pi r^2\,E$
E: None of these

2.24

A point charge q is at position **R**, as shown.
What is ρ(**r**), the charge density in all space?



A) $\rho(\vec{\mathbf{r}}) = q\,\delta^3(\vec{\mathbf{R}})$

B) $\rho(\vec{\mathbf{r}}) = q\,\delta^3(\vec{\mathbf{r}})$

C) $\rho(\vec{\mathbf{r}}) = q\,\delta^3(\vec{\mathbf{r}}-\vec{\mathbf{R}})$

D) $\rho(\vec{\mathbf{r}}) = q\,\delta^3(\vec{\mathbf{R}}-\vec{\mathbf{r}})$

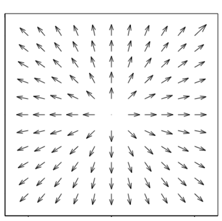
E) None of these or More than one of these

MD-1

Consider the vector field

$$\vec{V}(\vec{r}) = c\,\hat{r}$$

where c = constant .



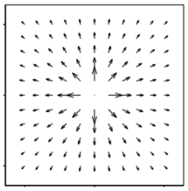
The divergence of this vector field is:
A) Zero everywhere except at the origin
B) Zero everywhere including the origin
C) Non-zero everywhere, including the origin.
D) Non-zero everywhere, except at origin (zero at origin)

(No fair computing the answer. Get answer from your brain.)

Consider the 3D vector field

$$\vec{V}(\vec{r}) = c\left(\frac{\hat{r}}{r^2}\right)$$

in spherical coordinates, where c = constant .



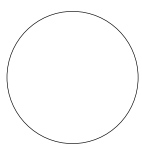
The divergence of this vector field is:
A) Zero everywhere except at the origin
B) Zero everywhere including the origin
C) Non-zero everywhere, including the origin.
D) Non-zero everywhere, except at origin (zero at origin)

(No fair computing the answer. Get answer from your brain.)

2.26

A spherical *shell* has a uniform positive charge density on its surface. (There are no other charges around)

What is the electric field *inside* the sphere?

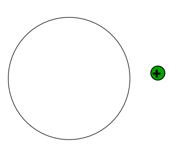


A: **E**=0 everywhere inside
B: **E** is non-zero everywhere in the sphere
C: **E**=0 only at the very center, but non-zero elsewhere inside the sphere.
D: Not enough info given

2.29

Now we add a single extra charge Q just outside the sphere (fixing all the other charges exactly as they were)

What is the electric field *inside* the sphere?



A: 0 everywhere inside
B: non-zero everywhere in the sphere
C: Not enough info given

2.29
alt

If we place a charge Q just outside an insulating, spherical shell *(fixing* all surface charges uniformly around the sphere)

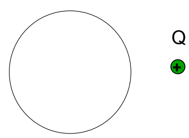
What is the electric field *inside* the sphere?

A: 0 everywhere inside

B: non-zero everywhere in the sphere

C: Something else

D: Not enough info given



2.33

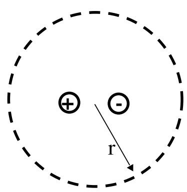
A dipole sits near the origin. We draw an imaginary Gaussian sphere (radius r) around it.

Gauss' law says: $\oint_{surf} \vec{E} \cdot d\vec{a} = \frac{Q_{inside}}{\varepsilon_0}$

Do we conclude that E=0 everywhere around that sphere?

A)Yes, E=0 everywhere

B) No, E is not 0 at all points on that sphere.

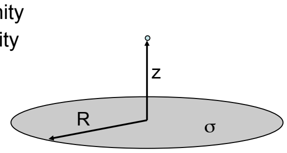


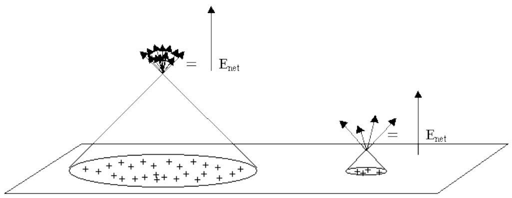
MD16-1

Consider the z-component of the electric field E_z at distance z above the center of a uniformly charged disk (charge per area = +σ, radius = R).

In the limit, z << R, the value of E_z approaches

A) zero
B) a positive constant
C) a negative constant
D) +infinity
E) -infinity

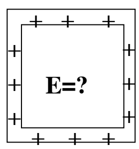




The E-field near an infinite plane of charge is constant.

2.27

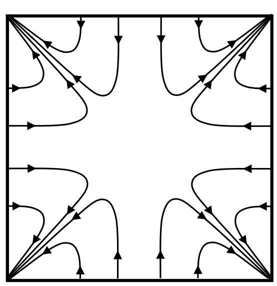
A cubical non-conducting *shell* has a ***uniform*** positive charge density on its surface. (There are no other charges around)
What is the field inside the box?



A: **E**=0 everywhere inside
B: **E** is non-zero everywhere inside
C: **E**=0 only at the very center, but non-zero elsewhere inside.
D: Not enough info given

E-field inside a cubical box with a **uniform** surface charge.

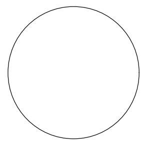
The E-field lines sneak out the corners!



2.26

A spherical *shell* has a uniform positive charge density on its surface. (There are no other charges around)

What is the electric field *inside* the sphere?



A: **E**=0 everywhere inside

B: **E** is non-zero everywhere in the sphere

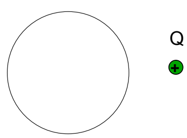
C: **E**=0 only at the very center, but non-zero elsewhere inside the sphere.

D: Not enough info given

2.29 alt

If we place a charge Q just outside an insulating, spherical shell *(fixing* all surface charges uniformly around the sphere)

What is the electric field *inside* the sphere?



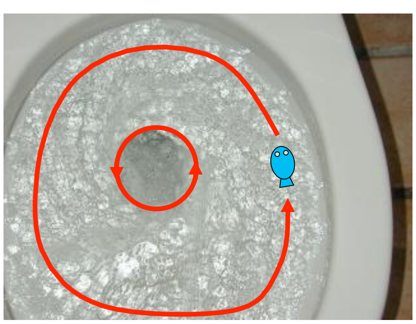
A: 0 everywhere inside

B: non-zero everywhere in the sphere

C: Something else

D: Not enough info given

Common vortex



Feline Vortex

2.42

$$\mathbf{E}(\mathbf{r}) = \frac{1}{4\pi\varepsilon_0}\iiint \frac{\rho(\mathbf{r}')\,\hat{\Re}}{\Re^2}\,d\tau'$$

(with $\vec{\Re} = \mathbf{r} - \mathbf{r}' = (x - x', y - y', z - z')$)

However, $\dfrac{\hat{\Re}}{\Re^2} = -\nabla\dfrac{1}{|\Re|}$

where $\nabla = \left(\dfrac{\partial}{\partial x}, \dfrac{\partial}{\partial y}, \dfrac{\partial}{\partial z}\right)$

Question: is the following mathematically ok?

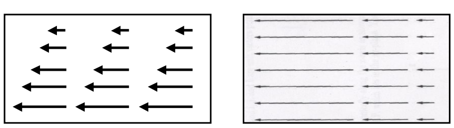
$$\mathbf{E}(\mathbf{r}) = \frac{1}{4\pi\varepsilon_0}\iiint \rho(\mathbf{r}')\left(-\nabla\frac{1}{|\Re|}\right)d\tau' = -\nabla\frac{1}{4\pi\varepsilon_0}\iiint\frac{\rho(\mathbf{r}')}{|\Re|}\,d\tau'$$

A) Yes B) No C) ???

2.43b/1.7b

Which of the following *could* be a static physical E-field in a small region?

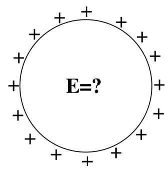
I II



A) Only I B) Only II
C) Both D) Neither
E) Cannot answer without further info

2.26

A spherical *shell* has a uniform positive charge density on its surface. (There are no other charges around)



What is the electric field *inside* the sphere?

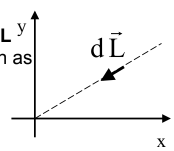
A: **E**=0 everywhere inside

B: **E** is non-zero everywhere in the sphere

C: **E**=0 only at the very center, but non-zero elsewhere inside the sphere.

D: Not enough info given

Consider an infinitesimal path element d**L** directed radially inward, toward the origin as shown.



In spherical coordinates, the correct expression for d**L** is:

A) $d\vec{L} = +dr\,\hat{r}$

B) $d\vec{L} = -dr\,\hat{r}$

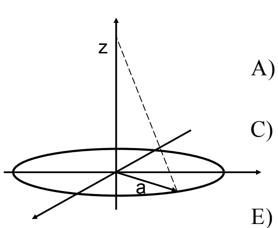
C) Neither of these.

cartesian: $d\vec{L} = dx\,\hat{x} + dy\,\hat{y}$

spherical: $d\vec{L} = dr\,\hat{r} + r\,d\theta\,\hat{\theta} + r\sin\theta\,d\phi\,\hat{\phi}$

A uniformly charged ring, in the xy plane, centered on the origin, has radius *a* and total charge Q. V(r = ∞) = 0.

What is the voltage at z on the z-axis?



A) $\frac{kQ}{a}$ B) $\frac{kQ}{z}$

C) $\frac{kQ}{\sqrt{a^2+z^2}}$ D) $\frac{kQ}{a^2+z^2}$

E) None of these

2.43

Could the following electrostatic field possibly exist in a finite region of space that contains no charges? (A, and c are constants with appropriate units)

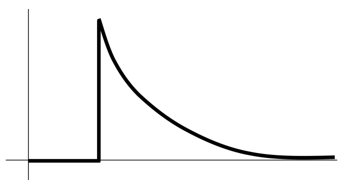
$$\vec{\mathbf{E}} = A(\frac{z^2}{2}\hat{i} - cy\hat{j} + xz\hat{k})$$

A) Sure, why not?

B) No way

C) Not enough info to decide

2.44



Could this be a plot of |E|(r)? Or V(r)? (for SOME physical situation?)

A) Could be E(r), or V(r)

B) Could be E(r), but can't be V(r)

C) Can't be E(r), could be V(r)

D) Can't be either E) ???

2.46

Why is $\oint \vec{\mathbf{E}} \cdot d\vec{\mathbf{L}}$ in electrostatics?

a) Because $\nabla X \vec{E} = 0$

b) Because E is a conservative field

c) Because the potential between two points is independent of the path

d) All of the above

e) NONE of the above - it's not true!

The voltage is zero at a point in space.

You can conclude that :

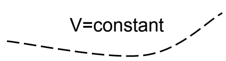
A) The E-field is zero at that point.

B) B) The E-field is non-zero at that point

C) You can conclude nothing at all about the E-field at that point

---

The voltage is constant everywhere along a line in space.



You can conclude that :

A) The E-field has constant magnitude along that line.

B) The E-field is zero along that line.

C) You can conclude nothing at all about the magnitude of **E** along that line.

SC-4

We usually choose $V(r \rightarrow \infty) \equiv 0$ when calculating the potential of a point charge to be $V(r) = kq/r$. How does the potential V(r) change if we choose our reference point to be V(R)=0 where R is closer to +q than r.

+q R r ∞

A V(r) is positive but smaller than kq/r

B V(r) is positive but larger than kq/r

C V(r) is negative

D V(r) doesn't change (V is independent of choice of reference)

Two isolated spherical shells of charge, labeled A and B, are far apart and each has charge Q. Sphere B is bigger than sphere A. Which shell has higher voltage? [$V(r=\infty) = 0$]

A) Sphere A B) Sphere B
C) Both have same voltage.

2.45 Given a spherical SHELL with uniform *surface charge* density σ (no other charges anywhere else) what can you say about the potential V *inside* this sphere? (Assume as usual, $V(\infty)=0$)

A) V=0 everywhere inside
B) V = non-zero constant everywhere inside
C) V must vary with position, but is zero at the center.
D) None of these.

2.46

Why is $\oint \vec{E} \cdot d\vec{l} = 0$ in electrostatics?

a) Because $\nabla \times \vec{E} = 0$

b) Because E is a conservative field

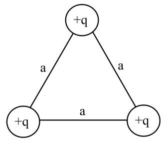
c) Because the potential (voltage) between two points is independent of the path

d) All of the above

e) NONE of the above - it's not true!

2.47

Three identical charges +q sit on an equilateral triangle.



What would be the final KE of the *top* charge if you released it (keeping the other two fixed)

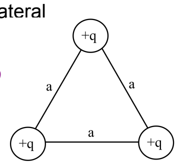
A) $\frac{1}{4\pi\varepsilon_0}\frac{q^2}{a}$ B) $\frac{1}{4\pi\varepsilon_0}\frac{2q^2}{3a}$

C) $\frac{1}{4\pi\varepsilon_0}\frac{2q^2}{a}$ D) $\frac{1}{4\pi\varepsilon_0}\frac{3q^2}{a}$

E) None of these

2.48

Three identical charges +q sit on an equilateral triangle.



What would be the final KE of the *top* charge if you released ***all three***?

A) $\frac{1}{4\pi\varepsilon_0}\frac{q^2}{a}$ B) $\frac{1}{4\pi\varepsilon_0}\frac{2q^2}{3a}$

C) $\frac{1}{4\pi\varepsilon_0}\frac{2q^2}{a}$ D) $\frac{1}{4\pi\varepsilon_0}\frac{3q^2}{a}$

E) None of these

During the last class we found that the energy stored in a particular arrangement of charges can be expressed as:

$W_{sys} = ½ \sum q_i \cdot V_i(\mathbf{r}_i)$

or as: $W_{sys} = ½ \int \mathbf{E}^2 \, d\tau'$

Why can the first expression be negative, but the second one is positive (or zero)?

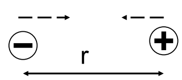
A – We did a mistake in the derivation.
B –The second expression also contains the energy required to *make* the charges.
C – Energy is always a positive quantity, which we expressed by squaring the E-field.
D – Must be something else.
E – How should I know. I don't do the reading assignments.

Does energy superpose?

That is, if you have one system of charges with total stored energy W1, and a second charge distribution with W2… if you superpose these charge distributions, is the total energy of the new system W1+W2?

A) Yes

B) No

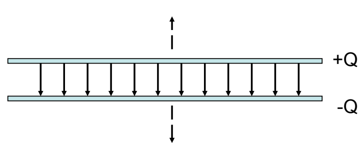


Two charges, +q and –q, are a distance r apart. As the charges are slowly moved together, the total field energy

$$\frac{\varepsilon_0}{2}\int E^2\, d\tau$$

A) increases
B) decreases
C) remains constant

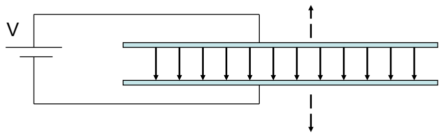
(Come up with two different reasons for your answer.)



A parallel-plate capacitor has +Q on one plate, -Q on the other. The plates are isolated so the charge Q cannot change. As the plates are pulled apart, the total **electrostatic energy** stored in the capacitor

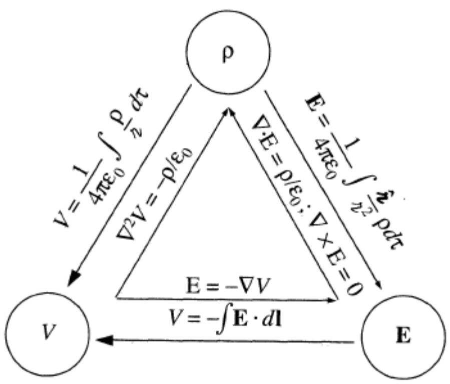
A) increases
B) decreases
C) remains constant.

(Come up with two different reasons for your answer.)



A parallel plate capacitor is attached to a battery which maintains a constant voltage difference V between the capacitor plates. While the battery is attached, the plates are pulled apart. The electrostatic energy stored in the capacitor

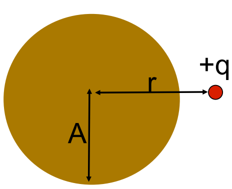
A) increases
B) decreases
C) stays constant.



2.30

A copper sphere (radius A) has total charge +Q. A separate point charge +q sits outside. (We are in static equilibrium.)

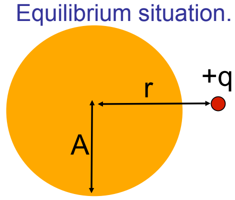
What is the magnitude of the E-field at the center of the sphere?



A) $|E| = kq/r^2$
B) $|E| = kq/A^2$
C) $|E| = k(q-Q)/r^2$
D) $|E| = 0$
E) None of these!

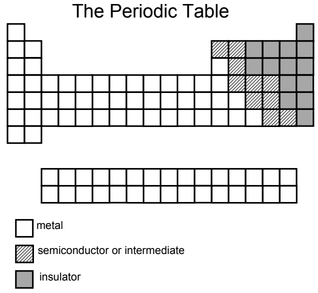
2.30

A point charge +q sits outside a solid *neutral* copper sphere of radius A. The charge q is a distance r > A from the center, on the right side. What is the E-field at the center of the sphere? Equilibrium situation.

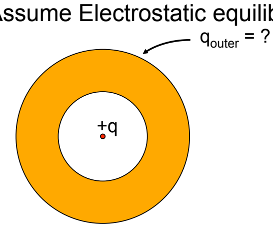


A) $|E| = kq/r^2$, to left
B) $kq/r^2 > |E| > 0$, to left
C) $|E| > 0$, to right
D) E = 0
E)None of these

The Periodic Table

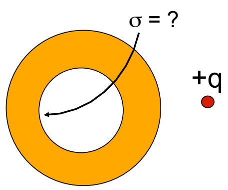


A **neutral** copper sphere has a spherical hollow in the center. A charge +q is placed in the center of the hollow. What is the total charge on the *outside* surface of the copper sphere? (Assume Electrostatic equilibrium.)



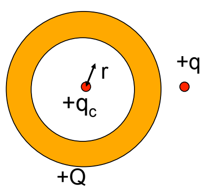
A) Zero
B) -q
C) +q
D) $0 < q_{outter} < +q$
E) $-q < q_{outer} < 0$

A point charge +q is near a neutral copper sphere with a hollow interior space. In equilibrium, the surface charge density σ on the interior of the hollow space is..



A) Zero everywhere
B) Non-zero, but with zero net total charge on interior surface
C) Non-zero with non-zero net total charge on interior surface.

2.30a A HOLLOW copper sphere has total charge +Q.
A point charge +q sits outside.
A charge q_c is in the hole at the center.
(As usual, assume static equilibrium.)
What is the magnitude of the E-field a distance r from q_c, (but, still inside the hole) .



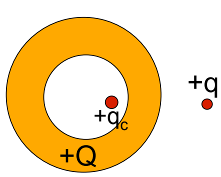
A) $|E| = kq_c/r^2$

B) $|E| = k(q_c-Q)/r^2$

C) $|E| = 0$

D) None of these! / it's hard to compute

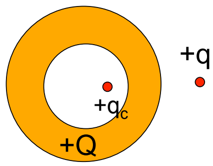
2.30b
A HOLLOW copper sphere has total charge +Q.
A point charge +q sits outside.
A charge, q_c, is in the hole, SHIFTED right a bit.
(Assume static equilibrium.)
What does the E field look like in the hole?



A) Simple Coulomb field (straight away from q_c, right up to the wall)
B) Complicated/ it's hard to compute

2.30c

A HOLLOW copper sphere has total charge +Q.
A point charge +q sits outside.
A charge, $+q_c$, is in the hole, SHIFTED right a bit.
(Assume static equilibrium.)
What does the charge distribution look like on the inner surface of the hole?



A) All minus charges, uniformly spread out
B) Minus charges close to q_c, plus charges opposite q_c
C) All minus but more close to q_c and fewer opposite
D) All plus but more opposite q_c and fewer close
E) Not enough information

Consider two situations, both with very large (effectively infinite) planes of charge, with the same uniform charge per area σ:

I. A plane of charge completely isolated in space:

\+ +

II. A plane of charge on the surface of a metal in equilibrium:

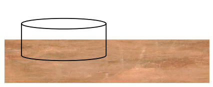
\+ +

Which situation has the larger electric field above the plane?

A) I B) II C) I and II have the same size E-field

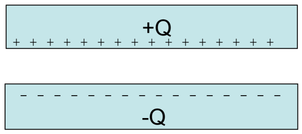
2.34

We have a large copper plate with uniform surface charge density σ. Imagine the Gaussian surface drawn below. Calculate the E-field a small distance s *above* the conductor surface.



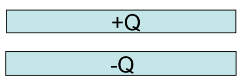
A) $|E| = \sigma/\varepsilon_0$
B) $|E| = \sigma/2\varepsilon_0$
C) $|E| = \sigma/4\varepsilon_0$
D) $|E| = (1/4\pi\varepsilon_0)(\sigma/s^2)$
E) $|E| = 0$

2.49 Given a pair of very large, flat, conducting capacitor plates with surface charge densities +/- σ, what is the E field in the region between the plates?



A) $\sigma/2\varepsilon_0$
B) σ/ε_0
C) $2\sigma/\varepsilon_0$
D) $4\sigma/\varepsilon_0$
E) Something else

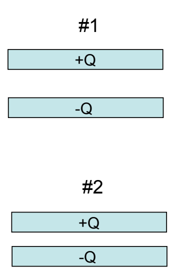
2.49m Given a pair of very large, flat, conducting capacitor plates with total charges +Q and –Q. Ignoring edges, what is the equilibrium distribution of the charge?



A) Throughout each plate
B) Uniformly on both side of each plate
C) Uniformly on top of + Q plate and bottom of –Q plate
D) Uniformly on bottom of +Q plate and top of –Q plate
E) Something else

2.50

You have two parallel plate capacitors, both with the same area and the same charge Q.
Capacitor #1 has twice the gap of Capacitor #2.
Which has more stored potential energy?

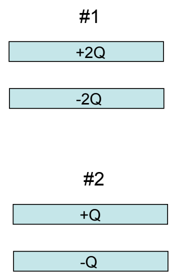


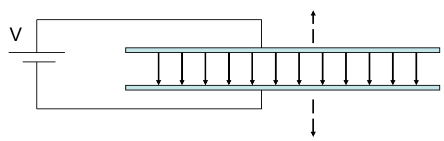
A) #1 has twice the stored energy
B) #1 has *more* than twice
C) They both have the same
D) #2 has twice the stored energy
E) #2 has more than twice.

2.51

You have two parallel plate capacitors, both with the same area and the same gap size.
Capacitor #1 has twice the charge of #2.
Which has more capacitance? More stored energy?

A) C1>C2, PE1>PE2
B) C1>C2, PE1=PE2
C) C1=C2, PE1=PE2
D) C1=C2, PE1>PE2
E) Some other combination!





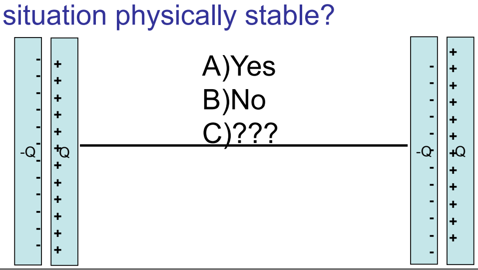
A parallel plate capacitor is attached to a battery which maintains a constant voltage difference V between the capacitor plates. While the battery is attached, the plates are pulled apart. The electrostatic energy stored in the capacitor

A) increases
B) decreases
C) stays constant.

3.4

Two very strong (big C) ideal capacitors are well separated.

What if they are connected by one thin conducting wire, is this electrostatic situation physically stable?



A)Yes
B)No
C)???