Review Exam 1

CH 22, CH 23, CH 24

Q.1

At a certain distance from a charged particle, the magnitude of the electric field is 456 V/m and the electric potential is -2.60 kV.

(a) What is the distance to the particle?
5.7 m
(b) What is the magnitude of the charge?
1.65 µC

Q2.

Over a certain region of space, the electric potential is $V = 3x - 2x^2y + 7yz^2$.

(a) Find the expressions for the x, y, z components of the electric field over this region. (Use any variable or symbol stated above as necessary.)

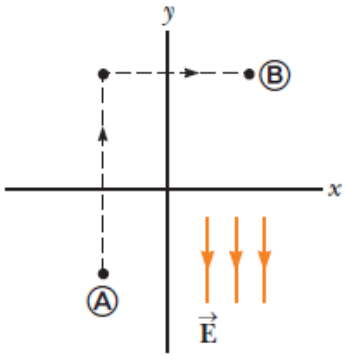
Ex = -3 + (2*2*x*y)
Ey = $2*x^2- 7*z^2$
Ez = -2*7*y*z
(b) What is the magnitude of the field at the point P that has coordinates (1.00, 0, -5.00) m?

173 N/C

Q.3

A uniform electric field of magnitude 315 V/m is directed in the negative *y* direction as shown in the figure below. The coordinates of point Ⓐ are (−0.850, −0.650) m, and those of point Ⓑ are

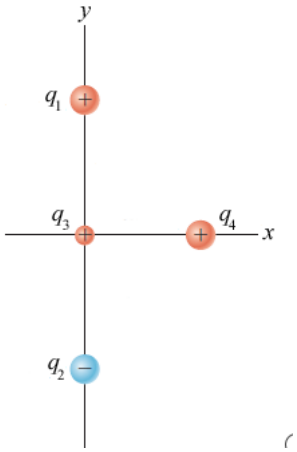
(0.200, 0.450) m. Calculate the electric potential difference $V_B - V_A$ using the dashed-line path.
347 V



Q. 4

Three charged particles of q_1 = 70.0 nC, q_2 = −70.0 nC, and q_3 = 35.0 nC are placed on the y-axis, as shown in the figure.
Charge q_1 has the coordinates (0, 12.0 cm),q_2 has the coordinates (0, −12.0 cm),and q_3 is located at the origin.
(a)Find the electric potential energy (in J) of the configuration of the three fixed charges.

-0.000184 J



(b)A fourth particle, with a mass of 1.74 × 10^{-13} kg and a charge of q_4 = 140.0 nC, is released from rest at the point
(9.00 cm, 0).Find its speed (in m/s) after it has moved freely to a very large distance away.

75000 m/s

Q. 5

(a) Find the electric potential difference ΔV_e required to stop an electron (called a "stopping potential") moving with an initial speed of 2.88 × 10^7 m/s.

-2.36 kV

(b) Would a proton traveling at the same speed require a greater or lesser magnitude of electric potential difference?

greater

(c) Find a symbolic expression for the ratio of the proton stopping potential and the electron stopping potential, $\Delta V_p/\Delta V_e$. (Use the following as necessary: m_p for the mass of proton and m_e for the mass of electron.)

$= -\frac{m_p}{m_e}$

Q.6

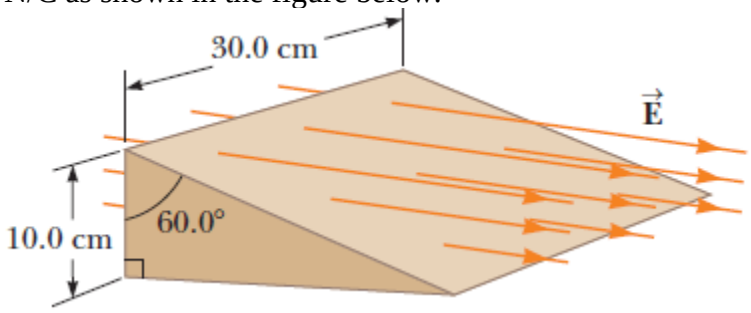
Oppositely charged parallel plates are separated by 4.84 mm. A potential difference of 600 V exists between the plates.
(a) What is the magnitude of the electric field between the plates?
1.24e+05 N/C

(b) What is the magnitude of the force on an electron between the plates?
1.98e-14 N

(c) How much work must be done on the electron to move it to the negative plate if it is initially positioned 2.96 mm from the positive plate?
3.73e-17 J

Q.7

Consider a closed triangular box resting within a horizontal electric field of magnitude E = 8.68 10^4 N/C as shown in the figure below.



(a)Calculate the electric flux through the vertical rectangular surface of the box.
-2.6 kN · m^2/C

(b) Calculate the electric flux through the slanted surface of the box.
2.6 kN · m^2/C

(c) Calculate the electric flux through the entire surface of the box.
0 kN · m^2/C

Q.8

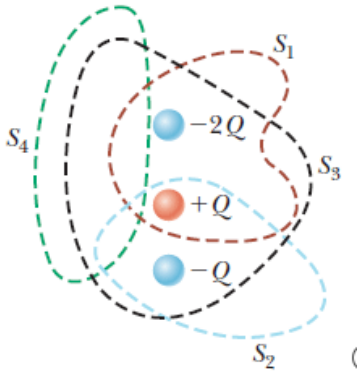
Four closed surfaces, S1 through S4, together with the charges −2Q, Q, and −Q are sketched in the figure below. (The colored lines are the intersections of the surfaces with the page.) Find the electric flux through each surface. (Use the following as necessary: $\varepsilon 0$ and Q.)

Φ_{S1} = 1a $-\frac{Q}{\epsilon_0}$

Φ_{S2} = 1b 0

Φ_{S3} = 1c $\frac{-2 \cdot Q}{\epsilon_0}$

Φ_{S4} = 1d 0



Q.9

(a)A solid sphere, made of an insulating material, has a volume charge density of ρ = a/r, where r is the radius from the center of the sphere, a is constant, and a > 0. What is the electric field within the sphere as a function of the radius r? Note: The volume element dV for a spherical shell of radius r and thickness dr is equal to $4\pi r^2 dr$. (Use the following as necessary: a, r, and ε_0.)

Magnitude E = $\frac{a}{2\epsilon_0}$ radially outward

(b)What If? What if the charge density as a function of r within the charged solid sphere is given by $\rho = a/r^2$?

Find the new magnitude and direction of the electric field within the sphere at radius r. (Use the following as necessary: a, r, and ε_0.)

magnitude E = $\frac{a}{\epsilon_0 r}$ radially outward

Q.10

A long, straight metal rod has a radius of 4.60 cm and a charge per unit length of 22.8 nC/m. Find the electric field at the following distances from the axis of the rod, where distances are measured perpendicular to the rod's axis.

(a) 2.70 cm

magnitude 0 N/C

direction magnitude is zero

(b) 14.0 cm

magnitude 2930 N/C

direction outward

(c) 140 cm

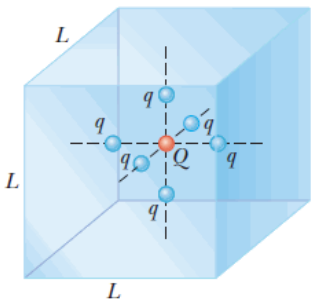
magnitude 293 N/C

direction outward

Q.11

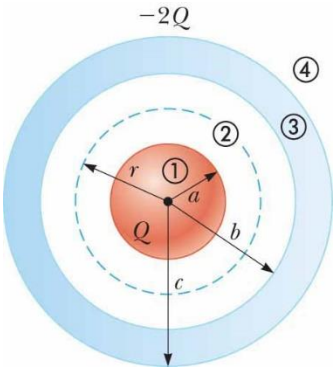
A particle with charge Q = 5.10 μC is located at the center of a cube of edge L = 0.120 m. In addition, six other identical charged particles having q = −1 μC are positioned symmetrically around Q as shown in the figure below. Determine the electric flux through one face of the cube.

-16.9 kN · m^2/C



Q.12

A solid insulating sphere of radius a carry a net positive charge Q uniformly distributed throughout its volume. A conducting spherical shell of inner radius b and outer radius c is concentric with the solid sphere and carries a net charge $-2Q$. Using Gauss's law, find the electric field in the regions labeled 1, 2, 3, and 4 and the charge distribution on the shell when the entire system is in electrostatic equilibrium.



$E_1 = k_e \frac{Q}{a^3} r \quad (\text{for } r < a)$

$E_2 = k_e \frac{Q}{r^2} \quad (\text{for } a < r < b)$

$E_3 = 0 \quad (\text{for } b < r < c)$

$E_4 = -k_e \frac{Q}{r^2} \quad (\text{for } r > c)$

$q_{\text{inner}} = -Q$

$q_{\text{outter}} = -Q$

Q.13

(a)A small amber bead with a mass of 18.4 g and a charge of −0.746 μC is suspended in equilibrium above the center of a large, horizontal sheet of glass that has a uniform charge density on its surface. Find the charge per unit area on the glass sheet (in μC/m²).

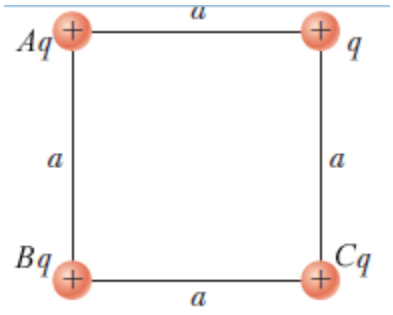
-4.28 μC/m²

(b)**What If?** What are the magnitude and direction of the acceleration of the piece of amber if its charge is doubled? (Enter the magnitude in m/s².)

magnitude 9.8 m/s² direction upward

Q.14. a

In the figure below, each charged particle is located at one of the four vertices of a square with side length = *a*.In the figure, *A* = 5,*B* = 4, and *C* = 7,and *q* > 0.
What is the expression for the magnitude of the electric field in the upper right corner of the square (at the location of *q*)? (Use the following as necessary: *q*, *a*, and k_e.) and direction.



E = $10.58k_e\frac{q}{a^2}$ 52.7 ° (counterclockwise from the +*x*-axis)

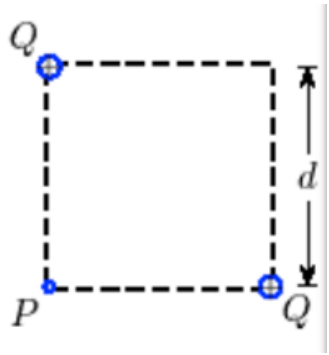
(b)Determine the expression for the total electric force exerted on the charge *q*. (Enter the magnitude. Use the following as necessary: *q*, *a*, and k_e.) and direction.

F = $10.58k_e\frac{q^2}{a^2}$ 52.7 ° (counterclockwise from the +*x*-axis)

Q.14. b

Two particles, each with charge +Q, are located at the opposite corner of a square of side d. Given Q = 15 nC and d = 0.5 m, what is the magnitude and direction of electric field at point P?

764 N/C, -135 º CW from the +x axis



Q.15. a

A proton moves at 5.20×10^5 m/s in the horizontal direction. It enters a uniform vertical electric field with a magnitude of 7.60×10^3 N/C. Ignore any gravitational effects.

(a) Find the time interval required for the proton to travel 4.50 cm horizontally.

86.5 ns

(b) Find its vertical displacement during the time interval in which it travels 4.50 cm horizontally. (Indicate direction with the sign of your answer.)

2.73 mm

(c) Find the horizontal and vertical components of its velocity after it has traveled 4.50 cm horizontally.

$\vec{v}$ = (520 $\hat{i}$ + 63 $\hat{j}$) km/s

Q.15. b

A proton accelerates from rest in a uniform electric field of 680 N/C. At one later moment, its speed is 1.60 Mm/s (nonrelativistic because v is much less than the speed of light).

(a) Find the acceleration of the proton.

6.52e+10 m/s^2

(b) Over what time interval does the proton reach this speed?

2.45e-05 s

(c) How far does it move in this time interval?

19.6 m

(d) What is its kinetic energy at the end of this interval?

2.14e-15 J

Q.16

In a thundercloud there may be electric charges of +36.0 C near the top of the cloud and -36.0 C near the bottom of the cloud. These charges are separated by 2.30 km. What is the electric force on the top charge?

magnitude

2.20e+06

Ndirection

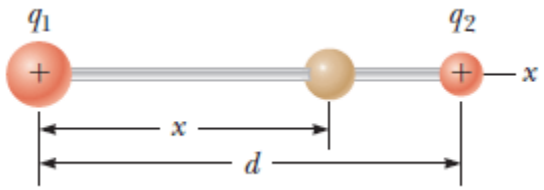
attractive repulsive

Q.17

Two small beads having positive charges $q_1 = 19q$ and $q_2 = q$ are fixed at the opposite ends of a horizontal insulating rod of length $d = 1.50$ m. The bead with charge q_1 is at the origin. As shown in the figure below, a third small, charged bead is free to slide on the rod.

At what position x is the third bead in equilibrium?

x =1.22m



Q.18

(a) A ball is attached to a filament of length L = 23.1 cm and suspended from the ceiling, as shown in the figure. A uniform electric field points to the right in the figure. When θ = 17.2°,the ball is in equilibrium. Find the net charge on the ball (in μC).

6.07 μC

(b)**What If?** If the electric field is suddenly turned off, what is the speed of the ball at the bottom of its swing (in m/s)?

0.45 m/s

Q.19

The figure below shows the electric field lines for two charged particles separated by a small distance.

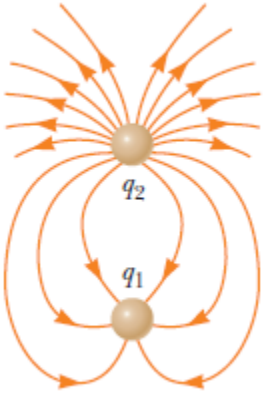
(a) Determine the ratio q_1/q_2.

-0.333

(b) What are the signs of q_1 and q_2?

q_1 negative

q_2 positive



Q 20

As shown in the figure, a charge $q_1 = 2.00\ \mu C$ is located at the origin and a charge $q_2 = -6.00\ \mu C$ is located at (0, 3.00) m.

(A) Find the total electric potential due to these charges at the point P, whose coordinates are (4.00, 0) m.

-6.29×10^{3} V