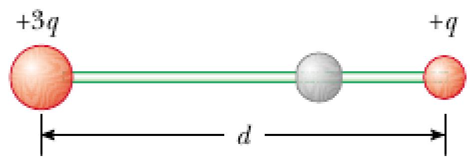
Physics 207 – Exam 1

Sections (519-524; 525-530) – February 16, 2022

1) [8 pts] A negative charge of -0.51 μC exerts an upward 0.70 N force on an unknown charge that is located 3 cm directly above the first charge. The sign and magnitude of the unknown charge is

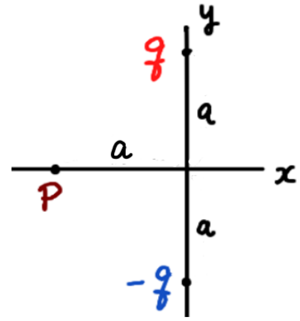
A) positive, 1370 μC
B) positive, 137.0 μC
C) positive, 13.7 μC [4]
D) positive, 1.37 μC
E) negative, 1370 μC [4]
F) negative, 137.0 μC [2]
G) negative, 13.7 μC [8]

2) [8 pts] Two small beads having positive charges ***3q*** (placed at x=0) and ***q*** (placed at x=d) are fixed at the opposite ends of a horizontal insulating rod extending from the origin to the point x=d. A third small charged bead is free to slide on the rod as shown in the Figure. At what position is the third bead in equilibrium?



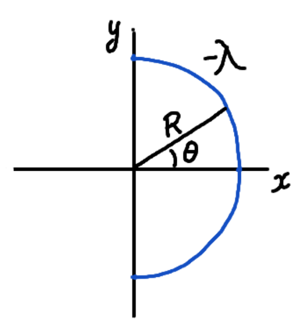
A) $x = \frac{d}{\sqrt{3}+1}$ [4]
B) $x = \frac{d}{\sqrt{3}}$
C) $x = \frac{\sqrt{3}d}{\sqrt{3}+1}$ [8]
D) $x = \frac{2d}{\sqrt{3}+1}$ [4]
E) $x = \frac{d}{2}$
F) $x = \frac{3d}{4}$
G) $x = \frac{d}{3}$

3) [8 pts] Two point-charges are located on the y-axis; charge **+*q*** at $y = a$ and charge **-*q*** at the y= $-a$. Calculate the electric field vector on the position P as shown**.**



A) $\vec{E} = \frac{kq}{\sqrt{2}a^2}(\hat{\mathbf{i}}+\hat{\mathbf{j}})$ [2]
B) $\vec{E} = -\frac{kq}{\sqrt{2}a^2}\hat{\mathbf{j}}$ [8]
C) $\vec{E} = \frac{kq}{\sqrt{2}a^2}\hat{\mathbf{j}}$ [6]
D) $\vec{E} = \frac{kq}{a^2}(\hat{\mathbf{i}}+\hat{\mathbf{j}})$
E) $\vec{E} = \frac{kq}{\sqrt{2}a^2}\hat{\mathbf{i}}$ [4]
F) $\vec{E} = \frac{kq}{a^2}\hat{\mathbf{i}}$

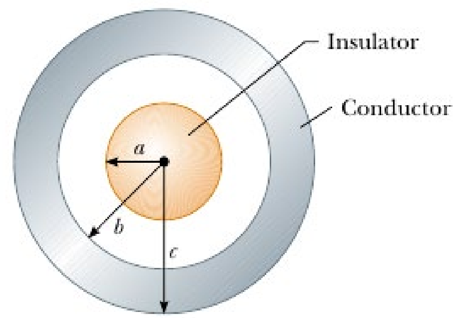
4) [8 pts] A uniform line of charge is formed into a semicircle of radius ***R*** shown in Figure. The charge per unit length is **-λ.** The electric field vector at the origin is



A) $\vec{E} = \frac{k\lambda}{R}\hat{\boldsymbol{i}}$ [2]
B) $\vec{E} = \frac{2k\lambda}{R}\hat{\boldsymbol{i}}$ [8]
C) $\vec{E} = -\frac{k\lambda}{R}\hat{\boldsymbol{i}}$
D) $\vec{E} = -\frac{2k\lambda}{R}\hat{\boldsymbol{i}}$ [6]
E) $\vec{E} = \frac{k\lambda}{R}(\hat{\boldsymbol{i}}+\hat{\boldsymbol{j}})$
F) $\vec{E} = -\frac{k\lambda}{R}(\hat{\boldsymbol{i}}+\hat{\boldsymbol{j}})$

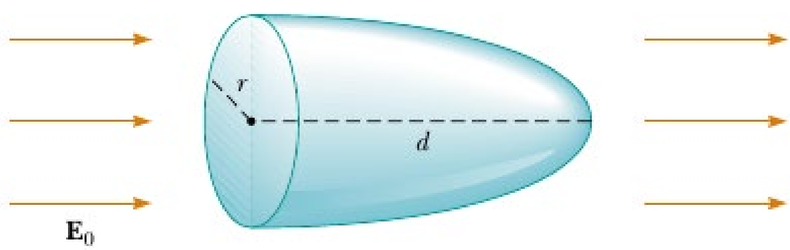
5) [8 pts] A solid, insulating sphere of radius ***a*** has a uniform charge density ***ρ*** and a total charge ***Q***. Concentric with this sphere is an uncharged, conducting hollow sphere whose inner and outer radii are ***b*** and ***c***, as shown in the Figure. Determine the induced charge per unit area on the inner and outer surfaces of the hollow sphere.

A) $\sigma_b = \frac{-Q}{4\pi b^2}$ $\quad \sigma_c = \frac{Q}{4\pi c^2}$ [8]
B) $\sigma_b = \frac{-Q}{4\pi b^2}$ $\quad \sigma_c = 0$ [4]
C) $\sigma_b = \frac{Q}{4\pi b^2}$ $\quad \sigma_c = \frac{-Q}{4\pi c^2}$ [6]
D) $\sigma_b = 0$ $\quad \sigma_c = 0$
E) $\sigma_b = 0$ $\quad \sigma_c = \frac{Q}{4\pi c^2}$ [4]
F) $\sigma_b = 0$ $\quad \sigma_c = \frac{-Q}{4\pi c^2}$
G) $\sigma_b = -Q$ $\quad \sigma_c = Q$



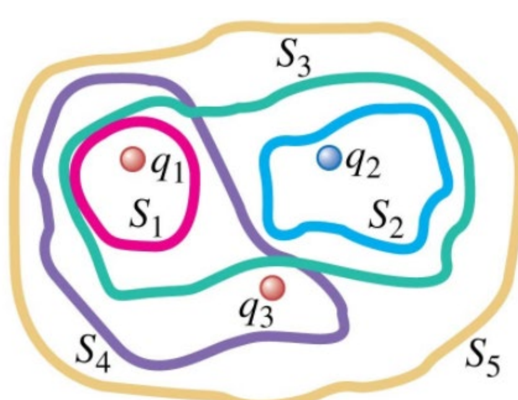
6) [7 pts] Consider a closed surface that consists of a disc and a parabolic surface. Calculate the total electric flux through only the paraboloidal surface due to a constant electric field of magnitude E_0in the direction shown in the Figure.

A) 0 [2]
B) $\pi r^2 E_0$ [7]
C) $-\pi r^2 E_0$ [4]
D) $\pi r d E_0$
E) $-\pi r d E_0$
F) $E_0 r\, d/\varepsilon_0$
G) $-E_0 r\, d/\varepsilon_0$



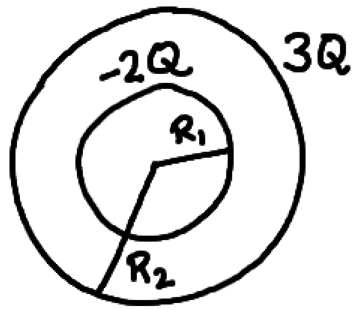
7) [7 pts] Charges q_1= Q, q_2=3Q and q_3=-3Q are enclosed by surface S_1, S_2, S_3, S_4 and S_5. Which two surfaces enclose the same amount of flux?

A) S_1 and S_2
B) S_2 and S_3
C) S_3 and S_4
D) S_4 and S_5
E) S_5 and S_1 [7]
F) S_1 and S_3
G) S_3 and S_5



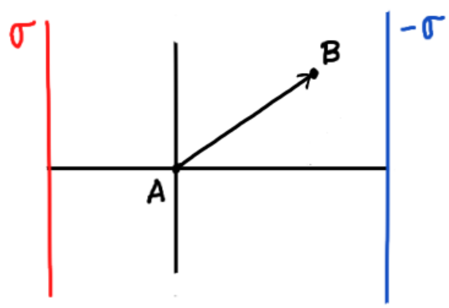
8) [8 pts] Two concentric spherical surfaces have radii R_1 and R_2 with $R_1 < R_2$. A total charge of -2Q is uniformly spread on the inner surface and a total charge of 3Q is spread on the outer surface. The electric field vector in the region between the two surfaces, at R1 < r < R2, is

A. $\frac{kQ}{r^2}\hat{\boldsymbol{r}}$ [2]
B. $-\frac{kQ}{r^2}\hat{\boldsymbol{r}}$
C. $\frac{k2Q}{r^2}\hat{\boldsymbol{r}}$ [6]
D. $-\frac{k2Q}{r^2}\hat{\boldsymbol{r}}$ [8]
E. $\frac{k3Q}{r^2}\hat{\boldsymbol{r}}$
F. $-\frac{k3Q}{r^2}\hat{\boldsymbol{r}}$
G. $-\frac{k2Q}{r}\hat{\boldsymbol{r}}$



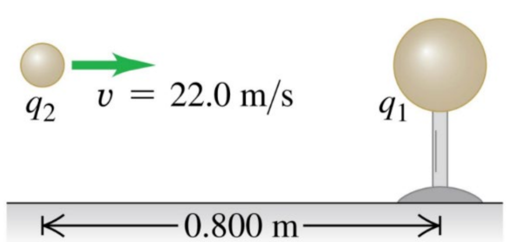
9) [8 pts] The work (per unit charge) done by the electric field from A=(0,0) to B=(a,b) inside of two uniformly charged planes with surface charge densities σ and –σ as shown is

A) $\frac{\sigma}{2\varepsilon_0}a$ [3]
B) $-\frac{\sigma}{2\varepsilon_0}a$ [2]
C) $\frac{\sigma}{\varepsilon_0}a$ [8]
D) $-\frac{\sigma}{\varepsilon_0}a$ [4]
E) $\frac{\sigma}{\varepsilon_0}\sqrt{a^2+b^2}$
F) $-\frac{\sigma}{\varepsilon_0}\sqrt{a^2+b^2}$
G) 0



10) [8 pts] A point particle of mass *m* charge q_2 is moving horizontally toward another charged particle with charge q_1 fixed in place. When q_2 is at distance of 0.8 m from q_1 it is moving with velocity v=22.0 m/s. If it is known that $m/(kq_1q_2)=7.63\times10^{-3}$ in MKS units, the closest distance that q_2 can approach q_1 is

A) 1.677 m [2]
B) 1.256 m
C) 0.982 m
D) 0.542 m [3]
E) 0.637 m
F) 0.323 m [8]
G) 0.246 m



11) [8 pts] Two point-charges, 2q and -q are placed on the y-axis as shown, the line integral of their combined electric field along any path from A to B is

A. $k\frac{q}{a} - k\frac{2q}{b}$

B. $k\frac{q}{a} - k\frac{q}{b} + k\frac{q}{\sqrt{b^2+a^2}}$

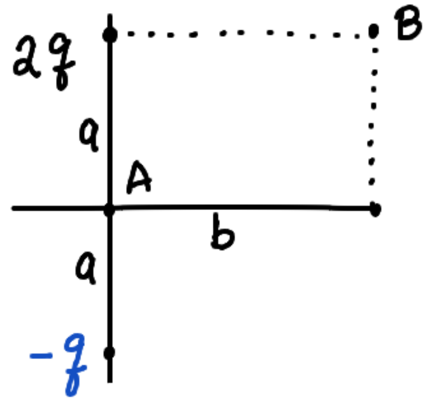
C. $k\frac{q}{a} - k\frac{q}{b} + k\frac{q}{\sqrt{b^2+a^2}}$

D. $k\frac{q}{a} - k\frac{2q}{b} + k\frac{q}{\sqrt{b^2+a^2}}$ [2]

E. $-k\frac{q}{a} + k\frac{2q}{b} - k\frac{q}{\sqrt{b^2+4a^2}}$ [6]

F. $k\frac{q}{a} - k\frac{2q}{b} + k\frac{q}{\sqrt{b^2+4a^2}}$ [8]

G. $k\frac{q}{a} + k\frac{2q}{b} + k\frac{q}{\sqrt{b^2+4a^2}}$ [2]



12) [7 pts] Two semicircular arcs of radius *a* and *2a* are uniformly charged with total charge of -*Q* and *Q* respectively as shown. The electric potential due to these two charge arcs at the origin is

A. $k\frac{Q}{a}$

B. $-k\frac{Q}{a}$ [2]

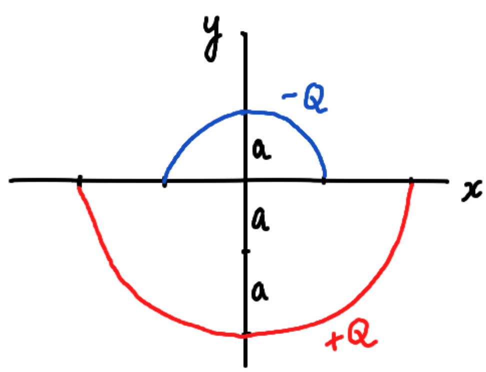
C. $k\frac{Q}{2a}$ [2]

D. $-k\frac{Q}{2a}$ [7]

E. $k\frac{3Q}{2a}$

F. $-k\frac{3Q}{2a}$

G. 0



13) [7 pts] Positive charge Q is uniformly distributed along the x-axis from x=0 to x=a as shown. A positive point charge q is located on the positive x-axis at x=a+r. The potential energy of this charge configuration is

A. $\frac{kQq}{a}$

B. $\frac{kQq}{a+r}$

C. $\frac{kQq}{a-r}$

D. $\frac{kQq}{a}\left(\frac{1}{r} - \frac{1}{a+r}\right)$ [2]

E. $\frac{kQq}{a}\left(\frac{1}{a+r} - \frac{1}{r}\right)$

F. $\frac{kQq}{a}\ln\left(\frac{r+a}{r}\right)$ [7]

G. $\frac{kQq}{a}\ln\left(\frac{r}{r+a}\right)$ [3]