‘On my honor, I have neither received nor given aid on this examination.’

DO THE MULTIPLE CHOICE QUESTIONS AND THE TWO PROBLEMS.

NAME: ____________________________

SIGNATURE: _______________________

I.D. # ____________________________

Discussion Sec. __________________

1. The figure below shows electric field lines for a system of two small spheres of charge. Which of the following describes possible values for the charges of the (left, right) spheres?

   (1) (-3nC, +nC) (2) (3nC, +6nC) (3) (+15nC, -5nC) (4) (-15nC, +5nC) (5) (3nC, -6nC)

2. A uniform charge per area (call it \( \sigma \)) is located on the outer surface of a hollow, but thick, spherical conducting shell with inner radius 3\( R \) and outer radius 6\( R \). The total charge everywhere on the conductor is 3\( Q \). The conducting shell also surrounds a point charge 3\( Q \) at its center. What is the correct relation between total charge and
and $\sigma$?

1. $Q = \sigma / 4\pi R^2$
2. $\sigma = Q / 12\pi R^2$
3. $Q = \sigma / 8\pi R^2$
4. $\sigma = Q / 24\pi R^2$

5. There is no relation between $Q$ and $\sigma$.

3. What is the electric field $\mathbf{E}$ at a point a distance $r < R$ from the origin, inside a solid sphere of radius $R$, of uniform volume charge density $\rho$?

1. $\mathbf{r} \rho R^2 / (3\varepsilon_0 r)$
2. $\mathbf{r} kq / 3(Rr)$
3. 0
4. $\mathbf{r} \rho r / (3\varepsilon_0)$
5. $\mathbf{r} kq / (3Rr^2)$.

4. If a point charge is located at the center of a cylinder and the electric flux leaving one end of the cylinder is 20% of the total flux leaving the cylinder, what portion of the flux leaves the curved surface of the cylinder?

1. 80%
2. 40%
3. 100%
4. 60%
5. 20%.

5. The electric field along the axis of the dipole, and at large distances $x$ from the center of the dipole, compared to the charge separation

1. decreases inversely with the square of the distance,
2. decreases inversely with the cube of the distance,
3. remains constant as the distance decreases,
4. decreases linearly with increasing distance,
5. cannot be determined.
6. Three small beads of mass $m$ each are threaded into a thin stiff, straight rod with the
two end beads glued at either end at a distance $2a$ from each other. Take the thin
rod to be on the x-axis. The third bead in the middle is free to slide without friction
along the rod. Now all three beads are charged with the same charge $q$ each, and the
middle bead comes to rest at $x = 0$.

If the free to slide middle bead, is moved, to the right a distance $x$ find:

a) Find the net force the two end charges exert on the middle bead when it is in the
   position $x$.

b) If $x << a$ find the approximate value of the force by keeping in your approxima-
tion only terms of magnitude $x/a$ or bigger.

c) Use the approximated force to write the equation of motion ($\vec{F} = m\vec{a}$) if the bead
   is released.

d) Will the bead return to the position it was released from and if so how long after
   its released?

Hint : 
\[(1 + z)^n = 1 + nz + \frac{n(n-1)}{2!} z^2 + \ldots\]

7. An annulus of interior radius $R_1$ and exterior radius $R_2$, is in the $xy$-plane and has a
   uniform area charge density $\sigma$.

   a) Compute the total charge $Q$ on the annulus.

   b) Select an area element $dA$ and write the appropriate charge element $dq$.

   c) Write the element of the electrical field $d\vec{E}$ at the point $P$ on the $z$-axis of given
      coordinate $z$.

   d) Find the electric field $\vec{E}$ at at the point $P$ on the $z$-axis of given coordinate $z$, due
      to the annulus.

Essay problems: Show your work. No work means no credit