

Name: _____

Physics 272 Exam Practice Problems

On the midterm there will be 4 problems. Each is assigned 25 points.

Three require detailed calculations and one is conceptual.

You may bring a single 3 x 5 notecard and a calculator.

Problem 1: 25 points

A point charge of $5 \mu\text{C}$ is on the y-axis at $y = 3 \text{ cm}$, and a second charge of $-5 \mu\text{C}$ is on the y-axis at $y = -3 \text{ cm}$.

Find the force on a charge of $2\mu\text{C}$ on the x-axis at $x = 8 \text{ cm}$.
(Hint: first draw a diagram)

Problem 2: 25 points

Two small spheres, each with mass $m = 3.0$ g and charge q are suspended from a point by threads of length $L = 0.22$ m.

What is the charge on each sphere if the threads make an angle $\theta = 15^\circ$ with the vertical ?

Problem 3: 25 points

A point charge $q = +2\mu\text{ C}$ is at the center of a sphere of radius 0.5 m.

- (a) Find the *surface area* of the sphere
- (b) Find the *magnitude of the electric field* at the surface of the sphere.
- (c) What is the direction of the electric field ?
- (d) What is the **flux** of the electric field due to the point charge through the surface of the sphere ?
- (e) How would your answer to part (d) *change* if the point charge were moved 0.1 m from the center of the sphere ?
- (f) What is the net **flux** through a cube (side length 1 m) that encloses the sphere ?

Problem 4: 25 points

Suppose a non-conducting sphere of radius R has a *non-uniform* charge density $\rho(r) = C/r^2$ inside.

- (a) Draw a sketch of this sphere.
- (b) Find the electric field inside the sphere. (show the Gaussian surface used on your sketch).
- (c) Find the electric field outside of the sphere. (show the Gaussian surface used on your sketch).

Problem 5: 25 points

Two long cylindrical shell conductors carry equal and opposite charges. The inner shell has radius a and charge q ; the outer shell has radius b and charge $-q$. The length of each cylindrical shell is L .

- (a) Draw a sketch of this configuration.
- (b) What is the E field inside, outside, and in-between the cylinders ?
- (c) Find the *potential difference* between the two shells (i.e. $V_a - V_b$). (your answer should be given in terms of a , b and q .)

Problem 6: 25 points

A ring of radius 5 cm is in the y - z plane with its center at the origin. The ring carries a uniform charge of 10 nC. A small particle of mass $m = 10$ mg and charge $q_0 = 5$ nC is placed at $x = 12$ cm and released.

- (a) What is the initial potential energy of the particle ?
- (b) What is the speed of the particle when it is a great distance away from the ring ?

Problem 7: 25 points

(a) Two equal point charges (Q) are located on the x-axis at $x = -3m$ and $x = 3m$. What is the \vec{E} field at the origin? What is the electric potential at the origin?

(b) Explain why the electric field increases with r rather than decreasing as $1/r^2$ as one moves out from the center inside a spherical charge distribution with constant volume charge density.

(c) Three charges $+q$, $+Q$, $-Q$ are placed at the corners of an equilateral triangle as shown. What is the *direction of the net force* on charge $+q$?

(d) Two solid charged metal cylinders are connected by a conducting wire. Cylinder A is much larger than cylinder B, is the magnitude of the electric potential of cylinder A (*larger, smaller, or the same*) as that of cylinder B? Explain.

(e) One electron is accelerated through a potential difference of 10 kV. Another electron is accelerated through a potential difference of 20 kV. What is the ratio of the final velocities of the two electrons?