EXAM I Physics 208 SPRING 2014

Name..Section Number......

USEFUL INFORMATION

For two point particles

$$\vec{F} = \frac{1}{4\pi\epsilon_0} \frac{q_1 q_2}{r^2} \hat{r}$$

$$Volume \quad of \quad a \quad sphere = \frac{4}{3}\pi r^3$$

$$Area \quad of \quad a \quad sphere = 4\pi r^2$$

$$d\vec{r} = dx\vec{i}_x + dy\vec{i}_y \qquad d\vec{r} = dr\vec{i}_r + rd\theta\vec{i}_\theta$$

PLEASE DO NOT SPEND TIME DOING NON-TRIVIAL INTEGRALS

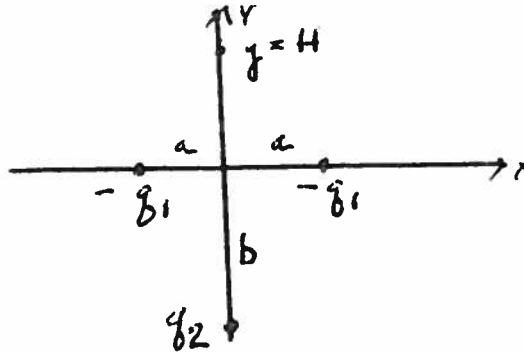Only integrals like $\int kx^n dx$ are considered trivial

1.

2.

3.

4.

1. (25 points) Three charges are placed as shown.

The distances a and b are known. The charges on the x axis are known and negative, $-q_1$. The charge q_2 at $y = -b$ is unknown. What must be the unknown charge q_2 if the electric field is to be zero at $x = 0, y = H$? Here H is known and positive.

Law

Application

Result What does your answer reduce to if $a = b = H$?

2. (25 points)An amount of charge Q is distributed along the y axis from $y = H$ to $y = 2H$.
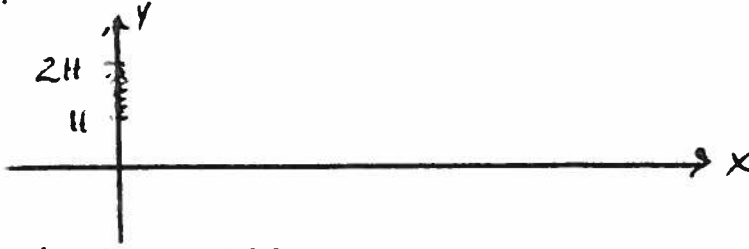
Find the electric potential function at any point on the x axis. For 20 points, first do this assuming the charge is uniformly distributed. For 5 more points, then do it if the charge per unit length between $y = H$ and $y = 2H$ is $\lambda(y) = Q_0(\frac{y}{H})$.

Law

Application

Result

3. (25 points) Suppose the force exerted on a point charge q_0 by a point charge Q was given by

$$\vec{F} = C\frac{q_0 Q}{r^4}\hat{r}$$

where, just like in the Coulomb force, r is the distance between the points, $\hat{r}$ is along the line from one point to the other and C is a positive, known constant. The force is repulsive for these two positive charges. What would be the work done by this force if the charge Q were fixed at $(x = a, y = 0)$ and the charge q_0 moved from $(x = 0, y = b)$ to $(x = 2a, y = b)$?
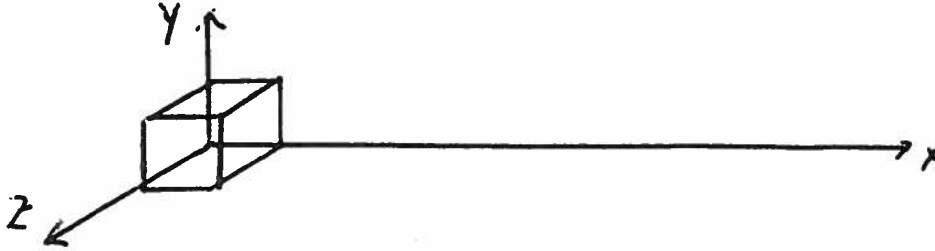
Law

Application

Result

4. (25 points)A cube with sides of length a is located with one corner at the origin. An electric field is present which is given by

$$\vec{E} = \alpha x^2 \vec{i}_x + \beta xy \vec{i}_y$$

where α and β are known constants. How much charge is contained inside the cube?

Law

Application

Result