Physics 208, Spring 2015 – Exam #1

A

Name (Last, First): _____

ID #: _____

Section #: _____

- You have 75 minutes to complete the exam.
- Formulae are provided on a separate colored sheet. **You may NOT use any other formula sheet.**
- You may use only a simple calculator: one without memory, or with a memory demonstrated to be cleared.
- When calculating numerical values, be sure to keep track of units. Results must include proper units.
- Be alert to the number of significant figures in the information given. Results must have the correct number of significant figures.
- If you are unable to solve part of a problem whose solution is needed in another part of the problem, then assign a symbol for the solution of the first part and use that symbol in solving the second/later part of the problem.
- If you need additional space to answer a problem, use the back of the sheet it is written on **AND ensure to note on the main page of the problem that you have continued your work overleaf.**
- Also, **Show your work**. Without supporting work, the answer alone is worth nothing.
- Mark your answers clearly by drawing boxes around them.
- This booklet has 7 pages. **DO NOT remove any sheets.**
- Please write clearly. You may gain marks for a partially correct calculation if your work can be deciphered.

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Multiple Choice (20 points)	Problem 1 (20 points)	Problem 2 (20 points)	Problem 3 (20 points)	Problem 4 (20 points)	TOTAL (100 points)

MULTIPLE CHOICE: *Clearly mark the correct option(s)* [Each MC: 5 points. Total: 20 points]

1. A net positive charge $+Q_0$ is placed on a *conducting* parallelepiped. The length of *all sides* of the parallelepiped is $\boldsymbol{a}$. Consider the three Gaussian surfaces – a cubic surface, a parallelepiped and a spherically symmetric surface as shown in figures labeled A, B and C below.

Fig A.

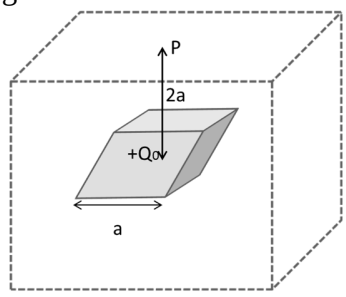


Fig B.

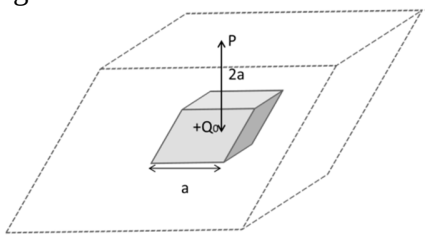
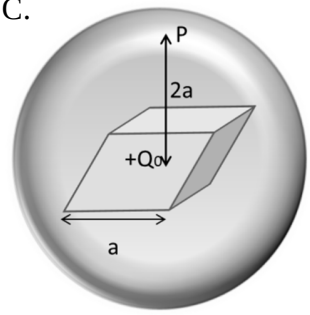


Fig C.



Which of the following are ***correct statements*** for the **magnitude of the E-field at point P** that is located a distance $2a$ from the center of the conducting parallelepiped as shown in the figures above. [In the options below, *σ represents the surface charge density* and $\boldsymbol{k = 1/4\pi\varepsilon_0}$].

i) The E-field at P is $\frac{kQ_0}{4a^2}$ if we choose the Gaussian surface in figure A

ii) The E-field at P is σ/ε_0 if we choose the Gaussian surface in figure A

iii) The E-field at P is $\frac{kQ_0}{4a^2}$ if we choose the Gaussian surface in figure B

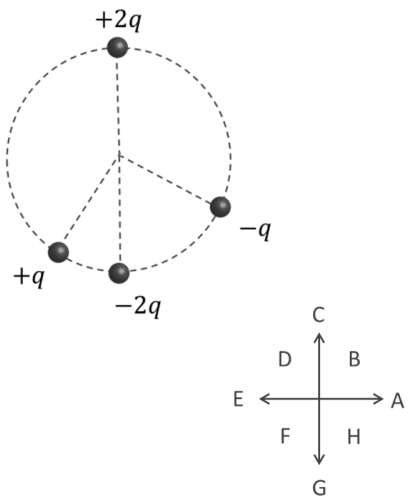
iv) The E-field at P is σ/ε_0 if we choose the Gaussian surface in figure B

v) The E-field at P can only be $\frac{kQ_0}{4a^2}$ if we choose the Gaussian surface in figure C

vi) None of the above Gaussian surfaces can be used to estimate the E-field at point P.

vii) The E-field at Point P is *zero* because the charges are in the inner parallelepiped and not *ON* the Gaussian surface.

2. Four point charges, *with a net charge of zero* are placed in a circle as shown in the adjoining figure. Select the *correct direction* for the total electric field at the center of the circle and mark your choice in the options below.

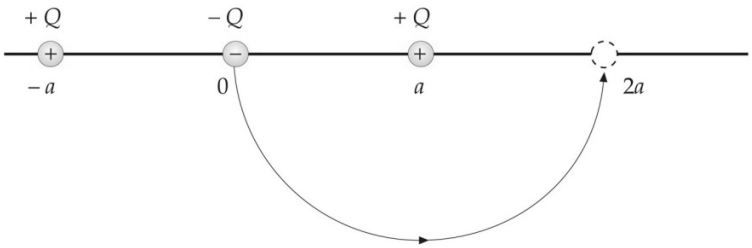


i) Along direction A
ii) In sector/quadrant B.
iii) Along direction C
iv) In sector/quadrant D.
v) Along direction E
vi) In sector/quadrant F.
vii) Along direction G
viii) In sector/quadrant H.
ix) None of the above. The net E-field at the center is zero by Gauss's law.

3. A solid conducting sphere of radius $\boldsymbol{b}$ carries a net charge of $-Q$. Select the correct option on the right panel, for the electric potential $V(r)$ at a radial distance of ($\boldsymbol{r = b/2}$) from the center of the sphere, with respect to the potential of the sphere at infinity. [Note: $k = 1/4\pi\varepsilon_0$]

a. $-kQ/b$
b. $-2kQ/b$
c. $-4kQ/b$
d. $-kQ/2b$
e. $-kQ/4b$
f. Zero.
g. None of the above

4. Select the correct option on the right panel for the work done by the electric field when the $-Q$ charge is moved from its location at *x=0 to x=2a*, as shown in the figure, while the two positive charges are held at rest. [Note: $k = 1/4\pi\varepsilon_0$]



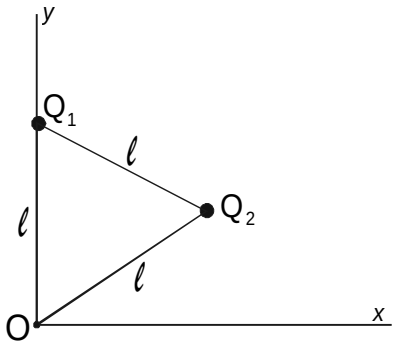
a. $-kQ^2/a$
b. $+kQ^2/a$
c. $-2kQ^2/a$
d. $-kQ^2/2a$
e. $+kQ^2/2a$
f. $-1.33\ kQ^2/a$
g. $-0.67kQ^2/a$
h. $-kQ^2/\pi a$
i. $+kQ^2/\pi a$
j. Zero

1. **(20 marks)** Two 1.0-cm-diameter conducting spheres have a total charge of 75.0 μC (shared between them) and are placed 1.05 m apart. The spheres are not connected to each other.

   a) If the force each exerts on the other is 11.0 N and is attractive, what is the charge on each?
   b) If the force each exerts on the other is 11.0 N and is repulsive, what is the charge on each?

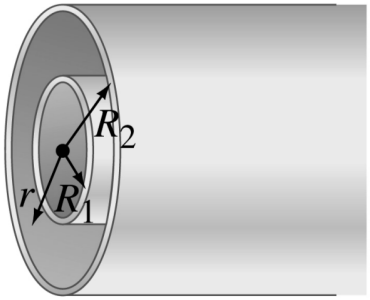
2. **(20 marks)** Find the total electric field **E** (as a vector) at the origin O in the figure as a result of the charges Q_1 and Q_2, under the following conditions:

   a) The distances ℓ are 25cm, and the charges are $Q_1 = +5.0\ \mu C$ and $Q_2 = +10.0\ \mu C$;
   b) The values of ℓ and Q_1 are the same as in part (a) but $Q_2 = -10.0\ \mu C$.



3. **(20 marks)** A thin cylindrical shell of radius R_1 = 3.0 cm is surrounded by a second concentric cylindrical shell of radius R_2 = 7.0 cm. Both cylinders are *7.0 m long* and the inner one carries a total charge $Q_1 = -4.8\ \mu C$ and the outer one $Q_2 = +5.6\ \mu C$. The charges are uniformly distributed over the respective cylinders. For points far from the ends of the cylinders, determine the electric field at a radial distance *r* from the central axis for the following cases:

(a) $r = 2.8\ cm$;
(b) $r = 5.0\ cm$;
(c) $r = 9.0\ cm$



4. (20 marks) A thin rod of length $2L$ is centered on the x axis as shown in the figure. The rod carries a uniformly distributed charge Q. Determine the potential V as a function of y for points along the positive y axis. Let $V = 0$ at infinity.