Name:	Signature:
Surname:	Number:

KOÇ UNIVERSITY

College of Sciences
PHYS 102 General Physics 2
Spring Semester 2017
Midterm Exam 1
March 14, 2017 Thursday, 19:00-20:40

Please read.

- Count to make sure that there are 5 pages in this question booklet
- Check your **name, number, on front page, and student ID on each page.**.
- This examination is conducted with closed books and notes.
- Put all your personal belongings underneath your seat and make sure that pages of books or notebooks are not open.
- Absolutely no talking or exchanging anything (like rulers, erasers) during the exam.
- You must show all your work to get credit; you will not be given any points unless you show the details of your work (this applies even if your final answer is correct).
- Write neatly and clearly; unreadable answers will not be given any credit.
- If you need more writing space, use the backs of the question pages and put down the appropriate pointer marks.
- Make sure that you include units in your results.
- Make sure that you label the axis and have units in your plots.
- You are not allowed to use calculators during this exam.
- Turn off your mobile phones, and put away.
- You are not allowed to leave the class during the first 15 minutes, and last 15 minutes.

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1	2	3	4	Total

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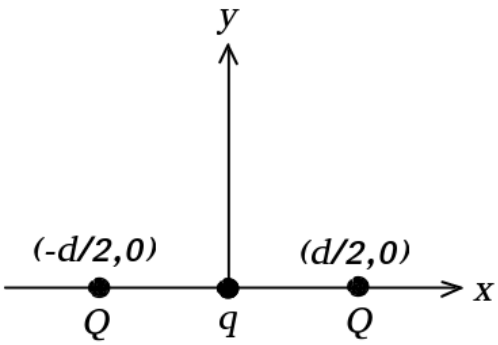
1-(25 Points) Two identical point charges with charge Q are positioned a distance d apart. Another point charge q is placed in the middle of the two.

a) Find the charge q (in terms of Q) if the system is in equilibrium.



b) Assume the charges reside on the x-axis and the charge q is at the origin (see figure). Find the point on the positive y-axis where the electric field is zero.

c) Is the charge q in stable equilibrium? Are the charges Q in stable equilibrium? Give your answers by considering a small horizontal displacement of the charge and checking if you get a restoring force.

Solution continues on the back side of the page **Yes** □ **No** □

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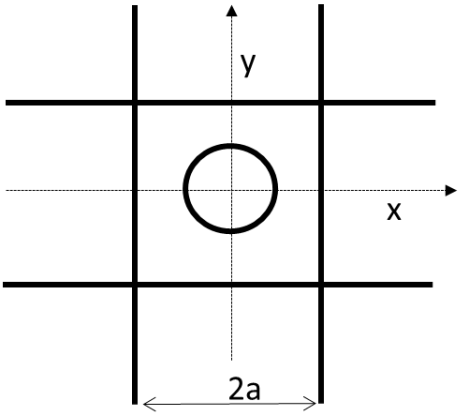
2-(25 Points) 2) Four *infinite,* non-conducting planes each with *uniform* surface charge density σ are perpendicular to the *x-y* plane, and they intersect each other to form a square of side *2a*. An *infinitely long*, non-conducting, thin cylindrical shell of radius *a* is also parallel to the planes (its central axis is the *z* axis). The cylindrical shell has *uniform* surface charge density $-\sigma$. You can see the cross section of the charge configuration in the figure, all shapes continue infinitely in the *z* direction.



a) Find the electric field *vector* on the *x* axis for all values of $-\infty < x < \infty$

b) Find the electric field *vector* at the point $(x, y) = (3a, 4a)$

Solution continues on the back side of the page **Yes** □ **No** □

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3-(25 Points) *Answer the following questions. Show your calculations. Unjustified answers will not be given any score. Write your answers in the boxes; answers outside the boxes will not be given any score.*

(i) Find the potential at a distance z above the centre of a thin disk of Radius R with uniform charge distribution σ.

(ii) Using the electric field of a uniformly charged solid sphere of radius R and total charge Q, which is given by

$$\vec{E} = \begin{cases} \frac{1}{4\pi\varepsilon_0}\frac{Q}{r^2}\hat{r}, & \text{outside (r>R);} \\ \frac{1}{4\pi\varepsilon_0}\frac{Q}{R^3}r\hat{r}, & \text{inside (r<R),} \end{cases}$$

find the potential inside and outside the sphere.

(iii) The potential of a charge distribution is given by $V(x, y, z) = Ax^2y^2 + Bxyz$, where A, B, and C are constants and x, y, and z are the Cartesian coordinates. Find the electric field.

(iv) How much work does it take to assemble a charge configuration where four charges of q_1=q, q_2=q, q_3=q, and q_4=q are located at the corners of

Solution continues on the back side of the page **Yes** □ **No** □

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4-(25 Points) Two concentric spherical conducting shells are separated by vacuum. The inner shell has radius r_a and a total charge *+Q,* while the outer shell has radius r_b and a total charge -Q.
Give your answers in terms of Q, r_a, r_b, and ε_0.

a) Calculate the electric-field energy density at a point a distance *r* from the center of the sphere for $r<r_a$, $r_a<r<r_b$, and $r>r_b$.

b) Calculate the total electric field energy associated with the charged spheres.

c) By using $U = Q^2/2C$, calculate the capacitance of the system.

Solution continues on the back side of the page **Yes** □ **No** □