Name, Surname:	Student ID Number:
Exam Room:	Signature:

KOÇ UNIVERSITY

College of Sciences

PHYS 102 General Physics 2

Fall Semester 2022

Midterm 1 Exam

November 10, 2022 Thursday, 19:00-21:00

Please read.

- Please turn off mobile phones and stow away your belongings. Have your student ID ready for attendance check. Only exam booklet, pencil and eraser are allowed throughout the exam.
- Check that there are 4 question sheets in this question booklet.
- Use only black pencil for writing.
- Write your **name, number, on front page, and student ID on each page.**.
- Write neatly and clearly; unreadable answers will not be given any credit.
- **Final answers must be written into the respective answer box. It may not get credit otherwise.**
- A final answer that is not based on a reasonable, consistent solution attempt on the exam paper may not get credit even if it coincides with the correct answer.
- Use the back pages in case you need more blank space. Label the continuing solution clearly.

IMPORTANT: Do not continue the solution of a question on a different question sheet!

- Mathematical expressions in the result must be simplified as possible. Mathematical and physical constants may be left in symbolic form, unless their numerical value for a calculation is explicitly requested in the problem.
- If applicable, make sure to include units in your final answer.
- In graphing questions, use proper scaling, label the axes and indicate units.
- Using calculators is not allowed.
- Students must respect the time restrictions on leaving/entering the exam room as stated by the exam proctors.

Integrals:

$$\int x^n dx = \frac{x^{n+1}}{n+1} \quad (n \neq -1) \qquad \int \frac{dx}{x} = \ln x \qquad \int e^{ax} dx = \frac{1}{a} e^{ax}$$

$$\int \sin ax\, dx = -\frac{1}{a}\cos ax \qquad \int \cos ax\, dx = \frac{1}{a}\sin ax \qquad \int \frac{dx}{\sqrt{a^2 - x^2}} = \arcsin\frac{x}{a}$$

$$\int \frac{dx}{\sqrt{x^2 + a^2}} = \ln\left(x + \sqrt{x^2 + a^2}\right) \qquad \int \frac{dx}{x^2 + a^2} = \frac{1}{a}\arctan\frac{x}{a} \qquad \int \frac{dx}{(x^2 + a^2)^{3/2}} = \frac{1}{a^2}\frac{x}{\sqrt{x^2 + a^2}}$$

$$\int \frac{x\, dx}{(x^2 + a^2)^{3/2}} = -\frac{1}{\sqrt{x^2 + a^2}}$$

P102_Index:

1	2	3	4	Total

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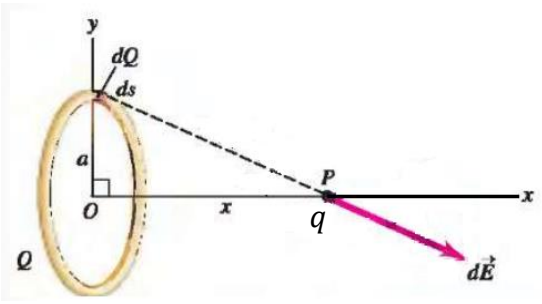
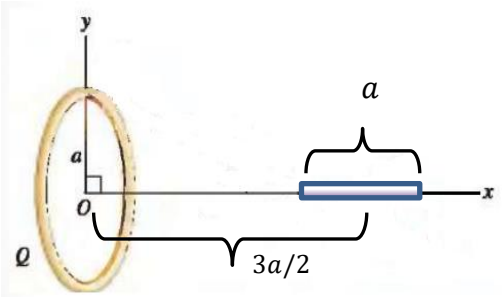
Q1-(25 pts) a) (15 pts) A point charge $\boldsymbol{q}$ is placed at a distance $\boldsymbol{x}$ from the center of a uniformly charged (total charge $\boldsymbol{Q}$) ring of radius $\boldsymbol{a}$. Calculate the electrostatic force on the point charge.



b) (10 pts) A uniformly charged (total charge $\boldsymbol{q}$) rod of length $\boldsymbol{a}$ is placed on the center axis of a uniformly charged (total charge Q) ring of radius $\boldsymbol{a}$. The center of the rod is at a distance $\boldsymbol{3a/2}$ from the center of the ring. Calculate the electric force on the rod.



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

P102_Index:	Student ID Number:
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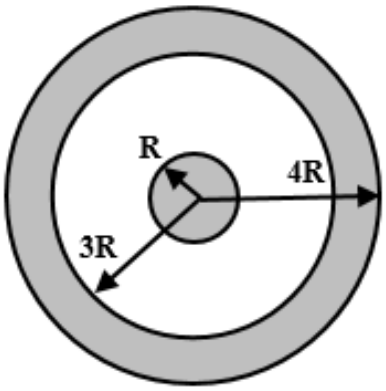
Q2-(25 pts) Q2- (25 pts) A conducting solid sphere of radius R with charge $9q_0$ is at the center of a conducting hollow sphere of inner radius $3R$ and outer radius $4R$. The hollow sphere has net charge $7q_0$. The spheres are isolated. Take the origin as the center of the spheres. Take the potential at infinity as zero. Coulomb constant: $k = 1/4\pi\varepsilon_0$



a) Using Gauss's theorem determine the electric-field E for the regions given below as a function of distance (r) from the center.

r> 4R E(r) =

3R < r < 4R E(r) =

R < r < 3R E(r) =

r< R E(r) =

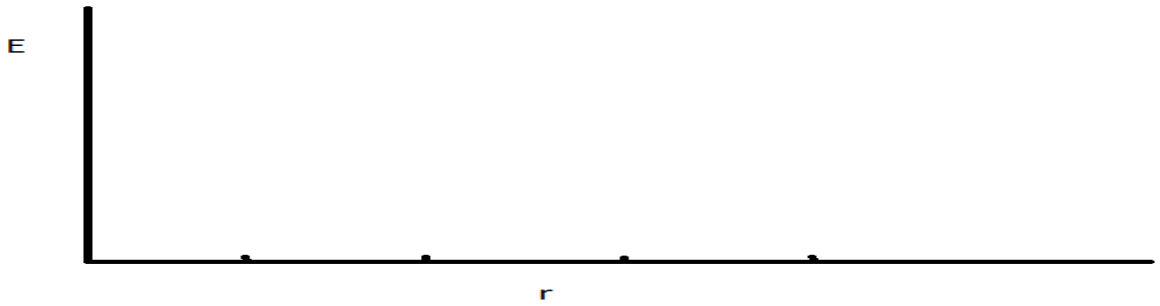
b) Calculate the surface charge densities on the surfaces

σ (R) =

σ (3R) =

σ (4R) =

c) Plot the electric field E(r) as a function of distance from the center.



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

P102_Index:	Student ID Number:
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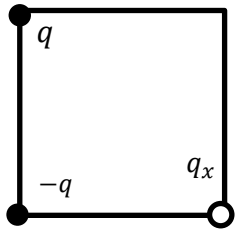
Q3-(25 pts) Three point charges $q, -q$ and unknown q_x are placed at three corners of a square edge length d as shown.



a) (10 pts) Determine q_x if the electric potential at the empty corner is zero.

b) (10 pts) Calculate the amount of work done to assemble this charge configuration.

c) (5 pts) Reconfigure the charges such that the potential at the empty corner only depends on q_x. Sketch your configuration below and show by equation that this is achieved.

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

P102_Index:	Student ID Number:
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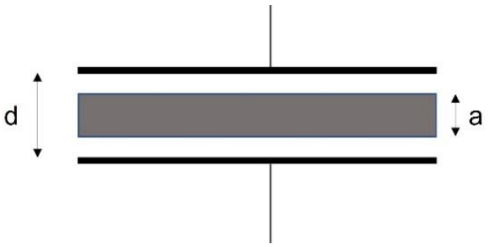
Q4-(25 pts) Q4- An air capacitor is made by using two flat plates, each with area A, seperated by distance d. Then a metal slab having thickness a (less than d) and the same shape and size as the plates is inserted between them, parallel to the plates and not touching either plate.



a) [Formulate the capacitance of this arrangement in terms of given parameters.

b) Express the capacitance in terms of C_0, the capacitance when the metal slab is not present.

c) Suppose that this capacitor is connected to a constant power source of potential V. If the metal slab is removed, does the charge on the capacitor increase or decrease? Calculate how much the charge on the capacitor changes.

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