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

KOÇ UNIVERSITY

College of Sciences

PHYS 102 General Physics 2

Spring Semester 2022

Midterm 1 Exam

March 24, 2022 Thursday, 20:20-22:00

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

P102_Index:	Student ID Number:
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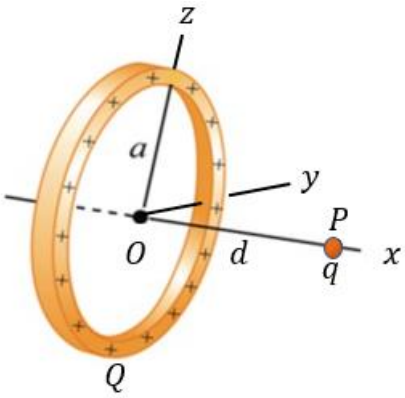
Q1-(25 pts) A ring-shaped conductor with radius a has a total positive charge Q uniformly distributed around it. The center of the ring is at the origin of coordinates O (see the figure).



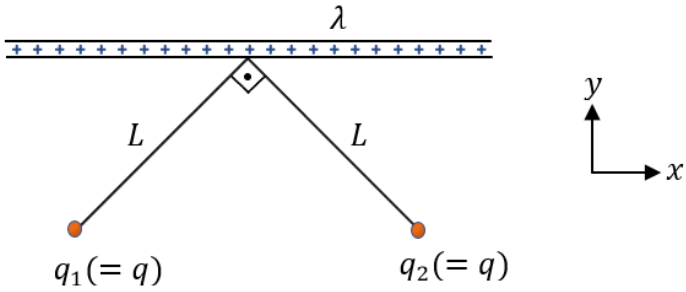
a) Derive the electric field (magnitude and direction) at point P, which is on the positive x-axis at a distance d from the origin.

b) A negative point charge q is placed at P. What are the magnitude and direction of the force exerted by the charge q on the ring?

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

P102_Index:	Student ID Number:
Exam Room:	Signature:

Q2-(25 pts) Two small objects, each carrying a charge q, are attached by insulating strings of length L to a very long, thin, insulating rod. The rod and objects lie in the same plane. The rod has a positive, uniform line charge density λ and generates an electric field with a magnitude $E(r) = \lambda/2\pi\epsilon_0 r$ at a distance r from it. The system is in equilibrium when the strings stretch with a right angle between them, as shown. There is no gravitational field acting on the system.



a) What is the sign of q?

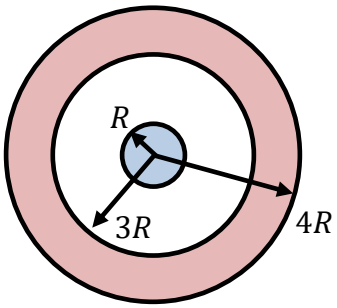
b) Calculate the net *electric* force vector on charge q_1 in the given coordinate system.

c) Calculate q in terms of λ and L.

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

P102_Index:	Student ID Number:
Exam Room:	Signature:

Q3-(25 pts) A solid conducting sphere of radius R is inside a concentric conducting spherical shell of inner radius $3R$ and outer radius $4R$. The spheres are electrically isolated. The solid sphere has a net charge $-2Q$, the spherical shell has a net charge $+5Q$. Each part below start with this initial condition described here and the parts are unrelated. Electrostatic equilibrium applies in each case.



a) (6 pts) Calculate the electric field $\vec{E}$ at $r = 2R$ and at $r = 5R$.

b) (6 pts) Suppose that the solid sphere and the spherical shell are connected by a conducting wire. Calculate the electric field $\vec{E}$ at $r = 2R$ and at $r = 5R$.

c) (6 pts) Suppose that the spherical shell is connected to the ground. (so that it obtains the same electrical properties as the ground). Calculate the electric field $\vec{E}$ at $r = 2R$ and at $r = 5R$.

d) (7 pts.) How much charge must be added to the outer sphere so that the electric field $\vec{E}$ is the same at $r = 2R$ and $r = 5R$?

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

P102_Index:	Student ID Number:
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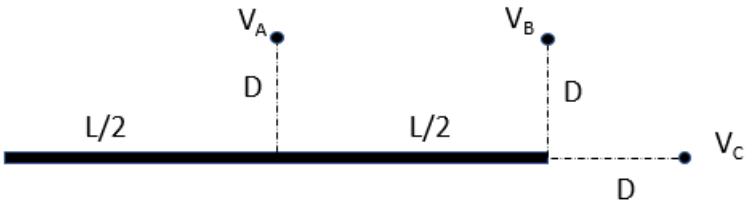
Q4-(25 pts) Positive electric charge Q is distributed uniformly along a plastic rod of length L. Find the electric potential (V) at three different points A, B, C.
D is the verticle and horizontal distances from the right end of the rod.



V_A=

V_B=

V_C=

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