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

KOÇ UNIVERSITY

College of Sciences

PHYS 102 General Physics 2

Fall Semester 2022

Final Exam

January 16, 2022 Monday, 11:45-13:45

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 provided 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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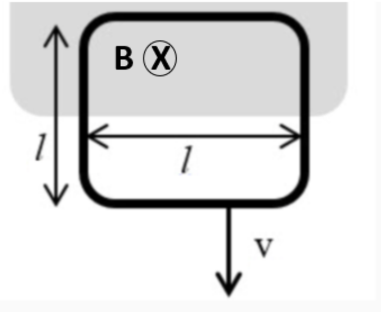
Q1-(25 pts) A vertically oriented square loop of copper wire falls through a region where a uniform horizontal (into the page) magnetic field ***B*** is present. As shown in the figure, the magnetic field is present only in the rectangular shaded area. The total resistance of the wire is ***R*** , the mass is ***m*** and the side length of the loop is ***l***. When the loop reaches constant terminal speed its upper segment is still in the magnetic field region. ($g=10m/s^2$)



a) Calculate the terminal speed of the falling loop.

b) Indicate the direction of the induced current along the loop at the instant shown in the picture and give a detailed physical argument supporting your answer.

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

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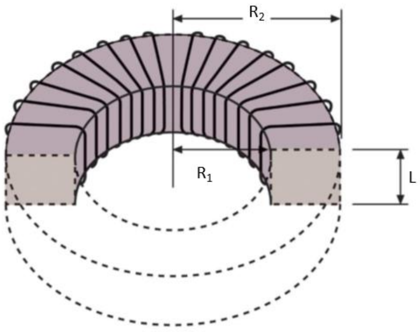
Q2- (25 pts) A toroidal solenoid with rectangular cross section has inner radius R_1 , outer radius R_2, height L, and consists of N uniformly spaced turns of wire. The material in the cross section is air.



a) Calculate the magnetic field ***B(r)*** in the cross-sectional area of the toroid as a function of radial distance from the center. (Assume that the magnetic field does not depend on the height direction)

b) Using the magnetic field ***B(r)*** found in part (a), calculate the total magnetic flux through the cross section of the toroid when a current i_0 is applied.

c) Calculate the inductance **L** of the solenoid.

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

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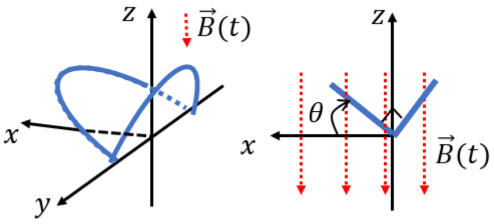
Q3- (25 pts) A conducting circular loop of radius R centered at the origin is folded about its diameter along the y axis to form two mutually perpendicular semicircular arcs and placed in a uniform magnetic field $\vec{B} = -B\hat{k}$ as shown. Let θ be the angle measured from x-axis in clockwise rotation of the loop about the y-axis (that is, for $\theta = 0$, the loop coincides with the x and z axes when viewed from y-axis)



(isometric view) (view from y-axis)

a) Calculate the magnetic flux through the loop as a function of θ. Caution: The loop is nonplanar. Verify that the sign of the flux is consistent with your choice of positive flux direction and also check that $\theta = 0$ and $\theta = \pi/2$ give expected results.

a) Find the value of θ for which the flux through the loop has maximum absolute value.

b) Let $\theta = \omega t$, that is, at $t = 0$, the loop starts to rotate about y-axis with constant speed ω. Find the induced emf along the loop. When does the induced emf take its maximum absolute value first after the loop starts to rotate?

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

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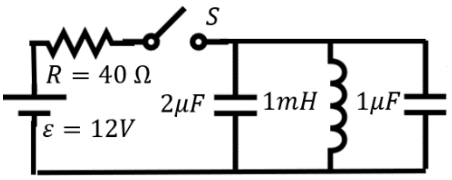
4- (25 pts) Answer the following in proper scaled SI units. Tip: First solve algebraically and then make the numerical calculation.



a) In the circuit, both capacitors are initially uncharged. The switch S is closed at $t = 0$. Calculate i_R, i_L at $t = 0$.

b) When the current in the circuit reached steady state, calculate the energy stored in the $2\mu F$ capacitor and in the inductor.

c) After the current reached steady state, S is opened and time is reset to $t = 0$. Calculate the maximum charge the $2\mu F$ capacitor can get.

d) Calculate the first time when the $2\mu F$ capacitor get its maximum charge after S is opened.

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