20S-PHYSICS1C-1 Quiz 1

CHARLES ZHANG

TOTAL POINTS

13 / 30

QUESTION 1

1 1a **6 / 10**

- **- 0 pts** Correct
- **- 2 pts** minor errors
- ✓ **- 4 pts missing an answer/partly correct**
- **- 4 pts** errors but on the right track
- **- 7 pts** wrong but attempted/insufficient
- **- 10 pts** no attempt

QUESTION 2

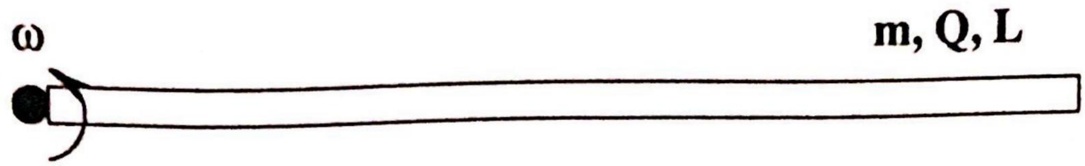
2 1b **4 / 10**

- **- 0 pts** Correct
- **- 1 pts** minor errors(signs, missing a value in the end)
- **- 2 pts** partly correct(error while integrating) conceptually correct
- **- 4 pts** on the right track (conceptual error)
- ✓ **- 6 pts attempted a step or two (sort of right)**
- **- 10 pts** missing/ completely wrong

QUESTION 3

3 1c **3 / 10**

- **- 0 pts** Correct
- **- 1 pts** small error(signs, numbers etc)
- **- 2 pts** mostly correct.
- **- 4 pts** attempted(on the right track)
- ✓ **- 7 pts some attempt**
- **- 10 pts** missing/ no attempt



A rod of mass m, electric charge -Q and length L rotates around one end with an angular velocity $\vec{\omega}$. While mass is uniformly distributed along the rod, the electric charge is not - the linear charge density is given by $\lambda(r) = Cr(L-r)$ where C is a (unknown) proportionality constant and r is the distance from the pivot.

- 1a) (10 points) Use the given constraints to find the proportionality constant C, and in so-doing, obtain the "normalized" electric charge density function.

$\lambda(r) = Cr(L-r)$

$\lambda = \frac{Q}{L}$

$Q = \int \partial q = \int \lambda(r)\,\partial L = \int \lambda(r)\,dr$

$Q = \int Cr(L-r)\,dr = C\int_0^L (rL - r^2)\,dr$

$Q = C\left[-\frac{1}{3}r^3 + \frac{1}{2}r^2 L\right]_0^L$

$Q = \frac{1}{6}CL^3$

$|\vec{\tau}| = r_\perp F = L(I\vec{L}\times\vec{B})$

$\vec{\tau} = I\vec{L}^2 \times \vec{B}$

$H_0 = I\vec{L}^2$

$\partial H_0 = \partial I L$

$\partial I = \frac{\partial q}{T} = \frac{\partial q \cdot \omega}{2\pi}$

$\partial I = \frac{\partial q \omega}{2\pi} L$

$dq = \lambda\,\partial L = \lambda r\,dr$

$\partial I = \frac{\lambda r^2\,dr\,\omega}{2\pi}$

$\partial I = \frac{Cr^2(L-r)\,dr\,\omega}{2\pi} = \frac{\omega}{2\pi} \cdot \frac{CLr^3 - r^4}{2\pi}\,dr$

- **1b)** (10 points) Find the (vector) magnetic dipole moment of the spinning charge distribution. Use the normalized electric charge density for full credit.

$$\vec{\mu} = N I \vec{A}$$

$$L = 2\pi r \rightarrow r = \frac{L}{2\pi}$$

$$A = \pi r^2 = \pi\left(\frac{L^2}{4\pi^2}\right) = \frac{L^2}{4\pi}$$

$$\vec{\mu} = N I \left(\frac{L^2}{4\pi}\right) \rightarrow N = 1$$

$$I = \frac{Q}{T} = \frac{Q\omega}{2\pi}$$

$$Q = \lambda(L)$$

$$\vec{\mu} = \frac{\lambda L \omega}{2\pi}\left(\frac{L^2}{4\pi}\right)$$

$$\vec{\mu} = \frac{\lambda L^3 \omega}{8\pi^2} = \frac{Cr(L-r)L^3\omega}{8\pi^2} = \boxed{\frac{CrL^3\omega(L-r)}{8\pi^2}}$$

- **1c)** (10 points) Suppose the spinning rod begins to precess with an angular frequency Ω when immersed in a uniform magnetic field. What is the magnitude of that magnetic field?

$$\vec{\tau} = \vec{\mu} \times \vec{B} \qquad F = I\vec{L} \times \vec{B}$$

Under assumption $\vec{B}$ is ?

$$rF = \vec{\mu} \times \vec{B}$$

$$\int B \cdot ds = BL = \mu_0 I$$

$$I = \frac{Q\omega}{2\pi}$$

$$B = \frac{\mu_0 Q \omega}{2\pi L} = \frac{\mu_0\left(\frac{1}{6}CL^3\right)\Omega}{2\pi L} = \boxed{\frac{\mu_0 C L^2 \Omega}{12\pi}}$$

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1CS20 QUIZ 1

Full Name (Printed) Charles Zhang

Full Name (Signature)

Student ID Number 305-413-659

- The exam is open-book and open notes. You will probably do better to limit yourself to a single page of notes you prepared well in advance.
- **All work must be your own.** You are not allowed to collaborate with anyone else, you are not allowed to discuss the exam with anyone until all the exams have been submitted (after the close of the submissions window for the exam).
- You have 30 minutes to complete the exam and sufficient time to scan the exam and upload it to GradeScope. The exam *must* be uploaded to GradeScope within the time alloted (that is, by the end of the lecture hour). We will only except submissions through GradeScope and will not accept any exam submitted after the submission window closes (CAE students must contact Corbin for instructions).
- **Given the limits of GradeScope, you must fit your work for each part into the space provided.** You may work on scratch paper, but you will not be able to upload the work you do on scratch paper, so it is essential that you copy your complete solution onto the exam form for final submission. We can only consider the work you submit on your exam form.
- **For full credit the grader must be able to follow your solution from first principles to your final answer.** ***There is a valid penalty for confusing the grader.***
- It is <u>YOUR</u> responsibility to make sure the exam is scanned correctly and uploaded before the end of the submission window. The graders may refuse to grade pages that are significantly blurred, solutions to problems that are not written in the correct place, pages submitted in landscape mode and/or work that is otherwise illegible - if any of this occurs, you may not receive *any* credit for the affected parts.
- Focus on the concepts involved in the problem, the tools to be used, and the set-up. If you get these right, all that's left is algebra.
- **Have Fun!**

The following must be signed before you submit your exam:

By my signature below, I hereby certify that all of the work on this exam was my own, that I did not collaborate with anyone else, nor did I discuss the exam with anyone while I was taking it.

Signature