Printed Name	Nine-digit GT ID

signature

Fall 2021 **PHYS 2212 G** **Test 04**

- Put nothing other than your name and nine-digit GT ID in the blocks above. Print clearly so that OCR software can properly identify you. Sign your name on the line immediately below your printed name.
- Free-response problems are numbered I–III. Show all your work clearly, including all steps and logic. Write darkly. Blue or black ink is recommended. Do not make any erasures in your free-response work. Cross out anything you do not want evaluated. Box your answer.

Test Form:

4A

- Multiple-choice questions are numbered 1–6. For each, select the answer most nearly correct, circle it on yourtest, and fill the bubble for your answer **on this front page**.
- Initial the odd pages in the top margin, in case the pages of your quiz get separated.
- If the page for a free-response problem has insufficient space for your work, ask a proctor for an additional sheet. If you wish this work to be evaluated, put your name on the sheet and make a note on the problem page, so graders know where to find your work. Place any added pages at the **back** of your test, when submitting your exam.
- You may use a calculator that cannot store letters, but no other aids or electronic devices.
- Scores will be posted when your test has been graded. Test grades become final when the next is given.

Fill in bubbles for your Multiple Choice responses HERE
Mark answers answers darkly and neatly.
If you wish to change an answer, draw a clear "X" through the non-answer!

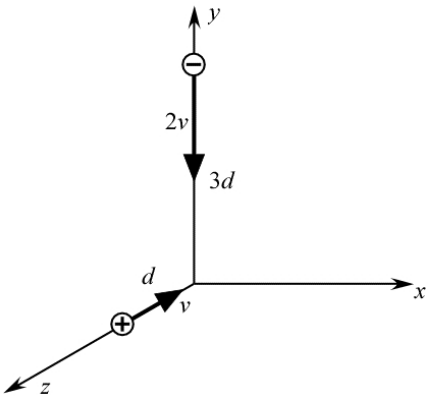
1. ⓐ ⓑ ⓒ ⓓ ⓔ ⓕ
2. ⓐ ⓑ ⓒ ⓓ ⓔ ⓕ
3. ⓐ ⓑ ⓒ ⓓ ⓔ ⓕ
4. ⓐ ⓑ ⓒ ⓓ ⓔ ⓕ
5. ⓐ ⓑ ⓒ ⓓ ⓔ ⓕ
6. ⓐ ⓑ ⓒ ⓓ ⓔ ⓕ

Extra Worksapace: If you use this space for a free-response problem, be sure to point it out on that problem's page!

The following problem will be hand-graded. Show all supporting work for this problem.

[I] *(20 points)* At a particular moment in time, a proton is located on the positive z-axis at a distance d from the origin, and is moving with speed v in the negative z-direction. At the same moment, an electron is located on the positive y-axis at a distance $3d$ from the origin, moving in the negative y-direction with speed $2v$.

Determine the **magnetic** force on the proton by the electron. Be sure to specify magnitude and direction.

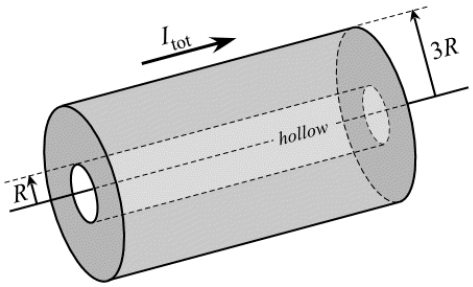


The following problem will be hand-graded. Show all supporting work for this problem.

[II] *(20 points)* A long straight current-carrying wire is hollow, with an inner (cavity) radius R and and outer (surface) radius $3R$. A non-uniform but symmetric current flows in the wire, with a current density give by

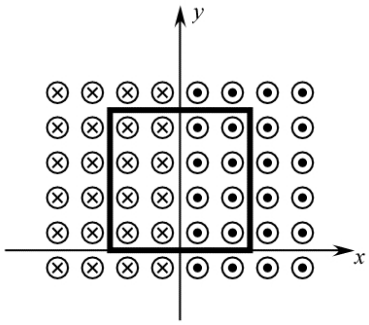
$$J(s) = \frac{J_o\, s}{R}, \quad \text{for} \quad R \le s \le 3R,$$

where J_o is a positive constant and s is the distance from the central axis of the wire. Determine the magnitude of the magnetic field at a distance $2R$ from the central axis of the wire.



The following problem will be hand-graded. Show all supporting work for this problem.

[III] *(20 points)* A square wire loop of dimension L lies in the xy-plane, extending from $x = -L/2$ to $x = +L/2$. The loop lies in a magnetic field that points in the negative z-direction in the left half-plane (i.e. for $x < 0$), and points in the positive direction in the right half-plane (i.e. for $x > 0$).



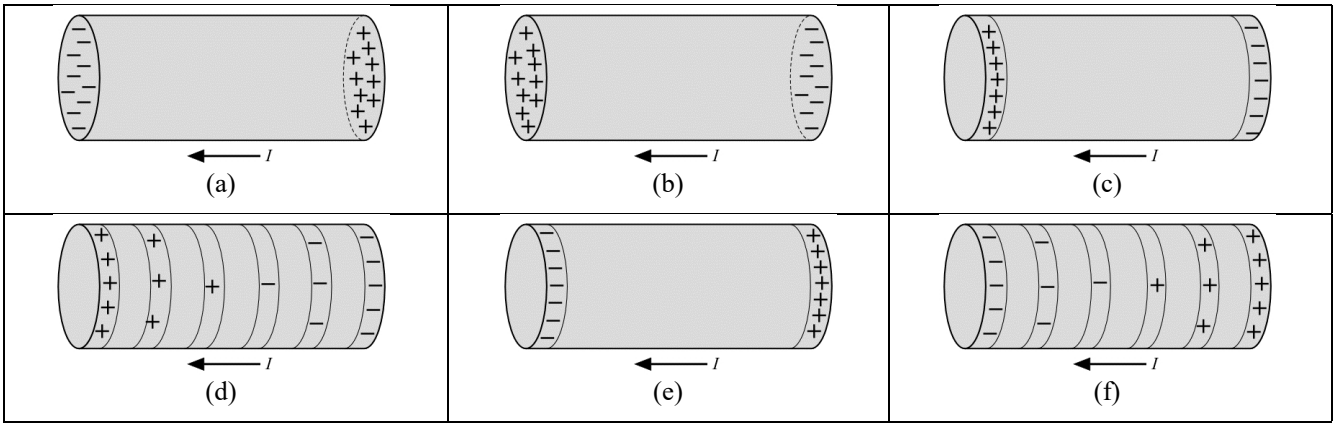
The magnetic field in both regions varies with time, according to:

$$\vec{B}(t) = \begin{cases} (B_0 - at)(+\hat{k}) & x > 0 \\ (B_0 + at)(-\hat{k}) & x < 0 \end{cases}$$

Determine the magnitude of the induced emf in the loop at time $t = 0$, and determine the direction in which the induced current (if any) would flow around the loop. You **must** support the latter answer with quantitative or qualitative reasoning, to receive **any** credit for your response.

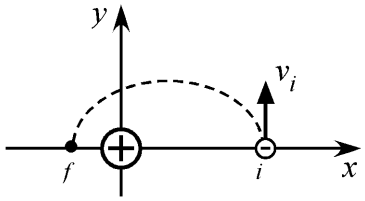
Question value 4 points

(01) A cylindrical wire of length L and diameter D carries a right-to-left current I. Which of the figures below best represents the distribution of charges on the wire that "shepherd" the flow of current in the wire?



Question value 4 points

(2) In the figure at right, a positive source charge is held fixed at the origin, and a negative test charge is initially at location i, moving vertically with speed v_i. The test charge follows the dotted trajectory, reaching position f—at which point it is moving vertically *downward*. No external forces act during this process.

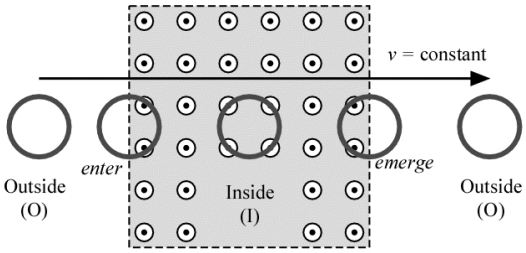


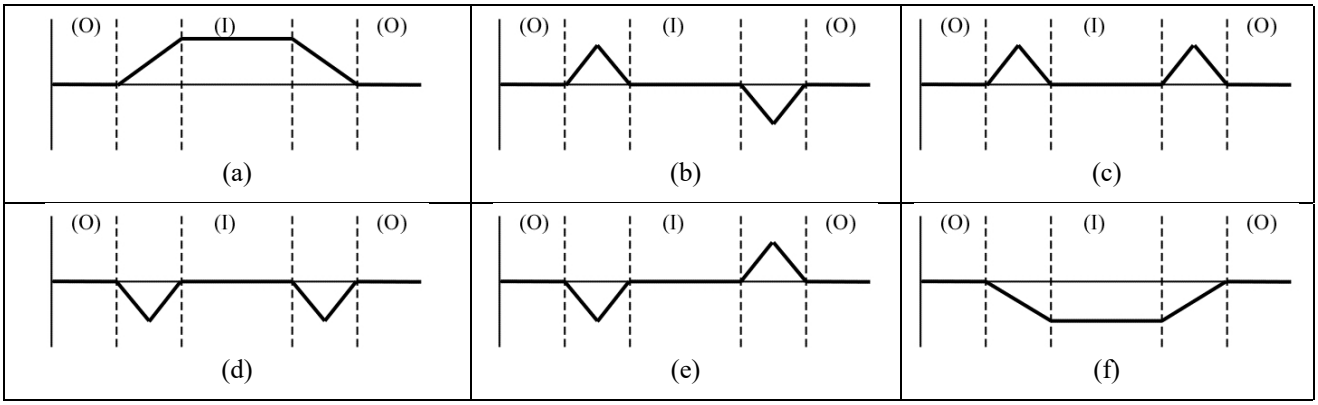
What can you say about the work done by the electric field of the (positive) source charge, and the change in the electric potential experienced by the (negative) test charge, as the test charge moves from i to f?

(a) The field has done positive work and the charge has moved to higher electric potential.
(b) The field has done zero work and the charge has moved to lower electric potential.
(c) The field has done negative work and the charge has moved to higher electric potential.
(d) The field has done negative work and the charge has moved to lower electric potential.
(e) The field has done positive work and the charge has moved to lower electric potential.

Question value 8 points

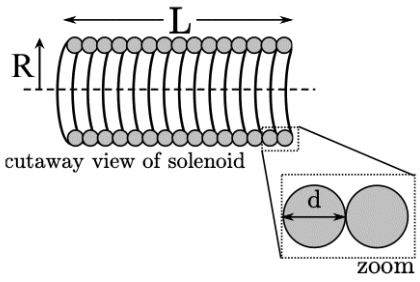
(03) A region of space has a uniform magnetic field $\vec{B}$ directed out of the page. A circular copper ring is pulled through the field at constant speed from left to right, with the plane of the ring oriented perpendicular to $\vec{B}$. Assume a sign convention that a *positive* induced current in the ring denotes a *clockwise* flow of positive charge. Which of the plots below *best* denotes the induced current in the ring, as a function of time?





Question value 8 points

(04) You have constructed a solenoid out of a wire having diameter d, by winding a single layer of wire with the coils as close together as possible, around a cylinder of length L and radius R. When a current I flows through the wire, what will be the magnitude of the magnetic field inside the solenoid?



(a) $B = \mu_0 I \cdot \pi R^2$

(b) $B = \mu_0 I \cdot (1/d)$

(c) $B = \mu_0 I \cdot L$

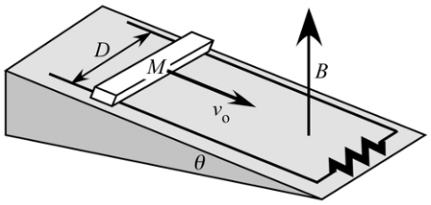
(d) $B = \mu_0 I \cdot (1/R)$

(e) $B = \mu_0 I \cdot (R/d)$

(f) $B = \mu_0 I \cdot (d/\pi R^2)$

Question value 8 points

(05) A conducing bar of length D slides at constant speed v_o down a ramp inclined at an angle θ below the horizontal. The bar is in a uniform verical magentic field of magnitude B. What is the magnitude of the motional emf induced in the bar?



(a) $\mathcal{E}_{ind} = v_o BD / \sin\theta$

(b) $\mathcal{E}_{ind} = v_o BD / \cos\theta$

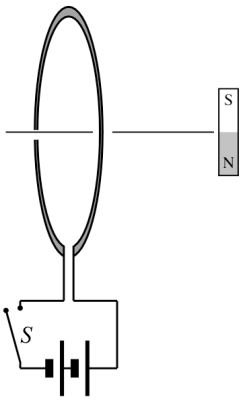
(c) $\mathcal{E}_{ind} = v_o BD \cdot \cos\theta$

(d) $\mathcal{E}_{ind} = v_o BD$

(e) $\mathcal{E}_{ind} = v_o BD \cdot \sin\theta$

Question value 8 points

(06) When the switch in the diagram at right is closed, the emf will drive a current through the large loop. What effect (if any) will there be on the nearby bar magnet when the switch is closed?



(a) The magnet will rotate so that the north pole is on the left and the south pole on the right.

(b) The magnet as a whole will be pulled toward the loop, without rotating.

(c) The magnet will rotate so that the south pole is on the left and the north pole on the right.

(d) There will be no effect, because an electrically charged ring will not influence a magnet.

(e) The magnet will flip so that the north pole is on top and the south pole is on the bottom.