

Physics 305 – Sample Exam 1 Questions

There are four problems on this exam. Each problem is worth 25 points. Start each problem on a new sheet of paper, and use only one side of each sheet. GOOD LUCK !!!

- (1) An infinitely long cylinder of radius R is centered on the z axis. It carries a magnetization $\mathbf{M} = ks^3 \hat{\phi}$, where k is a constant.
 - a) Locate all of the bound current.
 - b) Find the magnetic field due to \mathbf{M} for points inside and outside the cylinder.

- (1) A long, straight, circular cable carries a current in one direction uniformly distributed over its cross section. The current returns along the surface of the cable. (There is a very thin insulating layer separating the currents.) Find the self-inductance per unit length.

- (2) A capacitor consists of two circular plates of radius a separated by a distance $d \ll a$. The capacitor is being charged using very thin wires that are connected to the (outside) centers of the circular plates and carry a constant current I . Assume the current flows out over the plates in such a way that the surface charge is always uniform, and is zero at $t = 0$. Neglect edge effects.
 - a) Find the displacement current through the circle of radius $s < a$ that is centered on the axis of the capacitor and in the plane midway between the plates.
 - b) Show that your result from part (a) exactly equals the net current that is flowing onto the plates inside the circle of radius s . (This shows that the displacement current has just the right magnitude to complete the circuit across the capacitor.)

- (3) Concentric spherical shells with radii a and b ($a < b$) carry uniformly distributed charges $+Q$ (at a) and $-Q$ (at b). They are immersed in a uniform magnetic field with magnitude B_0 pointing in the z -direction. Calculate the angular momentum in the fields relative to the center.

Note: The funny numbering arises because the “first” question (1) comes from an old PHYS 304 Final Exam. Meanwhile, this overall exam is slightly shorter and easier than I usually target because this particular PHYS 304 question is shorter and easier than the original PHYS 305 question that involved material from early in Chapter 9.