

## Physics 305 – Sample Exam 2

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) Assume you have two uniform, isotropic media, separated by a planar interface, with indices of refraction  $n_1$  and  $n_2$ . ( $\mu_1 = \mu_2 = \mu_0$ .) A plane electromagnetic wave propagating in medium 1 strikes the interface at normal incidence.
  - a) Derive expressions for the reflection and transmission coefficients. (Note: If you simply copy expressions from your crib sheet, you will receive zero credit for this part.)
  - b) What condition(s) do  $n_1$  and  $n_2$  need to obey to obtain  $T = R$ ?
  
- (2) A point charge  $q$  moves in a circle of radius  $a$  in the  $x$ - $y$  plane, centered on the origin, with constant angular speed  $\omega$ . To be specific, assume its location at any given time is given by:
$$a \cos(\omega t)\hat{x} + a \sin(\omega t)\hat{y}$$
Find the Lienard-Wiechert potentials for points on the  $z$  axis.
  
- (3) A point charge  $q$  is located above a horizontal, perfect conducting plane. The conductor forms the  $x$ - $y$  plane, and the point charge at time  $t$  is on the  $+z$  axis at the location
$$z = a + b \cos(\omega t).$$
Assume  $a$  and  $b$  are both  $\ll c/\omega$ .
  - a) What is the angular distribution of the emitted radiation?
  - b) What is the total radiated power?
  
- (4) A hollow rectangular waveguide with perfect conducting walls has inner dimensions  $a$  and  $b$ . To be specific, assume the walls are on the planes  $x=0$ ,  $x=a$ ,  $y=0$ , and  $y=b$ , and  $a > b$ .
  - a) Find  $E_z(x,y)$  for TM modes.
  - b) What is the lowest cut-off frequency for a TM mode?