Name KEY Student Number
Last First MI

Written Response. Show your work and/or explain your reasoning for full credit.

II. *Electron Spin* [26 pts]: The electron has a spin of ½.

A) Assume the electron is a solid sphere of radius 10^{-23} m and that its outer edge is rotating at the speed of light. Find the angular momentum of this sphere (hint $I=2/5\ mr^2$ for a solid sphere)

$\vec{L} = I\omega = \frac{2}{5}mr^2\frac{v}{r}$

$\vec{B}$

$\omega = \frac{v}{r}$

$L = \frac{2}{5}mvr = \frac{2}{5}(9.11\times10^{-31}\,kg)(3\times10^{8})\left(\frac{10^{-23}\,m}{0.5\pi 0}\right)$

$L = 1.08\times10^{-45}\,J\cdot s$ $\left(kg\cdot m^2/s\right)$

CLASSICAL ANGULAR MOMENTUM

B) Calculate the actual value of the spin angular momentum with quantum mechanics.

$S = \sqrt{s(s+1)}\,\hbar$

$= \sqrt{\frac{1}{2}\left(\frac{1}{2}+1\right)}\,\hbar$

$= \frac{\sqrt{3}}{2}\,\hbar$

$= \frac{\sqrt{3}}{2}\frac{6.63\times10^{-34}}{2\pi}\,J\cdot s = 9.11\times10^{-35}\,J\cdot s = S$

C) Which value is larger? What does this say about the likelihood that the electron is actually spinning?

$L_{classical} \ll S_{Q.M.}$

THUS THE ELECTRON WOULD NEED TO ROTATE MANY TIMES FASTER THAN THE SPEED OF LIGHT.

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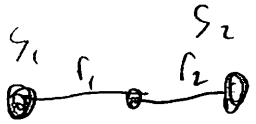
III. *Interference and Power* [26 pts] Two sound speakers are in phase and a distance of 5m apart.

A) Is the point directly between the two speakers a minimum or maximum? Explain.

MAX. BOTH ARE IN PHASE AND DISTANCE IS EQUAL. $r_2 - r_1 = 0$, SO CONSTRUCTIVE.



B) Moving along the line connecting the two speakers, how far until you reach the next max or min, assuming the wavelength is 3m?

$r_2 - r_1 = \frac{\lambda}{2}$ FOR NEXT MIN

$r_2 + r_1 = 5m$ → TOTAL DISTANCE

ADD FIRST TWO EQNS + $r_2 - r_1 = 1.5m$

$2r_2 = 6.5m$

SOLVE FOR r_2 $r_2 = 3.25m$

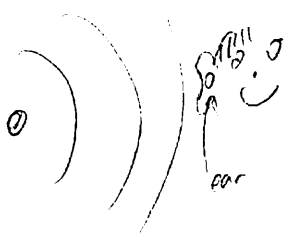
FROM CENTER

$3.25 - 2.5 = 0.75$

MOVE 0.75 meters TO NEXT MIN FROM CENTER

C) One of the speakers emits sound with a power of 100W, if you are a distance of 10m away how much power does your ear receive from the one speaker. Assume your ear radius 1cm.

$I = \frac{P_s}{A} = \frac{100W}{4\pi(10m)^2} =$



$P_{ear} = I A_{ear}$

$= I \pi r_{ear}^2$

$= \frac{100W}{4\pi(10m)^2} \pi (0.01m)^2$

$P_{ear} = 2.5 \times 10^{-5}$ watts