

Physics 220 Assignment 5

1. T&D 7.10 $z = x + iy = r(\cos\theta + i\sin\theta) = re^{i\theta}$

so $\tan\theta = y/x \rightarrow \theta = \tan^{-1}(y/x)$

and $r^2\cos^2\theta + r^2\sin^2\theta = r^2 = x^2 + y^2 \rightarrow r = \sqrt{x^2 + y^2}$

$x = r\cos\theta$

$y = r\sin\theta$

2. T&D 7.18 proton ($m = 938.3 \text{ MeV}/c^2$) in rigid box with $a = 5 \text{ fm}$

1D box energy levels:

$$E_n = n^2 \frac{\pi^2 \hbar^2}{2ma^2} = n^2 \left(\frac{\pi^2 (hc)^2}{2mc^2 a^2} \right)$$

$$E_n = n^2 \left(\frac{\pi^2 (197.3 \text{ MeV} \cdot \text{fm})^2}{2(938.3 \text{ MeV})(5 \text{ fm})^2} \right) = n^2 (8.189 \text{ MeV})$$

so three lowest levels are 8.2 MeV, 33 MeV, 74 MeV

$n = 1, 2, 3$

3. T&D 7.19 electron in 1D wire of length 1 cm

here $mc^2 = 0.511 \text{ MeV}$, $a = 10^{-2} \text{ m} = 10^7 \text{ nm}$

$$E_n = n^2 \left(\frac{\pi^2 (hc)^2}{2mc^2 a^2} \right) = n^2 \left(\frac{\pi^2 (197.3 \text{ eV} \cdot \text{nm})^2}{2(511000 \text{ eV})(10^7 \text{ nm})^2} \right) = 3.75 \times 10^{-15} \text{ eV}$$

so spacing between two lowest levels is

$$E_2 - E_1 = 4E_1 - E_1 = 3E_1 = 3(3.75 \times 10^{-15} \text{ eV}) = 1 \times 10^{-14} \text{ eV}$$

4. T&D 7.20 $n = 5, 6, 7$ levels and wave functions for particle in 1D rigid box

$E_5 = 25E_1$, $E_6 = 36E_1$, $E_7 = 49E_1$

antinodes = n

