Physics 212 – Quiz #1
Chapter 1

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Name: Key Id#:

1. A rod of proper length 1.0 m is at rest in a reference frame S'. It lies in the (x',y') plane and makes an angle of 30^0 with the x' axis. If S' moves with constant velocity v parallel to the x axis of another frame S, what is the value of v if, as measured in S, the rod is at 45° to the x axis? (5 points)

See your notes $\tan\theta = \gamma \tan\theta_0 \Rightarrow \gamma = \frac{\tan\theta}{\tan\theta_0} = 1.732$

$$\frac{1}{\sqrt{1 - v^2/c^2}} = 1.732 \Rightarrow 1 - \frac{v^2}{c^2} = \frac{1}{3}$$

$$\frac{v^2}{c^2} = \frac{2}{3} \Rightarrow \boxed{v = \sqrt{\frac{2}{3}}\, c}$$

2. (a) At what speed does the kinetic energy of an electron equal its rest energy? (3 points)

$$K = (\gamma - 1) m_0 c^2 = m_0 c^2 \Rightarrow \gamma - 1 = 1 \Rightarrow \gamma = 2$$

$$\frac{1}{\sqrt{1 - v^2/c^2}} = 2 \Rightarrow 1 - v^2/c^2 = \frac{1}{4} \Rightarrow \frac{v^2}{c^2} = \frac{3}{4}$$

$$\boxed{v = \frac{\sqrt{3}}{2} c}$$

(b) What is the total relativistic energy in MeV? (the rest energy of the electron is 0.511 MeV) (2 points)

$$E = \gamma m_0 c^2 = 2 m_0 c^2 = \boxed{1.022 \text{ MeV}}$$