(Keung's section) **Quiz 2 - PHY244** Feb 08, 2008

Print Your **Last Name:** Solution a

First name:

Show detailed work to receive full scores. ($c = 300$ m/μs)

Giving or receiving aid is cause for dismissal from the university.

A particle P travels at a uniform velocity. It passes the center C detector at $t = 0$, $x = 0$, leaving an electronic signal. The particle continues its motion and registers another signal at a remote R detector at $x = 6$ m, $t = 0.025\mu$s. The unprimed coordinates (x, t) are measured in the frame of the ground.

Determine the velocity u of the particle in unit of c in the unprimed frame.

$$u = \frac{600\ m}{0.025\mu s} = 240\ m/\mu s \qquad \frac{u}{c} = \frac{240}{300} = 0.8$$

Another observer O' also travels at uniform velocity v along the negative x axis. It take 0.05μs for O' to pass the R and then C detectors described above. Determine v/c (a sign may help).

$$\frac{6\ m}{0.05\mu s} = 120\ m/\mu s \qquad \frac{v}{c} = -\frac{120}{300} = -0.4$$

Find the relative velocity of P, u'/c, as measured by the primed observer O'.

$$u' = \frac{u - v}{1 - uv/c^2} = \frac{0.8c - (-0.4c)}{1 - 0.8(-0.4)} = \frac{1.2c}{1 + 0.32} = \frac{120}{132}c = \frac{10}{11}c$$

The rest mass of P is known to be 500 MeV/c^2, determine the momentum (in MeV/c) and the relativistic energy (in MeV) of P in the unprimed frame.

$$E = \frac{500}{\sqrt{1 - 0.8^2}} = \frac{500}{0.6} = 833\ MeV$$

$$pc = E\frac{v}{c} = 833 \times 0.8 = 667\ MeV$$

Find the energy of P in the primed frame.

$$E' = \frac{500}{\sqrt{1 - \left(\frac{10}{11}\right)^2}} = 1200\ MeV$$

(Keung's section) **Quiz 2 - PHY244** Feb 08, 2008

Print Your **Last Name:** Solution b

First name:

Show detailed work to receive full scores. ($c = 300$ m/μs)

Giving or receiving aid is cause for dismissal from the university.

A particle P travels at a uniform velocity. It passes the center C detector at $t = 0$, $x = 0$, leaving an electronic signal. The particle continues its motion and registers another signal at a remote R detector at $x = 9$ m, $t = 0.05\mu$s. The unprimed coordinates (x, t) are measured in the frame of the ground.

Determine the velocity u of the particle in unit of c in the unprimed frame.

$$\frac{9\,m}{0.05\mu s} = 180\ m/\mu s \quad ; \quad \frac{u}{c} = \frac{180}{300} = 0.6$$

Another observer O' also travels at uniform velocity v along the negative x axis. It take 0.1μs for O' to pass the R and then C detectors described above. Determine v/c (a sign may help).

$$\frac{v}{c} = \frac{-\frac{9m}{0.1}}{300} = -\frac{90}{300} = -0.3$$

Find the relative velocity u'/c of P as measured by the primed observer O'.

$$\frac{u'}{c} = \frac{0.6 + 0.3}{1 + 0.18} = \frac{0.9}{1.18} = \boxed{0.763}$$

The rest mass of P is known to be 500 MeV/c^2, determine the momentum (in MeV/c) and the relativistic energy (in MeV) of P in the unprimed frame.

$mc^2 = 500$ MeV $\qquad Pc = \frac{(mc^2)(\frac{u}{c})}{\sqrt{1 - u^2/c^2}}$

$$Pc = \frac{500 \times 0.6}{0.8} = 375\ \text{MeV} \quad ; \quad \boxed{P = 375\ \text{MeV}/c}$$

$$E = \frac{500}{\sqrt{\ }} = \frac{500}{0.8} = 625\ \text{MeV} \quad \boxed{E = 625\ \text{MeV}}$$

Find the energy of P in the primed frame.

$$E = \frac{500}{\sqrt{1 - 0.763^2}} = \frac{500}{\sqrt{0.418}} = 773\ \text{MeV}$$