Physics II

Special Relativity

$\beta = \frac{v}{c}$, where $c = 3\times10^8 m/s$

$\gamma = \frac{1}{\sqrt{1-\beta^2}}$

Length contraction $L = \frac{L_o}{\gamma}$, where L_o is the proper length, measured at rest.

Time dilation $T = \gamma T_o$, where T_o is the proper time, measured at rest.

Problem 1.- A certain unstable particle travels at a speed of $v = 2.4\times10^8 m/s$. At this speed the average lifetime of the particle is 2.7μs. What is the lifetime at rest?

Problem 2.- A particle has a lifetime of 1ns in its own rest frame, but it covers 0.6m (in average) in the laboratory before decaying. How fast is it moving?

Problem 2a.- A particle has a lifetime of 1ns in its own rest frame, but it covers 0.3m (in average) in the laboratory before decaying. How fast is it moving?

a) v = c
b) v = 0.81c
c) v = 0.71c
d) v = 0.61c
e) v = 0.51c

Problem 3.- If v=0.6c, how much is γ?

a) 1.20
b) 1.25
c) 1.58
d) 1.67

Problem 4.- An object has a length of 6 nm at rest, but it is moving at 60% the speed of light in the direction of its length. How long does it appear?

Problem 4a.- An object that has a length of 25 cm at rest, but it is moving at 28% the speed of light. How long does it appear?

a) 24 cm
b) 23 cm
c) 22 cm
d) 21 cm
e) 20 inches

Problem 5.- Neutrons have a half-life at rest of 608 s. What would be their half-life in motion with v = 0.8c?

a) 365 s
b) 608 s
c) 1013 s
d) 1216 s

Problem 6.- A nanowire of length 3nm is accelerated to a high velocity in the direction of its length. It is so fast that it seems to be only 1.8nm long. How fast is it moving?

a) v = 0.6c
b) v = 0.7c
c) v = 0.8c
d) v = 0.9c

Problem 7.- At high speeds it becomes more difficult to accelerate an object. What is the best explanation of this phenomenon?

a) The number of atoms in the object increases.
b) The object acquires more mass at high speeds.
c) Linear momentum increases beyond the classical value p=mv
d) $E=ma^2$
e) $E=mb^2$
f) $E=mc^2$

Problem 8.- How much energy is contained in 1kg of mass at rest?

a) 9×10^{16} joule
b) 4.5×10^{16} joule
c) 0 joule
d) 9×10^{16} eV
e) 4.5×10^{16} eV