Home work No. 4

① Relativistic particle motion in 1-D with constant acceleration:

(a) Show that the path of a relativistic particle moving along a straight line along the x-axis with constant acceleration 'α' is described by the eqn. of a hyperbola

$$x^2 - c^2 t^2 = \frac{c^4}{\alpha^2}.$$

Draw the world-line of this particle in a space-time diagram.

(b) A Newtonian particle moving with constant acceleration 'α' is described by the eqn. of a parabola

$$x = \frac{1}{2} \alpha t^2.$$

Show that the Newtonian particle motion is the $c \to \infty$ limit of the relativistic particle motion.

(Hint: shift the vertex of the hyperbola).

① (c) Show that 'α' doesn't have an upper bound.

(d) What is the physical significance of $\alpha \to \infty$.
What is the eqn. of motion in this case?

(e) Plot world-lines for particles moving with
$\alpha = c^2$, $\alpha = 10c^2$ and $\alpha = \infty$ on the same plot.

(f) Will a photon dispatched to 'chase' the particle in (a) at $t=0$ from $x=0$, ever catch up with it?

② Plot $E = \frac{mc^2}{\sqrt{1-\frac{v^2}{c^2}}}$ and $p = \frac{mv}{\sqrt{1-\frac{v^2}{c^2}}}$ as a function of $\frac{v}{c}$.

③ Work on : 12.32 to 12.35 (Griffiths) (on collisions).