Tutorial - 1

Date

Q1) (a) $\tau_{obs} = \gamma\tau$

$= \dfrac{\tau}{\sqrt{1-\frac{v^2}{c^2}}} = 7.046\times10^{-6}\ s$

(b) $s = vt \Rightarrow 3000 = 3\times10^8\, t \Rightarrow t = 10^{-5}\ s$

$N = N_0\, e^{-t/\tau_{obs}} = 5000\ \exp\left(-\dfrac{10^{-5}}{7.046\times10^{-6}}\right)$

$= 12094.8$

$\therefore$ # of particles = 12100

Q2) $\dfrac{mv^2}{r} = \dfrac{GMm}{r^2}$ (since centripetal force = Gravitational Force)

$\therefore v^2 = \dfrac{GM}{r}$

$M = 6\times10^{24}\ kg$; $G = 6.67\times10^{-11}\ N\,m^2\,kg^{-2}$

$r = (16\,0000 + 6.4\times10^6)\ m$

$v = 7810.64\ m/s$

$\gamma\,\Delta t_{astronaut} = \Delta t_{earth}$ — (1)

$T = \Delta t_{earth} - \Delta t_{astronaut} = (\gamma-1)\,\Delta t_{astronaut}$ — (2)

$\Delta t_{astronaut} = \dfrac{2\pi r}{v} \times 22 = 116096.6711\ s$

$\therefore T = (\gamma-1)(116096.6711) = 39.3\ ms$

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(Q3) (a) NO

(b) YES

(Q4) $\Delta t_{ast} = \frac{1}{\gamma} \Delta t_{earth}$

$= \left(\sqrt{1-(0.95)^2}\right) \times 80$

$= 24.98 \text{ years}$

$\approx 25 \text{ years}.$