PH 105 Tutorial Solution

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20) ν + n → τ + ρ

Conservation of momentum 4 vector gives

͢p ν + ͢p n = ͢p τ + ͢p ρ

Since the neutron is at rest pn=0.

(p ν , i(E ν + E n)/c ) = (p τ + p ρ , i(E τ + E ρ)/c)

Squaring both sides,

p ν2 - (E ν + E n) 2/c2 = (p τ + p ρ)2 - (E τ + E ρ)2/c2  --(2)

For the neutrino to possess minimum energy, the products should also possess minimum energy. This occurs when the products are at rest.

i.e. p τ = 0 and p ρ =0 ----(3)

also, E τ and E ρ is simply the rest mass energy.(γ=1)

i.e. E τ = 2GeV and E ρ = 1 GeV -----(4)

Substitute (3) and (4) into (2)

On solving,

***E ν = 4 GeV.***

In the COM frame net momentum of products =0.

Also E τ and E ρ the respective rest mass energies.

pn +p ν =0 ---(5)

and

E ν + E n = E τ (2GeV) + E ρ (1 GeV) ---(6)

Also note that E ν = p νc (zero rest mass) ----(7)

Solving (5) and (6) using (7)

***pn = -4/3 (GeV/c)***

E n2 = pn2c2 + m n2c4

***E n = 5/3 GeV***

i.e γn = 5/3

***Vn = -0.8c*** (since pn<0)

From (5)

***p ν= 4/3 (GeV/c)***

***E ν = p νc = 4 GeV***

***V ν = c*** (A neutrino has zero rest mass and moves at the same speed as light. 'c' is a universal constant and is independent of the frame of observation.)