PHY293 Quiz #3 – Solutions

November 9, 2017

This is the answer key to all four of the Quiz versions. Each 'sub-part' of each question was worth equal weight (so for v1 and v2 each part was worth 25% of the quizz and for v3 and v4 each part was worth 33%). All results here are rounded to 2 significant figures. Up to 3 significant figures acceptable. More than that is too much and should have 10% deducted (only once if answers too all parts have too much (or too little) precision).

Version 1 3.1:1 $\gamma = 1.25$ Anna sees the 25 lyrs length contracted to 20 lyrs. At $v = 0.6c$ this takes 33.3 yrs.

3.1:2 Anna will predict Bob ages less than her (by a factor γ) so gets Bob's age: 33.3/1.25 = 26.4 yrs.

3.1:3 Bob just watches Anna's ship travel to planet X at $v = 0.6c$. This takes 25 lyrs/0.6c = 41.6 yrs.

3.1:4 Bob predicts Anna is younger than him (by a factor γ). This is 41.6 yrs/1.25 = 33.3 yrs. Same as answer to part 1.

Version 2 3.2:1 Bob just watches Anna's ship travel to planet X at $v = 0.8c$. This takes 10 lyrs/0.8c = 12.5 yrs.

3.2:2 First need to work out Anna's age (part 3 of this question): $\gamma = 1.66$ Anna sees the 10 lyrs length contracted to 6 lyrs. At $v = 0.8c$ this takes 7.5 yrs. But Anna will measure time passing more slowly for Bob (by a factor γ) so Bob will be 7.5yrs/$\gamma = 4.5$yrs old according to her (moving) clocks

3.2:3 Already worked this out above. Anna will age 7.5 years during her journey – according to her clock

3.2:4 Bob predicts Anna is younger than him (by a factor γ). This is 12.5 yrs/1.66 = 7.5 yrs. Same as answer to part 3.

Version 3 3.3:1 The particle travels at 0.85c for 320 ns, travels $0.85 \times 3 \times 10^8$ m/s $\times 320$ ns = 82m

3.3:2 Time dilation allows it live **longer** in the stationarly frame: $\tau_{lab} = \tau_0 \cdot \gamma$, so in the particle's rest frame (moving wrt the lab) $\tau_0 = \tau_{lab}/\gamma = 320\text{ns}/1.9 = 170\text{ns}$

3.3:3 The moving particle sees the experimental hall length contracted: $L_{part} = L_{hall}/\gamma = 82\text{m}/1.9 = 43\text{m}$.

Version 4 3.4:1 Time dilation tells us that the particle lives the shortest amount of time in its rest frame. So lab time (given a 6 μs) is longer by a factor $\gamma = 7.1$ (here). Thus particle lives for 6μs/7.1 = 0.85 μs.

3.4:2 The particle travels at 0.99c for 6μs, giving $0.99 \times 3 \times 10^8\text{m/s} \times 6\mu\text{s}$ = 1800m (A pretty big, but not unimaginable, size experimental hall)

3.4:3 The moving particle sees the experimental hall length contracted: $L_{part} = L_{hall}/\gamma = 1800m/7.1 = 250\text{m}$.