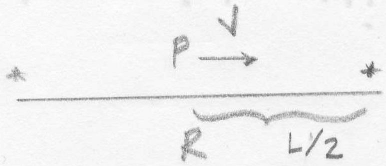
CQ

remark on Q 3,4 In both these cases even though the persons 'see' the events at different times they can infer, from known distances and speed of light, exact times of the events (explosions here). With little bit of calculation they can figure out when actually the events took place. However these "actual" times themselves differ when we go over to different reference frames (and we now know it's all because the speed of light in vacuum is the same in all inertial frames).

5 ⓑ Let's assume Ryan (or more precisely observers in Ryan's frame) did not see the explosions and all they know about the events is that Peggy, who was standing at the centre of the railroad car, saw the explosions at the ends of the car at the same time.

Now to these observers, Peggy is trying to move away from the light from left explosion and move towards

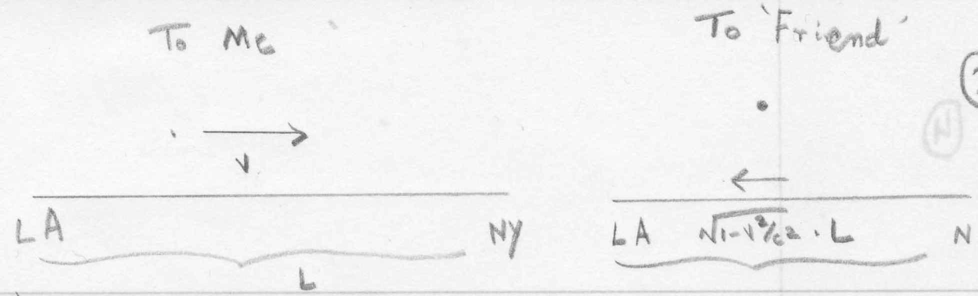


, Peggy trying to move away from light of left explosion.

the light of right explosion. But isn't the speed of light is just c in both cases? then the time it takes the light of left explosion to reach Peggy will be more (to wit $\frac{L/2}{c-v}$) as compared to light from right explosion $\left(\frac{L/2}{c+v}\right)$. But Peggy says she 'saw' them happen at the same time (i.e. light reached her at the same time from both explosions). Surely then left explosion took place earlier (by, to wit, $L/2\,\left(1/_{c-v} - 1/_{c+v}\right) = \frac{L/2 \cdot 2v}{c^2-v^2} = \frac{Lv}{c^2-v^2}$).

6. (b) It's now the same analysis as in 5 (b). The inference of the student is that the left tree was struck first.

7 If observers of reference frame A observes their counter-parts in reference frame B to move w/ velocity $\bar{v}$, observers in B will find their counterparts in A to move w/ velocity $-\bar{v}$.



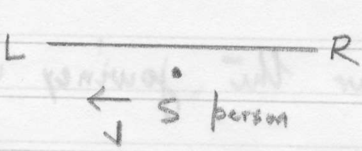
Hence 'friend' finds the observers in the reference frame of 'me' i.e. of earth to move with velocity $\overline{-v}$ i.e. w/ same speed in opposite direction. Hence the distance between LA and NY will seem to her contracted and moving w/ speed v the new distance being $\sqrt{1-v^2/c^2} \cdot L$. Obviously then to her the journey w/ last $\sqrt{1-v^2/c^2} \cdot L/v$ whereas I ('me') shall find it to last L/v (greater).

8. Well, we learned in problems 5 & 6 that events simultaneous in one frame is not so in another. Also to the experimenter in s' their counter-parts in s are trying to move away from the right end of the ruler. According to him light from right end should take more time (to reach a person in s who was at the centre of the ruler at s' frame's time of supposedly simultaneous measurement of both ends). The very assertion that it's not the case (that the s-person got the light signalling measurement of

(4)

ends at the same time) will make the S' experimenter think that right end observation/measurement was made first and signal was sent earlier (to make it reach the S-person above at the same time).

To S' experimenter



E & P (8) However the energy of the forward photon will be more than the energy of the backward photon [Think why?]

(15) Just compare w/ conceptual problem 5 & 6. [In frame of slai
which one explodes later?]

(16) The trick of the problem is that the velocity of the cosmic ray frame too is given. Interestingly this problem can also be solved applying the idea of length contraction. The length of the atmosphere covered seems to be $\sqrt{1-v^2/c^2} \cdot L_{proper}$

$= \sqrt{1-\left(\frac{60{,}000}{400\times10^{-6}\times3\times10^{8}}\right)^2} \cdot 60{,}000\ m \cong 51{,}962$ m to the cosmic ray frame. But the atmosphere is moving w/ a speed of $60{,}000/400\times10^{-6}$ m/s $= 1.5\times10^{8}$ m/s w.r.t. thereby taking

$51{,}962\ m / 1.5\times10^{8}\ m/s \cong 3.464\times10^{-4}\ s \cong 346\ \mu s$ which is the time span in its frame. [Just as in conceptual problem 7]

17→20 Either use the time dilation idea or the approach taken in problem (16) which is perhaps easier to visualise.

24, 26. refer E & P (16) above.

The approach to the problem taken here has the two following principles:

① that of length contraction by a factor of $\sqrt{1-v^2/c^2}$,

& ② that of reciprocity of relative velocity as stated in the beginning of the solution of conceptual problem 7 (ultimately related to the isotropicity of space)

In the book derivation however one takes dilation of time as being primary effect whence length contraction comes out of principle ②. Any one can be followed to solve problem according to ones ease of visualisation.