Exercise 2

Monday, November 16, 2020 12:33 PM

1.

We will look at the time it takes for the light beam to travel from the left-spaceship to the right-spaceship. Because we are looking from the spaceships reference frame, the the left spaceship is moving with the same velocity as the right spaceship, thus making them stationarry in their reference system. The time it takes for the light beam to travel from left to the right must therefore be the same as the time for the lightbeam to travel from the right to the left.

2.

Now we are looking at the same situation but from the spacestations reference system. These two spaceships are moving with a constant velocity to the left.

When leftmost spaceship emmits the lightbeam, the lightbeam will travel with the constant speed of light towards the right spaceship. However, the spacestation sees that the spaceship is moving towards to the lightbeam, and the lightbeam must therefore travel shorter way than L.

When the lightbeam is reflected by the mirror in right spaceship, spacestation sees the lightbeam travel back to the left spacestation. In addition, the spacestation sees that the left spaceship is traveling away from the lightbeam. The lightbeam must therefore travel the distance more than L. We can therefore say that the time it takes for the light beam to travel from A to B has lesser value than the time it takes to travel back.

3.

We have answered that in \ref{2}.

4.

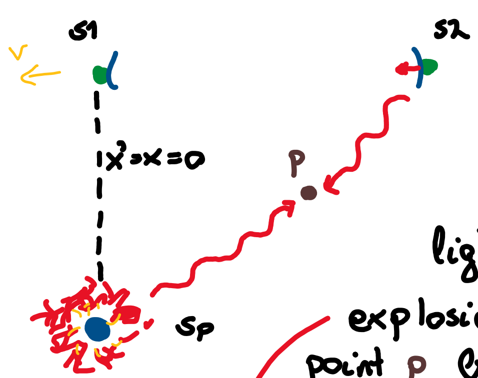
Oh

5.

No, this cannot be the case. The important thing in this non-relativistic situation is that the velocity of the ping-pong ball is not constant in these two references.

The situation uses Euclideon-geometri. Meaning that the pingpong ball in spacestation reference exceeds velocity of (80 + 50)km/h, while on the spaceships reference system, the ping pong travels only at 80km/h.

6.



light from explosion reaches point P before ligh from reflection at event B.

Because point P moves towards the explotion event C.

At least this is

something we assume?

7.
Frame 2 was the frame reference from the spacestation

The spacestation sees the emmition of the light beam from the spacestation at the left.

A

it then explodes and dies

C

then the light beam get's reflected at right spaceship

B

and then event D.

8.
No.

9. $\boxed{\text{Event A: } x'_A = 0\,\text{km} \quad t'_A = 0\,\text{ms}}$

$\boxed{\text{Event B: } x'_B = 400\,\text{km} \quad t'_B = 1{,}33765\,\text{ms}}$

$\boxed{\text{Event C: } x'_C = 260{,}661\,\text{km} \quad t'_C = 1{,}33765\,\text{ms}}$

$\boxed{\text{Event D: } x'_D = 0\,\text{km} \quad t'_D = 2{,}67529}$

$x'_C = \frac{260{,}661\,\text{km}}{c} = \frac{260661}{299\ 9}$

$x'_B = \frac{400\,\text{km}}{c} = \frac{400\ 000}{299\ 792}$

$= 1{,}33426 \cdot 10^{-3}$

$= 1{,}33426\ \text{ms}$

V stays at origin all the time,

V and H has constant distance d' all the time.

d' must therefore be $d' = x'_B = 400\,\text{km}$

$\Delta t'_{AB} = \frac{d'}{c} = d' = 400\,\text{km}$

$\Delta t'_{BD} = \frac{d'}{c} = d' = 400\,\text{km}$

10.

1. write down x's and t's

2. Only unknowns:

x_B, t_B, t_D

x_B , t_B , t_D
and t_c

Event A:

$x_A = 0$, $t_A = 0$

Event B:

$x_B = x_B$, $t_B = t_B$

Event C:

$x_c = 0$ $t_c = t_c$

Event D:

$x_D = |v t_D|$

ii. $(\Delta s')^2 = \Delta s^2 = \Delta t^2 - (\Delta x)^2 = (\Delta t')^2 - (\Delta x)^2$

- $\Delta S_{AB} = \Delta t_{AB}^2 - \Delta x_{AB}^2$

$$= (0 - t_B)^2 - (0 - x_B)^2 = t_B^2 - x_B^2$$

- $\Delta S'_{AB} = (\Delta t'_{AB})^2 - (\Delta x'_{AB})^2$

$$= \left(\frac{d'}{c}\right)^2 - (d')^2$$

Invariance of the interval:

$$\Delta S_{AB} = \Delta S'_{AB}$$

$$t_B^2 - x_B^2 = (d')^2 - (d')^2$$ ← define $c = 1$

$$t_B^2 - x_B^2 = 0 \Rightarrow \sqrt{t_B^2} = \sqrt{x_B^2}$$

$$\Downarrow$$

$$t_B = x_B$$

12. $\Delta S^2_{AC} = (\Delta S')^2_{AC}$

$x_A = 0 \qquad x'_A = 0$

$x_C = 0 \qquad x'_C = 0,869471 \text{ ms}$

$t_A = 0 \qquad t'_A = 0$

$t_C = t_C \qquad t'_C = 1,33765 \text{ ms}$

$$t_C^2 - 0^2 = (1,33765)^2 - (0,869471)^2$$
$$= (1,33765)^2 - 0,7559807$$
$$t_C^2 = 1,03332 \text{ ms}$$
$$\underline{t_C = 1,0165 \text{ ms}}$$

13. $\Delta S^2_{AB} = (\Delta S'_{AB})^2$

$x_B = x_B \qquad x'_B = 1,334256 \text{ ms}$

$t_B = t_B \qquad t'_B = 1,33765 \text{ ms}$

$t_C = 1,0165 \text{ ms} \qquad t'_C = 1,33765 \text{ ms}$

$x_C = 0 \qquad x'_C = 0,869471 \text{ ms}$

$$(t_B - t_C)^2 - x_B^2 = 0^2 - (1{,}334256 - 0{,}869471)^2$$

$$\cancel{t_B^2} - 2t_B t_c + t_c^2 - \cancel{x_B^2} = -0{,}216025$$

Vet at $t_B = x_B$

$$-2t_B \cdot 1{,}0165 + 1{,}033272 = -0{,}216025$$

$$-2{,}033\, t_B = -1{,}249297$$

$$t_B = 0{,}61451 \text{ ms}$$

14 Rewriting the table for spacestation reference frame.

$$x_A = 0 \qquad t_A = 0$$

$$x_B = 0{,}61451 \text{ms} = t_B$$

$$x_C = 0 \qquad t_C = 1{,}0165 \text{ms}$$

Spacetime tried :

$$\Delta s_{AC} \, , \quad \Delta s_{AB} \, , \quad \Delta s_{BC}$$

try AD

$$\Delta s_{AD}^2 = (0 - t_D)^2 - (0 - x_D)^2$$

$$= (\Delta s'_{AD})^2 = (0 - 2{,}67529)^2 - (0-0)^2$$

*(1) $t_D^2 - x_D^2 = 7{,}15717$

$$\Delta s_{CD}^2 = (1{,}0165 - t_D)^2 - (0 - x_D)^2$$

$$= (\Delta s'_{CD})^2 = (1{,}33765 - 2{,}67529)^2 - (0{,}86947 - 0)^2$$

$$\Rightarrow (1{,}0165 - t_D)^2 - x_D^2 = 1{,}78928 - 0{,}75597$$

(2)* $\Rightarrow 1{,}033272 - 2{,}033 t_D + t_D^2 - x_D^2 = 1{,}03328$

setter (1) inn i (2)

$$1{,}033272 - 2{,}033 t_D + (7{,}157177) = 1{,}03328$$

$$8{,}190449 - 2{,}033 t_D = 1{,}03328$$

$$-2{,}033 t_D = -7{,}157169$$

(3) $t_D = 3{,}52049 6311 \text{ ms}$

Setter (3) inn i (1)

$$(3{,}52049 6311)^2 - x_D^2 = 7{,}157177$$

$$-x_D^2 = 7,157177 - 12,3939 =$$

$$x_D^2 = 5,236723$$

$$x_D = 2,288368734$$

15 $\Delta t_{AB} = t_B - t_A = t_B = 0,61451\,ms$

16 $\Delta t_{BD} = t_D - t_B = (3,520496 - 0,61451)ms$

$$= 2,905986\,ms$$

17 $t_c = 1,0165\,ms$

$t_B = 0,61451\,ms$

Event B happened before C.

This does not match with my reasoning above