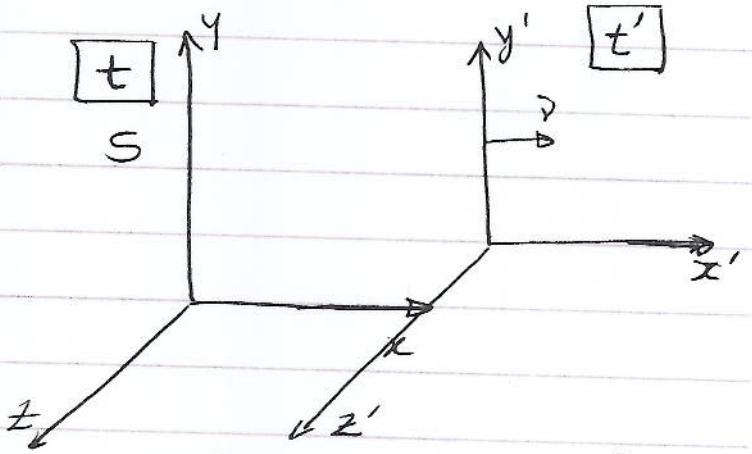
Physics 3305

Home Work # 1

Problem 2-18 :

Equation (2-4)

$$\begin{cases} x' = Ax + Bt \\ t' = Cx + Dt \end{cases}$$



$t \neq t'$, time is not absolute

1) $x' = 0$ and $x = vt$ in (2-4)

$0 = Avt + Bt$

So, $\boxed{B = -Av}$

2) $x' = -vt'$ and $x = 0$ in équation (2-4)

$-vt' = Bt$ & $t' = Dt$

$-vDt = Bt \Rightarrow \boxed{D = -\frac{B}{v}} \Rightarrow \boxed{A = D}$

3) $x' = ct'$ & $x = ct$ in (2-4)

$ct' = Act + Bt$ $\underline{B = -Av}$ $ct' = Act - Avt = At(c - v)$

$t' = Cct + Dt$

(*) $\boxed{t' \overset{A=D}{=} t(Cc + A)}$ (**) $\boxed{t' = At\left(1 - \frac{v}{c}\right)}$

(*) = (**) $t(Cc + A) = At(1 - v/c)$

$\boxed{C = -\frac{vA}{c^2}}$ ✓

Problem 2-20

Let Δt be the time in your frame (S)
and $\Delta t'$ be the time in Carl's frame (S')
The time in your frame will be longer, thus,

$$\Delta t = \gamma \Delta t'$$

$$\Delta t' = \frac{\Delta t}{\gamma} \quad \text{with } \Delta t = 1\,\text{min} = 60\,\text{s}$$

$$\text{and } \gamma = \left(\sqrt{1-\left(\frac{v}{c}\right)^2}\right)^{-1} = \frac{1}{\sqrt{1-\left(\frac{0.5c}{c}\right)^2}}$$

$$= \frac{1}{\sqrt{1-(0.5)^2}} = 1.15$$

$$\text{So } \Delta t' = \frac{60}{1.1547}$$

$$\boxed{\Delta t' = 52.5}$$

Problem 2-21

For an observer on Earth, a spacecraft with a velocity of 0.6c will be shorter in Length
Let L be the length of the spacecraft in the observer's frame and L_o in the moving frame (S')

$$L = L_o\sqrt{1-\frac{v^2}{c^2}} \Rightarrow L_o = \frac{L}{\sqrt{1-\left(\frac{v}{c}\right)^2}}$$

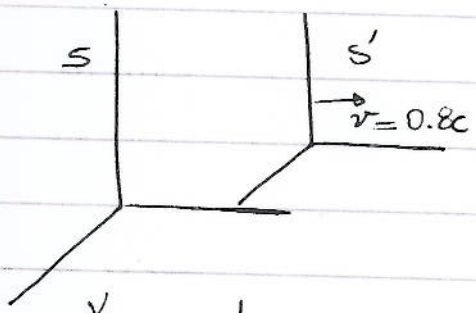
$$L_o = \frac{35\,m}{\sqrt{1-(0.6)^2}}$$

$$\boxed{L_o = 43.75\,m}$$

Problem.2-31

$v = 0.8c$

$d = 4000\ km$



$$\Delta t = \gamma \Delta t'$$

$$\Delta t = \frac{d}{v} = \frac{4 \times 10^6\ m}{0.8 \times 3 \times 10^8\ m/s}$$

$$\boxed{\Delta t = 0.0167\ s}$$

$$\gamma = \frac{1}{\sqrt{1 - \left(\frac{v}{c}\right)^2}}$$

$v = 0.8c$

$\gamma = 1.67$

$$\Delta t' = \frac{\Delta t}{\gamma} = \frac{0.0167}{1.67} = 0.01\ s$$

$$\boxed{\Delta t' = 0.01\ s}$$

$$\Delta t - \Delta t' = 0.0167\ s - 0.01\ s = 0.0067\ s \checkmark$$

So, The clock seen on the plane from the ground will be 0.0067s behind.

Problem.2.45

Let Δt be the time in Bob's frame and $\Delta t'$ in Anna's frame (moving frame)

Thus $\Delta t = \gamma \Delta t'$

$$\gamma = \frac{1}{\sqrt{1 - \left(\frac{v}{c}\right)^2}} = \frac{1}{\sqrt{1 - (0.6)^2}}$$

$$\boxed{\gamma = 1.25}$$