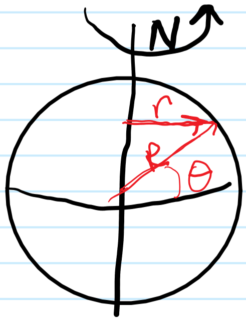
MODERN PHYS--HW 1 CH 1

CH. 1 --4,5,6,7, 11, 22, AND CYOP

Problem 1.

Compare F_c to F_g for any latitude at the surface of the Earth.



$R = 6400\ KM$

$r = R\cos\theta$

$$F_c = \frac{mv^2}{r} = m r \omega^2$$

$$\omega = \frac{2\pi}{T} = \frac{2\pi}{(24 \times 3600)} = 7.27 \times 10^{-5}\ rad/s$$

$$\frac{F_c}{F_g} = \frac{\cancel{m} r \omega^2}{\cancel{m} g} = 3.45 \times 10^{-3} \cos\theta$$

This indicates that centripetal force is small compared to gravitational force for all latitudes. For many applications the centripetal force can be neglected. However roughly one part in a thousand may have a significant effect for things like ICBM, or hitting the spacex landing pad, or motion of Earth matters for astronomy imaging. YES, IT IS WISE TO HAVE INTERPRETATION OF RESULTS IN PROBLEMS.

Problem 1-5

If Frame "s1 " is inertial and Galilean, how does one know if frame "s2" is also inertial?

If $F_{1\,net} = 0$ in some given inertial frame

Then if $F_{2\,net} = 0$ (some object) frame 2 is inertial

math

(1) $F_{1\,net} = 0 \rightarrow \ddot{x}_1 = 0$ (accel)

(2) $x_2 = x_1 - vt$

$\ddot{x}_2 = 0$ so is inertial

Problem 1-6

If equation 1.1 is true then are both frames inertial?

$$X_2 = X_1 - V_{21} t_1$$

NO!. This differs from problem 5 where we were given the initial frame was inertial. Here, we still have the "Bill and Ted" scenario--of simply falling together. Then the equation is still valid, but it just means both frames are accelerating together. We must be given that first "inertial".

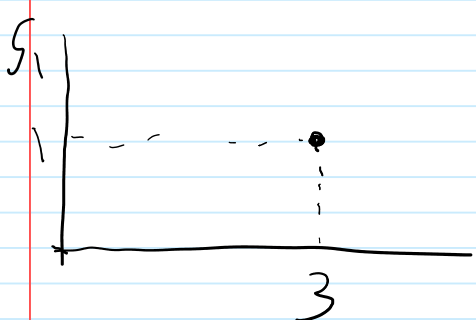
So, IF INERTIAL, THEN GALILEAN TRANFORMS ARE TRUE. The converse is not correct (less general)---if Galilean transforms are true---this does not guarantee inertial.

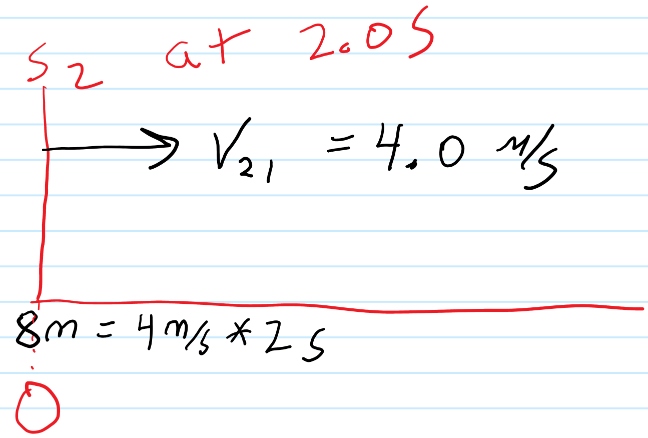
Problem 1-7

An event occurs at (3.0, 1.0, -0.5)m at t1=2.0s. v_{21}=4.0m/s

Some notes:

- Always presume that numbers were given with sufficient precision so we don't round off the answer (maybe (3.000, 1.000, -0.5000) etc. This is messy in relativity where effects can be small.
- Sketch a figure if possible





$$X_2 = 3m - 4\,m/s * 2s = -5.0\ m$$

$$Y_2 = 1 \qquad Z = \text{same} \qquad t = \text{same}$$

Only x has the translation. We can see it

Problem 1-11

Two positions are measured in frame 2 to determine a length or distance. Consider a stick with far end x_2' and near end x_2. The length of the stick is normally simply $L2=x_2'-x_2$. Show that the stick has the same length in frame 1 (under Galilean Transformations).

$$L_2 = X_2' - X_2 = (X_1' - V_{21} t_1) - (X_1 - V_{21} t_1)$$
$$= X_1' - X_1$$
$$= L_1$$

These will not be the same under Lorentz transformation (special rel). But normal Galilean, a stick has the same length in any reference frame--moving any speed.

Problem 1-15

Does "invariance" mean that measurements are the same in each frame?

NO, NO, NO! A ball at rest with me on the train appears to have zero momentum and KE with respect to me. You will observe the SAME ball as moving, and it has non-zero momentum and KE. Whether Galilean or Lorentz----the numbers will be different. Invariance refers to the form of the equation describing the physical law.

Problem 1-22

Problem 1-22 Show that the following matrix notation is a valid method of writing out Galilean transformations. ---Review Matrix multiplication if needed. Basically each row of the matrix "dots" (scalar product) into the column vector denoted--to form each element of the resulting column vector. $\beta = v/c$

$$\begin{pmatrix} x_2 \\ y_2 \\ z_2 \\ ict_2 \end{pmatrix} = \begin{pmatrix} 1 & 0 & 0 & i\beta \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} x_1 \\ y_1 \\ z_1 \\ ict_1 \end{pmatrix}$$

I have circled the first row of the matrix and the column vector --I'll write out explicitly every term for x_2

$$x_2 = 1\,x_1 + 0\,y_1 + 0\,z_1 + (i\beta)(ict_1)$$

$$= x_1 - vt_1$$

All other terms multiply out to give the remaining Galilean transformations. The matrix method is a way to write things out.