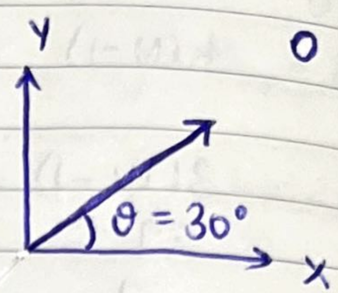
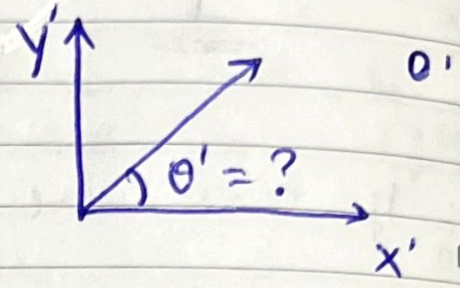
SCIENCE I - Assignment 2



① $v = 0.7c$

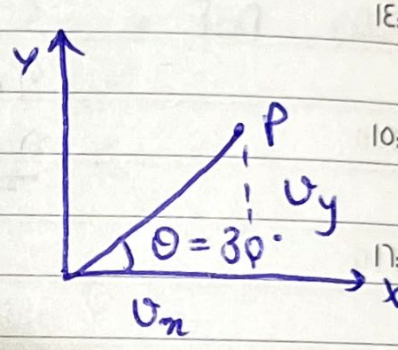
$c = 3 \times 10^8$ m/s

$v' = -0.6c$ (x' direction)



To find θ', we find the components of v_x' and v_y' and take $\tan^{-1}\left(\frac{v_x'}{v_y'}\right)$.

First we find v_x and v_y :-



$$v_x = v\cos\theta$$
$$= 0.7c \times \cos 30°$$
$$= 0.7 \times 3 \times 10^8 \times \frac{\sqrt{3}}{2}$$
$$= \underline{\underline{0.6c}} \text{ m/s}$$

$$v_y = v\sin\theta$$
$$= 0.7c \times \sin 30$$
$$= 0.7c \times \frac{1}{2}$$
$$= \underline{\underline{0.35c}} \text{ m/s}$$

Using Lorentz formula to find v_x' and v_y',

$$v_x' = \frac{v_x - v'}{1 - \frac{v v_x}{c^2}}$$

$$= \frac{0.6c - (-0.6c)}{1 - \frac{(-0.6c)(0.6c)}{c^2}}$$

$$= \frac{1.2c}{1 + (0.36)}$$

$$= \frac{1.2c}{1.36}$$

$$= \underline{0.88c} \text{ m/s}$$

Similarly, $v_y' = \dfrac{v_y \sqrt{1 - v^2/c^2}}{1 - \frac{v v_x}{c^2}}$

$$= \frac{0.35c \sqrt{1 - (-0.6c)^2/c^2}}{1 - \frac{(0.6c)(-0.6c)}{c^2}}$$

$$= \frac{0.35c \sqrt{1 - 0.36}}{1 + 0.36}$$

$$= \frac{0.8 \times 0.35c}{1.36}$$

$$= \frac{0.28c}{1.36} = \underline{0.205c} \text{ m/s}$$

$$\Rightarrow \theta' = \tan^{-1}\left(\frac{y'}{x'}\right)$$

$$= \tan^{-1}\left(\frac{0.205c}{0.88c}\right)$$

$$= \tan^{-1}(0.23)$$

$$= \underline{\underline{13.16^\circ}}$$

Velocity of particle as observed by O':

$$v_x' = v' \cos\theta'$$

$$\Rightarrow v' = \frac{v_x'}{\cos\theta'}$$

$$= \frac{0.88c}{0.971}$$

$$= \underline{\underline{0.9c}} \text{ m/s}$$

14:00

(2) From the momentum (p) vs velocity ratio (v/c) graph, we see that the linear and relativistic momentum graphs are the same for small values of v but diverge if the speed of the body becomes close to c.

The graph tells us that an objects speed can never reach c because its momentum would ~~reach~~ be infinite, which is impossible. Thus, classical momentum is only valid for velocities much smaller than c. Relativistic momentum is always correct. Similar interpretation can be made from the other graph.

August

S	1	8	15	22	29
M	2	9	16	23	30
T	3	10	17	24	31
W	4	11	18	25	
T	5	12	19	26	
F	6	13	20	27	
		14	21	28	

September

S		5	12	19	26
M		6	13	20	27
T		7	14	21	28
W	1	8	15	22	29
T	2	9	16	23	30
F	3	10	17	24	
S	4	11	18	25	

October

S		3	10	17	24	31
M		4	11	18	25	
T		5	12	19	26	
W		6	13	20	27	
T		7	14	21	28	
F	1	8	15	22	29	
S	2	9	16	23	30	

13:00 ۱۳:۰۰

(3) $m_0 = 0.511 \ MeV/c^2$

$= \underline{0.819 \times 10^{-13}} \ J/c^2$

14:00 ۱۴:۰۰

15:00 ۱۵:۰۰

$E = 1 \ MeV = 1.603 \times 10^{-13} \ J$

16:00 ۱۶:۰۰

Using the energy, mass, momentum relation:

17:00 ۱۷:۰۰

$E^2 = m^2c^4 + p^2c^2$

18:00 ۱۸:۰۰

$p^2 = \dfrac{E^2 - m^2c^4}{c^2}$

19:00 ۱۹:۰۰

$\Rightarrow p = \dfrac{\sqrt{E^2 - m^2c^4}}{c^2}$

20:00 ۲۰:۰۰

7:00

$$= \frac{\sqrt{(1.603\times10^{-13})^2 - (0.819\times10^{-13})^2/c^4 \times c^4}}{3\times10^8}$$

8:00 ٨:٠٠

$$= \frac{\sqrt{(2.57\times10^{-26}) - (0.819\times10^{-26})}}{3\times10^8}$$

9:00 ٩:٠٠

10:00 ١٠:٠٠

$$= \frac{\sqrt{1.151\times10^{-26}}}{3\times10^8}$$

11:00 ١١:٠٠

$$= \frac{1.33\times10^{-13}}{3\times10^8}$$

12:00 ١٢:٠٠

$$= \underline{\underline{0.44\times10^{-21}}}\ \text{kgm/s}$$

13:00 ١٣:٠٠

14:00 ١٤:٠٠