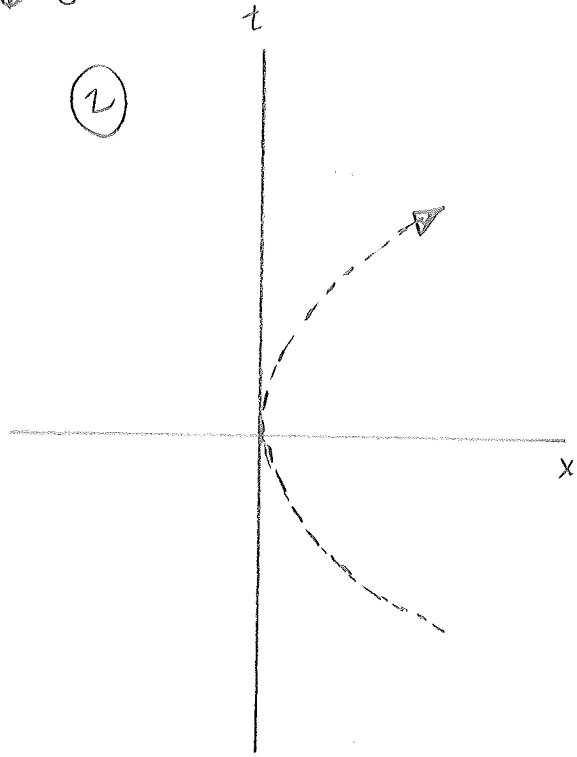
HW # 6 Solutions

2



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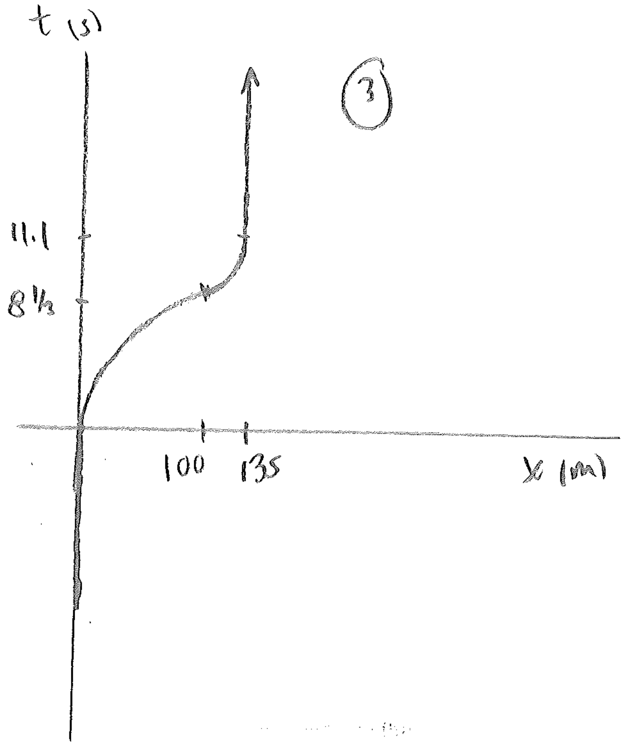

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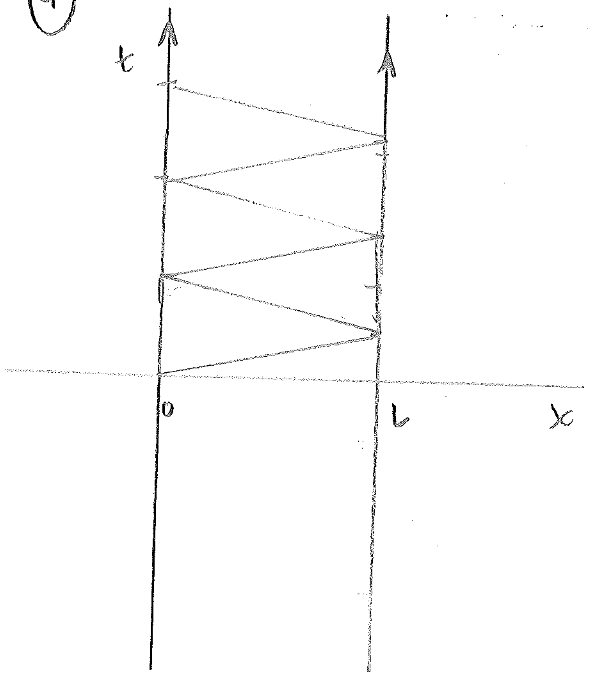

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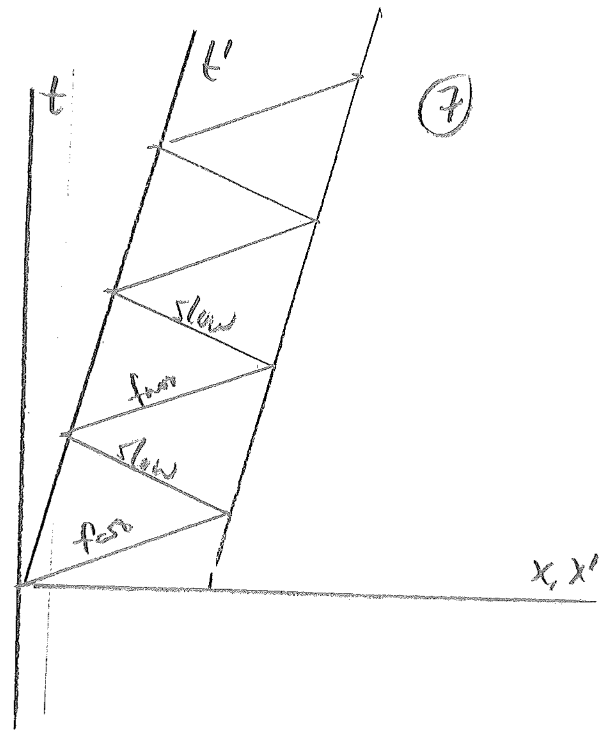


8 $\vec{V}_{p/e} = \vec{V}_{p/s} + \vec{V}_{s/e}$ $\quad V_{p/e} = 1.5 + 2.5 \times 10^8$ m/s $= 4 \times 10^8$ m/s $> c$.

You wouldn't see it before it hit you.

12. In SS frame $x_1' = x_1 - Vt_1$ & same for x_2', v_2'.
$v_1' = v_1 - V$

So $\frac{1}{2}mv_2'^2 - \frac{1}{2}mv_1'^2 = \frac{1}{2}m(v_2^2 - 2v_2V + \cancel{V^2} - v_1^2 + 2v_1V - \cancel{V^2})$

$= \frac{1}{2}mv_2^2 - \frac{1}{2}mv_1^2 + mV(v_1 - v_2) = \Delta K'$

$W' = F \times \text{displacement}'$

$= F(x_2' - x_1') = F(x_2 - Vt_2 - x_1 + Vt_1)$

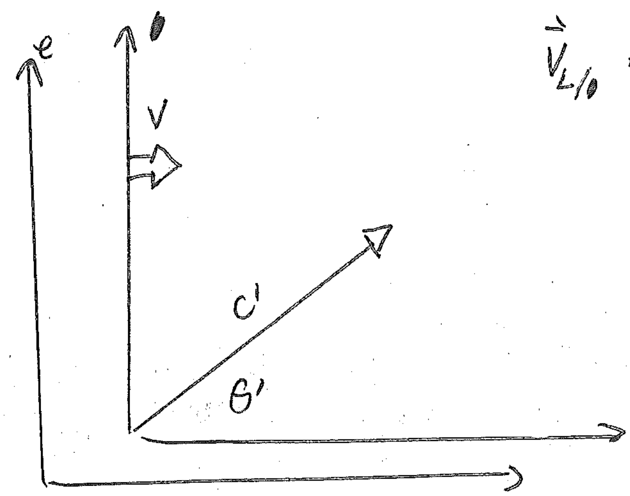
$= F(x_2 - x_1) + FV(t_1 - t_2)$

$= W + F \cdot V \cdot (t_1 - t_2)$

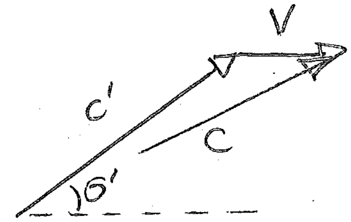
Note that $W = \frac{1}{2}mv_2^2 - \frac{1}{2}mv_1^2$

Does $FV(t_1 - t_2) = mV(v_1 - v_2)$? Yes, because $m\frac{\Delta v}{\Delta t} = F$ ✓

13.



$\vec{V}_{L/o} + \vec{V}_{o/e} = \vec{V}_{L/e} \leftarrow$ ether



$$c^2 = (c'_x + V)^2 + c_y'^2 = (c'\cos\theta' + V)^2 + c'^2\sin^2\theta'$$

$$= c'^2\cos^2\theta' + 2c'V\cos\theta' + V^2 + c'^2\sin^2\theta'$$

$$= c'^2 + 2c'V\cos\theta' + V^2 \quad \text{(Law of cosines!)}$$

So

$$0 = c'^2 + 2c'V\cos\theta' + (V^2 - c^2)$$

$$c' = \frac{-2V\cos\theta' \pm \sqrt{4V^2\cos^2\theta' + 4(c^2 - V^2)}}{2}$$ quadratic formula need + root to be > 0.

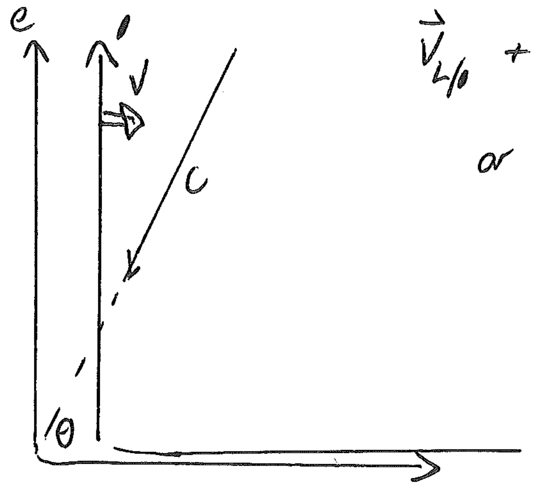
then $V^2(1-\cos^2\theta') = V^2\sin^2\theta'$ so $c' = \sqrt{c^2 - V^2\sin^2\theta'} - V\cos\theta'$

Upstream $\theta' = 0$ $\quad c' = c - V.$

Downstream $\theta' = 180°$ $\quad c' = c + V$ $\quad (\cos\theta' = -1)$

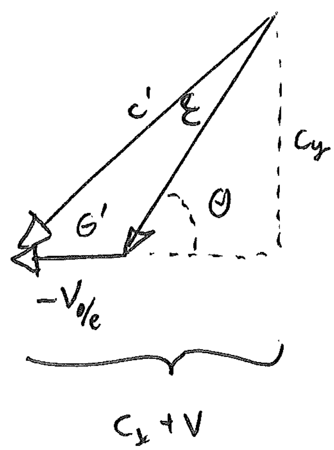
across $\quad \theta' = 90°$ $\quad \sin\theta' = 1$ $\quad \cos\theta' = 0$ $\quad c' = \sqrt{c^2 - V^2}$

16.(a)



$$\vec{V}_{L/o} + \vec{V}_{o/e} = \vec{V}_{L/e}$$

or $$\vec{V}_{L/o} = \vec{V}_{L/e} - \vec{V}_{o/e}$$



so $$\tan\theta' = \frac{c_y}{c_x + V} = \frac{c\sin\theta}{c\cos\theta + V}$$

$$= \frac{\sin\theta}{\cos\theta + V/c}$$

(b) For $\theta = 90^\circ$, $\tan\theta' = \frac{c}{V} = \frac{3\times10^8\ \text{m/s}}{30\times10^3\ \text{m/s}} = 10^4$ $\theta' = 89.994^\circ$

17. Just modify the vector drawing above, by adding $\vec{V}_{1/e}$, the ether drag velocity, to $\vec{c}'$. You get $\vec{c}$ back!