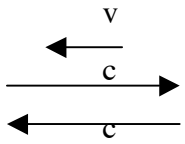
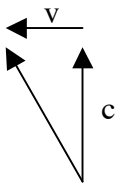
CHAPTER-1 HOMEWORK

#4.





(a) $T_1 = L/c+v + L/c-v$
$= 2Lc / (c^2+v^2)$
$= (2L/c)/ (1- v^2 / c^2)$
$= 0.4167$ h

$T_2 = (2L/c)/ (1- v^2 / c^2)^{1/2}$
$= 0.4082$ h

(b) **$\Delta T = 0.0085$ h**

#9. $L = Lo/\gamma$ $\gamma = 1/[1-.9^2]^{1/2} = 2.294$
$L = Lo/2.294 =$ **0.436 Lo**

#11. $\Delta t = \gamma \Delta to$ with $\gamma \sim 1 + 1/2 \beta^2$
$\Delta t - \Delta to = (\gamma - 1) \Delta to = 1/2 \beta^2$ $\Delta to = (8.89 \times 10^{-13}) (3600s) = 3.2$ ns
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#13. (a) $\tau = \gamma \tau o$ ground based observer measures τ
$\gamma = 1/(1-0.95^2)^{1/2} = 3.20$ $\beta = 0.95c$
$\tau = \gamma \tau o = (3.20) 2.2 \mu s =$ **7.04 μs**

(b) $t = d / 0.95 c = 1.05 \times 10^{-5}$ s $= 10.5 \mu s$

$N(t) = No\, e^{-t/\tau} = (5 \times 10^4$ muons) exp[- (10.5/7.04)] = **1.13×10^4 muons**

 # 17 (a) $\lambda = \lambda o [1-\beta / 1+\beta]^{1/2}$ approaching- blue shift
$x = (\lambda / \lambda o) = 450 / 550 = 0.818$
$\beta = (1-x^2) / (1+x^2) = 0.330 / 1.669 =$ **0.197**

(b) $700nm = 550nm [1+\beta / 1-\beta]^{1/2}$ receding - red shift
$x = (\lambda / \lambda o) = 700 / 550 = 1.273$
$\beta = (x^2 -1) / (x^2 +1) = 0.620/ 2.620 =$ **0.236**

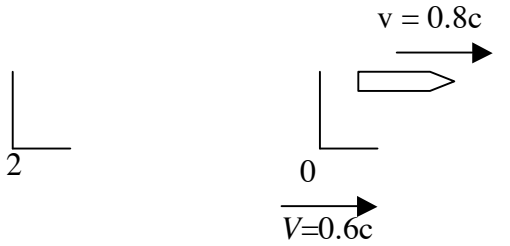
#34 Frames 0, 1, 2 are atttached to Liz, rocket-1 and rocket-2
Observer-0 believes $Lo = 2.52 \times 10^{12}$ m

(a) $50m = x1 / \gamma 1$ where $\gamma 1 = [1/1-0,8^2]^{1/2} =$ **$1.67 = \gamma 1$**
$x1 = (50)(1.67)m =$ **83.5 m**

$\gamma 2 = [1/1-0,6^2]^{1/2} =$ **$1.27 = \gamma 2$**

x2 = (50)(1.25) = **62.5 m**

(b) Observer-2 sees Observer-0 approaching at V = 0.6c . relative velocity. They can both agree to this. Rocket-1 is moving in Frame-0 with velocity v=0.8c . The velocity measured by Observer-2 is v2 = V + v / [1+ *V* v /c2] from the velocity addition formula. Observer-1 measures the same relative velocity. Oberver-1 and Observer-2 agree.



v2= 0.8c + 0.6c /[1 + (0.8)(0.6)/c^2]
= **0.946 c**

Also v1 = **0.946c**

γ_{12} = 3.08 both cases

Observer-2 measures Observer-1's ship length to be x2 = 83.5m / γ_{12}
x1 = 27.1 m
Observer-1 measures Observer-2's ship length to be x2 = 62.5m / γ_{12}
x1 = 20.3 m

(c) Observer-0 sees the rockets approaching at Vrel = 1.4 c.
The time for collision is the t = 2.52 x 10^{12} m / 1.4 c. = **6000s = 1.67 hrs**

(d) Lo is the initial distance between rockets measured by Observer-0
Observer-1 measures the distance between ships Lo/γ_1 = 1.51 x 10^{12} m.
and time before collision ΔT_1 = 1.51 x 10^{12} m / 0.946 c = **1.47 hrs < 1.5 hrs**

(e) Lo is the initial distance between rockets measured by Observer-0
Observer-2 measures the distance between ships Lo/γ_2 = 2.02 x 10^{12} m.
and time before collision ΔT_2 = 1.98 x 10^{12} m / 0.946 c = **1.97 hrs > 1.5 hrs**

(f) Crew –2 makes it but Crew-1 does not