PHYS 262 EXAM 2 SOLUTIONS

(1) A) $\boxed{t = \frac{d}{V}}$

B) P is approaching S with velocity $\boxed{-V \text{ (or } V\text{); speed } V}$

C) Distance to P will be length contracted

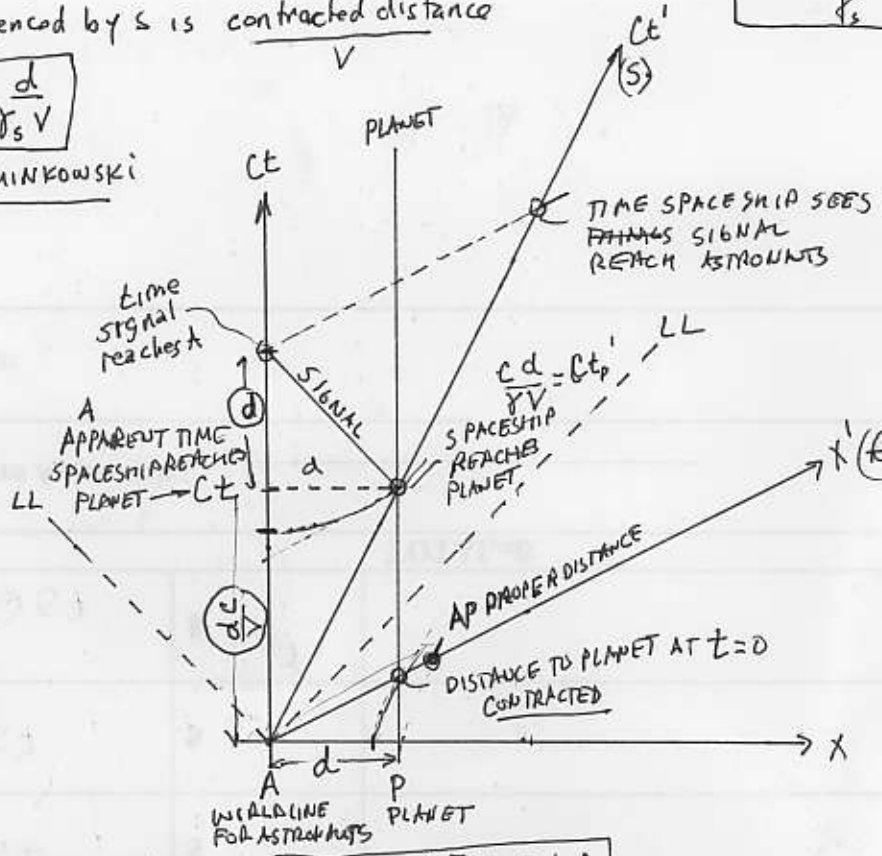
$$\boxed{d_s = \frac{d}{\gamma_s} = \sqrt{1 - \frac{V^2}{c^2}}\, d}$$

D) Time experienced by S is contracted distance / V

$$\boxed{t_s = \frac{d}{\gamma_s V}}$$

E) CHECK MINKOWSKI

F)



TIME SIGNAL REACHES ASTRONAUTS

$ct_A = \frac{d}{V} \cdot c + d$

$\boxed{ct_A = d\left(\frac{c}{V} + 1\right)}$

(2) A) APPARENT CLOSING SPEED IS $\boxed{0.7c + 0.7c = 1.4c}$ IN EARTH'S IRF

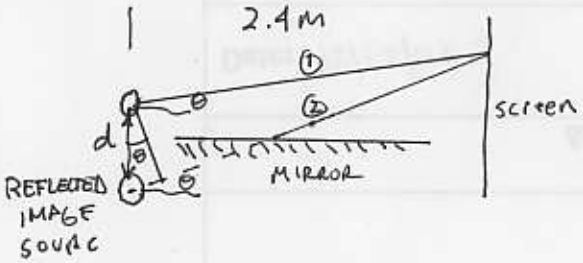
B) L: → 0.7c E ← 0.7c :R

CONSIDER IRF TO BE I.R.F MOVING WITH RIGHT SPACESHIP. $\therefore V = -0.7c$

$$v_x' = \frac{(+0.7c) - (-0.7c)}{1 - \frac{(+0.7c)(-0.7c)}{c^2}} = \frac{+1.4c}{1.49c} \boxed{= 0.94c}$$

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

(3) Assume 2.4m is far enough away that the two rays ① + ② will be parallel. (CHECK AT END!)



$kd\sin\theta_m = 2\pi m$ for constructive interference

TAKE $m = -1, 0, +1$ for FRINGES

$\sin\theta_0 = 0$

$\sin\theta_{+1} = \frac{2\pi}{kd} = \frac{2\pi\lambda}{2\pi d} \approx \theta_1 \approx \frac{1.3mm}{2.4m} = 5.4\times10^{-4}$

$$\therefore \boxed{d = \frac{\lambda \cdot 2.4}{1.3\times10^{-3}} = 1.07\times10^{-3}\,m}$$

$$\boxed{\frac{d}{2} = 0.54\,mm}$$

SINCE $\sin\theta \approx \theta$ WORKS WELL OUR INITIAL ASSUMPTION IS CORRECT

PROB 4

4 (A) $\frac{300 \text{ lines}}{\text{INCH}} \cdot \frac{1 \text{ inch}}{25.4 \text{ mm}} = \frac{11811 \text{ lines}}{\text{m}} \Rightarrow \frac{84.7 \times 10^{-6} \text{ m}}{\text{line}} = d$

GRATING ORDERS OCCUR WHEN

BOOK:

$d \sin\theta = \lambda m$

$\sin\theta_m = \frac{\lambda}{d} m$

MY WAY:

$I = I_0 \frac{\sin^2 \frac{M\phi}{2}}{\sin^2 \frac{\phi}{2}}$ M: NUMBER OF SOURCES/SLITS

$\phi = kd\sin\theta$

SUPER MAXIMA (ORDERS):

WHEN $\sin^2 \frac{\phi}{2} = 0$

$\sin \frac{\phi}{2} = 0 \quad \frac{\phi}{2} = \pi m$

$\phi = 2\pi m$

$\phi = kd\sin\theta$

$kd\sin\theta = 2\pi m$

$\sin\theta = \frac{2\pi m}{kd} = \frac{\lambda}{d} m$

THE SAME

$\therefore \sin\theta_1 = \frac{670 \text{nm} \cdot 1}{84.7 \mu\text{m}} = 7.9 \times 10^{-3}$

$\theta_1 \approx 7.9 \times 10^{-3}$ Radians $= 0.45°$

$\therefore$

θ_{-1}	-7.9×10^{-3} R
θ_0	0
θ_1	7.9×10^{-3} R

(B) FOR $\sin\theta = \pm\frac{\pi}{2} = 90°$ (FULL HALF CIRCLE)

$\sin\theta_{max} = 1 = \frac{670 \text{nm}}{84.7 \mu\text{m}} m \quad M = (126 \text{ or } 127) \times 2$ for $\pm 90°$

$\frac{\Delta\lambda}{\lambda} = \frac{1 \text{nm}}{670 \text{nm}} = \frac{1}{670} = \frac{1}{M m}$

M: number of "sources" or lines illuminated by my laser pointer

$M = \frac{1.5 \text{mm}}{84.7 \mu\text{m}} = 17.7 \text{ or } 18$

THE ORDER REQUIRED TO ACHIEVE THE DESIRED RESOLUTION IS

$m = 37 \text{ or } 38$