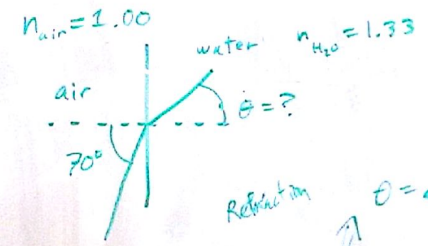


- 32 ✓ reflection, refraction
- 34 diffraction
- 36 ✓ special relativity
- 38
- 39
- 41
- 44

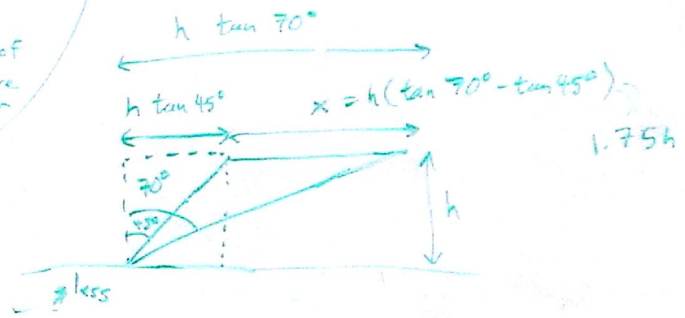
$v = \frac{c}{n}$ $v = \frac{f \lambda}{\lambda}$
 frequency wavelength
 reflections add 180° phase shift
 λ decreases by factor n ; f same
 interference: $\Delta(\text{path length}) = \begin{cases} 0, \pm \lambda, \pm 2\lambda, \dots & \text{constructive} \\ \pm \frac{\lambda}{2}, \pm 3\lambda/2, \pm 5\lambda/2, \dots & \text{destructive} \end{cases}$

Reflection
 $\frac{1}{d_{\text{object}}} + \frac{1}{d_{\text{image}}} = \frac{1}{f}$
 $f = \text{focal length} = \frac{1}{2} \text{ radius of curvature of mirror}$

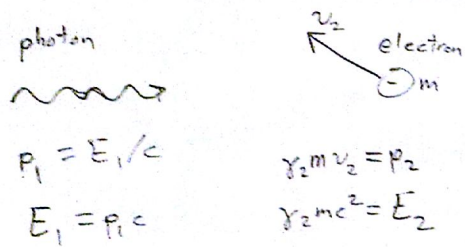


Refraction $\theta = \arcsin\left(\frac{\sin 70^\circ}{1.33}\right) = 45^\circ$
 $1.00 \sin 70^\circ = 1.33 \sin \theta$

Lorentz invariants: same in all frames
 rest energy $mc^2 = \sqrt{E^2 - (pc)^2}$
 wristwatch time: $\Delta t_0 = \sqrt{(\Delta t)^2 - (\Delta x/c)^2}$
 odometer length: $\Delta x_0 = \sqrt{(\Delta x)^2 - (c\Delta t)^2}$



Can a free electron absorb a photon with emitting another photon? No.



before

$$\beta_2 = \frac{v_2}{c}$$

$$\gamma_2 = \frac{1}{\sqrt{1-\beta_2^2}}$$



$$p_3 = p_1 + p_2$$

$$E_3 = E_1 + E_2$$

after

2 equations
1 free variable v_3

$$\gamma_3 m v_3 = p_1 + \gamma_2 m v_2$$

$$\gamma_3 m c^2 = p_1 c + \gamma_2 m c^2$$

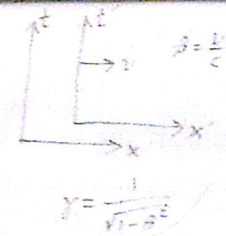
$$\gamma_3 = \frac{1}{\sqrt{1-\beta_3^2}} \quad \beta_3 = \frac{v_3}{c}$$

$$x = \gamma(x' + \beta c t')$$

$$c t = \gamma(\beta x' + c t')$$

$$p c = \gamma(p' c + \beta c E')$$

$$E = \gamma(\beta E' + p' c)$$



$$\Delta E \Delta t \geq \frac{h}{2\pi} = h$$

$$6.63 \times 10^{-34} \text{ J s}$$

$$\frac{v_3}{c} = \frac{p_1 + \gamma_2 m v_2}{p_1 c + \gamma_2 m c^2} \Rightarrow \beta_3 = \frac{p_1 c + \gamma_2 m v_2}{p_1 c + \gamma_2 m c^2}$$

Let a ratio of the 2 equations

In "after" electron's reference frame,
 $v_3 = 0$, so $p_3 = 0$ & $E_3 = m c^2$

But before, in all frames, $E_2 \geq m c^2$

& $E_1 > 0$.

$E_1 + E_2 > m c^2 = E_3$ violates conservation of energy.