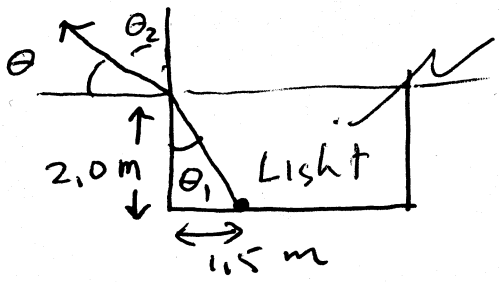
Physics 1C Spring 2010
Final Exam form A.

1) Refraction.



$$\tan\theta_1 = \frac{1.5}{2.0} = 0.75$$

$$\theta_1 = 36.9^\circ$$

$$n_1 \sin\theta_1 = n_2 \sin\theta_2$$

$$\sin\theta_2 = \frac{n_1 \sin\theta_1}{n_2} = \frac{1.33 \sin 36.9^\circ}{1.00} = 0.798$$

$$\theta_2 = 53^\circ$$

$$\theta = 90 - \theta_2 = 90 - 53 = \boxed{37^\circ}$$

2) Harmonic oscillator

$$\omega = \sqrt{\frac{k}{m}} = 2\pi f = \frac{2\pi}{T}$$

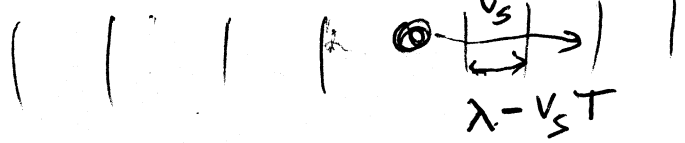
$$T = \frac{1}{2\pi}\sqrt{\frac{m}{k}}$$

$$\frac{T'}{T} = \sqrt{\frac{m'}{m}} = \sqrt{\frac{2m}{m}} = \sqrt{2}$$

T' will be increased by $\sqrt{2}$.

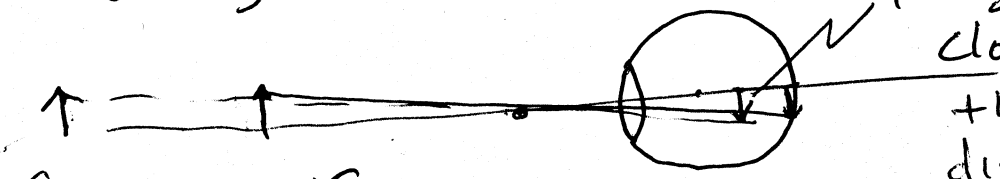
3) Doppler shift.

moving source.



The frequency shift heard by the observer is due to the change in the wavelength of sound in the air.

4) Nearsighted vision



far out of focus

near in focus

image from for object closer to f_ inside the eye - The distance from lens to retina is too long.

The lens is too converging - this can be corrected using a diverging lens

5) Sound Intensity.

Sound will be reduced by 15 dB.

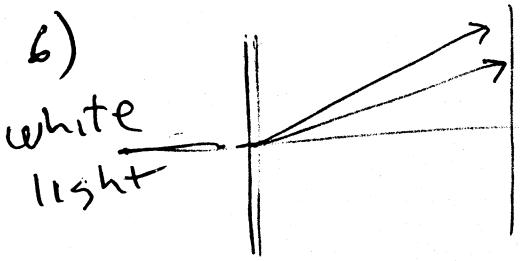
$$\beta = 10 \log \frac{I_2}{I_1} = -15$$

$$\log \frac{I_2}{I_1} = -1.5$$

$$\frac{I_2}{I_1} = 10^{-1.5} = 3.2 \times 10^{-2}$$

$$I_2 = 3.2 \times 10^{-2} (10^{-4}) = \boxed{3.2 \times 10^{-6} \ W/m^2}$$

6)



$(\lambda_{red} > \lambda_{blue})$ for a grating.

$$d \sin\theta = m\lambda$$

red is deviated more than blue -

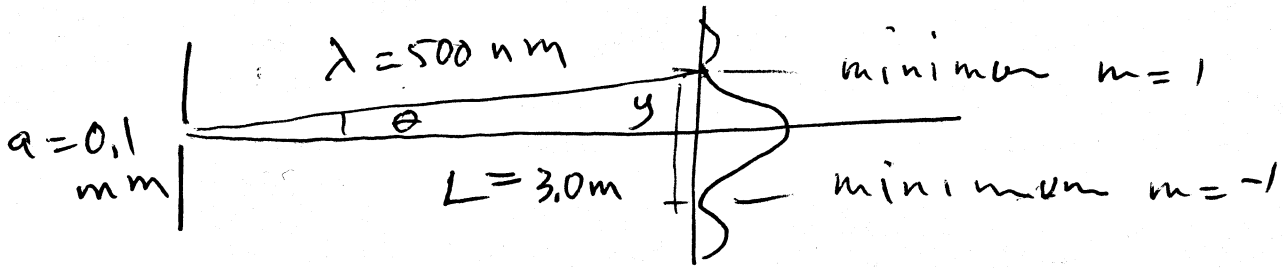
for a prism

$n_{red} < n_{blue}$

blue is deviated more than red.

∴ The spectrometer uses a grating

7) Single slit diffraction



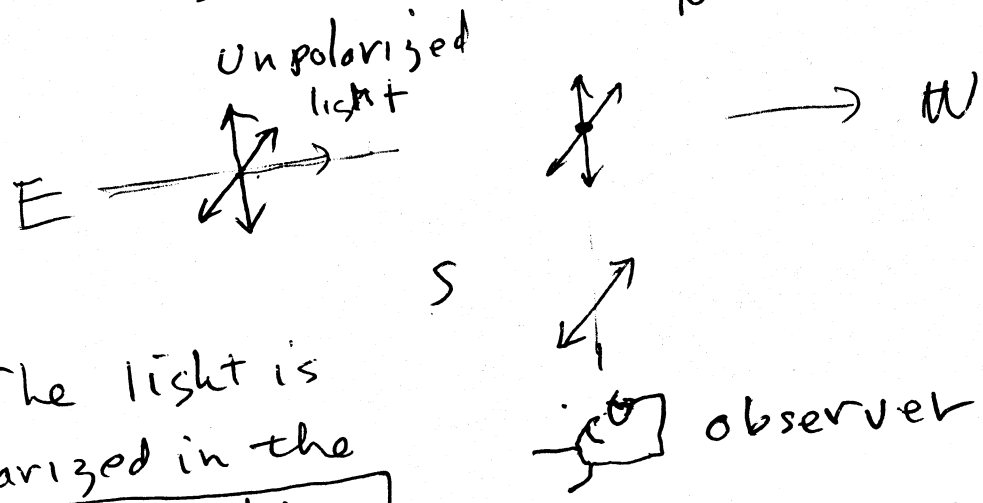
$a \sin\theta = \lambda$

$\sin\theta = \frac{y}{L}$, $a \frac{y}{L} = \lambda$

$y = \frac{\lambda L}{a} = \frac{500 \times 10^{-9} (3.0\,m)}{0.1 \times 10^{-3}\,m} = 1.5 \times 10^{-2}\,m$

The distance between minima is $2y =$ **3.0 cm**

8) Polarization



The light is polarized in the **N-S direction**

There is no field along the direction of propagation

9) Radioactive decay –

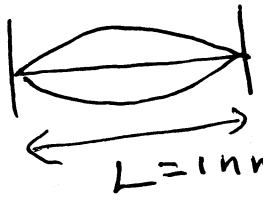
$$N = N_0 \left(\frac{1}{2}\right)^{t/T_{1/2}}$$

$$\frac{N}{N_0} = \left(\frac{1}{2}\right)^{t/T_{1/2}}$$

$$\log \frac{N}{N_0} = \frac{t}{T_{1/2}} \log 0.5$$

$$t = T_{1/2} \frac{\log \frac{N}{N_0}}{\log 0.5} = 4.5 \frac{\log \frac{0.001}{1}}{\log 0.5} = \boxed{45 \text{ days}}$$

10) Particle in a box –



$$\lambda = 2L = \frac{h}{p} \quad \text{(de Broglie } \lambda\text{)}$$

$$\text{Kinetic Energy} = \frac{1}{2} mV^2 = \frac{1}{2} \frac{m^2v^2}{m} = \frac{1}{2} \frac{p^2}{m}$$

$$= \frac{1}{2m} \left(\frac{h}{2L}\right)^2 = \frac{1}{8} \frac{h^2}{mL^2}$$

$$KE = \frac{1}{8} \frac{(6.6 \times 10^{-34} \text{ J·s})^2}{(9.1 \times 10^{-31} \text{ kg})(1 \times 10^{-9} \text{ m})^2} = \frac{6.0 \times 10^{-20} \text{ J}}{1.6 \times 10^{-19} \text{ J/eV}}$$

$$KE = \boxed{0.37 \text{ eV}}$$

11) Photoelectric effect - Increasing the light intensity increases the no. of photons/sec - This causes the maximum photo current to increase but does not change the stopping voltage because the frequency of the light is not changed.

12) ^{235}U fission - (208 MeV) $\equiv \epsilon$

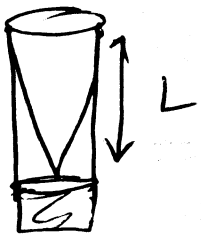
$\Longrightarrow 5 \times 10^{10} J = E = n\epsilon$

$$n \text{ atoms} = \frac{E}{\epsilon} = \frac{5 \times 10^{10} J}{208 \times 10^6 eV \times 1.6 \times 10^{-19} J/eV} = 1.5 \times 10^{21} \text{ atoms}$$

$$\text{mass}^{235}U = nMM = 1.5 \times 10^{21} \text{ atoms} \left(1.66 \times 10^{-27} \frac{kg}{\text{mass/atom}} \times 235\right)$$

$$= 5.8 \times 10^{-4} kg = \boxed{0.6 g}$$

13)



standing waves -

$\lambda_1 = 4L$ fundamental frequency

$$f_1 = \frac{v}{\lambda_1} = \frac{v}{4L}$$

$$L = \frac{v}{4f_1} = \frac{340 \text{ m/s}}{4(283.5^{-1})} = \boxed{0.30 \text{ m}}$$

14) Li^{2+} Hydrogen-like with $Z = 3+$

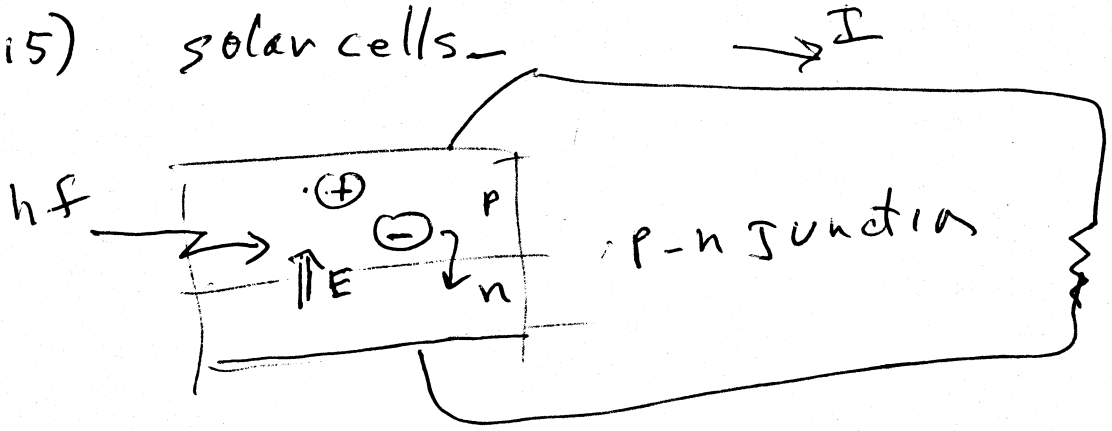
$$\frac{1}{\lambda} = Z^2 R\left[\frac{1}{n_f^2} - \frac{1}{n_i^2}\right]$$

$$= (3)^2 (1.097 \times 10^7 m^{-1})\left[\frac{1}{4^2} - \frac{1}{5^2}\right]$$

$$\frac{1}{\lambda} = 2.22 \times 10^6 m^{-1}$$

$$\lambda = 4.5 \times 10^{-7} m = \boxed{450 nm}$$

15) solar cells



Electron-hole pairs are created by the absorption of a photon which are separated across the p n junction giving a current

16) Radioactivity ^{131}I $T_{\frac{1}{2}} = 8.04$ days

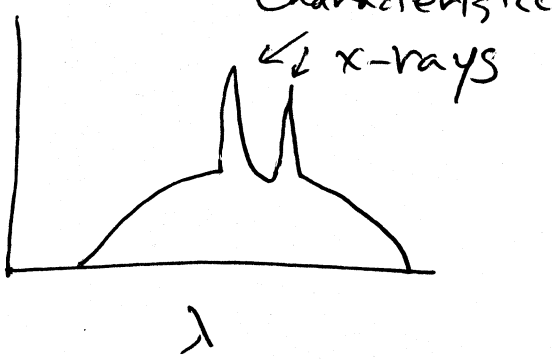
$$R = \lambda N$$

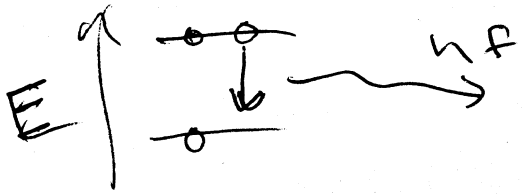
$$\lambda = \frac{0.693}{T_{\frac{1}{2}}} = \frac{0.693}{8.04 \text{ days}\left(\frac{24 hr}{day}\right)\left(\frac{60 min}{hr}\right)\left(\frac{60 s}{min}\right)}$$

$$\lambda = 1.00 \times 10^{-6} s^{-1}$$

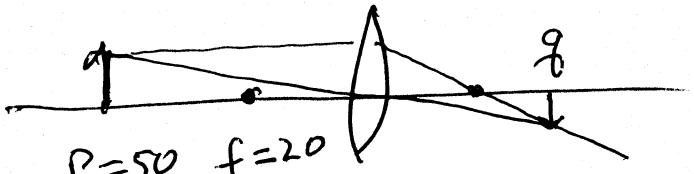
$$N = \frac{R}{\lambda} = \frac{2 \times 10^{-6} Ci\,(3.7 \times 10^{10} \frac{dps}{Ci})}{1 \times 10^{-6} s^{-1}} = \boxed{7.4 \times 10^{10} \text{ atoms}}$$

17) Characteristic x-rays have sharp bands due to emission from transitions to empty electronic states





18) Lens

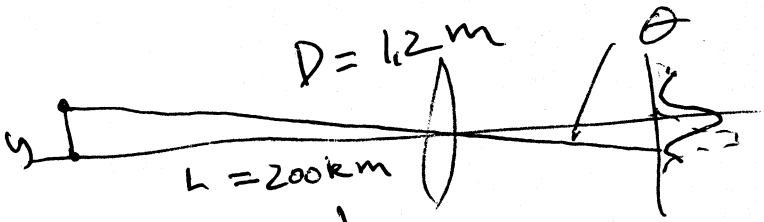


$$q = \frac{pf}{p-f} = \frac{(50)(20)}{50-20} = 33 \text{ cm}$$

$$m = -\frac{q}{p} = -\frac{33}{50} = -0.67$$

$$h' = mh = -0.67(10) = \boxed{-6.7 \text{ cm}}$$

19)

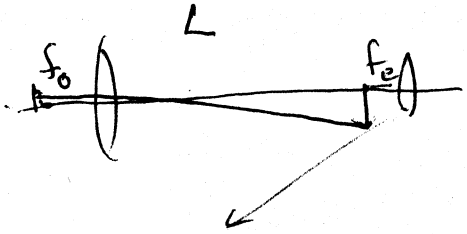


$$\theta = \frac{1.22\lambda}{D} = \frac{y}{L}$$

$$y = \frac{1.22\lambda}{D} L = \frac{1.22(500 \times 10^{-9} \text{ m})}{1.2 \text{ m}} (200 \times 10^{3} \text{ m})$$

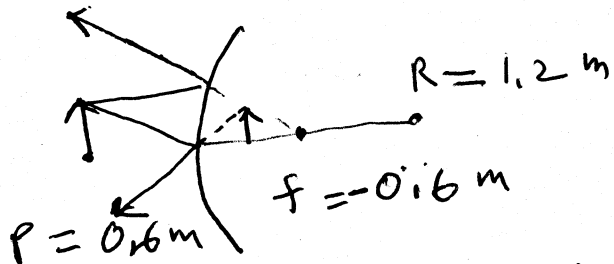
$$y = \boxed{1.0 \times 10^{-1} \text{ m}} =$$

20) Compound microscope -



$$m = \frac{L}{f_o}\frac{25\,cm}{f_e} = \frac{20\,cm}{1.5\,cm}\frac{25\,cm}{3.0\,cm} = \boxed{110}$$

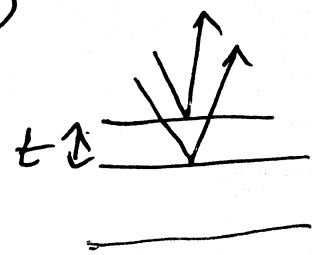
21) Convex mirror



$$\frac{q}{0} = \frac{p(f)}{p-f} = \frac{(0.6)(-0.6)}{0.6-(-0.6)} = -0.3\ m$$

$$m = -\frac{q}{p} = -\frac{-0.3}{0.6} = \boxed{0.5}$$

22)



air $n = 1.0$ } phase shift
oil $n = 1.50$ }
water $n = 1.33$ } no phase shift

There is a phase shift difference of 180° between the two reflected waves. The condition for constructive interference is.

$$2t = (m+\tfrac{1}{2})\frac{\lambda}{n_{oil}}$$

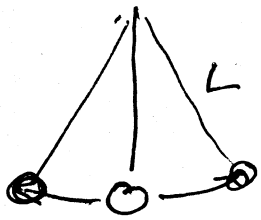
22) the minimum thickness is for $m = 0$

$$2t \; \frac{1}{2} \frac{\lambda}{n_{oil}}$$

$$t = \frac{1}{4} \frac{\lambda}{n_{oil}} = \frac{500 \times 10^{-9} m}{4(1,50)} = 8,3 \times 10^{-8} m$$

$$t = \boxed{83 \text{ nm}}$$

23) Pendulum



$$\omega = \sqrt{\frac{g}{L}} = 2\pi f = \frac{2\pi}{T}$$

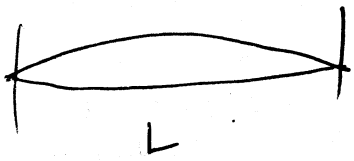
$$T = 2\pi \sqrt{\frac{L}{g}}$$

$$T^2 = 4\pi^2 \frac{L}{g}$$

$$L = \frac{g T^2}{4\pi^2} = \frac{(9,8 \; m/s^2)(5,0 s)^2}{4\pi^2} = \boxed{6,2 m}$$

24) For efficient fission of ^{235}U it is important to have slow neutrons. This is the role of the moderator in a nuclear reactor.

25) Violin –



$f_1 = 650\,Hz$ 10 Hz too low

$$f_1 = \frac{V}{2L} = \frac{1}{2L}\sqrt{\frac{F}{\mu}}$$

$$\frac{f_1'}{f_1} = \sqrt{\frac{F'}{F}}$$ (L, and μ are not changed)

$$\frac{F'}{F} = \left(\frac{f_1'}{f_1}\right)^2 = \left(\frac{660\,Hz}{650\,Hz}\right)^2 = 1.031$$

$F' = 1.031\,F$

The tension must be increased by 3%