phys 225 homework due Nov 20

6.14

100eV

$\lambda = d\sin\theta \Rightarrow d = \lambda/\sin\theta$

For 1°, $\sin\theta \doteq \theta = \frac{(1^\circ)(\pi)}{180^\circ}$ radians since $180^\circ = \pi$ radian

$\lambda = h/p$ and $p = \sqrt{2mK}$

$= hc/pc$ $\quad pc = \sqrt{2mc^2K}$

$= \left[(200)(511\times10^3)\right]^{1/2}$ eV

so $d = \frac{hc}{pc}\frac{1}{\sin\theta} = \frac{1240}{\left[(200)(511\times10^3)\right]^{1/2}}\frac{180}{\pi}$

$= 7.03$ nm

6.18 eq 6.19 says $y(x,t) = A\sin(kx - \omega t)$

this could also be $y(x,t) = A\sin\left(\frac{2\pi x}{\lambda} - 2\pi f t\right)$

so $\lambda = 2\pi/k = 2\pi/6 = 1.05$ m

$f = \omega/2\pi = 22/2\pi = 3.5$ Hz

[note, Hz = s^{-1} and is used for f but not for ω.]

$v = \lambda f = \omega/k = 22/6 = 3.7$ m/s

6.21 $\lambda = 550$ nm $\Rightarrow k = 2\pi/\lambda = 0.0114\ \text{nm}^{-1}$

$\omega/k = c \Rightarrow \omega = (3\times10^8)(0.0114\times10^9) = 3.42\times10^{15}$ rad/s

6.23 for 300 eV, $pc = \sqrt{2mc^2K}$ still

so λ here will be $1/\sqrt{3}$ x lambda for prob 6.14, for what that is worth.

$$\lambda = hc/pc = \frac{hc}{\sqrt{2mc^2K}} = \frac{1240}{\sqrt{(2)(511\times10^3)(300)}}$$

$$= 0.071 \text{ nm.} \quad k = \frac{2\pi}{\lambda} = 88.7 \text{ nm}^{-1}$$

6.24 eq 6.18 says $y(x,t) = A\sin 2\pi\left(\frac{x}{\lambda} - \frac{t}{T}\right)$

at fixed x, $(x/\lambda)(2\pi) = \phi$ is fixed.

so $y(t) = -A\sin(2\pi t/T - \phi)$

which is simple harmonic oscillation

with $f = 1/T$

6.25 $y = A\sin(kx_0 - \omega t) = -A\sin(\omega t - kx_0)$

$= +A\sin(\omega t - kx_0 \pm \pi)$

a) so $\phi = -kx_0 \pm \pi$

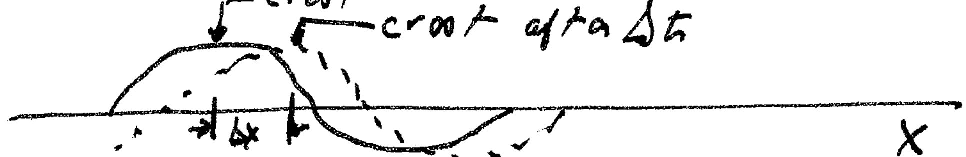
I would take $+\pi$, if kx_0 was > 0

so $\phi = \pi - kx_0$ works.

b) $\phi = \pi - 0 = \pi$ for $x_0 = 0$

c.) if $\pi - kx_0 = 2\pi$, then $x_0 = -\pi/k = -\frac{\pi\lambda}{2\pi} = -\lambda/2$

6.27



$y = \sin(ax - bt)$

at t, and at $t + \Delta t$

crest is at $ax_c - bt = \pi/2 \Rightarrow x_c = \frac{\pi}{2a} + \frac{bt}{a}$

$dx_c/dt = b/a$ = speed of crest