Modern Homework 20

It is MUCH easier to comment on your worn when you use one column.

$\boxed{8/8}$

Good job

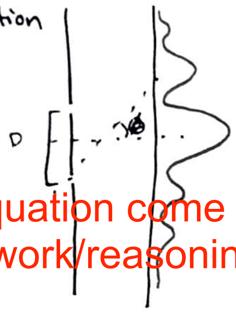
1.

+4 a) Using the set up in the book:

their equation, for diffraction

$D\sin\theta = \lambda/2$

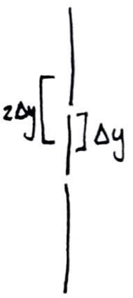
$\sin\theta \approx \Delta\theta = \frac{\lambda}{2D}$



Where did this equation come from? Show all of your work/reasoning.

b) the cut off for the error ranges in the cutoff for both slits. So if the particle went through the top slit, it must have be in the top half of the D. This error down is also reflected up, so:

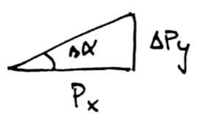
$\Delta y = D/2$ ✓



c) $\Delta y \Delta p_y \geq \frac{\hbar}{2}$

$\Delta p_y \geq \frac{\hbar}{\Delta y 2} = \frac{\hbar}{D}$ ✓

D)



$\tan(\Delta\alpha) \approx \Delta\alpha = \frac{\Delta P_y}{P_x}$ $\lambda = \frac{h}{P_x}$

$\Delta\alpha = \frac{\Delta P_y \lambda}{h} = \frac{\hbar\lambda}{Dh}$

$= \frac{\lambda}{2\pi D}$ ✓

$\Delta\alpha = \frac{\lambda}{2\pi D} \approx \frac{\lambda}{2D} = \Delta\theta$

$\Delta\alpha \approx \Delta\theta$

2.

+4 a) Energy γ: rest energy of Proton

$\Delta E \Delta t \geq \frac{\hbar}{2}$

$\Delta E \geq \frac{\hbar}{2\Delta t}$

Specifically, any smaller ΔE and we could detect this "virtual" particle, violating conservation.

We see that if $\frac{\hbar}{2\Delta t} < \Delta E$, then ΔE could be less than the point where π^0 is created, so energy is added. So the time is limited to be, at max, $\Delta t = \frac{\hbar}{2\Delta E}$ ✓

A smaller t is okay, because that just means the particle needs momentum to get a larger ΔE. Or rather, it can have momentum, doesn't have to.

$\Delta t = \frac{\hbar}{2mc^2} \Rightarrow 1.5320 \times 10^{-23}$ s $= 15.320$ yacto seconds

Bad math happened, should be 2.5e-24

b) $c\Delta t = d_{max} \Rightarrow 4.5928 \times 10^{-15}$ m $= 4.5928$ fm ✓

Consistent

c) $10^{-6}/\Delta t = 6.527 \times 10^{16}$ ✓

This is a min since Δt we used was the max. This inverse relationship means that if a max is used in the denominator, the result is minimized. ✓