Problem 1

#1

The figure above represents the photons in a beam of light with some fixed wavelength and intensity. If size represents photon energy in the picture, which of the pictures below best representes a beam of light with half the wavelength but double the intensity?

A) 

B) 

C) 

D) 

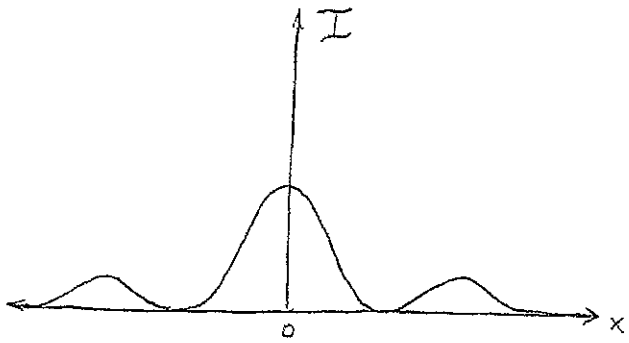
Problem 2

A physicist sets up a series of polarizers and finds that photons which are initially polarized in the vertical direction pass through all the polarizers with a net probability of exactly one quarter. If we send in a beam of vertically polarized light with an intensity 1600 W/m^2 through this series of polarizers, the intensity of the transmitted beam will be

A) 100 W/m^2
B) 400 W/m^2
C) 800 W/m^2
D) 1600 W/m^2
E) 6400 W/m^2

#2

~~Problem 7~~



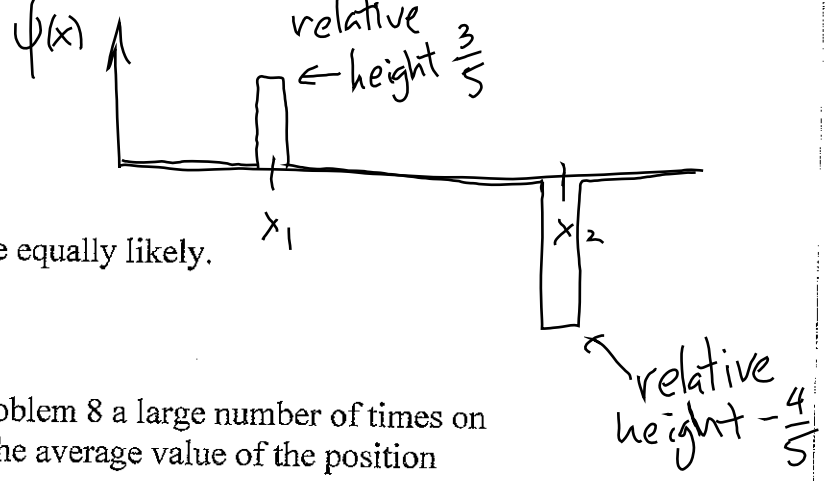
The graph shows a plot of intensity versus position on the screen for an interference pattern produced in a double slit experiment with light. If we send four individual photons through the same apparatus, which of the following statements is correct?

A) Two of the photons will hit the screen at $x<0$ and two of the photons will hit the screen at $x>0$.
B) Each photon will hit the screen directly behind one of the slits.
C) The number of photons hitting the screen at $x>0$ could be anything between 0 and 4, but is most likely 2.
D) Since the photons are identical, each photon distributes its energy onto the screen in the same way, with the energy distribution matching the classical intensity pattern.

~~Problem 8~~

#3

An electron is in a state shown . If we do a measurement of position, we are most likely to find the electron at



A) x_1
B) x_2
C) $3/5\ x_1 - 4/5\ x_2$
D) $9/25\ x_1 + 16/25\ x_2$
E) All positions between x_1 and x_2 are equally likely.

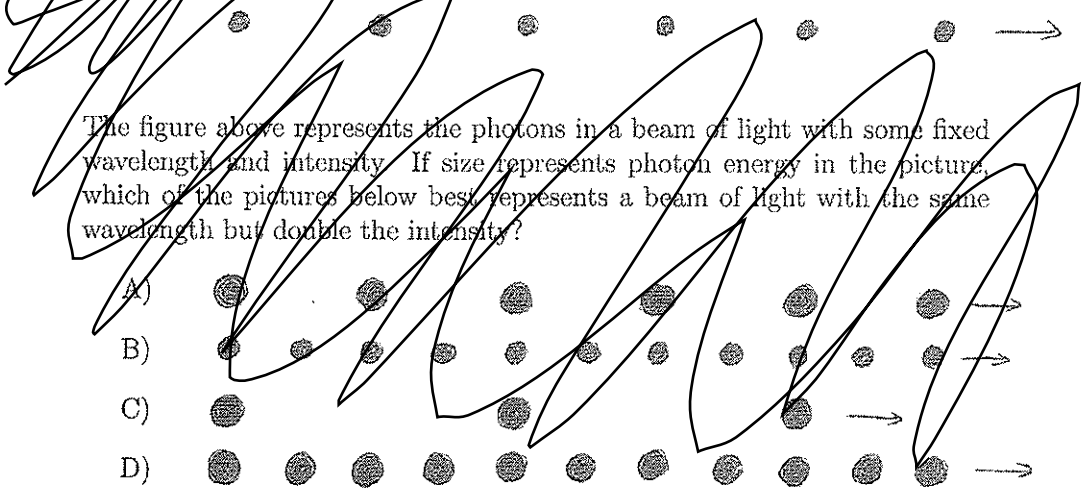
~~Problem 9~~

#4

If we perform the measurement of problem 8 a large number of times on electrons with the same initial state, the average value of the position measurements will be

A) x_1
B) x_2
C) $3/5\ x_1 - 4/5\ x_2$
D) $9/25\ x_1 + 16/25\ x_2$
E) $1/2\ (x_1 + x_2)$

Problem 4



The figure above represents the photons in a beam of light with some fixed wavelength and intensity. If size represents photon energy in the picture, which of the pictures below best represents a beam of light with the same wavelength but double the intensity?

A)

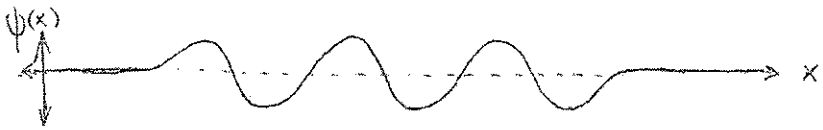
B)

C)

D)

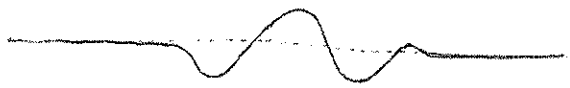
#5

Problem 5

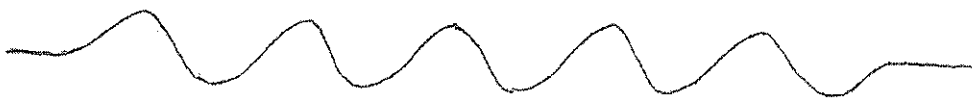


The wavefunction for a traveling electron is described by a wavepacket [redacted] shown above. Which of the following could be the [redacted] wavefunction for an electron traveling with double the velocity?

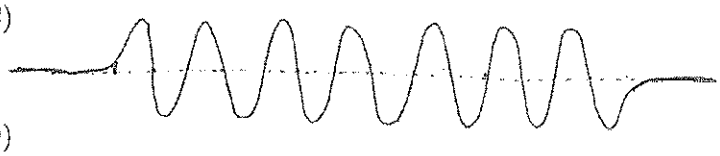
A)



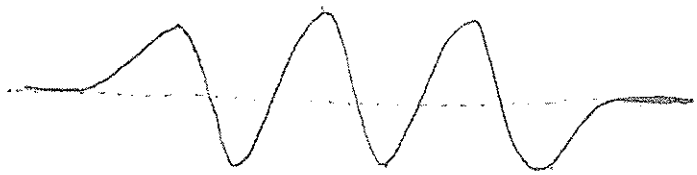
B)



C)

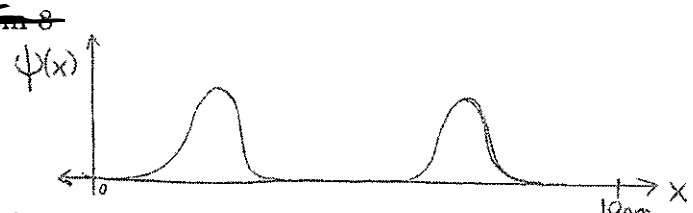


D)



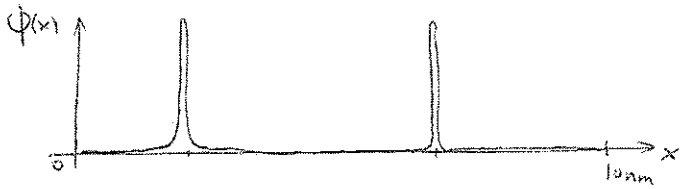
#6

~~Problem 8~~

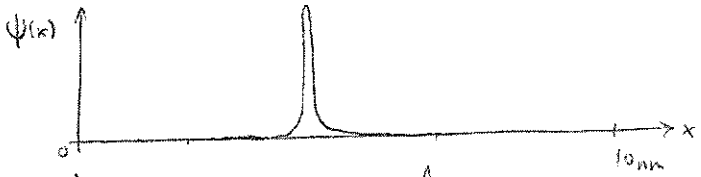


For an electron in a state represented by the wavefunction shown, a measurement of position is performed. Which of the following best represents a possible wavefunction immediately after the measurement?

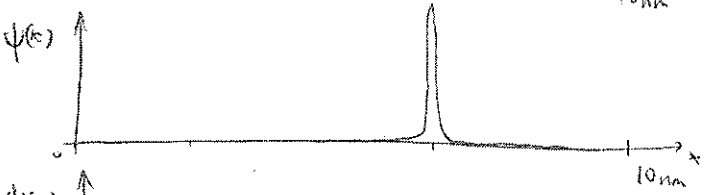
A)



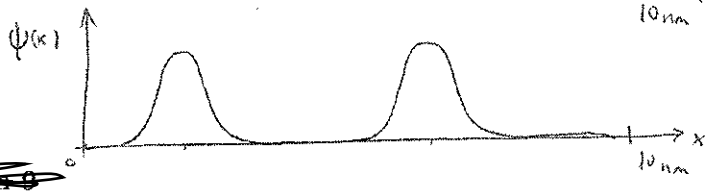
B)



C)



D)



assume all wavefunctions are normalized.

E) Either B or C is possible

#7

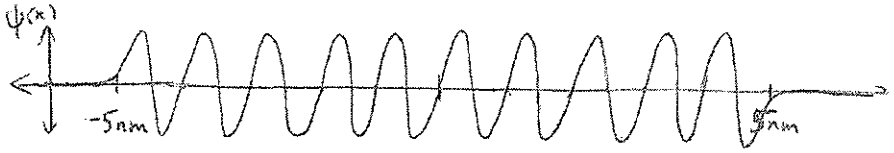
~~Problem 9~~

In a double slit experiment with electrons, what happens to the interference pattern if we double the velocity of the electrons?

A) It stays the same.
B) The fringes get further apart.
C) The fringes get closer together.

#8

Problem 18



The graph above shows the one-dimensional wavepacket for an electron traveling in a thin wire. For this electron, the uncertainty in position is closest to

A) 0.5nm
B) 5nm
C) 0
D) $\hbar$

#9

Problem 19

For the electron in the previous problem, the momentum is approximately

A) 6.6×10^{-25} kg m/s
B) 6.6×10^{-26} kg m/s
C) 1.3×10^{-25} kg m/s
D) 1.3×10^{-20} kg m/s

Problem 20

For the electron in the previous two problems, the minimum uncertainty in momentum is closest to

A) 10^{-24} kg m/s
B) 10^{-25} kg m/s
C) 10^{-26} kg m/s
D) $\hbar/2$

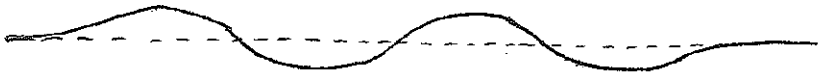
#10

~~Problem 9~~

The wavefunction for a traveling electron is described by a wavepacket ~~whose real part is~~ shown above. Which of the following could be the ~~real part of~~ the wavefunction for an electron traveling with half the momentum?

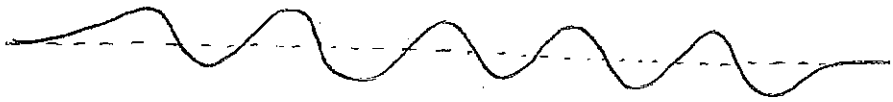
(A)

(B)



(C)

(D)



#11

~~Problem 10~~

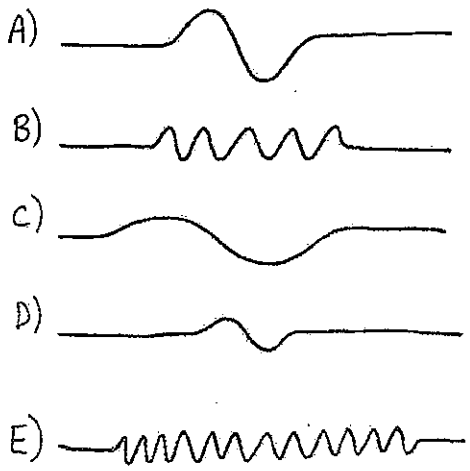
Wavepackets for traveling particles tend to spread out with time, a phenomenon known as dispersion. Which of the wavepackets below ~~(no longer shown)~~ will spread out the fastest?

(A)

(B)

(C)

(D)



The five functions shown above represent the [redacted] wavefunctions for traveling electrons.

#12 [redacted]: Which wavefunction describes the particle with the largest momentum?

A) A B) B C) C D) D E) E

#13 [redacted]: Which wavefunction describes the particle with the largest uncertainty in momentum?

A) A B) B C) C D) D E) E

#14 [redacted]: Which wavefunction describes the particle with the largest uncertainty in position?

A) A B) B C) C D) D E) E

#15 [redacted]: A double slit experiment is performed with electrons and an interference pattern is observed. A beam of *neutrons* (larger mass particles) with the same momentum as the electrons is now sent through the same slits. Compared to the pattern observed for electrons, the neutron interference pattern has "bright" spots which are

A) closer together
B) further apart
C) at the same locations
D) in a completely different pattern.