

PHYS-1200 PHYSICS II QUIZ 3 DECEMBER 7, 2005

NAME _____

Put a mark in the box next to the section of the course to which you are assigned. If you are not now in the examination room to which your section is assigned, ***GO TO IT NOW!***

	SECTION NUMBER	EXAMINATION ROOM	INSTRUCTOR	DAY AND TIME THAT SECTION MEETS
	1	DCC 324	SCOTT DWYER	MR 8:00 A.M.
	2	DCC 324	SCOTT DWYER	MR 10:00 A.M.
	3	DCC 308	HEIDI NEWBERG	MR 10:00 A.M.
	4	DCC 308	THOMAS SHANNON	MR 12:00 NOON.
	5	DCC 330	TIMOTHY HAYES	MR 12:00 NOON.
	6	DCC 308	GARY ADAMS	MR 2:00 P.M.
	7	DCC 308	THOMAS SHANNON	MR 2:00 P.M.
	8	DCC 308	GARY ADAMS	MR 4:00 P.M.
	9	DCC 318	SUSANNE HAUGER	TF 10:00 A.M.
	10	DCC 337	ANGEL GARCIA	TF 12:00 NOON
	11	DCC 318	SUSANNE HAUGER	TF 12:00 NOON
	12	DCC 330	TIMOTHY HAYES	TF 2:00 P.M.

There are 8 different pages in this quiz, including the cover page. Check now to see that you have all of them.

	CREDIT	GRADE
PART A	40%	
PART B	20%	
PART C-1	20%	
PART C-2	20%	
TOTAL	100%	

All work and answers must be given in the spaces provided on these pages.

NAME _____

PART A. (40%) Each question is worth 5%. In the space provided, to the left of the question number, write the letter corresponding to the best answer to the question.

___ 1. A source of sound waves emits waves uniformly in all directions. The sound level of the waves is β at a distance of r from the source. At a distance of $2r$ from the source, the sound level of the waves will be:

- A. $\frac{\beta}{\sqrt{2}}$ B. $\beta/2$ C. $\beta/4$ D. $\beta - 3.0$ db E. $\beta - 6.0$ db

___ 2. When light passes from air into glass it experiences a change of:

- A. frequency and speed
B. speed and wavelength
C. frequency and wavelength
D. frequency, speed and wavelength
E. speed only

___ 3. In a Young's double slit experiment, the separation between the interference maxima on the screen can be changed by the following actions:

- I. Increasing the distance between the slits.
II. Decreasing the distance between the slits.
III. Increasing the wavelength of the light used.
IV. Decreasing the wavelength of the light used.
V. Increasing the distance from the slits to the screen.
VI. Decreasing the distance from the slits to the screen.

Those actions that will *increase* the separation between the maxima are:

- A. I, III, and V D. II, III, and V
B. II, IV, and VI E. I, IV, and V
C. I, IV, and VI

___ 4. When light waves travel through an open window, there is no noticeable diffraction; they do not spread out. When sound waves pass through the same open window, they spread out over a wide angle; they show noticeable diffraction. The reason for this difference is:

- A. light waves are transverse and sound waves are longitudinal
B. sound waves need a medium (air) to propagate, but light waves do not
C. the speed of light is much greater than the speed of sound in air
D. frequencies are much higher for sound waves than they are for light waves
E. wavelengths are much longer for sound waves than they are for light waves

___ 5. Photon A has twice the energy of photon B . The ratio of the momenta of the two photons,

$\frac{p_A}{p_B}$ is:

- A. $\frac{1}{2}$ B. $\frac{1}{4}$ C. 1 D. 2 E. 4

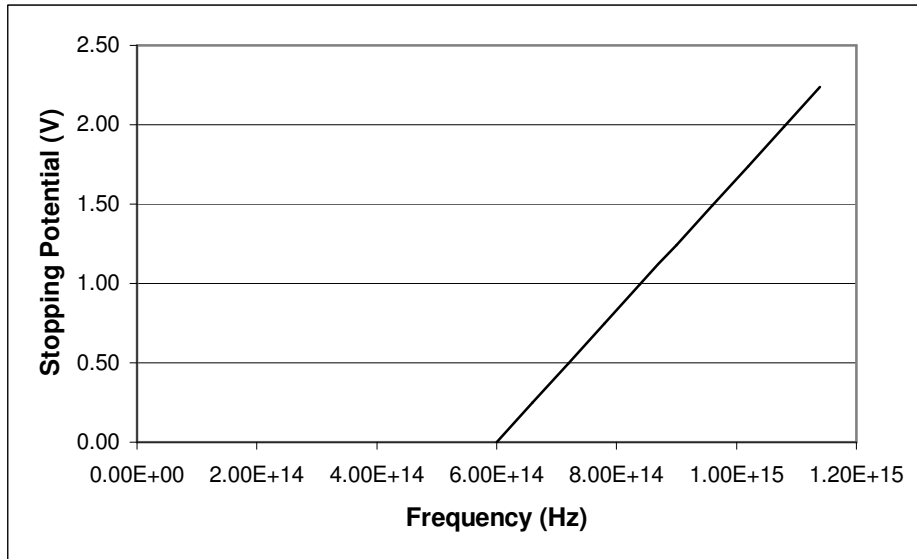
NAME _____

- ___ 6. A free electron and a free proton have the same momentum. When the wavelengths and the kinetic energies of the two particles are compared, the electron has:
- A. a shorter wavelength and a greater kinetic energy
 - B. a longer wavelength and a greater kinetic energy
 - C. the same wavelength and the same kinetic energy
 - D. the same wavelength and a greater kinetic energy
 - E. the same wavelength and a smaller kinetic energy
- ___ 7. When a piece of copper is connected to a source of emf, the motion of charges produces a current in the metal that flows in the direction of the electric field in the metal. When a piece of p -type semiconductor is connected to a source of emf, the direction of the current in the semiconductor is:
- A. in the direction of the electric field in the semiconductor
 - B. opposite to the direction of the electric field in the semiconductor
 - C. perpendicular to the direction of the electric field according to the right hand rule
 - D. there is no real current, only displacement current
 - E. this is a topic of much current research
- ___ 8. On what day of the week does the professor in charge of your Physics II section have office hours? If the professor has office hours on more than one day, you only have to select one of them to get credit.
- A. Monday
 - A. Tuesday
 - A. Wednesday
 - A. Thursday
 - A. Friday

NAME _____

PART B. (20%)

1. (10%) The figure shows graph of data taken during a photoelectric effect experiment on an unknown metal. It is a plot of stopping potential of the ejected electrons versus frequency of the incident photons.



- a) (5%) Find the cutoff frequency for the photoelectric effect for this unknown metal.

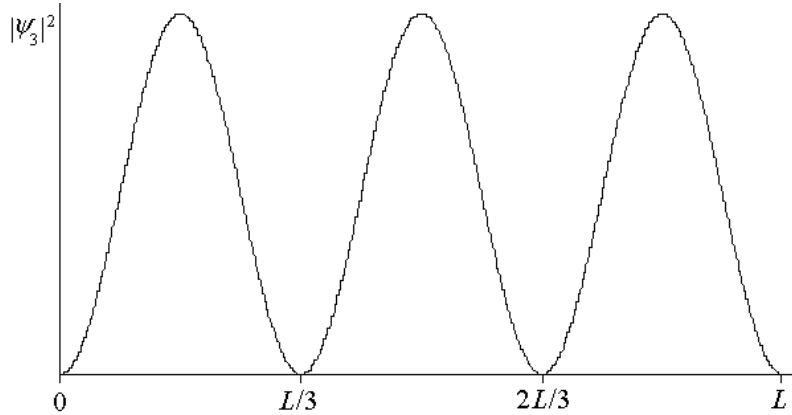
$$f_c = \underline{\hspace{2cm}} \text{ units}$$

- b) (5%) Find the work function of this unknown metal.

$$\Phi = \underline{\hspace{2cm}} \text{ units}$$

NAME _____

2. (10%) An electron is in the $n = 3$ state of an infinitely deep potential energy well of width L . The wave function of that state is $\psi_3 = \sqrt{\frac{2}{L}} \sin \frac{3\pi x}{L}$. The graph below shows a plot of $|\psi_3|^2$ as a function of x .



- a) (5%) What is the probability that the electron will be found between $x = 0$ and $x = L/3$? If you can figure this out without calculation, just write the answer and go on to part b).

$$\int_0^{L/3} |\psi_3|^2 dx = \underline{\hspace{2cm}}$$

- b) (5%) How did you arrive at the answer to part a)? Circle the answer that applies. (Not all of them will earn full credit.)

I carried out the integral.

I deduced the answer based on the symmetry of the wave function.

I had the whole thing worked out on my formula sheet.

I guessed.

Some other (honest) method which is explained below. (Explain briefly.)

NAME _____

PART C. (40%) You must show all your work or state your reasoning in order to receive credit.

1. (20%) Light from a mercury lamp, such as was used in the photoelectric effect experiment, emits light at four visible wavelengths, 405 nm, 436 nm, 546 nm, and 578 nm. Light of all four wavelengths, in the form of plane waves, is normally incident on a surface with a small circular aperture. The light passes through the aperture and each wavelength produces a circular diffraction pattern on a screen. The diffraction angles are small enough to allow small angle approximations; i.e. $\sin \theta = \tan \theta$.

a) (4%) What is the color of the light of each of the four wavelengths? Indicate your choice for the color of each wavelength by circling the appropriate color.

405 nm	GREEN	BLUE	YELLOW	VIOLET
436 nm	GREEN	BLUE	YELLOW	VIOLET
546 nm	GREEN	BLUE	YELLOW	VIOLET
578 nm	GREEN	BLUE	YELLOW	VIOLET

b) (4%) For which of the four wavelengths is the radius of the central diffraction maximum the smallest? In other words, for which wavelength will the first diffraction minimum occur at the smallest distance from the center on the pattern? Circle your choice.

405 nm 436 nm 546 nm 578 nm

c) (6%) The central maximum of the diffraction pattern formed on the screen by the light of wavelength 546 nm ($1.0 \text{ nm} = 1.0 \times 10^{-9} \text{ m}$) has a radius of 2.5 cm ($1.0 \text{ cm} = 1.0 \times 10^{-2} \text{ m}$). The light of wavelength 546 nm delivers power of $P = 3.0 \text{ W}$ to the central maximum of its diffraction pattern. Find the average intensity of the light of wavelength 546 nm that forms the central maximum of the diffraction pattern

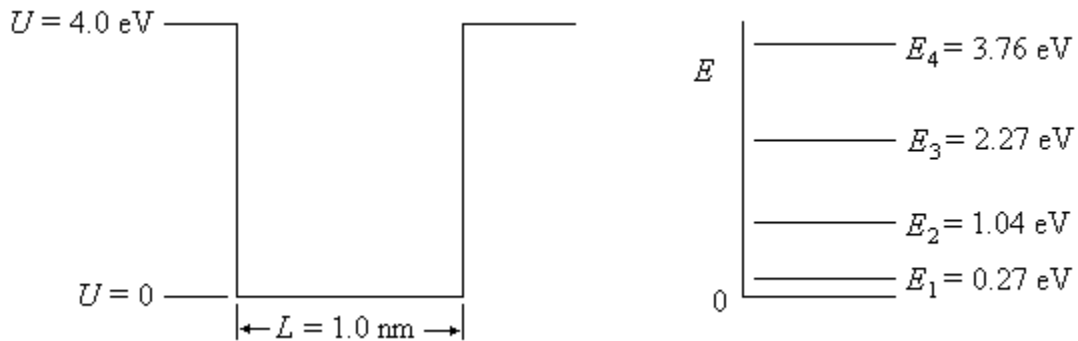
$I =$ _____ units

NAME _____

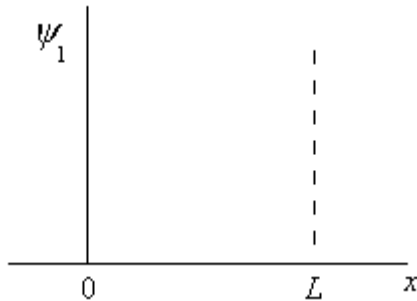
- d) (6%) Find the radius of the diffraction pattern formed on the screen by the light of wavelength 436 nm. No credit will be awarded for this question without a clear explanation, with equations, of how the answer was obtained.

$R =$ _____ units

2. (20%) The sketch on the left below shows a one dimensional potential energy well in which an electron is trapped. The depth of the well is 4.0 eV, and its width is 1.0 nm. There are four bound states for an electron in this well. The energies of the four states are shown in the diagram on the right below. The energies of the states are measured from the bottom of the well.



- a) (5%) On the axes below, make an approximate sketch of the electron wave function as a function of x , for the lowest energy state, ψ_1 , for which $E_1 = 0.27 \text{ eV}$. The well extends from $x = 0$ to $x = L$ in the diagram.



NAME _____

- b) (5%) When the electron is in the lowest energy state of the finite well of width 1.0 nm (1.0×10^{-9} m), its wavelength is: (Circle the correct choice.)

Less than 1.0 nm

Equal to 2.0 nm

Equal to 1.0 nm

Greater than 2.0 nm

Between 1.0 nm and 2.0 nm

- c) (5%) When the electron is in the lowest energy state of the finite well, E_1 , it absorbs a photon of wavelength $\lambda = 620$ nm ($1.0 \text{ nm} = 1.0 \times 10^{-9}$ m). Find the energy of the photon.

$$E_{\text{photon}} = \frac{\hspace{10em}}{\text{units}}$$

- d) (5%) As a result of absorbing the 620 nm photon, the electron is excited out of the lowest energy state for which $E_1 = 0.27$ eV. The electron ends up in which state?

(Circle the correct choice.)

$E_1 = 0.27$ eV

$E_2 = 1.04$ eV

$E_3 = 2.27$ eV

$E_4 = 3.76$ eV

The electron is ejected from the well.