

Please check the number next to your section below.

SECTION NUMBER	EXAMINATION ROOM	INSTRUCTOR	Section time
___1	DCC 308	SCOTT DWYER	MR 8:00 A.M.
___2	DCC 308	SCOTT DWYER	MR 10:00 A.M.
___3	West Hall	HEIDI NEWBERG	MR 10:00 A.M.
___4	West Hall	JOEL GIEDT	MR 12:00 NOON.
___5	DCC 318	THOMAS SHANNON	MR 12:00 NOON
___6	West Hall	ANGEL GARCIA	MR 2:00 P.M.
___7	RI 203	WAYNE ROBERGE	MR 2:00 P.M.
___8	RI 203	GLENN CIOLEK	MR 4:00 PM
___9	DCC 308	KIM LEWIS	TF 10:00 A.M.
___10	DCC 308	KIM LEWIS	TF 12:00 NOON
___11	DCC 330	JOHN SCHROEDER	TF 12:00 NOON.
___12	DCC 318	GYORGY KORNISS	TF 2:00 PM

There are 7 different pages in this quiz, including the cover page. Check now to see that you have all of them. Place your name on every page.

	CREDIT	GRADE
PART A	40%	
PART B-1	10%	
PART B-2	12%	
PART C-1	18%	
PART C-2	20%	
TOTAL	100%	

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

You are permitted the use of one 8 ½ x11" sheet of notes. Use of any other materials will result in a zero for this examination. You may use a calculator for math functions.

Collaboration on this exam will result in zero grade and letter to the Dean of Students for all students involved.

On parts B and C, answer questions in the space provided. Show your work logically and neatly.

On questions or explanations, use complete sentences. You must show adequate work to justify your answer to receive credit. Ambiguous answers will be graded incorrect.

NAME _____

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

_____A1) A sound wave propagates in material A with the following characteristics: wavelength, $\lambda_A = 2m$; frequency, $f_A = 400Hz$. It crosses a boundary into material B. The speed of sound in material B is twice that in material A. What are the characteristics of the wave in material B?

a) $\lambda_B = 2m$, $f_B = 800Hz$
b) $\lambda_B = 4m$; $f_B = 200Hz$
c) $\lambda_B = 2.82m$; $f_B = 282Hz$
d) $\lambda_B = 4m$; $f_B = 400Hz$
e) $\lambda_B = 1m$; $f_B = 400Hz$

_____A2) Suppose that a Young's double slit experiment is performed with light of wavelength λ_1 nm. The slits are b_1 mm apart. The viewing screen is a distance L_1 from the slits. The distance between bright fringes on the screen is y_1 . What is the distance between bright fringes when the distance between the slits is reduced to $b_1/2$ and the wavelength is doubled to $2\lambda_1$?

a) y_1 , b) $y_1/2$ c) $2y_1$ d) $4y_1$ e) $y_1/4$

_____A3) Light of intensity I_0 is received at a distance R from a isotropically emitting source. What is the intensity at distance 2R from the source?

a) $I_0/4$ b) $I_0/2$ c) $I_0/\sqrt{2}$ d) $\sqrt{2} I_0$ e) $2I_0$

_____A4) Electron A has twice the momentum of electron B. The ratio of the wavelengths of the two electrons, $\frac{\lambda_A}{\lambda_B}$ is:

a. $1/2$ b. $1/4$ c. 1 d. 2 e. 4

_____A5) 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:

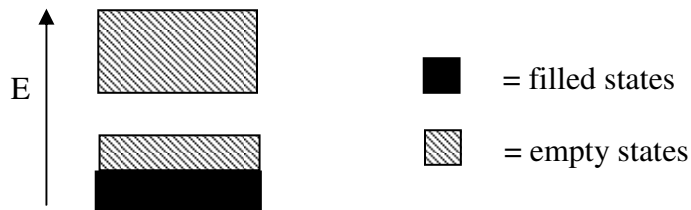
a. a shorter wavelength and a greater kinetic energy
b. a longer wavelength and a greater kinetic energy
c. the same wavelength and the same kinetic energy
d. the same wavelength and a greater kinetic energy
e. the same wavelength and a smaller kinetic energy

NAME _____

_____A6) The Fermi level of a metal (measured with respect to the bottom of the conduction band) depends primarily on (pick the best answer)

- a) the color of the metal (gold, silver, copper...)
- b) the density of the metal
- c) the density of electrons in the conduction band of the metal
- d) the volume of the sample
- e) the temperature

_____A7) The energy level diagram shown below applies to



- a) a metal
- b) a semiconductor
- c) an isolated atom
- d) a free electron gas
- e) none of the above

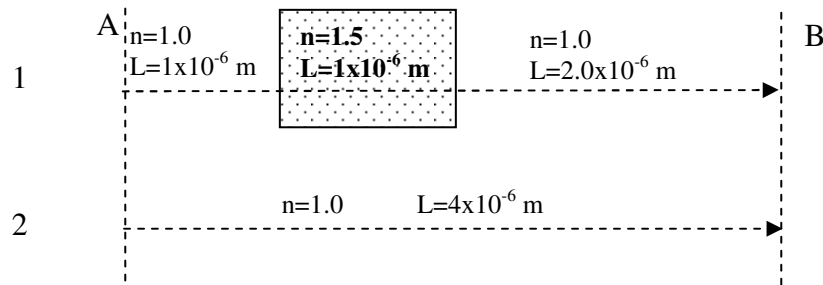
_____A8) A particle of mass m is confined in an one dimensional box with infinitely high potential walls a distance of L_0 apart. The energy of the ground state is E_0 . What would be the ground state energy of a particle of mass $2m$ in a box with side $2L_0$?

- a) $E_0/8$
- b) $E_0/2$
- c) E_0
- d) $2E_0$
- e) $8E_0$

NAME _____

PART B.

B1) (10%) Two waves of light of (vacuum) wavelength $\lambda_0 = 500$ nm, are initially in phase at plane A and traveling to the right. They then travel through layers of material as shown below.



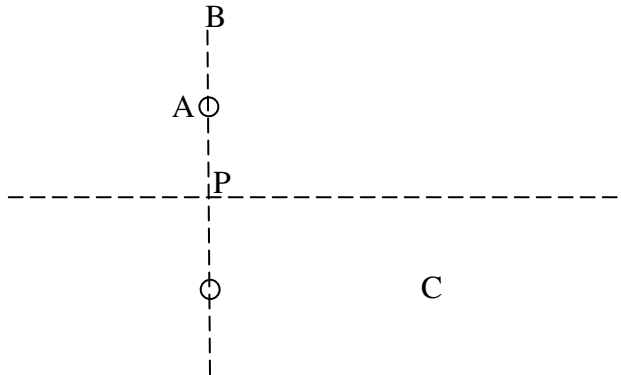
a) (7%) What is the phase difference (in multiples of wavelength λ_0) between these two beams when they pass through plane B?

ANSWER: _____

b) (3%) At plane B, are these two beams completely in-phase, completely out of phase, or somewhere in between? Explain.

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B2) (12%) Two isotropic point sources S_1 at $(0,-0.5)$ and S_2 at $(0,0.5)$ emit radio waves of wavelength 2 m. The wave from S_1 is in phase with the wave from S_2 at point $P=(0,0)$ midway between the two sources. Give the phase difference (in wavelengths) between the two waves at points $A=(0,0.5)$, $B=(0,1)$, $C=(1,-0.5)$. (All coordinates are in meters.)



A) _____

Explain your answer: _____

B) _____

Explain your answer: _____

C) _____

Explain your answer: _____

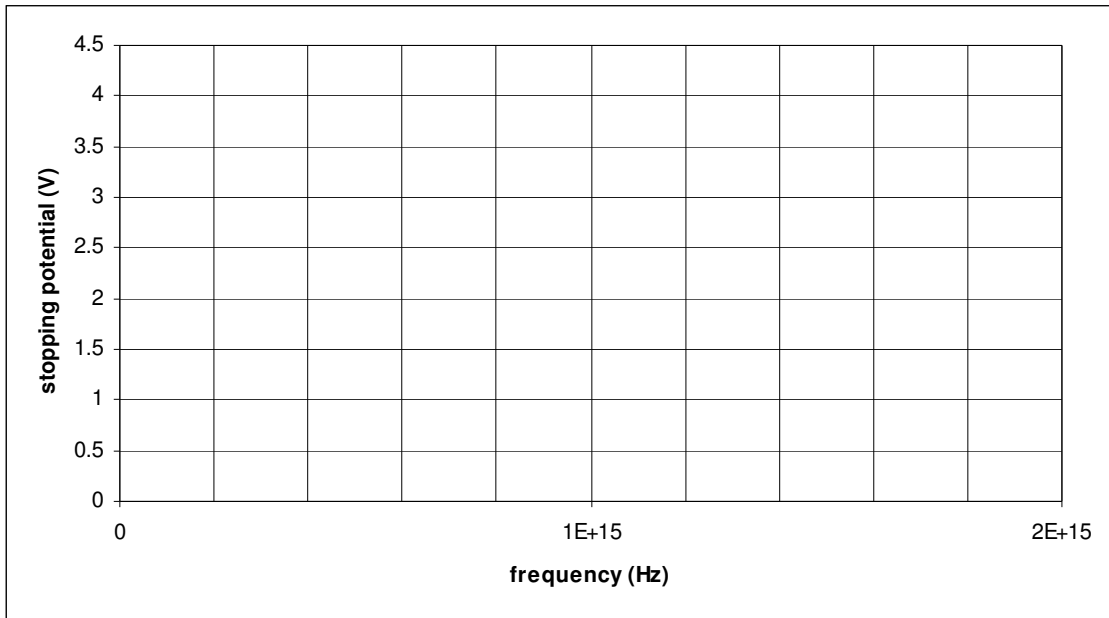
NAME _____

PART C.

C-1) A photoelectric effect measurement is carried out on an unknown metal with the following results.

wavelength (nm)	200	310	410	500
stopping potential (V)	4.1	2.0	0.95	0.55

a) (6%) Plot the stopping potential against frequency and estimate the cutoff frequency of the material in Hz.



b) (8%) Estimate Planck's constant from your plot. (Use $c=3 \times 10^8$ m/s.) (Explain your logic.)

$h =$ _____

b) (4%) Find the work function of this unknown metal. (Use $h=6.6 \times 10^{-34}$ J-s for this part.)

$\Phi =$ _____
units

NAME _____

C-2) (20%) At a particular time, the wavefunction for an electron trapped in a box extending from $x=-0.5$ nm to $x=+0.5$ nm is given by $\psi = -\sqrt{\frac{2}{1nm}} \cos\left(\frac{3\pi x}{1nm}\right)$.

a) Sketch the probability distribution for finding the electron as a function of position.



b) Write the mathematical expression for finding the particle between $x=-a$ and $x=a$. (You don't have to solve it, but you should have the correct functions and constants in the correct place.)

c) What is the probability of finding the electron between $x=-1/6$ nm and $x=+1/6$ nm? If you don't do the integral, explain your answer.

d) Estimate the probability of finding the particle between $x=-0.001$ and $x=+0.001$. (You don't necessarily have to do the integral, but you must explain your logic clearly.)