

Name (printed) _____

Name (signature as on ID) _____

Lab Section _____

Exam IV Chaps. 26, 28, 29 in Young/Geller

Note: The speed of light in air is $c = 3.00 \times 10^8$ m/s.
 $1 \text{ eV} = 1.60 \times 10^{-19} \text{ J}$

Multiple choice questions. Circle the correct answer. No work need be shown and no partial credit will be given.

(5 pts) 1. Two antennas A and B emit coherent electromagnetic waves of frequency 2.5×10^7 Hz. Initially, the interference at point P , 80.0 m from antenna A , is constructive. Then antenna A is slowly moved toward P , while the location of antenna B is unchanged. How far has A moved toward P when the interference at P first becomes destructive?

- (a) 2.0 m
- (b) 3.0 m
- (c) 6.0 m
- (d) 9.0 m
- (e) 12.0 m
- (f) 18.0 m
- (g) none of these answers

(5 pts) 2. Light of wavelength 300 nm shinning on a metal surface produces photoelectrons with maximum kinetic energy 2.0 eV. If the wavelength of the light is decreased while the intensity of the light is kept the same, the maximum kinetic energy of the photoelectrons will

- (a) stay the same
- (b) decrease
- (c) increase

(5 pts) 3. Two very narrow parallel slits are a distance d apart. Monochromatic coherent light passing through them in air produces a series of interference fringes on a distant screen. If you immerse the entire apparatus (slits, screen and space in between) in water, adjacent bright fringes near the center of the screen will

- (a) stay the same distance apart
- (b) move closer to each other
- (c) move farther apart

(5 pts) 4. Monochromatic coherent light passing through a single slit produces a diffraction pattern on a distance screen. If you increase the width of the slit, the width of the central diffraction maximum will

- (a) increase
- (b) decrease
- (c) stay the same

(5 pts) 5. When a photon scatters off a free stationary electron, the frequency of the photon

- (a) decreases
- (b) increases
- (c) stays the same

Show all your work. Partial credit will be given if earned. Write your answers in the blanks provided.

(16 pts) 6. A thin layer of oil ($n = 1.50$) floats on the flat surface of water ($n = 1.33$). Light of wavelength 500 nm in air is incident perpendicular to the surface of the oil. What is the minimum nonzero thickness of the oil film for which there will be destructive interference between the light reflected from the top and bottom surfaces of the oil film?

Ans. _____

(13 pts) 7. A converging lens 5.00 cm in diameter has a focal length of 75 mm. If the resolution is diffraction limited and Rayleigh's criterion is applied, how far can the object be from the lens if points on the object 4.00 mm apart are resolved? Use $\lambda = 500$ nm.

Ans. _____

(15 pts) 8. Consider an electron in the $5f$ state of a hydrogen atom. In the quantum mechanical description of the atom, what are

a) the energy of the atom in eV, if the ground state energy is -13.6 eV?

Ans. _____

b) the magnitude of the orbital angular momentum of the electron, in terms of \hbar ?

Ans. _____

c) the largest possible value for the z -component of the angular momentum of the electron, in terms of \hbar ?

Ans. _____

(15 pts) 9. An electron in a hydrogen atom makes a transition from an $n = 3$ level to the $n = 2$ level.

a) What is the wavelength of the photon emitted in this transition?

Ans. _____

b) In the Bohr model, what is the angular momentum of the electron in the $n = 3$ level, in terms of \hbar

Ans. _____

(16 pts) 10.

a) Electrons are accelerated from rest through a potential difference of $V = 200$ V. What is the de Broglie wavelength of the electrons after they have been accelerated?

Ans. _____

b) What is the energy of a free electron that has wavelength 300 nm?

Ans. _____

c) What is the energy of a photon that has wavelength 300 nm?

Ans. _____