Purdue University
PHYS 221
EXAM II
11/6/03

All questions are worth 5 points unless otherwise stated.

1 An electromagnetic wave has an electric field with peak value 250 N/C, What is the average intensity of the wave? (10 points)

a) 0.66 W/m^2
b) 0.89 W/m^2
c) 83 W/m^2
d) 120 W/m^2
e) 170 W/m^2

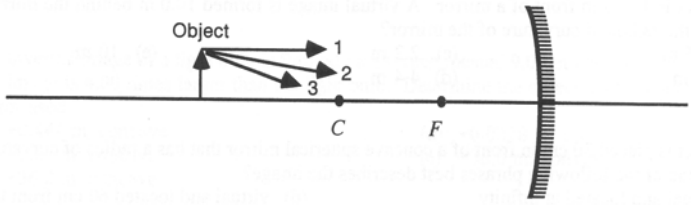
2 Near San Francisco, where the vertically downward component of the earth's magnetic field is 4.8×10^{-5} T, a car is traveling forward at 25 m/s. An emf of 2.4×10^{-3} V is induced between the sides of the car. (a) Which side of the car is positive, the driver's side or the passenger's side? (b) What is the width of the car? (Assume the car has the steering wheel on the standard left side.)

a) The driver's side, the width of the car is 3.0 m
b) The driver's side, the width of the car is 2.0 m
c) The passenger side, the width of the car is 3.0 m
d) The passenger side, the width of the car is 2.0 m
e) none of the above

3 Which one of the following statements concerning the wavelength of an electromagnetic wave in a vacuum is true?

a) The wavelength is independent of the speed of the wave for a fixed frequency.
b) The wavelength is inversely proportional to the speed of the wave.
c) The wavelength is the same for all types electromagnetic waves.
d) The wavelength is directly proportional to the frequency of the wave.
e) The wavelength is inversely proportional to the frequency of the wave.

4 An object is placed in front of a concave spherical mirror as shown below. The three rays **1, 2** and **3,** leave the top of the object and, after reflection, converge at a point on the top of the image. Ray **1** is parallel to the principal axis, ray **2** passes through *F*, and ray **3** passes through *C*.



Which one of the following groups of terms best describes the image?

a) real, upright, enlarged
b) real, inverted, reduced
c) virtual, upright, enlarged
d) real, inverted, enlarged
e) virtual, inverted, reduced

5 You are an ex-navy seal sniper working for the CIA. Your mission is to take out the leader of a drug cartel. You are diving off the coast of Guadalupe at a depth of 10 m. You see the cartel leader standing on the deck of his yacht 30 m or so away. If you fire your rifle directly at him (as you see him) what will happen? (You may neglect the effect of gravity on the bullet, i.e. assume the bullet travels in a straight line).

a) miss high (and inadvertently kill an undercover US agent on an upper deck)
b) miss low (and somehow manage to sink his yacht with a single bullet)
c) hit your target
d) no way of knowing
e) it depends on which way you're looking

6 A high quality picture frame contains glass coated with a thin film. The purpose of the film is to act as an anti-reflective coating for yellow/orange light of wavelength 558 nm (the color our eyes are most sensitive to). This way we will more easily see the picture behind the glass and not a reflection off the glass. If the coating has an index of refraction of 1.7, and the glass has an index of 1.52, what is the thinnest layer of film that will accomplish this? (10 points)

a) 164 nm
b) 323 nm
c) 82 nm
d) 558 nm
e) none of the above

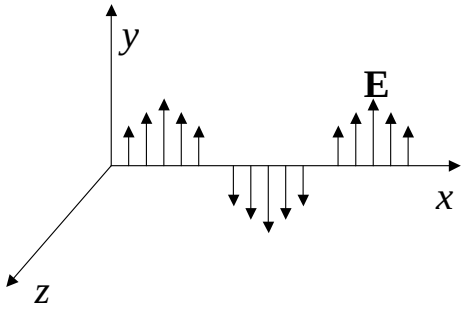
7 The earth's magnetic field, like any magnetic field, stores energy. The maximum strength of the earth's field is about 7.0×10^{-5} T. Find the maximum magnetic energy stored in the space above a city if the space occupies an area of 5.0×10^{8} m^2 and has a height of 1500 m.

a) 3.0 J
b) 6.7×10^{-10} J
c) 1.5×10^{9} J
d) 1.0×10^{6} J
e) none of the above

8 Light has a wavelength of 340.0 nm and a frequency of 5.403×10^{14} Hz when traveling through a certain substance. What substance from Table 1 could this be? (Table 1 is on the last page of the exam.)

a) air
b) benzene
c) diamond
d) carbon disulfide
e) sodium chloride

9 The electric field **E** of an electromagnetic wave traveling the positive *x* direction is illustrated in the figure. This is the wave of the radiation field of an antenna. What is the direction and the phase relative to the electric field of the magnetic field at a point where the electric field is in the negative *y* direction?

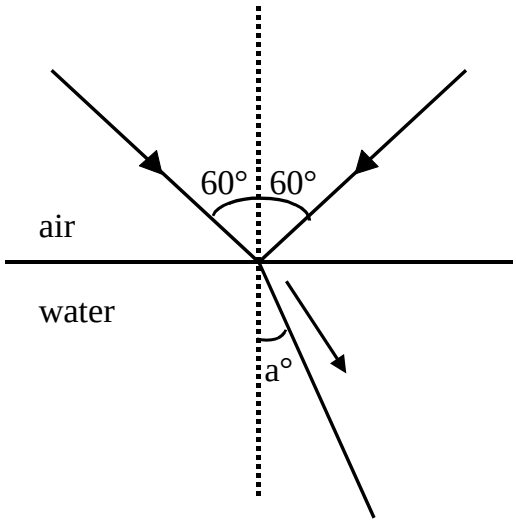


a) +*y* direction, in phase
b) -*z* direction, 90º out of phase
c) +*z* direction 90º out of phase
d) -*z* direction, in phase
e) +*z* direction, in phase

10 Which one of the following statements concerning rays is false?

a) Rays point in the direction of the wave velocity.
b) Rays point outward from the wave source.
c) Rays are parallel to the wave front.
d) Rays are radial lines that originate from a point source of waves.
e) Rays for a plane wave are parallel to each other.

11 A ray of light traveling through the air (n=1) is incident on water (n=1.33). Part of the beam is reflected at an angle of sixty degrees relative to the normal to the surface of the water. What angle, a, does the refracted beam, i.e. the part of the beam that passes through the water, make with the normal?



a) 60.0º
b) 41.0º
c) 39.5º
d) 40.6º
e) 0º

12 Which one of the following will *not* generate electromagnetic waves or pulses?

a) a steady direct current
b) an accelerating electron
c) a proton in simple harmonic motion
d) an alternating current
e) charged particles traveling in a circular path in a mass spectrometer

13 Optical fibers made of glass depend upon what phenomenon in order to transport light effectively?

a) total polarization of light
b) total internal reflection of light
c) complete dispersion of light
d) divergence of crystalline glass
e) the polarity of laser light

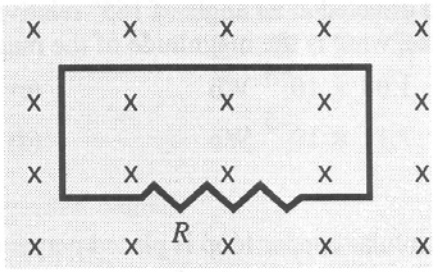
14 A spherical concave mirror has a radius of curvature of 6.0 cm. At what distance from the mirror should a 6.0-cm object be placed to obtain an image that is 48 cm tall? (10 points)

a) 1.3 cm
b) 3.4 cm
c) 4.2 cm
d) 5.3 cm
e) 6.8 cm

15 A Young's double slit setup can be used to determine the unknown wavelength of a laser. The separation between the slits and the screen is 2.0 m, slit separation is 1.0×10^{-4} m, and the 3rd order bright fringe is seen at 0.05 m above the central, bright fringe, what is the wavelength of the laser? (10 points)

a) 833 nm
b) 633 nm
c) 2500 mm
d) 0.0167 m
e) 1×10^{-4} m

16 The figure shows a uniform magnetic field that is normal to the plane of a conducting loop, which has a resistance *R*. Which one of the following changes will cause an induced current to flow through the resistor?



a) decreasing the area of the loop
b) decreasing the magnitude of the magnetic field
c) increasing the magnitude of the magnetic field
d) rotation of the loop through 90° into the plane of the paper
e) all of the above

Table 1
Index of Refraction[a]

Substance	Index of Refraction, *n*
Solids at 20 ºC	
Diamond	2.419
Glass, crown	1.523
Ice (0 ºC)	1.309
Sodium chloride	1.544
Quartz	
Crystalline	1.544
Fused	1.458
Liquids at 20 ºC	
Benzene	1.501
Carbon disulfide	1.632
Carbon tetrachloride	1.461
Ethyl alcohol	1.362
Water	1.333
Gases at 0 ºC, 1 atm	
Air	1.000 293
Carbon dioxide	1.000 45
Oxygen, O_2	1.000 271
Hydrogen, H_2	1.000 139

[a] Measured with light whose wavelength in a vacuum is 589 nm.