PHYS 1200 Spring 2024 Exam 3 Practice Questions

1) If an electromagnetic wave has components $E_y = E_0 \sin(kx - \omega t)$ and $B_z = B_0 \sin(kx - \omega t)$, in what direction is it traveling?
A) $-x$ B) $+x$ C) $+y$ D) $-y$ E) $+z$

2) If the magnetic field of an electromagnetic wave is in the $+x$-direction and the electric field of the wave is in the $+y$-direction, the wave is traveling in the
A) xy-plane. B) $+z$-direction. C) $-z$-direction. D) $-x$-direction. E) $-y$-direction.

3) A planar electromagnetic wave is propagating in the $+x$ direction. At a certain point P and at a given instant, the electric field of the wave is given by $\vec{\boldsymbol{E}} = (0.082\ \text{V/m})\,\hat{\boldsymbol{j}}$. What is the Poynting vector at the point P at that instant?
A) $-18\,\frac{\mu W}{m^2}\,\hat{\boldsymbol{\imath}}$ B) $9.0\,\frac{\mu W}{m^2}\,\hat{\boldsymbol{\imath}}$ C) $-9.0\,\frac{\mu W}{m^2}\,\hat{\boldsymbol{\imath}}$ D) $-18\,\frac{\mu W}{m^2}\,\hat{\boldsymbol{k}}$ E) $18\,\frac{\mu W}{m^2}\,\hat{\boldsymbol{\imath}}$

4) If the intensity of an electromagnetic wave is 80 MW/m^2, what is the amplitude of the magnetic field of this wave?
A) 0.82 mT B) 0.33 μT C) 10 T D) 14 T E) 0.58 mT

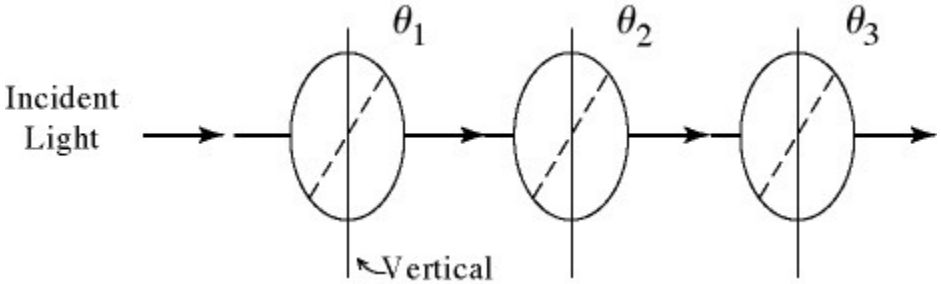
5) Which one of the following lists is a correct representation of electromagnetic waves from longer wavelength to shorter wavelength?
A) radio waves, infrared, microwaves, UV, visible, X-rays, gamma rays
B) radio waves, UV, X-rays, microwaves, infrared, visible, gamma rays
C) radio waves, microwaves, visible, X-rays, infrared, UV, gamma rays
D) radio waves, microwaves, infrared, visible, UV, X-rays, gamma rays
E) radio waves, infrared, X-rays, microwaves, UV, visible, gamma rays

6) When an electromagnetic wave falls on a white, perfectly reflecting surface, it exerts a force F on that surface. If the surface is now painted a perfectly absorbing black, what will be the force that the same wave will exert on the surface?
A) $4F$ B) $2F$ C) F D) $F/2$ E) $F/4$

7) An 800-kHz radio signal is detected at a point 8.5 km distant from a transmitter tower. The electric field amplitude of the signal at that point is 0.90 V/m. Assume that the signal power is radiated uniformly in all directions and that radio waves incident upon the ground are completely absorbed. What is the average electromagnetic energy density at that point?
A) 3.6 pJ/m^3 B) 5.1 pJ/m^3 C) 7.2 pJ/m^3 D) 10 pJ/m^3 E) 14 pJ/m^3

8) The following are positioned in sequence: A source of a beam of natural light of intensity I_0; three ideal polarizers A, B, and C; and an observer. Polarizer axis angles are measured clockwise from the vertical, from the perspective of the observer. The axis angle of polarizer A is set at 0° (vertical), and the axis angle of polarizer C is set at 50°. Polarizer B is set so that the beam intensity is zero at the observer. Which of the following pairs of angles are possible axis angle settings of polarizer B?
A) 40° and 90° B) 40° and 130° C) 40° and 140° D) 90° and 130° E) 90° and 140°

9) In the figure, the orientation of the transmission axis for each of three polarizing sheets is labeled relative to the vertical direction. A beam of light, polarized in the vertical direction, is incident on the first polarized with an intensity of 1000 W/m^2. What is the intensity of the beam after it has passed through the three polarizing sheets when $\theta_1 = 30°$, $\theta_2 = 30°$, and $\theta_3 = 60°$?



A) 141 W/m^2 B) 316 W/m^2 C) 433 W/m^2 D) 563 W/m^2 E) 188 W/m^2

10) When light goes from one material into another material having a HIGHER index of refraction,
A) its speed, wavelength, and frequency all decrease.
B) its speed and wavelength decrease, but its frequency stays the same.
C) its speed decreases but its wavelength and frequency both increase.
D) its speed decreases but its frequency and wavelength stay the same.
E) its speed increases, its wavelength decreases, and its frequency stays the same.

11) Two small forward-facing speakers are 2.50 m apart. They are both emitting, in phase with each other, a sound of frequency 1100 Hz in a room where the speed of sound is 344 m/s. A woman is standing opposite the midpoint between the speakers and is initially 35.0 m from the midpoint. As she slowly walks parallel to the line connecting the speakers, at what angle θ (relative to the centerline coming outward from the midpoint between the speakers) will she first hear no sound?
A) 0.063° B) 7.2° C) 1.8° D) 11° E) 3.6°

12) Light of wavelength 575 nm passes through a double-slit and the third order bright fringe is seen at an angle of 6.5° away from the central fringe. What is the separation between the double slits?
A) 5.0 µm B) 10 µm C) 15 µm D) 20 µm E) 25 µm

13) At most, how many bright fringes can be formed on each side of the central bright fringe (not counting the central bright fringe) when light of 625 nm falls on a double slit whose spacing is 1.97×10^{-6} m?
A) 1 B) 2 C) 3 D) 4 E) 5

14) In a single-slit diffraction experiment, the width of the slit through which light passes is reduced. What happens to the width of the central bright fringe?
A) It stays the same. B) It becomes wider. C) It becomes narrower.
D) Its behavior depends on the wavelength of the light.

15) Light of wavelength 687 nm is incident on a single slit 0.75 mm wide. At what distance from the slit should a screen be placed if the second dark fringe in the diffraction pattern is to be 1.7 mm from the center of the diffraction pattern?
A) 0.39 m B) 0.47 m C) 0.93 m D) 1.1 m E) 1.9 m

16) A 10-inch telescope (25.4 cm in diameter) is used to determine if what appears to be one star is actually two stars. Stars are so far away that they are essentially point sources. How close (in angle) can the two stars be and still be resolved by this telescope if it is focusing light of wavelength of 550 nm? (Consider only the limitation due to diffraction.)
A) 4.2×10^{-8} degree B) 2.6×10^{-6} degree C) 3.0×10^{-4} degree
D) 1.5×10^{-4} degree E) 6.6×10^{-8} degree

17) A He-Ne laser, which produces light of wavelength 632.8 nm, is used to calibrate a diffraction grating. If the first-order maximum occurs at 20.5° from the central spot, what is the distance between the slits of the grating?
A) 0.905 μm B) 1.81 μm C) 2.20 μm D) 3.62 μm E) 4.52 μm

18) An astronaut in an inertial reference frame measures a time interval Δt between her heartbeats. What will observers in all other inertial reference frames measure for the time interval between her heartbeats?
A) Δt B) less than Δt C) more than Δt
D) The answer depends on whether they are moving toward her or away from her.

19) As measured in Earth's rest frame, a spaceship traveling at $0.964c$ takes 11.2 y to travel between planets. How long does the trip take as measured by someone on the spaceship?
A) 2.98 y B) 5.51 y C) 7.28 y D) 42.1 y E) 30.7 y

20) A spaceship is moving between two distant stars at $0.932c$. To someone in the ship, the distance between the two stars appears to be 26.9 light-years (ly). What is the distance between the stars in the rest frame of the stars?
A) 9.75 ly B) 21.5 ly C) 41.3 ly D) 56.5 ly E) 74.2 ly

21) A particle is moving at $0.75c$ relative to a lab on Earth. By what percentage is the Newtonian expression for its momentum in error? (The percentage error is the difference between the erroneous and correct values, divided by the *correct* one).
A) 34% B) 28% C) 38% D) 43%

22) In a certain particle accelerator, a proton has a kinetic energy that is equal to its rest energy. What is the speed of the proton relative to the accelerator?
A) $0.25c$ B) $0.50c$ C) $0.71c$ D) $0.75c$ E) $0.87c$

23) During a nuclear reaction, the particles involved lose 4.8×10^{-28} kg of mass. How many joules of energy are released by this reaction?
A) 2.1×10^{-40} J B) 1.4×10^{-19} J C) 1.6×10^{-36} J D) 4.3×10^{-11} J E) 5.3×10^{-45} J

24) The mass of a deuterium atom is 3.34×10^{-27} kg. The mass of a deuterium atom in Mev/c^2 is
A) 2.09×10^{-14} Mev/c^2 B) 1880 Mev/c^2 C) 1.69×10^{20} Mev/c^2 D) 61 Mev/c^2
E) 210 Mev/c^2

25) A beam of red light and a beam of violet light each deliver the same power on a surface. For which beam is the number of photons hitting the surface per second the greatest?
A) The red beam. B) The violet beam. C) It is the same for both beams.

26) In a photoelectric effect experiment, electrons emerge from a copper surface with a maximum kinetic energy of 1.10 eV when light shines on the surface. The work function of copper is 4.65 eV. Which one of the following values is closest to the wavelength of the light?
A) 360 nm B) 150 nm C) 220 nm D) 1100 nm E) 520 nm.

27) A light beam from a 2.1-mW He-Ne laser has a wavelength of 633 nm. How many photons does the laser emit in one second?
A) 6.7×10^{15} B) 8.8×10^{15} C) 1.1×10^{16} D) 1.3×10^{16}

28) A beam of X-rays at a certain wavelength are scattered from a free electron at rest and the scattered beam is observed at 45.0° to the incident beam. What is the change in the wavelength of the X-rays?
A) 0.175 pm B) 0.276 pm C) 0.000 pm D) 0.356 pm E) 0.710 pm

29) A laser beam has a wavelength of 633 nm and a power of 0.500 mW spread uniformly over a circle 1.20 mm in diameter. This beam falls perpendicularly on a perfectly reflecting piece of paper having twice the diameter of the laser beam and a mass of 1.50 mg.
(a) What are the amplitudes of the electric and magnetic fields in this laser beam?
(b) What acceleration does the laser beam give to the paper?

30) In the figure, a slit 0.30 mm wide is illuminated by light of wavelength 426 nm. A diffraction pattern is seen on a screen 2.8 m from the slit. What is the linear distance on the screen between the first diffraction minima on either side of the central diffraction maximum?