

PHYS 273, Spring 2008

5 May

Test 7 Total points: 30 (+10 extra credit)

Time: 1 hr.

One formula sheet allowed

Last name: _____

First name: _____

z-id: _____

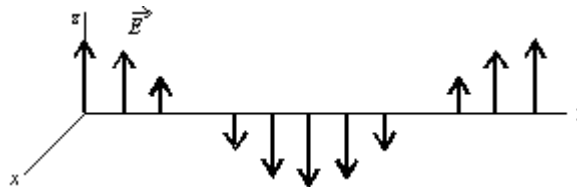
The (5) questions marked with a "*" carry 4 points each. For these, you must show either in the blank space at the end of the question paper, or in the space next to the question, how you arrived at the answer. The (10) questions without a special mark carry 1 point each. You don't need to show any work for those. Mark your answers on the scantron sheet AND the question paper for both of these types of questions. The (last 5) questions marked with a "***" carry 2 extra credit points each. You must show the work for these. **DO NOT ANSWER QUESTIONS 16-20 ON THE SCANTRON SHEET.** Turn both the scantron sheet and the question paper in at the end of the exam.

1. Which of the following is NOT true for electromagnetic waves?
 - A) they consist of changing electric and magnetic fields.
 - B) their speed in vacuum depends on their frequency.
 - C) they carry energy.
 - D) they carry momentum.
 - E) they can be reflected.

2. Maxwell's equations predict that the speed of electromagnetic waves in free space is given by
 - A) $\mu_0 \epsilon_0$.
 - B) $(\mu_0 \epsilon_0)^{1/2}$.
 - C) $1/\mu_0 \epsilon_0$.
 - D) $1/(\mu_0 \epsilon_0)^{1/2}$.
 - E) $1/(\mu_0 \epsilon_0)^2$.

3. * If the electric field in a plane electromagnetic wave is given by $E_m \sin[(3 \times 10^6/\text{m}^{-1})x - \omega t]$, in SI the value of ω is
 - A) 10.2 Hz.
 - B) 1800 Hz.
 - C) 9×10^{11} rad/s.
 - D) 1.35×10^{14} Hz.
 - E) 9×10^{14} rad/s.

4. An electromagnetic wave is generated by
- any moving charge.
 - any accelerating charge.
 - only a charge with changing acceleration.
 - only a charge moving in a circle.
 - only a charge moving in a straight line.
5. The electric field for a plane electromagnetic wave traveling in the $+y$ direction is shown. Consider a point where \vec{E} is in the $+z$ direction. The \vec{B} field is



- in the $+x$ direction and in phase with the \vec{E} field.
 - in the $-x$ direction and in phase with the \vec{E} field.
 - in the $+x$ direction and $1/4$ cycle out of phase with the \vec{E} field.
 - in the $+z$ direction and in phase with the \vec{E} field.
 - in the $+z$ direction and $1/4$ cycle out of phase with the \vec{E} field.
6. In a plane electromagnetic wave in vacuum, the ratio E/B of magnitudes of the two fields is
- the speed of light.
 - an increasing function of frequency.
 - a decreasing function of frequency.
 - $\sqrt{2}$.
 - $1/\sqrt{2}$.
7. * If the electric field in a plane electromagnetic wave traveling along the z axis wave is along the x axis and its magnitude is given by $E_m \cos(kx + \omega t)$, then the magnetic field's magnitude and direction are given by
- $-(E_m/c) \cos(kx + \omega t)$ along the y axis.
 - $(E_m/c) \cos(kx + \omega t)$ along the y axis.
 - $(E_m/c) \sin(kx + \omega t)$ along the y axis.
 - $E_m \cos(kx + \omega t)$ along the y axis.
 - $(E_m/c) \sin(kx + \omega t)$ along the z axis.

8. * If the amplitude of the electric field in a plane electromagnetic wave is 100 V/m then the amplitude of the magnetic field is:
- A) 3.3×10^{-7} T
 - B) 6.7×10^{-7} T
 - C) 0.27 T
 - D) 8.0×10^7 T
 - E) 3.0×10^9 T
9. For an electromagnetic wave the the vector $\vec{E} \times \vec{B}$ is parallel to
- A) the electric field.
 - B) the magnetic field.
 - C) the direction of wave propagation.
 - D) the magnetic flux through a surface it crosses.
 - E) the direction of the emf induced by the wave.
10. The energy in an electromagnetic wave is
- A) overwhelmingly electrical.
 - B) slightly more electrical than magnetic.
 - C) equally divided between its electric and magnetic fields.
 - D) slightly more magnetic than electrical.
 - E) overwhelmingly magnetic.
11. One consequence of momentum carried by electromagnetic waves is that
- A) the tail of a comet points away from the sun.
 - B) electron flow through a wire generates heat.
 - C) a charged particle in a magnetic field moves in a circular orbit.
 - D) heat can be generated by rubbing two sticks together.
 - E) the Doppler effect can be used to measure the speed of a moving object.
12. * A point source emits electromagnetic energy isotropically at a rate of 60 W. The intensity 10 m from the source is approximately
- A) 10 W/m².
 - B) 1.6 W/m².
 - C) 1 W/m².
 - D) 0.024W/m².
 - E) 0.048 W/m².

13. * Light with an intensity of 1 kW/m^2 falls normally on a surface with an area of 1 cm^2 and is completely absorbed. The force of the radiation on the surface is:
- A) $1.0 \times 10^{-4} \text{ N}$
 - B) $3.3 \times 10^{-6} \text{ N}$
 - C) $1.7 \times 10^{-9} \text{ N}$
 - D) $3.3 \times 10^{-10} \text{ N}$
 - E) $6.7 \times 10^{-12} \text{ N}$
14. Polarization experiments provide evidence that light is
- A) a longitudinal wave.
 - B) a stream of particles.
 - C) a transverse wave.
 - D) isotropic.
 - E) nearly monochromatic.
15. Light from any ordinary source (such as a flame) is usually:
- A) unpolarized
 - B) plane polarized
 - C) circularly polarized
 - D) elliptically polarized
 - E) monochromatic
16. ** The time for a laser signal to travel from Earth to the Moon and back, a one-way distance of about $3.8 \times 10^8 \text{ m}$, is approximately
- A) 1.26 s.
 - B) 2.53 s.
 - C) 8 s.
 - D) 8 min.
 - E) 12.5 min.
17. ** Radio waves of wavelength 3 m have a frequency of
- A) 10^7 Hz .
 - B) 100 kHz.
 - C) 1 MHz.
 - D) 10 MHz.
 - E) 100 MHz.

18. ** The unit of the Poynting vector $\vec{S} = (1/\mu_0)\vec{E} \times \vec{B}$ is
- A) J/m^2 .
 - B) J/s .
 - C) W/s .
 - D) W/m^2 .
 - E) J/m^3 .
19. ** The light intensity 10 m from an isotropic point source is 500 W/m^2 . The intensity 50 m from the same source is
- A) 2500 W/m^2
 - B) 500 W/m^2
 - C) 100 W/m^2
 - D) 20 W/m^2
 - E) 0.1 W/m^2
20. ** A clear sheet of polaroid is placed on top of a similar sheet so that their polarizing axes make an angle of 30° with each other. The ratio of the intensity of emerging light to incident unpolarized light is:
- A) 1:4
 - B) 1:3
 - C) 1:2
 - D) 3:4
 - E) 3:8