This print-out should have 14 questions. Multiple-choice questions may continue on the next column or page – find all choices before answering. The due time is Central time.

Please notice that for your homework to be considered towards your grade, it needs to be submitted one hour before the corresponding recitation starts. Work submitted after this time, but before the DUE DATE on top of this page, will be accepted but not graded.

PLEASE REMEMBER THAT YOU MUST CARRY OUT YOUR CALCULATIONS TO AT LEAST THREE SIGNIFICANT FIGURES. YOUR ANSWER MUST BE WITHIN ONE PERCENT OF THE CORRECT RESULT TO BE MARKED AS CORRECT BY THE SERVER.

Microwave Transmitter

34:04, trigonometry, numeric, > 1 min, wording-variable.

001

A microwave transmitter emits electromagnetic waves of a single wavelength. The maximum electric field 1 km from the transmitter is 6 V/m.

The speed of light is 2.99792×10^8 m/s and the permeability of free space is $4\pi \times 10^{-7}$ N/A^2.

Assuming that the transmitter is a point source and neglecting waves reflected from the Earth, calculate the maximum magnetic field at this distance. Answer in units of T.

002

Calculate the total power emitted by the transmitter. Answer in units of W.

Plane Electromagnetic Wave 02

34:03, trigonometry, numeric, > 1 min, normal.

003

A plane electromagnetic sinusoidal wave of frequency 40 MHz travels in free space.

The speed of light is 2.99792×10^8 m/s.

Determine the wavelength of the wave. Answer in units of m.

004

Find the period of the wave. Answer in units of s.

005

At some point and some instant, the electric field has has a value of 750 N/C.

Calculate the magnitude of the magnetic field at this point and this instant. Answer in units of T.

Cylindrical Filament

34:04, calculus, numeric, > 1 min, wording-variable.

006

A cylindrical filament has radius 1 mm. Its resistance is 1 Ω and its length is 1 m. The filament carries a uniform, steady current of 0.1 A.

The permeability of free space is $4\pi \times 10^{-7}$ N/A^2.

Find the electric field inside the filament. Answer in units of N/C.

007

Find B at the surface of the filament. Answer in units of T.

008

What is the magnitude of the Poynting vector $\vec{S}$ at the surface of the filament? Answer in units of W/m^2.

009

Which of the following correctly expresses the power dissipated per unit length of the filament?

1. Both $P = 2\,\pi\,r\,S$ and $P = \dfrac{\pi\,r\,B^2}{\mu_0}$

2. Both $P = \dfrac{I^2\,R}{\ell}$ and $P = \dfrac{\pi\,r\,B^2}{\mu_0}$

3. Both $P = \dfrac{I^2\,R}{\ell}$ and $P = 2\,\pi\,r\,S$

4. Both $P = I^2\,R$ and $P = \pi\,r\,S$

5. Both $P = \pi\,r^2\,S$ and $P = \dfrac{\pi\,r\,B^2}{\mu_0}$

6. Both $P = \pi\, r^2\, S$ and $P = \dfrac{I^2\, R}{\ell}$

7. Both $P = \dfrac{\pi\, r^2\, S}{\ell}$ and $P = \dfrac{I^2\, R}{\ell}$

8. Both $P = I^2\, R$ and $P = \dfrac{\pi\, r\, S}{\ell}$

9. Both $P = \dfrac{I^2\, R}{\ell}$ and $P = \dfrac{\pi\, \ell\, B^2}{\mu_0}$

High Power Lasers

34:04, trigonometry, numeric, > 1 min, wording-variable.

010

High power lasers in factories are used to cut through cloth and metal. One such laser has a beam diameter of 1 mm and generates an electric field at the target having an amplitude 0.7 MV/m.

The speed of light is 2.99792×10^8 m/s the permeability of free space is $4\pi \times 10^{-7}$ T $\cdot$ N/A.

What is the amplitude of the magnetic field produced? Answer in units of T.

011

What is the intensity of the laser? Answer in units of $\mathrm{W/m^2}$.

012

What is the power dissipated? Answer in units of W.

Suspended Glass Beads

34:04, trigonometry, numeric, > 1 min, normal.

013

Lasers have been used to suspend spherical glass beads in the Earth's gravitational field. A bead has a mass of 1 μg and a density of 0.2 $\mathrm{g/cm^3}$. The laser beam is larger than the glass bead with a radius 530 μm and fully impinges on the bead. Assume complete absorption.

The acceleration of gravity is 9.8 $\mathrm{m/s^2}$.

Determine the radiation intensity needed to support the bead. Answer in units of $\mathrm{W/m^2}$.

014

What is the power required for this laser? Answer in units of W.