Polytechnic Tutoring Center

Midterm Review – PH 2033 Fall 2021

Disclaimer: This mock exam is only for practice. It was made by tutors in the Polytechnic Tutoring Center and is not representative of the actual exam given by the Academic Department.

1. A simple spring harmonic oscillator has an amplitude of 2.0 cm and a spring constant k = 300 N/m. At what distance from equilibrium is the potential energy equal to 18% of the total energy of the oscillator?

   A. 0.25 cm B. 0.40 cm C. 0.55 cm D. 0.70 cm E. 0.85 cm

2. A 20 kg block slides to the left along a horizontal frictionless surface and hits an uncompressed spring of spring constant 810 N/m, which sends the mass back to the right with the same speed. For how long is the block in contact with the spring?

   A. 0.785 s B. 0.641 s C. 0.597 s D. 0.555 s E. 0.494 s

3. The intensity of an electromagnetic wave is 2.0×10^7 W/m^2. What is the amplitude of the magnetic field of this wave?

   A. 4.7×10^{-5} T B. 9.8×10^{-5} T C. 4.1×10^{-4} T
   D. 9.6×10^{-4} T E. 2.3×10^{-3} T

4. A bat is flying toward a prey at 10 m/s while using echolocation to detect the prey. The bat sends out a 100 kHz ultrasonic sound, and the wave bounces back after having contact with the stationary prey. What is the frequency that the bat will be hearing?

   A. 100 kHz B. 103 kHz C. 106 kHz D. 110 kHz E. 120 kHz

5. A ray of unpolarized light shined through a stack of polarizers. What is the minimum number polarizers it takes to layer up in order to produce polarized light with an intensity below 10% of its original intensity if the angle between each polarizer is 20°.

   A. 14 B. 17 C. 20 D. 21 E. 22

6. Two coherent in-phase sources of sound are at the origin and at the point (0 m, 2 m). What is the lowest frequency of sound that allows for the sound to interfere constructively at the point (3 m, 4 m)?

   A. 593 Hz B. 453 Hz C. 313 Hz D. 246 Hz E. 208 Hz

7. A layer of oil is spread evenly over the surface of water. If light enters the oil from the air at an angle of incidence of 45°, what is the angle of refraction of the light in the water? (The index of refraction for oil is 1.45, and for water it is 1.33.)

A. 51.2° B. 46.6° C. 32.1° D. 38.0° E. 43.0°

8. The magnetic field of a plane electromagnetic wave in vacuum is given by

$$B_z = B_0 \sin(kx - \omega t)$$

What is the corresponding expression for the electric field?

A. $E_x = E_0 \sin(kx - \omega t)$
B. $E_z = E_0 \sin(ky - \omega t)$
C. $E_z = E_0 \sin(kx - \omega t)$
D. $E_y = E_0 \sin(kx - \omega t)$
E. $E_x = E_0 \sin(kz - \omega t)$

9. A single speaker in a storefront display is playing The Killer's Mr. Brightside at a sound level of 75 dB (as heard from the register). What sound level will the cashier perceive if three more speakers in the display are activated?

A. 77.8 dB B. 81.0 dB C. 84.2 dB D. 89.1 dB E. 95.5 dB

10. A beam of light is travelling with electric field

$$\vec{E} = E_0 \sin(kx + \omega t)\ \hat{j}$$

and magnetic field

$$\vec{B} = B_0 \sin(kx + \omega t)\ \hat{k}$$

Compute the poynting vector $\hat{S}$.

A. $\frac{E_0^2 B_0^2}{\mu} \sin(kx + \omega t)\ \hat{\imath}$

B. $\frac{E_0 B_0}{\mu^2} \sin(kx + \omega t)\ \hat{\imath}$

C. $\frac{E_0 B_0}{\mu} \sin(kx - \omega t)\, \hat{\imath}$

D. $\frac{E_0 B_0}{\mu^2} \sin^2(kx - \omega t)\, \hat{\imath}$

E. $\frac{E_0 B_0}{\mu} \sin^2(kx + \omega t)\, \hat{\imath}$