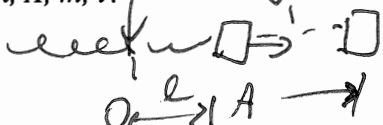
Name Phys116 Key
Last First MI Student Number

Written Response. Show your work and/or explain your reasoning for full credit.
II. *Harmonic Oscillator* (23 pts): A harmonic oscillator of mass m and spring constant k is stretched to a length l.

A) If the oscillator is given a tap and extends to a maximum amplitude of A, what is the initial velocity v_1 of the oscillator in terms of k, A, m, l?

unstretched



+8

$E = K + U$

$\frac{1}{2}kA^2 = \frac{1}{2}mv_1^2 + \frac{1}{2}kl^2$

$kA^2 = mv_1^2 + kl^2$

$mv_1^2 = k(A^2 - l^2)$

$v_1^2 = \frac{k}{m}(A^2 - l^2)$

$v_1 = \sqrt{\frac{k}{m}(A^2 - l^2)}$

B) What is the velocity at the equilibrium point in terms of the variables given above?

+8

$E = K + U$ (U = 0)

$\frac{1}{2}kA^2 = \frac{1}{2}mv_{max}^2$

NOT NEEDED

$v_{max} = \sqrt{\frac{kA^2}{m}} = A\sqrt{\frac{k}{m}} = \omega A$

$m = 100\,g$

C) If $l = 1.0$ cm and $k = 3.0$ N/m, find the max speed if the initial speed is 1.5 cm/s.

PART A from (A)

+7

$v_{max} = \sqrt{\frac{k}{m}}A = \sqrt{\frac{k}{m}}\left(\frac{m}{k}v_1^2 + l^2\right)^{\frac{1}{2}}$ use A

$= \sqrt{\frac{k}{m}}\left(\frac{m}{k}v_1^2 + l^2\right)^{\frac{1}{2}}$

$= \left(v_1^2 + \frac{k}{m}l^2\right)^{\frac{1}{2}} = \left((.015)^2 + \left(\frac{3}{0.1}\right)(.01)^2\right)^{\frac{1}{2}}$

$=$

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III. *Harmonic Plane Wave.* (22 pts) A traveling plane wave has a speed of v=343 m/s and wavelength of 3.0 m. Its amplitude is given by the variable *A*.

A) What is the wavenumber *k* of the wave?

+5 $k = \frac{2\pi}{\lambda} = \frac{2\pi}{3\,m} =$

B) What is the angular frequency of the wave?

+5 $\omega = 2\pi f \qquad v = \frac{\omega}{k}$

$vk = \omega = (343)\left(\frac{2\pi}{3}\right) = \frac{686\pi}{3}\ \frac{rad}{s}$

C) Write an equation describing the motion of the wave. Use a sinusoidal function and describe what each part of the argument of the function represents.

+6 $\psi(x,t) = A\sin(kx - \omega t)$

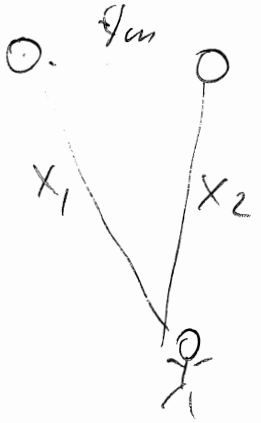
$\omega = \frac{686\pi}{3}\ s^{-1}$

$k = \frac{2\pi}{3}\ m^{-1}$

A: AMPLITUDE; kx: wavenumber; ωt: ang. freq; $-$: TRAVELLING TO THE RIGHT

D) If there are two sources in phase with each other separated by a distance of 4 m, what is the difference in distance from the two sources required to create destructive interference? Draw a picture to make clear what you mean.

+6



$X_2 - X_1 = d$

$d = 0, \lambda, \ldots$ const.

$d = \frac{\lambda}{2}, \frac{3\lambda}{2} \ldots$ destructive

$d = \frac{\lambda}{2} = \boxed{\frac{3}{2}\,m = d}$

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