PHYS 101: General Physics 1 **KOÇ UNIVERSITY** **Fall Semester 2010**

College of Arts and Sciences

Section 1 **Quiz 11** **30 December 2010**

Closed book. No calculators are to be used for this quiz.
Quiz duration: 10 minutes

Name: **Student ID:** **Signature:**

A thin, $1\,m$ wire has a mass of $20\,g$. One end is tied to a nail, and the other end is attached to a screw that can be adjusted to vary the tension in the wire. To what tension (in newtons) must you adjust the screw so that a transverse wave of wavelength $4\,cm$ makes 500 vibrations per second?

$L = 1\,m \quad m = 20\,g \quad \lambda = 4\,cm = 4 \cdot 10^{-2}\,m$

$f = 500\,Hz$

$F = \mu v^2 = \frac{m}{L}(\lambda f)^2 = \frac{20 \cdot 10^{-3}}{1}\left(500 \cdot 4 \cdot 10^{-2}\right)^2 =$

$= 20 \cdot 10^{-3} \cdot 400 = 8\,N$

$F = 8\,N$

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Section 2 **Quiz 11** **30 December 2010**

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Quiz duration: 10 minutes

Name: **Student ID:** **Signature:**

A 1.5 m string of weight 1.5 N is tied to the ceiling at its upper end, and the lower end supports a weight *W*. When you disturb the string slightly, the waves traveling up the string obey the equation $y(x,t) = 8.5\,mm\cos(140\,m^{-1}\,x - 2800s^{-1}t)$. What is the weight *W*? (Take $g = 10\,m/s^2$ and ignore the effect of the weight of the string on the tension)

$L = 1{,}5\ m \qquad W_s = 1{,}5\ N$

$y(x,t) = 8{,}5\ mm\ \cos(140m^{-1}x - 2800s^{-1}t)$

$W = F = \mu v^2 = \frac{W_s}{gL}\cdot\left(\frac{\omega}{k}\right)^2 = \frac{1{,}5}{10\cdot 1{,}5}\cdot\left(\frac{2800}{140}\right)^2 =$

$= \frac{1}{10}\cdot 400 = 40\ N$

$\boxed{W = 40\ N}$

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Section 3 **Quiz 11** **30 December 2010**

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Quiz duration: 10 minutes

Name: **Student ID:** **Signature:**

Transverse waves on a string have wave speed 8 m/s, amplitude 0.07 m, and wavelength 0.32 m. The waves travel in the –x-direction, and at $t = 0$ the $x = 0$ end of the string has its maximum upward displacement. Write a wave equation describing the wave.

$V = 8\,m/s$ $\lambda = 0{,}32\,m$ $t=0,\ x=0$

$A = 0{,}07\,m$ $y = A$

Let's write general wave equation:

since wave travel at $-x$ direction

$$y(x,t) = A\cos(kx + \omega t)$$

Note that $y(0,0) = A$

$$A = 0{,}07\,m,\quad k = \frac{2\pi}{\lambda} = \frac{2\pi}{0{,}32}$$

$$\omega = 2\pi f = \frac{2\pi V}{\lambda} = \frac{2\pi\, 8}{0{,}32} = \frac{2\pi}{0{,}04}$$

Thus:

$$y(x,t) = 0{,}07\,m\cos\left(2\pi\left(\frac{1}{0{,}32}x + \frac{1}{0{,}04}t\right)\right)$$

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Section 4	Quiz 11	30 December 2010

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Quiz duration: 10 minutes

Name: **Student ID:** **Signature:**

Show by direct substitution that $y(x,t) = A cos(kx - \omega t)$ satisfies the wave equation.

Let's substitude given expression to wave equation:

$$\frac{\partial^2 y}{\partial x^2} = \frac{\partial}{\partial x}\left(-Ak \sin(kx-\omega t)\right) = -Ak^2 \cos(kx-\omega t)$$

$$\frac{1}{v^2}\frac{\partial^2 y}{\partial t^2} = \frac{1}{v^2}\frac{\partial}{\partial t}\left(+A\omega \sin(kx-\omega t)\right) = \frac{1}{v^2}(-A\omega^2)\cos(kx-\omega t)$$

$$-Ak^2 \cos(kx-\omega t) = -\frac{A\omega^2}{v^2}\cos(kx-\omega t)$$

$$\boxed{k^2 = \frac{\omega^2}{v^2}}$$

→ This equation is correct therefore wave equation is satisfie[d]

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Section 5 **Quiz 11** **30 December 2010**

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Quiz duration: 10 minutes

Name: **Student ID:** **Signature:**

Does the function $y(x,t) = A(\sin(kx) + \cos(\omega t))$ describe a wave? Use the wave equation to find the answer.

Let's check whether it satisfies the wave equation:

$$\frac{\partial^2 y}{\partial x^2} = \frac{\partial}{\partial x}\left(Ak\cos(kx)\right) = -Ak^2 \sin kx$$

$$\frac{1}{v^2}\frac{\partial^2 y}{\partial t^2} = \frac{1}{v^2}\frac{\partial}{\partial t}\left(-A\omega \sin \omega t\right) = \frac{-A}{v^2}\omega^2 \cos \omega t$$

But:

$$-Ak^2 \sin kx \neq -\frac{A}{v^2}\omega^2 \cos \omega t$$

$$(\text{since } \sin kx \neq \cos \omega t)$$

Therefore the wave equation is not satisfied.