*. (20 points) A wave in a string is described by the following function:

$$y(x,t) = (0.34\,\text{mm})\cos((24\,\text{rad/m})x - (960\,\text{rad/s})t)$$

The mass per unit length of the string is 1.2 g/m. Identify or calculate the following (include correct units).

a. (1 point) Amplitude: $y_m = 0.34\,mm$

b. (1 point) Wavenumber: $k = 24\,rad/m$

c. (1 point) Wavelength: $\lambda = 2\pi/k = 0.2618\,m$

d. (1 point) Angular frequency: $\omega = 960\,rad/s$

e. (1 point) Cycle frequency: $f = \omega/2\pi = 152.8\,Hz$

f. (1 point) Period: $T = 2\pi/\omega = 1/f = 6.545\,ms$

g. (1 point) Wave velocity (include direction): $v = f\lambda = \omega/k = 40\,m/s$ (exact)
$+x$ direction

i. (2 points) Tension in the string: $v = \sqrt{T/\mu} \Rightarrow T = \mu v^2 = (0.0012\,kg/m)(40\,m/s)^2$
$= 1.92\,N$ _J

h. (2 points) Maximum speed of some specific part of the string:

$$\frac{\partial y}{\partial t} = \underbrace{y_m\,\omega}\,\sin(kx - \omega t)$$

$max\ speed = y_m\omega = (0.34\times10^{-3}m)(960\,rad/s)$
$= 0.3264\,m/s$

j. (2 points) Kinetic energy density (per unit length), time-averaged:

$$\langle \mu_K \rangle = \frac{1}{4} \mu \omega^2 y_m^2 = 31.96 \, \mu J/m$$

k. (1 point) Potential energy density, time-averaged:

$$\langle \mu_u \rangle = \langle \mu_K \rangle = 31.96 \, \mu J/m$$

l. (2 points) Rate of energy transfer across some specific point, time-averaged:

$$\langle P \rangle = \langle \mu_e \rangle v = 2(31.96 \, \mu J/m)(40 \, m/s) = 2.557 \, mW$$

m. (2 points) Total energy in a 100 m-long section:

$$\langle \mu_e \rangle = 2(31.96 \, \mu J/m) = 63.92 \, \mu J/m \; ; \quad E \approx \langle \mu_e \rangle L = 6.392 \, mJ$$

n. (2 points) How much time does it take for the amount of energy calculated in part m to cross a specific point in the string?

$$\Delta t = \frac{E}{\langle P \rangle} = \frac{L}{v} = 2.5 \, s \; (exact)$$

$$\# \; wavelengths = \frac{100 \, m}{0.2618 \, m} = 381.97 = integer?$$

close enough