PHYSICS 232 - Solution Key to Sample Test 1

1a. $x = A\sin\frac{2\pi t}{T}$ and $x/A = 0.5$, so $\frac{2\pi t}{T} = \frac{\pi}{6}, \frac{5\pi}{6}, \ldots$.
At $\frac{\pi}{6}$ the velocity is positive, so we set $\frac{2\pi t}{T} = \frac{5\pi}{6}$, so $t = \frac{5}{12}T = 0.625$ s.

1b. $v = A\frac{2\pi}{T}\cos\frac{5\pi}{6} = 2.18$ m/s.
$a = \omega^2 x = \left(\frac{2\pi}{T}\right)^2 x = 5.26$ m.
$K.E. = \frac{1}{2}Mv^2 = 23.69$ J.
$P.E. = \frac{1}{2}M\omega^2 x^2 = 7.89$ J.

2a. $v = \sqrt{F/\mu} = \sqrt{FL/M}$, so $F = Mv^2/L = 5.76$ N.

2b. $v_{max} = A\omega = 2\pi f A = 4.7$ m/s.

2c. $P = \frac{1}{2}\sqrt{\mu F}\omega^2 A^2 = \frac{1}{2}\frac{Mv}{L}v_{max}^2 = 3.98$ W.

3a. $f = \frac{3v}{2L}$ so $v = \frac{2}{3}fL = 352$ m/s.

3b. $\lambda = v/f = 2L/3$. Node is at $\lambda/2 = L/3$, so distance from middle is $L/2 - L/3 = L/6 = 11$ cm.

3c. $f = \frac{v}{4L'} = \frac{3v}{2L}$, so $L' = L/6 = 11$ cm.

4a. $I = I_0 = 10^{-12}$ W/m^2 at $R = 5$ km, so $P = I_0 4\pi R^2 = 3 \times 10^{-4}$ W.

4b. $40 = 10\log(I/I_0)$ so $I = I_0 \times 10^4 = 10^{-8}$ W. We have $P = 4\pi r^2 I$, so $r = \sqrt{\frac{P}{4\pi I}} = 48.86$ m.

4c. Again, $r' = \sqrt{\frac{P'}{4\pi I}} = \sqrt{\frac{5P}{4\pi I_0}} = 11$ km.