Physics 2711 – Homework #5

1. King 5.1
2. King 5.2
3. King 5.9
4. King 5.11

5. A long string of tension $T$ and linear mass density $\mu$ is attached to a small sphere of mass $m$. A second identical string is attached to the other side of the mass (with the same tension). An incident transverse wave given by $y_I(x, t) = Ae^{i(kx - \omega t)}$ is coming from the left side.

\[ \text{T} \]
\[ \mu \quad m \]
\[ x=0 \]

a) What is the displacement on the right side of the mass, $y_T(x, t)$? Ignore gravity.
[Hints: The boundary conditions are that the position and velocity of the strings must match the position and velocity of the mass. Use the position equality as one relationship. Then apply Newton’s second law for the mass to get a second relationship.]

b) Determine the transmission coefficient, $T$, and shows that it goes to 1 as the mass goes to zero, and to zero as the mass goes to infinity.

c) What is the mass that will allow half of the incident power to be transmitted?

6. A long uniform string with a linear mass density of 0.1 kg/m is stretched with a tension of 50 N. One end of the string ($x = 0$) is oscillated sinusoidally in time transversely with an amplitude of 0.02 m and a period of 0.1 s, creating a wave traveling in the $+x$ direction.

a) What is the speed of the wave?

b) What is the wavelength of the wave?

c) If $y(x = 0, t = 0) = 0.01$ m and $\partial y / \partial t < 0$ at $t = 0$, what is the equation for the wave, $y(x, t)$?

7. Two points on a string are observed as a traveling wave passes them. The points are at $x_1 = 0$ and $x_2 = 1$ m. The transverse motions of the two points are given by:

$y_1(t) = 0.2 \sin(3\pi t)$ m,

$y_2(t) = 0.2 \sin(3\pi t + \pi/8)$ m

a) What is the wavelength of the wave?

b) What is the velocity of the wave?
[Hints: Consider carefully any ambiguities allowed by the information you’ve been given. Be sure to give all possible answers.]