1. Energy and Power in Colliding Pulses

2. Boundary Conditions Without Energy Conservation

\[ (i'x)\eta d + (i'x)\eta d = \begin{cases} \varepsilon((a + x)\beta) - \varepsilon((a - x)\beta) \varepsilon a z = \varepsilon((a + x)\beta + (a - x)\beta) a z + (i'x) d \\
\end{cases} \]

SOLUTION: The total power transferred is a point in the plane of the two colliding pulses. The total power to the separable pulses is:

\[ (i'x)\eta d + (i'x)\eta d = (i'x) n \]

\[ \varepsilon((a + x)\beta + (a - x)\beta) \varepsilon a z = (i'x) n \]

The energy energy for the separated pulse is:

\[ \varepsilon((a + x)\beta + (a - x)\beta) \varepsilon a z \]

The first motion pulse is:

\[ \varepsilon((a - x)\beta) \]

The second motion pulse is:

\[ \varepsilon((a + x)\beta) \]

The total motion pulse is:

\[ \varepsilon((a - x)\beta + (a + x)\beta) \]

The total motion pulse is:

\[ \varepsilon((a - x)\beta + (a + x)\beta) = (i'x) n \]

The pulses are separated by the same amount, the total displacement is:

\[ (i'x) n + (i'x) n = (i'x) n \]

Haward September 14 1999

Physics 214 Fall 99—Problem Set 4—Optional Problems
SOLUTION: In 1 s the pulse will travel 10 m. Upon hitting the wall, the pulse will reflect with reverse amplitude.

3. Pulse Propagation

Sketch:

Highlight the significant dimensions of the pulse shape indicated in your sketch and show the shape of the wave just before the reflection. Use a scale where 1 in. = 0.6 in., the leading edge of the pulse is 6 in. from a wall and the pulse has the shape shown in the figure as it travels at 10 m/s along the x-axis.

\[
\begin{align*}
\frac{dw}{
\frac{d\theta}{\pi \Omega q} - 1} & = \frac{x}{\Omega q} \\
\text{on the right side, so} \quad \frac{x}{\Omega q} & = \text{force along the x-axis} \\
\text{force along the x-axis} & = \text{force due to the density of the fluid} \\
\text{the density due to the interface of the vertical component of the vertical forces exerted by the wall on the water.} \\
\text{The vertical component of the vertical forces exerted by the wall on the water.} \\
\end{align*}
\]

When \( b = a/2 \) and there is no reflected wave, what does this mean?

\( \text{What is the energy in the wave?} \)

\( \text{For what value of} \beta \text{is there no reflected wave? What does this mean?} \)

\( \text{Plot the graph of} \frac{d\theta}{d\Omega q} \text{on the} x-y \text{plane.} \)

\( \text{The force exerted by the density on the fluid} \)
For \( x > 0 \) m, this electric pulse represents the linear reflected pulse. If

\[ \text{SOLUTION: One way to construct the solution is to think of a reflection} \]

begin to move your hand to make the pulse.

(b) The string is 2m long. At the free end the string is attached to a

\[ y(x,5) \text{ (cm)} \]

below. The string has tension 8 N and \( f = 2 \text{ Hz}. \]

By moving your hand starting at \( t = 0 \) s, you want to produce a wave pulse

**Energy in Wave Motion**

The dashed lines show the parts of the pulse that are added together.

1. Head the end to a height of 4 cm at a constant rate for 0.5 s (or a

2. Hold the hand fixed at a height of 4 cm for 15 s.

3. Lower to zero at a constant rate for 2 s (or a velocity of 2 cm/s).

You might have

\[ \text{hard for 15 s. Pulling this together we have that to produce the pulse} \]

ended for the edge of the pulse is 4 m long so it looks 2 s to

produce. The leading edge of the pulse is 4 m long which with a

at \( t = 0 \) s, the leading edge of the pulse (at \( x = L \)) was made strings at

\[ = \text{With} \]
Consider the position of the string when the leading edge of the pulse is 10 in from the end. We can express this as:

\[
\text{velocity} = \frac{\text{length}}{\text{time}} = \frac{10}{\tau / 2}
\]

So the energy density is given by:

\[
\varepsilon = \frac{\text{energy}}{\text{area}} = \frac{\rho \cdot v}{h}
\]

\text{SOLUTION:}

\text{The total wave is just the reflected wave. Hence will add to the undisturbed pulse to produce the total wave for } t < 1.4. 

\text{Sketch the string at } t = 1.4 \text{ seconds, or 1.2 seconds after you begin to move your hand (as shown in the first figure).}

\text{Your sketch must include units in your answer, and label your sketch carefully.}
6. Energy Transfer on a String

(a) Least and greatest: Both the slope and transverse vector are zero ±

\[ \frac{d}{dx} \left( \frac{d^2 y}{dx^2} \right) = \frac{1}{I} \frac{d}{dx} \left( \frac{d}{dx} \left( \frac{d^2 y}{dx^2} \right) \right) \]

is positive. This means that energy is flowing to the right, i.e., the string is being stretched. Therefore, the power entering the string is positive. The least and greatest: Both the slope and transverse vector are positive ±

\[ \frac{d}{dx} \left( \frac{d^2 y}{dx^2} \right) = \frac{1}{I} \frac{d}{dx} \left( \frac{d}{dx} \left( \frac{d^2 y}{dx^2} \right) \right) \]

is positive. This means that energy is flowing to the left, i.e., the string is being stretched. Therefore, the power entering the string is positive.

**Case (b):**

\[ \frac{d}{dx} \left( \frac{d^2 y}{dx^2} \right) = \frac{1}{I} \frac{d}{dx} \left( \frac{d}{dx} \left( \frac{d^2 y}{dx^2} \right) \right) \]

is negative. This means that energy is flowing out of the string. Therefore, the power leaving the string is negative.
a wave traveling to the left and a wave traveling to the right, and the two arbitrary functions and correspond to \( (1 - x) \theta \) and \( (1 + x) \theta \) respectively.

Thus, \( \frac{x + \theta}{\theta} = \frac{z}{z} \)

The wave equation

\[e^{-z(x - \theta)} (1 - x) \theta = (1 + x) \theta\]

Hence, \( \frac{z}{z} = \theta = \theta \)

Consider \( (1 - x) \theta + (1 + x) \theta \) into the wave equation. Indeed, \( (1 - x) \theta + (1 + x) \theta = (1 \cdot x) \theta \)

Hence, \( \frac{z}{z} = \theta = \theta \)

SOLUTION

\( \frac{z}{z} = \theta = \theta \)

Thus, \( \frac{z}{z} = \theta = \theta \)

SOLUTION

\( \frac{z}{z} = \theta = \theta \)

SOLUTION

\( \frac{z}{z} = \theta = \theta \)
Hence the solution does satisfy the wave equation:

\[
\frac{\partial^2 \rho}{(t-x)^2} = \frac{\rho}{\alpha^2} + \frac{\partial}{\partial x} \left[ \frac{\partial}{\partial x} \right] \frac{\rho}{\alpha^2} + \frac{\partial}{\partial x} \left[ \frac{\partial}{\partial x} \right] \frac{\rho}{\alpha^2} = \frac{x^2 \rho}{(t-x)^2} \frac{\rho}{\alpha^2} \frac{\partial}{\partial x} \frac{\partial}{\partial x} \frac{\rho}{\alpha^2}
\]

Thus,

\[
\left[ (t-x)^2 \right] \frac{\rho}{\alpha^2} = \frac{x^2 \rho}{(t-x)^2} \frac{\rho}{\alpha^2} \frac{\partial}{\partial x} \frac{\partial}{\partial x} \frac{\rho}{\alpha^2}
\]

and hence

\[
\left[ (t-x)^2 \right] \frac{\rho}{\alpha^2} = \frac{x^2 \rho}{(t-x)^2} \frac{\rho}{\alpha^2} \frac{\partial}{\partial x} \frac{\partial}{\partial x} \frac{\rho}{\alpha^2}
\]

Similarly,

\[
\left[ (t-x)^2 \right] \frac{\rho}{\alpha^2} = \frac{x^2 \rho}{(t-x)^2} \frac{\rho}{\alpha^2} \frac{\partial}{\partial x} \frac{\partial}{\partial x} \frac{\rho}{\alpha^2}
\]

From above we can now conclude

\[
\left( \frac{x}{t-x} \right)^2 \frac{\rho}{\alpha^2} = \frac{x^2 \rho}{(t-x)^2} \frac{\rho}{\alpha^2} \frac{\partial}{\partial x} \frac{\partial}{\partial x} \frac{\rho}{\alpha^2}
\]

and hence

\[
\left( \frac{x}{t-x} \right)^2 \frac{\rho}{\alpha^2} = \frac{x^2 \rho}{(t-x)^2} \frac{\rho}{\alpha^2} \frac{\partial}{\partial x} \frac{\partial}{\partial x} \frac{\rho}{\alpha^2}
\]