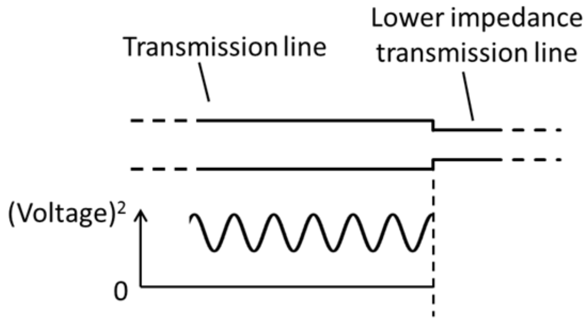
c)

This situation is intermediate between an open-circuit and a short-circuit end. The phase of the reflection is the same as that for a short-circuit end, but the amplitude is smaller (the reflection cannot be total because some power is transmitted on into the lower-impedance line). Consequently, we have a partial standing wave, not going to zero at the minima, but with the same phase as that of the short-circuited line.



Notes on how students answered this

Most students had some notions of transmission lines. For those that did not, it was possible to recast this question in terms of waves on a string, waves in other kinds of waveguides, or waves propagating up to dielectric interfaces.

The most common minor error was that, instead of drawing a $\sin^2$ function for the standing wave, students drew a rectified sine wave. (In fact, nearly all students did this!) I took little or nothing off for that error in itself because it is not such big problem for parts (a) and (b), but it made it conceptually more difficult to answer part (c).

In part (c), some students correctly reasoned that the answer should be between that of parts (a) and (b) in some sense. This could cause them to guess (incorrectly) that the phase on reflection was somewhere between 0 and 180 degrees. I took no marks off for that, though, because it is not easy to get the phase here based on purely logical (rather than algebraic) reasoning. The main difficulty most students had was in realizing that the partial reflection would lead to a standing wave pattern that does not reach zeros. If so, I tried to help them reason towards the right answer by asking them what the pattern would look like if both lines had the same impedance (the answer is a completely flat line, of course).

Supplementary question 1

Since this position (one quarter wavelength from the open end) is a node, this resistor has no effect; there is no voltage across it at any time.

The resistor could be positioned at any node in the line for the same effect. The nodes are a one-quarter wavelength, 3/4 wavelength, 5/4 wavelength, … and so on, from the right end of the line.

Notes

The students who got to this point generally got this answer correct.

Supplementary question 2

There are many possible ways of doing this. One possible solution here is shown below.