PHYS 293 – Quiz 2 Version A 21 Oct 2021

[Instructions: Solve the question below. Show all the steps to your solution; you do not have to derive any equations included on the Formula Sheet. Number of points awarded for each question is included in the brackets. Partial marks will be awarded.

You are allowed: a non-communicating calculator, a one-page formula sheet (can be annotated)].

A wave of amplitude A_i is coming from water ($v_{water} = 1480\,\frac{\mathrm{m}}{\mathrm{s}}, \rho_{water} = 1000\,\frac{\mathrm{kg}}{\mathrm{m}^3}$) is incident on a boundary with another, unknown liquid.

a. What is the bulk modulus of the water? [2 points]

$$v = \sqrt{\frac{B}{\rho}} \rightarrow B = v^2\rho = (1480)^2 * (1000) = 2.19\ \mathrm{GPa}$$

1 point for referring to the equation on the sheet; 1 for calculation

b. What is the impedance of the water? [2 points]

$$Z = \sqrt{B\rho} = \rho v$$

$$Z = 1.48 \times 10^6\,\frac{\mathrm{kg}}{\mathrm{m}^2 s}$$

Either equation is ok as both appear on the formula sheet (ρv is hidden in the power formula)

c. After the reflection from the boundary the reflected wave has an amplitude equal to $0.37A_i$ and the reflected and incident waves are in phase with each other. Determine the values of reflection and transfer coefficients [2 points]

$$In\ phase: \frac{A_r}{Ai} = +0.37$$

$$R = \frac{A_r}{A_i} = +0.37$$

$$1 + R = T = 1.37$$

d. What percent of energy is **transferred** to the unknown liquid?[2 points]

$$R_{energy} + T_{energy} = 1$$

$$R_{energy} = R^2 = 0.37^2 = 0.1369 = 0.137$$

$$T_{energy} = 1 - R^2 = 0.8631$$

Any solution is ok, somehow energy and amplitude coefficients and energy conservation need to be included.

e. What is the impedance of the unknown liquid? [2 points]

$$T_e = \frac{Z_2}{Z_1}T^2 \rightarrow Z_2 = \frac{T_e Z_1}{T^2} = \left(\frac{0.8431}{1.37^2}\right) 1.48 \times 10^6 = 0.681 \times 10^6\,\frac{\mathrm{kg}}{\mathrm{m}^2\mathrm{s}}$$