Physics 260 Homework Assignment 3

Chapter 16

1 PSE6 16.P.005

Assume the time required for faster wave to reach the seismographic station is t_1 , then the total time required by the slower wave would be $t_1 + \Delta t$. The distance d travelled by both waves is the same. Therefore,

$$d = v_1 t_1 = v_2 (t_1 + \Delta t)$$

Plug in the values and solve for t. And then multiply it by v_1 to find the total distance.

2 PSE6 16.P.004

a. the longitudinal wave because it travels faster and the distance is shorter.

b. Let L_P and L_R be the distances travelled by the P wave and the Rayleigh wave respectively. Then $L_P = 2R\sin(\frac{1}{2}\theta)$ and $L_R = R\theta$, where R is the radius of the Earth. Time required for P wave to reach point B is

$$t_P = \frac{L_P}{v_P} = \frac{2R\sin(\frac{1}{2}\theta)}{v_P}$$

Time required for Rayleigh wave to reach point B is

$$t_R = \frac{L_R}{v_R} = \frac{R\theta}{v_R}$$

Take the time difference.

3 PSE6 16.P.013

a. A = constant in front of the sin term.

b. $\omega = \text{constant in front of } t$.

c. k = constant in front of x.

d. $\lambda = 2\pi/k$.

e. $v = \omega/k$.

f. the wave function is given in the form of $f(kx - \omega t)$, therefore, it is travelling to the right, which is in the positive x direction.

4 PSE6 16.P.023

$$v = \sqrt{\frac{T}{\mu}}$$

5 PSE6 16.P.025

First, convert everything to SI unit.

Since a pulse requires t seconds to transverse the length of the wire, the speed of the pulse can be determine, v = L/t. The speed of the pulse can also be represented in terms of tension T and string density μ . Tension on the string is due to the gravitational force on the object, so $T = M_{object} \times g_{planet}$. String density is found using $\mu = M_{string}/L$. Set two expressions for v equal yields,

$$\frac{L}{t} = v = \sqrt{\frac{T}{\mu}}$$
$$\frac{L}{t} = \sqrt{\frac{M_{object} \times g_{planet}}{\frac{M_{string}}{L}}}$$

Therefore,

$$g_{planet} = \frac{M_{string}L}{M_{object}t^2}$$

6 PSE6 16.P.034

The expression for power is

$$\wp = \frac{1}{2}\mu\omega^2 A^2 v$$

We need to find string density of the string and angular frequency of the wave. String density can be found using mass over the length of the rope. The angular frequency can be found from the wavelength,

$$\omega = vk = v\frac{2\pi}{\lambda}$$

Therefore the required power is

$$\wp = \frac{2\pi^2 m A^2 v^3}{L\lambda^2}$$

7 PSE6 16.QQx.005

A linear wave equation satisfies the following relation:

$$\frac{\partial^2 y}{\partial x^2} = \frac{1}{v^2} \frac{\partial^2 y}{\partial t^2}$$

The only equation that satisfies this relation is $y = \sin^2(x + vt)$.

8 PSE6 16.P.031

In each wire, the time required is

$$t = \frac{L}{v} = L\sqrt{\frac{\mu}{T}}$$

Let A represent the cross-sectional area of one wire. The mass of one wire can be written both as $m = \rho V = \rho AL$, and $m = \mu L$. Set two equations equal and solve for μ , we get

$$\mu = \rho A = \frac{\pi \rho d^2}{4}$$

Plug this into the time expression and yields

$$t = L(\frac{\pi \rho d^2}{4T})^{1/2}$$

Plug in associated values for copper and steel and solve for both times. The total time would be the sum of these two. Be careful with the units.

9 PSE6 16.P.021

Suppose L is the length of the telephone cord, the down and back distance is 2L. The speed of the pulse is then

$$v = \frac{d_{total}}{t} = \frac{42L}{t} = \frac{8L}{t}$$

So the tension in the cord is

$$T = \mu v^2 = (\frac{m}{L})(\frac{8L}{t})^2 = \frac{64mL}{t^2}$$