Q- A steel wire having a mass of 5 g and a length of 1.2 m is fixed at both ends and has a tension of 974 N.

(a) Find the speed of transverse waves on the wire.

The speed of transverse wave on the wire is given by

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

Here T is the tension in the wire and μ is its mass per unit length. Thus

$$c = \sqrt{\frac{T}{\mu}} = \sqrt{\frac{T}{m/L}} = \sqrt{\frac{TL}{m}} = \sqrt{\frac{974*1.2}{5*10^{-3}}} = 483.49 \quad \text{m/s}$$

(b) Find the wavelength of the fundamental.

The fundamental oscillations are on the wire with two nodes at the ends and one anti-node at the midpoint. The distance between two consecutive nodes (or antinodes) equal to half of the wavelength which is equal to the length of the wire, hence the wavelength

λ = 2L = 2*1.2 = 2.4 m

(c) Find the frequency of the fundamental.

The frequency of the fundamental of the stretched string is given by

n = c*λ

or $$n = \frac{1}{2L}\sqrt{\frac{T}{\mu}} = \frac{c}{2L} = \frac{483.49}{2*1.2} = 201.45 \text{ Hz}$$

(d) Find the frequency of the second harmonic.

As the fundamental is called the first harmonic and the double of this is the second harmonic, the frequency of the second harmonic (or first overtone) is

2*201.45 = 402.90 Hz

(e) Find the frequency of the third harmonic.

Frequency of the third harmonic is three times of the fundamental hence equal to

3*201.45 = 604.35 Hz