Physics 11 IB **Standing Waves on a String**

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1 Planning A

1.1 Aim

To define and analyze two factors which affect the amplitude of standing waves on a string.

1.2 Hypothesis

Two factors which could potentially affect the amplitude of oscillation of a standing wave in a string are:

1. **The frequency of vibration**

   A greater frequency of vibration brings about a greater frequency of waves in the string. Repeated reinforcement between newly created and reflected cycles causes a large amplitude standing wave to develop. If a hand is the source of vibration, then the faster the hand moves up and down, the larger the amplitude build up will be due to an increased number of reinforcements. At large frequencies, large amplitude standing waves develop due to resonance.

2. **The tension in the string**

   When the tension F in the string is increased, the waves cannot move as freely as they can when the tension is mild. Increasing the tension therefore decreases the amplitude of oscillation in the standing waves, and conversely, if the tension in the string F is decreased, the amplitude of oscillation will increase. For example, in a guitar, when the strings are tightened, the guitar produces a much softer sound, which denotes a decrease in amplitude.

1.3 Variables

1. Frequency factor

    - Independent — Frequency of vibration of the hand
    - Dependent — The amplitude of oscillation in the string
    - Controlled — The length of the string

2. Tension factor

    - Independent — The tension F in the string
    - Dependent — The amplitude of oscillation
    - Controlled — The linear density m/L of the string, the frequency of vibration

2 Planning B

2.1 Materials Required

1. A long enough string (about $1m$ to $2m$)
2. Weights of known masses
3. A vibration generator with frequency control
4. Tension scale
5. Stop clocks
6. Meter rule
7. Weight balance

2.2 Procedure

1. Factor 1 — Frequency

    (a) Measure the length of the string.

    (b) Attach the string on both sides to a fixed object such as a wall.

    (c) Using your vibration generator, generate standing waves of a frequency equal to the natural frequency of the string. Record the amplitude of oscillation which uncertainties.

    (d) Repeat the previous step by doubling, tripling and quadrupling the frequencies and recording the respective amplitude of oscillation. Make sure the length of the string isn't modified in between trials.

    (e) Compare the change in oscillation to the change in frequency. How much does the amplitude change when the frequency is doubled, tripled, quadrupled?

    (f) If a plot of frequency versus amplitude were to be graphed, predict the shape of the resulting graph. Check your predictions.

2. Factor 2 — Tension in the string.

   (a) Measure the length of the string.

   (b) Attach the string on both side to a fixed, rigid object such as a wall.

   (c) To one end of the string, attach weights of known masses and let them hang free. The tension in the string will thus be equal to the weight ($m \times g$) of the masses. If other methods are used to increase the tension, measure the tension with the help of a tension scale.

   (d) Induce a standing wave in the string with the help of the vibration generator. Set the vibration generator to vibrate at a frequency equal to the that of the natural frequency of the string. Measure the resulting amplitude of oscillation and record the data in table with uncertainties.

   (e) Repeat the above step by increasing the tension in the string by increases the masses of the weights hanging of it. Calculate the corresponding amplitudes for each increase in mass. Make sure you use the same frequency of vibration each time, and also to keep the mass density of m/L of the string constant. This cane be achieved by using the same string each time.

   (f) Study the data collected and predict the shape of a Tension F versus amplitude A graph.

   (g) What would happen to the amplitude if the tension is doubled, tripled, halved?
