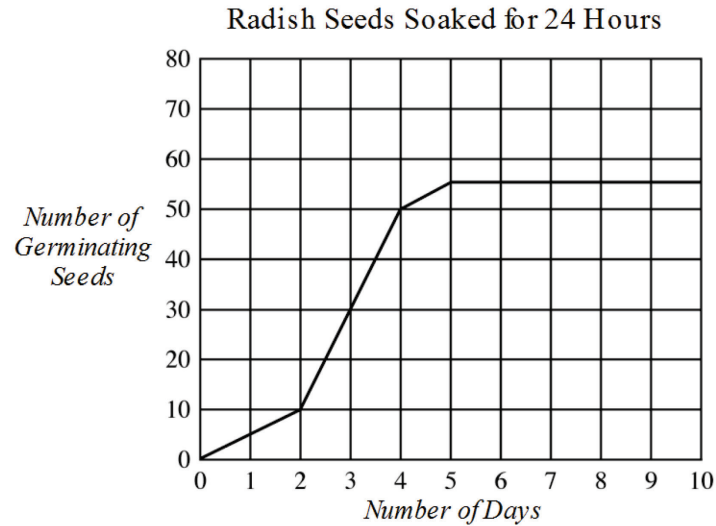


### Passage III

Germination is the beginning of the growth of a seed after a period of inactivity. The following experiments were designed to compare the amount of time it takes for seeds of different vegetables to germinate.

#### Experiment 1

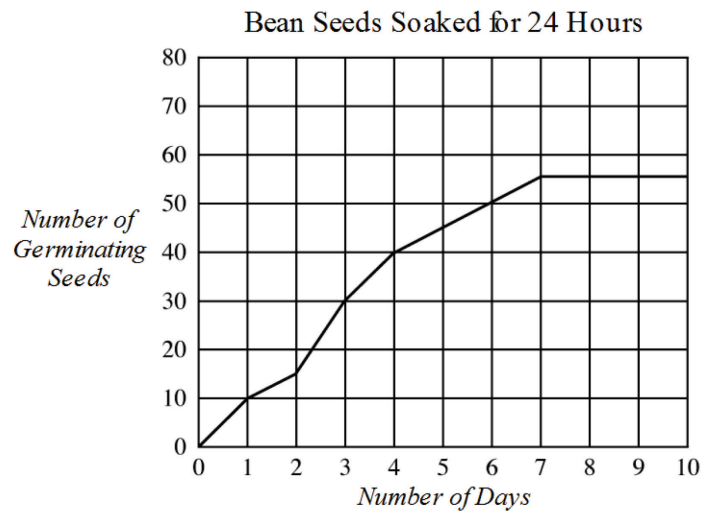
Radish seeds were soaked in water for 24 hours and then planted and kept at 25°C for 10 days. Each day the experimenters counted the total number of seeds that had germinated. The results are shown in Graph 1.



Graph 1

#### Experiment 2

Bean seeds were soaked in water for 24 hours and then planted and kept at 25°C for 10 days. Each day the experimenters counted the total number of seeds that had germinated. The results are shown in Graph 2.



Graph 2

## Passage IV

When one end of a cord under tension is disturbed, the displacement moves down the cord in the form of a *transverse wave*. If the other end of the cord is fixed, the wave is reflected and moves back in the opposite direction encountering other waves moving toward the fixed point. Certain frequencies produce *standing waves*, which are characterized by motionless nodes separating oscillating segments of cord (see Figure 1). For a cord of a given length and density, only certain frequencies will produce standing waves.

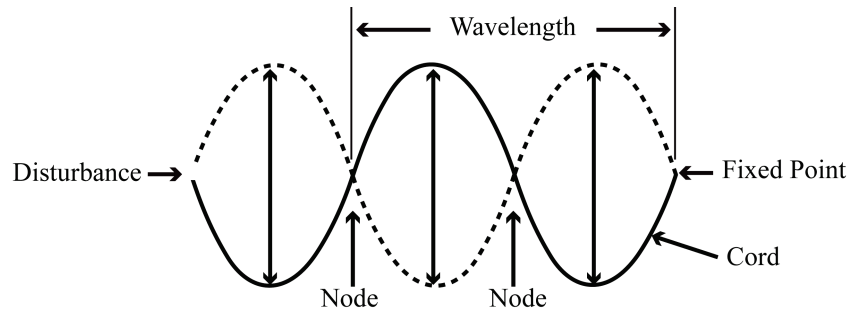


Figure 1

A group of students performed three investigations using the setup shown in Figure 2. One end of a cord was fastened to the reciprocating blade of a jig saw and the other was hung over a pulley and attached to a block. A stroboscope measured the frequency of the vibrations in the cord. The length of the cord from the jig saw blade to the pulley was 2 meters, and the length of the standing waves was measured using the meter stick attached to the lab table.

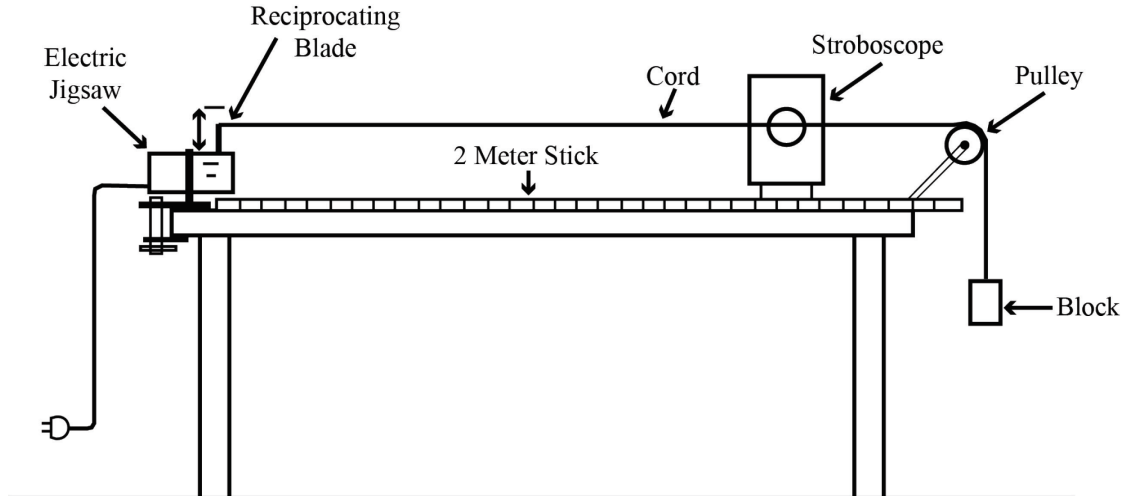


Figure 2

### Experiment 1

The students conducted five trials using the same cord of density 0.0076 kilograms per meter and block while adjusting the frequency to produce standing waves at pre-determined wavelengths. The cord tension in all five trials was 2 newtons. They recorded the length and frequency of the waves (see Table 1).

| Table 1 |                     |                   |
|---------|---------------------|-------------------|
| Trial   | Wavelength (meters) | Frequency (hertz) |
| 1       | 4                   | 4.05              |
| 2       | 2                   | 8.05              |
| 3       | 1.3                 | 12.33             |
| 4       | 1                   | 16.3              |
| 5       | 0.8                 | 20.25             |

### Experiment 2

Using the same cord, the students decreased the tension to 1 newton and conducted five more trials, adjusting the frequency to produce standing waves at pre-determined wavelengths (see Table 2).

| Table 2 |                     |                   |
|---------|---------------------|-------------------|
| Trial   | Wavelength (meters) | Frequency (hertz) |
| 1       | 4                   | 2.87              |
| 2       | 2                   | 5.74              |
| 3       | 1.3                 | 8.62              |
| 4       | 1                   | 11.47             |
| 5       | 0.8                 | 14.34             |

### Experiment 3

The students kept the tension at 1 newton but used five different cords of different densities. Again, they conducted five trials, adjusting the frequency to produce standing waves at pre-determined wavelengths and then recording the lengths of the waves and the frequencies (see Table 3).

| Table 3 |                                   |                     |                   |
|---------|-----------------------------------|---------------------|-------------------|
| Trial   | Cord Density (kilogram per meter) | Wavelength (meters) | Frequency (hertz) |
| 1       | 0.0076                            | 4                   | 2.87              |
| 2       | 0.011                             | 2                   | 4.77              |
| 3       | 0.018                             | 1.3                 | 5.60              |
| 4       | 0.025                             | 1                   | 6.32              |
| 5       | 0.032                             | 0.8                 | 6.99              |