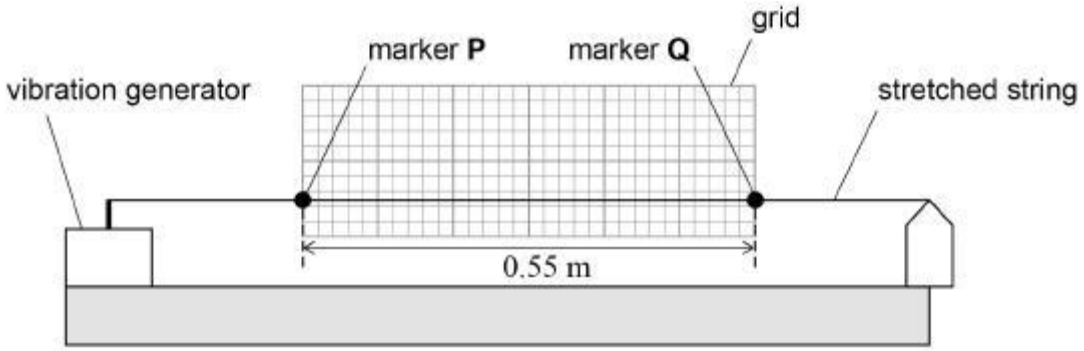
Name of the Student:_____
Max. Marks : 23 Marks **Time : 23 Minutes**

Q1.

Figure 1 shows the apparatus a student uses to investigate stationary waves in a stretched string.

Two small pieces of adhesive tape are fixed to the string as markers **P** and **Q**. Markers **P** and **Q** are 0.55 m apart and an equal distance from the ends of the string. A graph paper grid is placed behind the string between **P** and **Q**.

Figure 1



not to scale

(a) The string is made to vibrate at the second harmonic.

Compare the motion of **P** with that of **Q**.

_____

_____

_____

_____

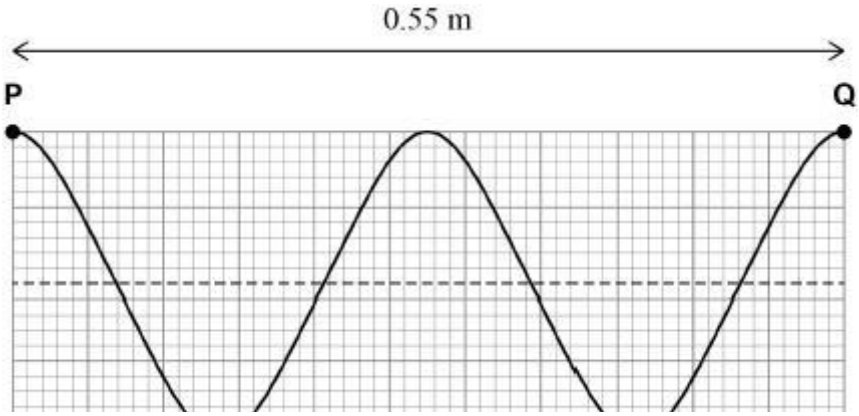
_____

(2)

(b) The frequency of the vibration generator is increased, and a higher harmonic of the stationary wave is formed.

Figure 2 shows the string between **P** and **Q** at an instant in time. The dashed horizontal line indicates the position of the string at rest when the vibration generator is switched off.

Figure 2



The frequency of the vibration generator is 250 Hz.

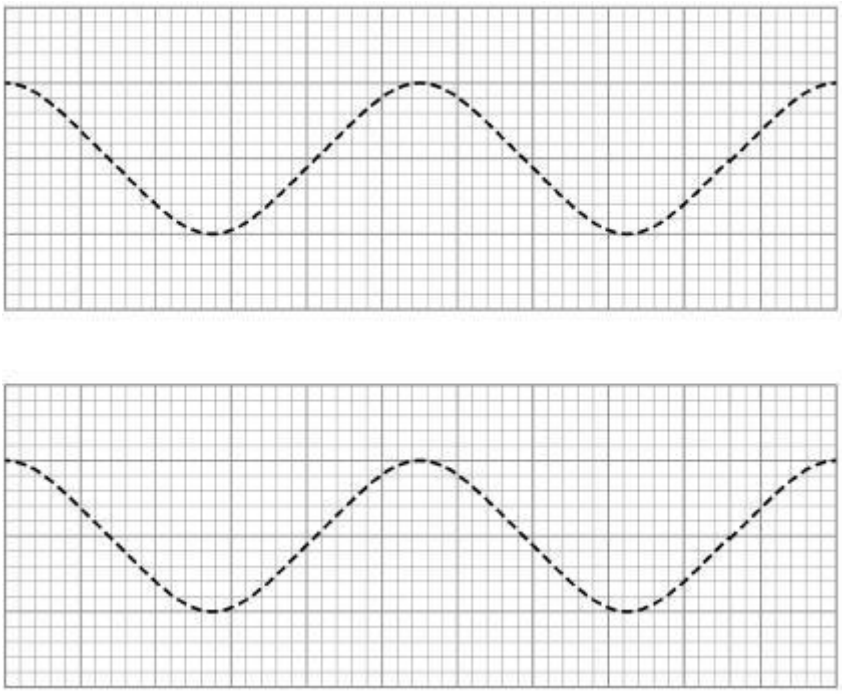
Calculate the wave speed.

wave speed = _____ m s^{-1}

(2)

(c) The instantaneous position of the string in **Figure 2** can be explained by the superposition of two waves. The instantaneous positions of these waves between **P** and **Q** are shown in **Figure 3**.

Figure 3



Describe the properties that the waves must have to form the shape shown in **Figure 2**.

_____

_____

_____

_____

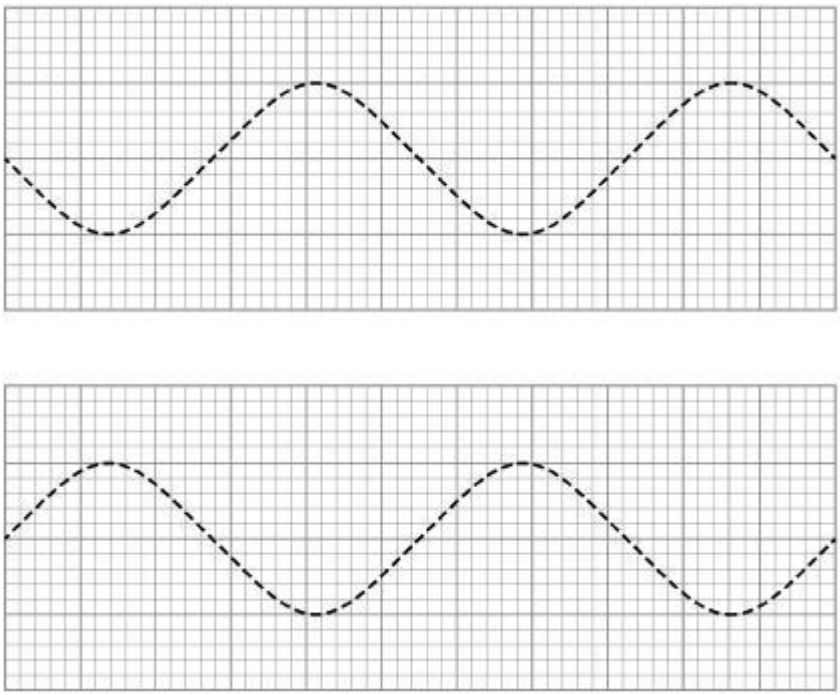
_____

_____

(3)

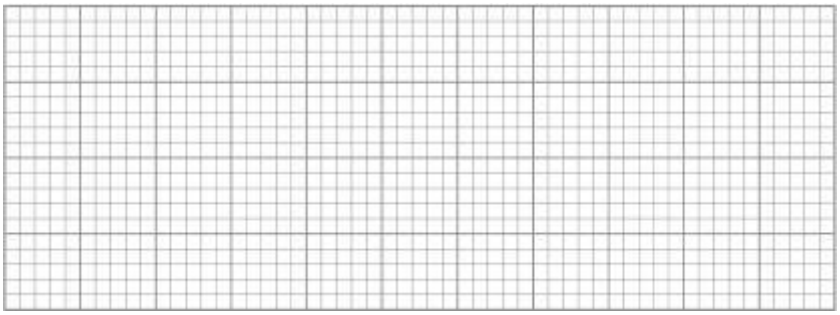
(d) **Figure 4** shows the positions of the two waves between **P** and **Q** a short time later.

Figure 4



Draw, on **Figure 5**, the appearance of the string between **P** and **Q** at this instant.

Figure 5



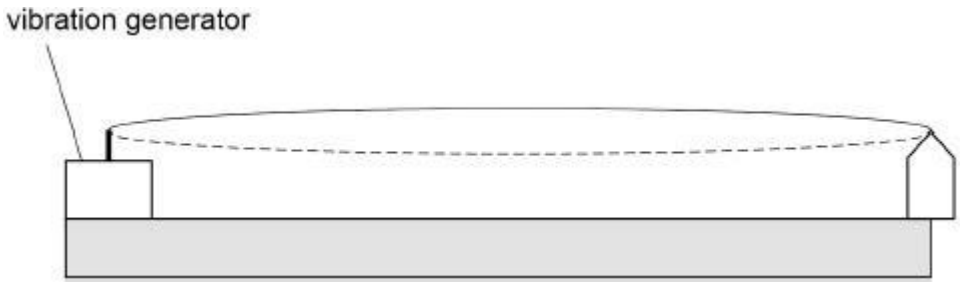
(1)

(e) Annotate (with an **A**) the positions of any antinodes on your drawing in **Figure 5**.

(2)

(f) The frequency of the vibration generator is reduced until the first harmonic is observed in the string, as shown in **Figure 6**.

Figure 6



The string in **Figure 6** is replaced with one that has 9 times the mass per unit length of the original string. All other conditions are kept constant, including the frequency of the vibration generator and the tension in the string.

Deduce the harmonic observed.

_____

_____

_____

_____

_____

_____

(3)

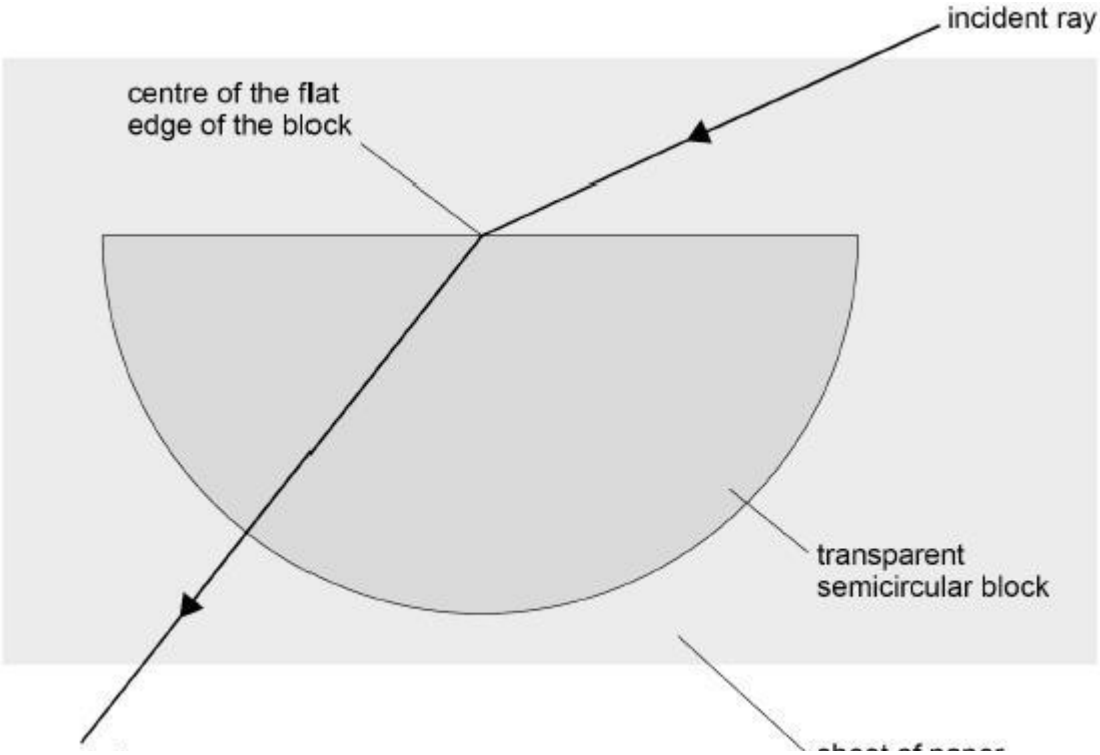
(Total 13 marks)

Q2.

A student places a transparent semicircular block on a sheet of paper and draws around the block. She directs a ray of light at the centre of the flat edge of the block.

Figure 1 shows the path of the ray through the block.

Figure 1



(a) State why the emergent ray does not change direction as it leaves the block.

_____

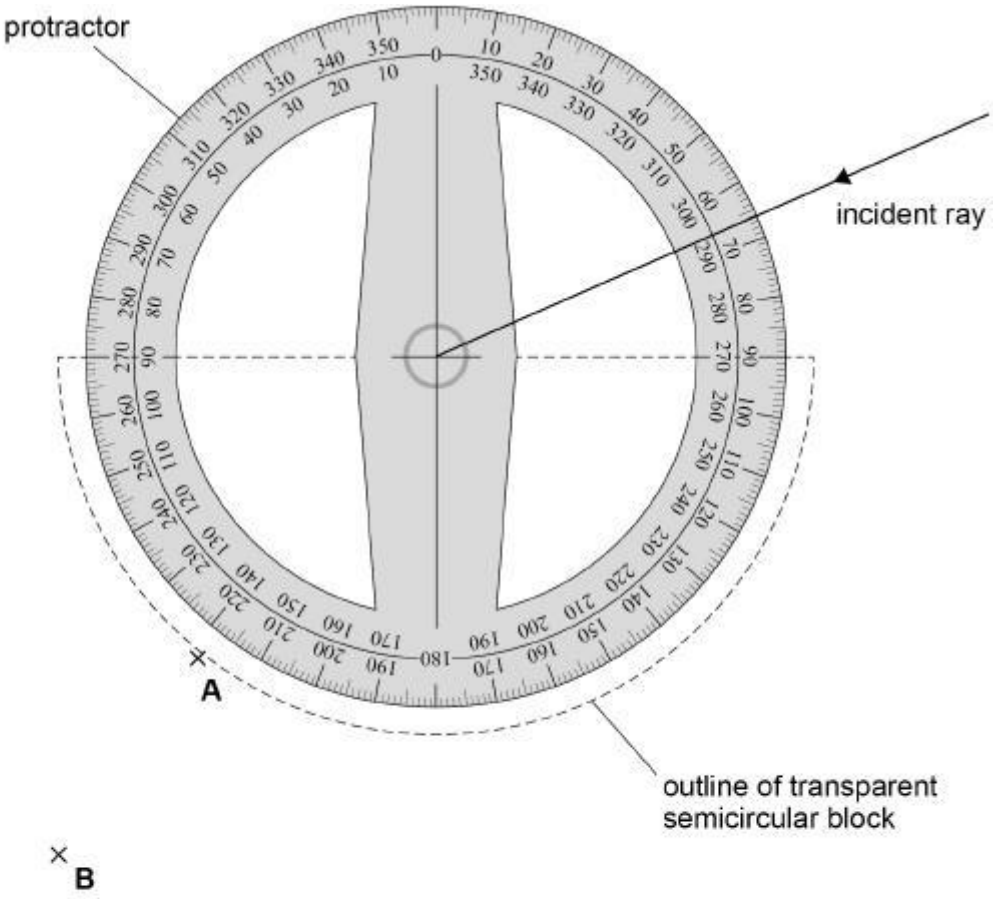
_____

(1)

(b) The student draws an arrow on the paper to mark the incident ray. She marks the path of the emergent ray with crosses **A**, **B** and **C**.

She removes the block from the paper and places a protractor over the outline of the block, as shown in **Figure 2**.

Figure 2



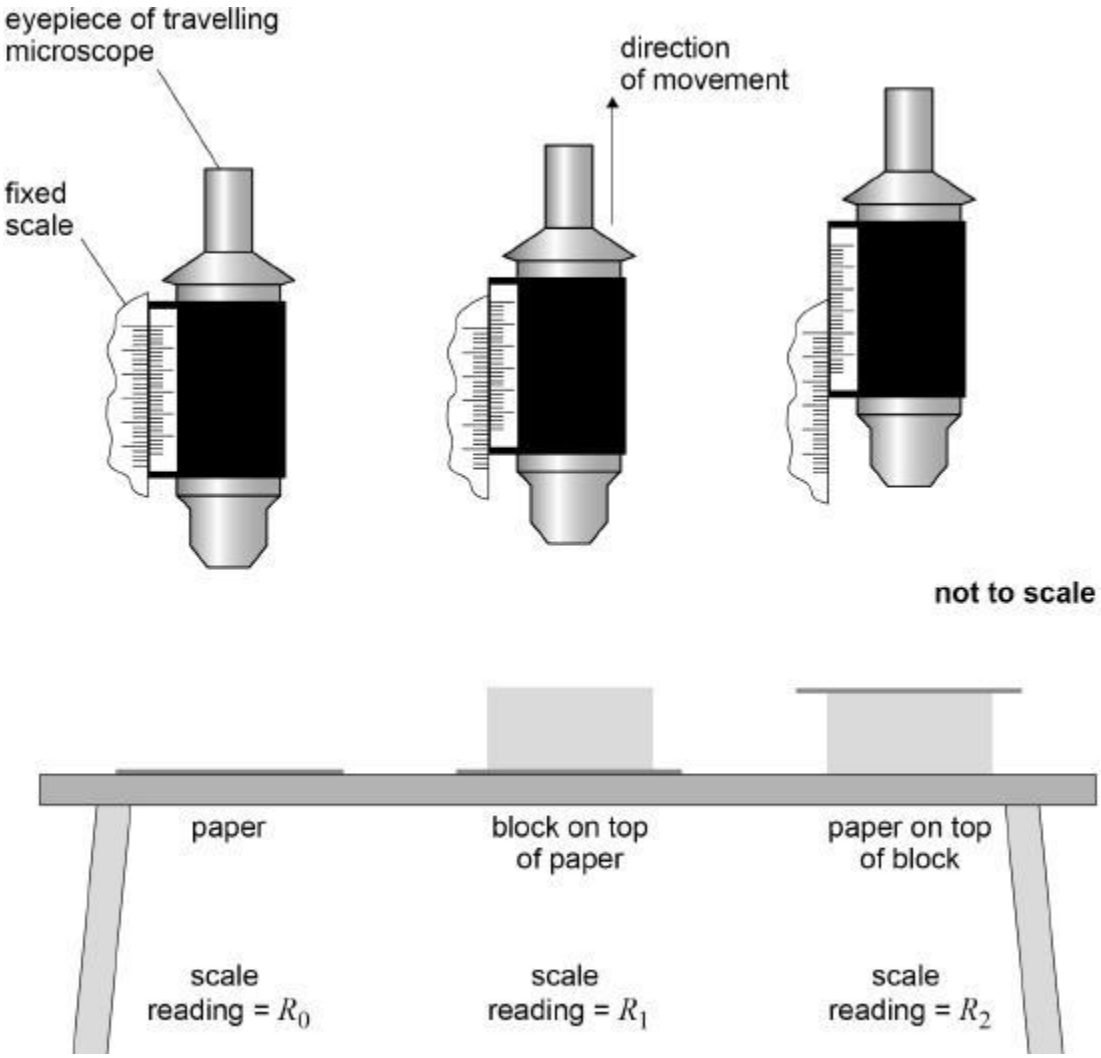
Determine, using **Figure 2**, the refractive index of the block.

refractive index = _____

(4)

The student uses a different method to determine the refractive index of the block. She focuses a travelling microscope on some dots on a sheet of paper for each of the three situations shown in **Figure 3**.

Figure 3



The table shows the readings made by the student.

R_0 / mm	R_1 / mm	R_2 / mm
5.74	10.31	20.02

(c) The refractive index n of the block is given by

$$n = \frac{R_2 - R_0}{R_2 - R_1}$$

Determine n.

n = _____

(1)

(d) The absolute uncertainty in each of the readings R_0, R_1 and R_2 is 0.04 mm.

State the absolute uncertainty in $R_2 - R_0$.

absolute uncertainty in $R_2 - R_0$ = _____ mm

(1)

(e) The absolute uncertainty in $R_2 - R_1$ is the same as the absolute uncertainty in $R_2 - R_0$.

Calculate the percentage uncertainty in n.

percentage uncertainty in n = _____%

(3)

(Total 10 marks)