

Name of the Student: \_\_\_\_\_

Max. Marks : 23 Marks

Time : 23 Minutes

**Q1.**

- (a) The speed of light is given by

$$c = f\lambda$$

State how each of these quantities will change, if at all, when light travels from air to glass.

$c$  \_\_\_\_\_

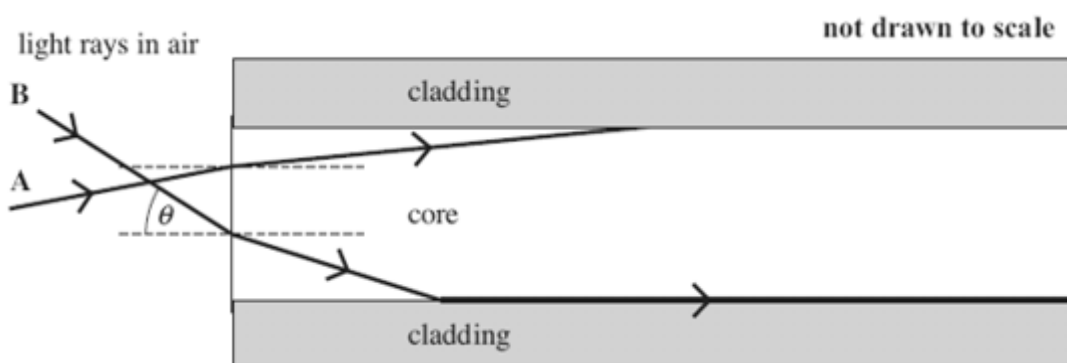
$f$  \_\_\_\_\_

$\lambda$  \_\_\_\_\_

(3)

Figure 1 shows a side view of a step index optical fibre.

**Figure 1**



- (b) Ray A enters the end of the fibre and then undergoes total internal reflection.

On **Figure 1** complete the path of this ray along the fibre.

(2)

- (c) (i) The speed of light in the core is  $2.04 \times 10^8 \text{ ms}^{-1}$ . Show that the refractive index of the core is 1.47.

(2)

- (ii) Show that the critical angle at the boundary between the core and the cladding is about  $80^\circ$ .

refractive index of the cladding = 1.45

(2)

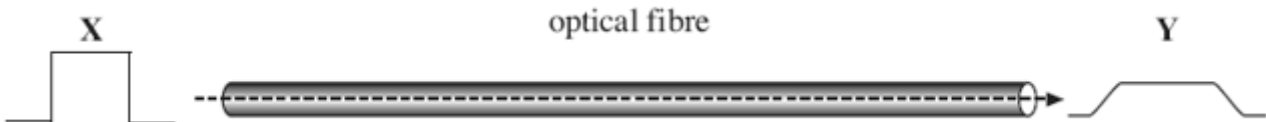
- (d) Ray **B** enters the end of the fibre and refracts along the core-cladding boundary. Calculate the angle of incidence,  $\theta$ , of this ray at the point of entry to the fibre.

answer = \_\_\_\_\_ degrees

(3)

- (e) **Figure 2** shows a pulse of monochromatic light (labelled **X**) that is transmitted a significant distance along the fibre. The shape of the pulse after travelling along the fibre is labelled **Y**. Explain why the pulse at **Y** has a lower amplitude and is longer than it is at **X**.

**Figure 2**



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(2)

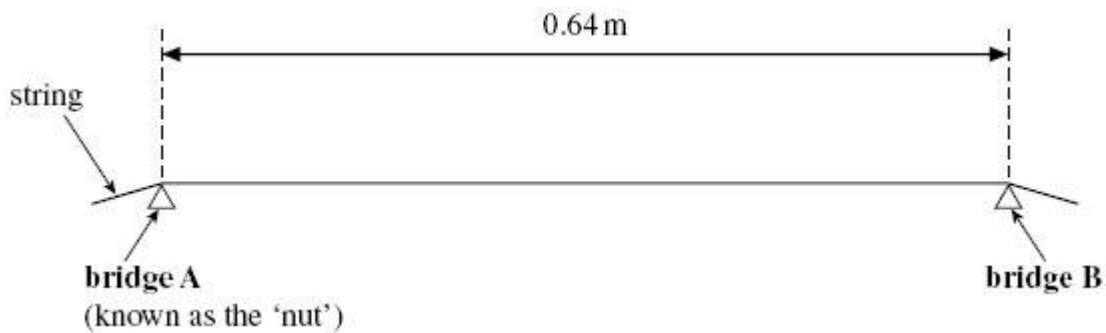
(Total 14 marks)

**Q2.**

**Figure 1** shows a side view of a string on a guitar. The string cannot move at either of the two bridges when it is vibrating. When vibrating in its fundamental mode the frequency of the sound produced is 108 Hz.

- (a) (i) On **Figure 1**, sketch the stationary wave produced when the string is vibrating in its fundamental mode.

**Figure 1**



(1)

- (ii) Calculate the wavelength of the fundamental mode of vibration.

answer = \_\_\_\_\_ m

(2)

- (iii) Calculate the speed of a progressive wave on this string.

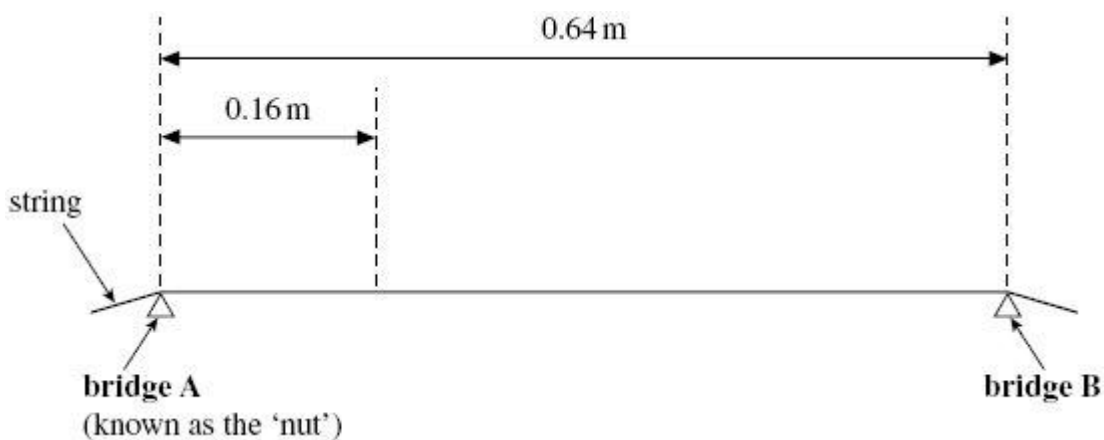
answer = \_\_\_\_\_ m s<sup>-1</sup>

(2)

- (b) While tuning the guitar, the guitarist produces an overtone that has a node 0.16 m from **bridge A**.

- (i) On **Figure 2**, sketch the stationary wave produced and label all nodes that are present.

**Figure 2**



(2)

- (ii) Calculate the frequency of the overtone.

answer = \_\_\_\_\_ Hz (1)

- (c) The guitarist needs to raise the fundamental frequency of vibration of this string. State **one** way in which this can be achieved.

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(1)  
(Total 9 marks)