Practice Question Set For A-Level
Subject : Physics
Paper-1 Topic: Waves

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Name of the Student:____

Max. Marks : 18 Marks **Time : 18 Minutes**

Q1.

Optical fibres are used to carry pulses of light.

(a) Explain what is meant by modal dispersion in an optical fibre.

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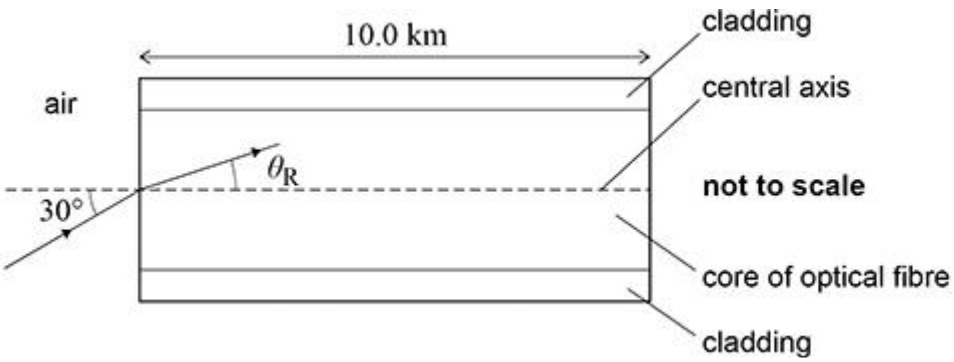
(2)

Figure 1 shows a ray of light incident on the central axis of an optical fibre at an angle of incidence of 30°. The optical fibre is straight and horizontal and has a length of 10.0 km.

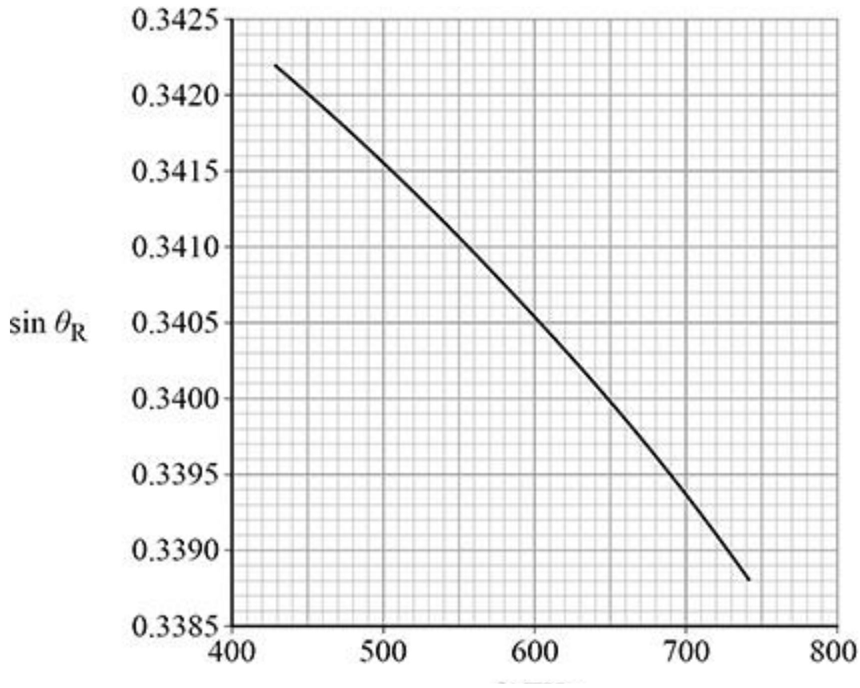
Figure 1



For light incident on the core at a given angle of incidence, the angle of refraction θ_R varies with the frequency f of the light.

Figure 2 shows how sin θ_R varies with f when the angle of incidence is 30°.

Figure 2



The transit time is the time between a pulse of light entering and leaving the optical fibre.
A single pulse of blue light is incident on the air−core boundary at an angle of incidence of 30°.

The transit time of this pulse along the 10 km length of the optical fibre is 5.225×10^{-5} s.

(b) Show that the horizontal component of the velocity of the pulse is approximately 1.9×10^{8} m s^{-1}.

(1)

(c) The frequency of the blue light in the pulse is 720 THz.

Calculate the speed of the blue light in the core of the optical fibre.

speed = _______________ m s^{-1}

(3)

(d) Two pulses of monochromatic light are incident normally on the air−core boundary. They then travel along the central axis of the core.

One pulse consists of blue light; the other consists of red light.

Explain, with reference to refractive index, why the pulse of red light has a shorter transit time than the pulse of blue light.

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(2)

(e) Another two pulses, identical to the pulses in part (d), are incident on the central axis of the optical fibre and travel along its length.
However, the pulse of red light and pulse of blue light are now incident on the air−core boundary at an angle of incidence of 30°.

Suggest **one** reason why the difference in their transit times may **not** be the same as in part (d).

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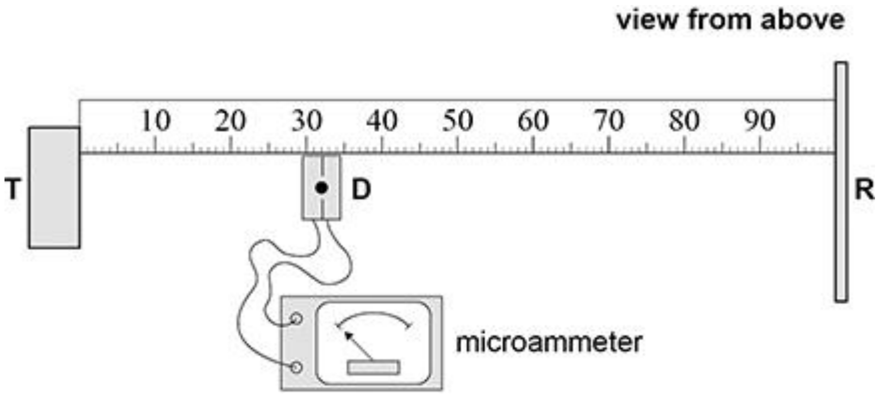
(1)
(Total 9 marks)

Q2.

A student investigates stationary waves using microwaves.

Figure 1 shows a metre ruler fixed to a bench. The student places a microwave transmitter **T** at one end of the ruler and a vertical metal reflector **R** at the other end. **R** is at a right angle to the ruler.

Figure 1



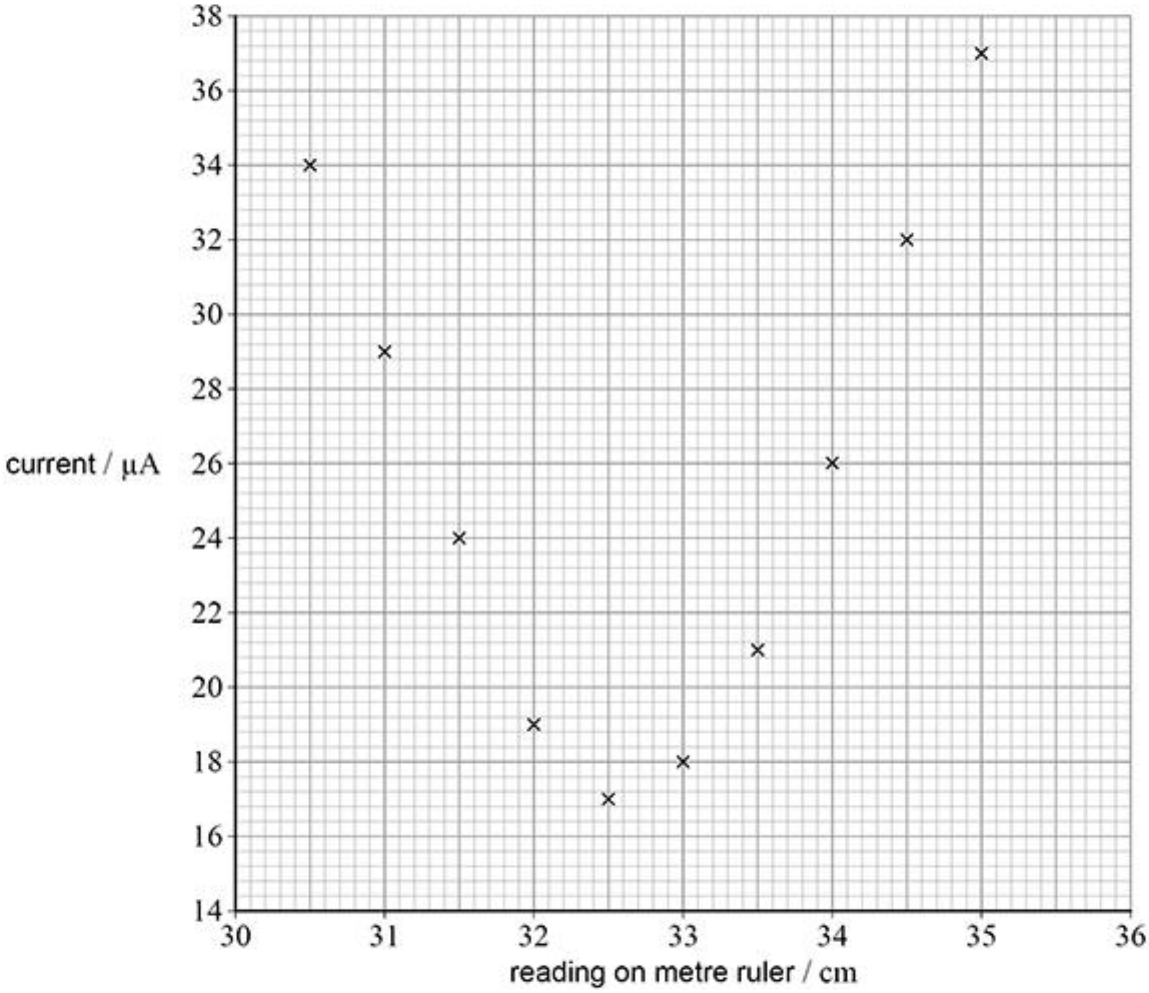
The student places a microwave detector **D** approximately one-third of the distance from **T** to **R**. When **T** is switched off, the microammeter connected to **D** reads zero.

When **T** is switched on, stationary waves are produced between **T** and **R**, and the microammeter registers a current. When the student moves **D** along the ruler, the size of the current changes between maximum and minimum values.

The student measures the current at different positions of **D** along the ruler to identify a position **P** of the minimum current.

Figure 2 is a plot of the measurements taken near **P**.

Figure 2



(a) Draw a line of best fit for these data.

(2)

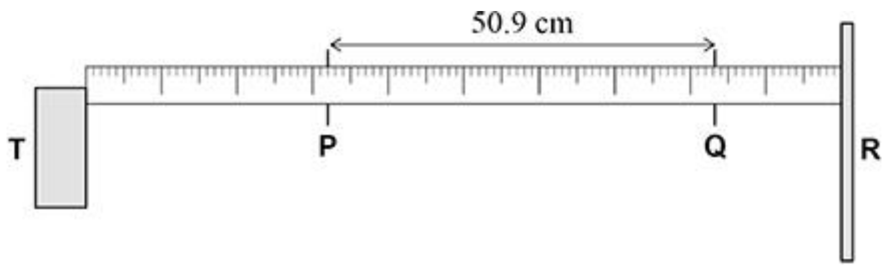
(b) State a value for the position of **P**.

position of **P** = ________________ cm

(1)

The student moves **D** along the metre ruler towards **R** and observes a series of maximum and minimum readings on the microammeter. He identifies **Q** as the position of the **8th minimum** current from **P**. He measures the distance **PQ** to be 50.9 cm, as shown in **Figure 3**.

Figure 3



(c) The absolute uncertainty in identifying any minimum current is ± 0.2 cm.

Determine the percentage uncertainty in the distance **PQ**.

percentage uncertainty in **PQ** = _______________ %

(2)

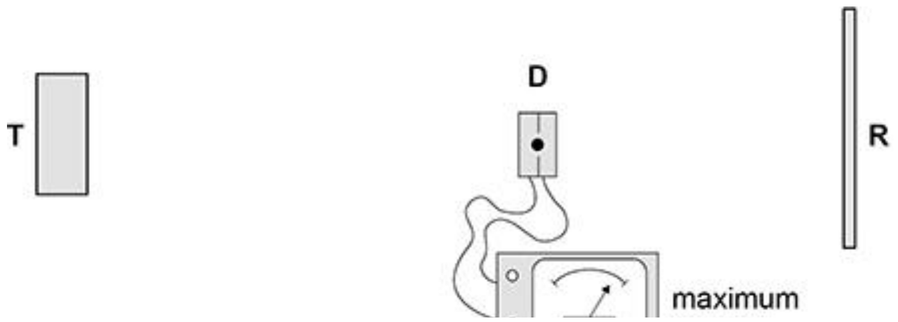
(d) Deduce the frequency of the microwaves produced by **T**.

frequency = _______________ Hz

(3)

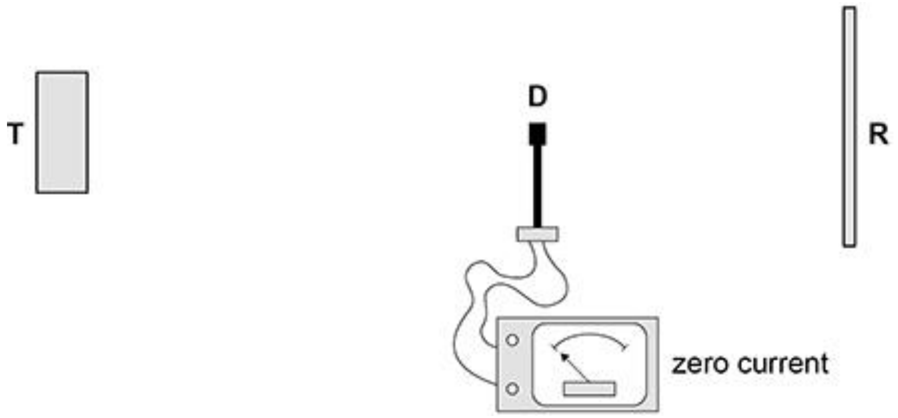
(e) **Figure 4** shows **D** placed at a position where the current is a maximum.

Figure 4



The student rotates **D** by 90°, without changing its distance from **T**, to the position shown in **Figure 5**. The current is now zero.

Figure 5



State the property of microwaves that is shown by this change in current.

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(1)
(Total 9 marks)