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.

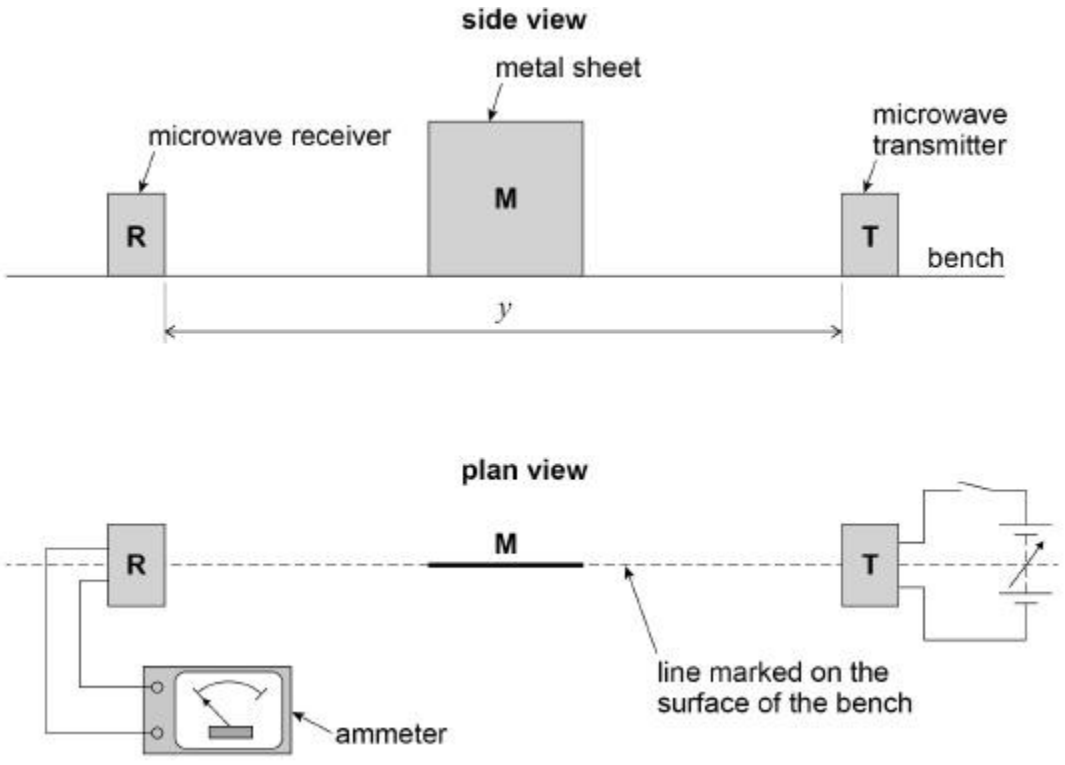
This question is about an experiment to measure the wavelength of microwaves.

A microwave transmitter **T** and a receiver **R** are arranged on a line marked on the bench.

A metal sheet **M** is placed on the marked line perpendicular to the bench surface.

Figure 1 shows side and plan views of the arrangement.
The circuit connected to **T** and the ammeter connected to **R** are only shown in the plan view.

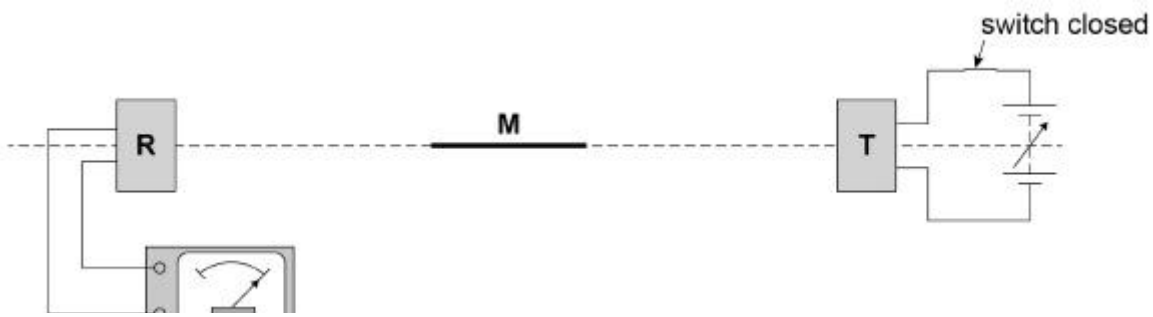
Figure 1



The distance *y* between **T** and **R** is recorded.

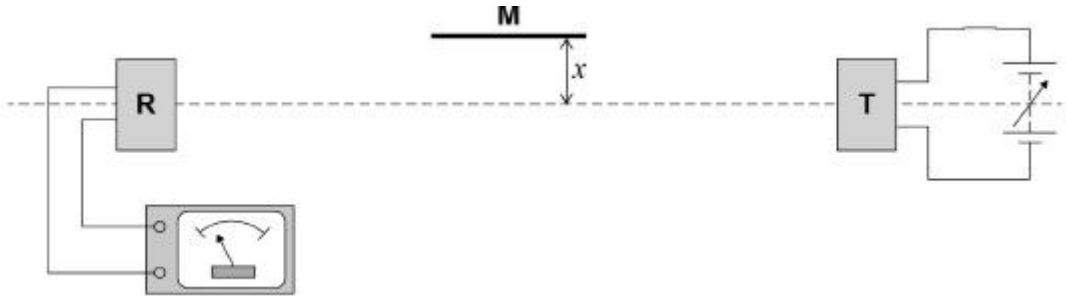
T is switched on and the output from **T** is adjusted so a reading is produced on the ammeter as shown in **Figure 2**.

Figure 2



M is kept parallel to the marked line and moved slowly away as shown in **Figure 3**.

Figure 3



The reading decreases to a minimum reading **which is not zero**.
The perpendicular distance x between the marked line and **M** is recorded.

(a) The ammeter reading depends on the superposition of waves travelling directly to **R** and other waves that reach **R** after reflection from **M**.

State the phase difference between the sets of waves superposing at **R** when the ammeter reading is a **minimum**.
Give a suitable unit with your answer.

_____

(1)

(b) Explain why the minimum reading is **not** zero when the distance x is measured.

_____

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(1)

(c) When **M** is moved further away the reading increases to a maximum then decreases to a minimum.

At the first minimum position, a student labels the minimum $n = 1$ and records the value of x.
The next minimum position is labelled $n = 2$ and the new value of x is recorded.
Several positions of maxima and minima are produced.

Describe a procedure that the student could use to make sure that **M** is parallel to the marked line before measuring each value of x.
You may wish to include a sketch with your answer.

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(2)

(d) It can be shown that

$$n\lambda = \sqrt{4x^2 + y^2} - y$$

where λ is the wavelength of the microwaves and y is the distance defined in **Figure 1**.

The student plots the graph shown in **Figure 4**.

The student estimates the uncertainty in each value of $\sqrt{4x^2 + y^2}$ to be 0.025 m and adds error bars to the graph.

Determine

- the maximum gradient G_{max} of a line that passes through all the error bars
- the minimum gradient G_{min} of a line that passes through all the error bars.

G_{max} = _____

G_{min} = _____

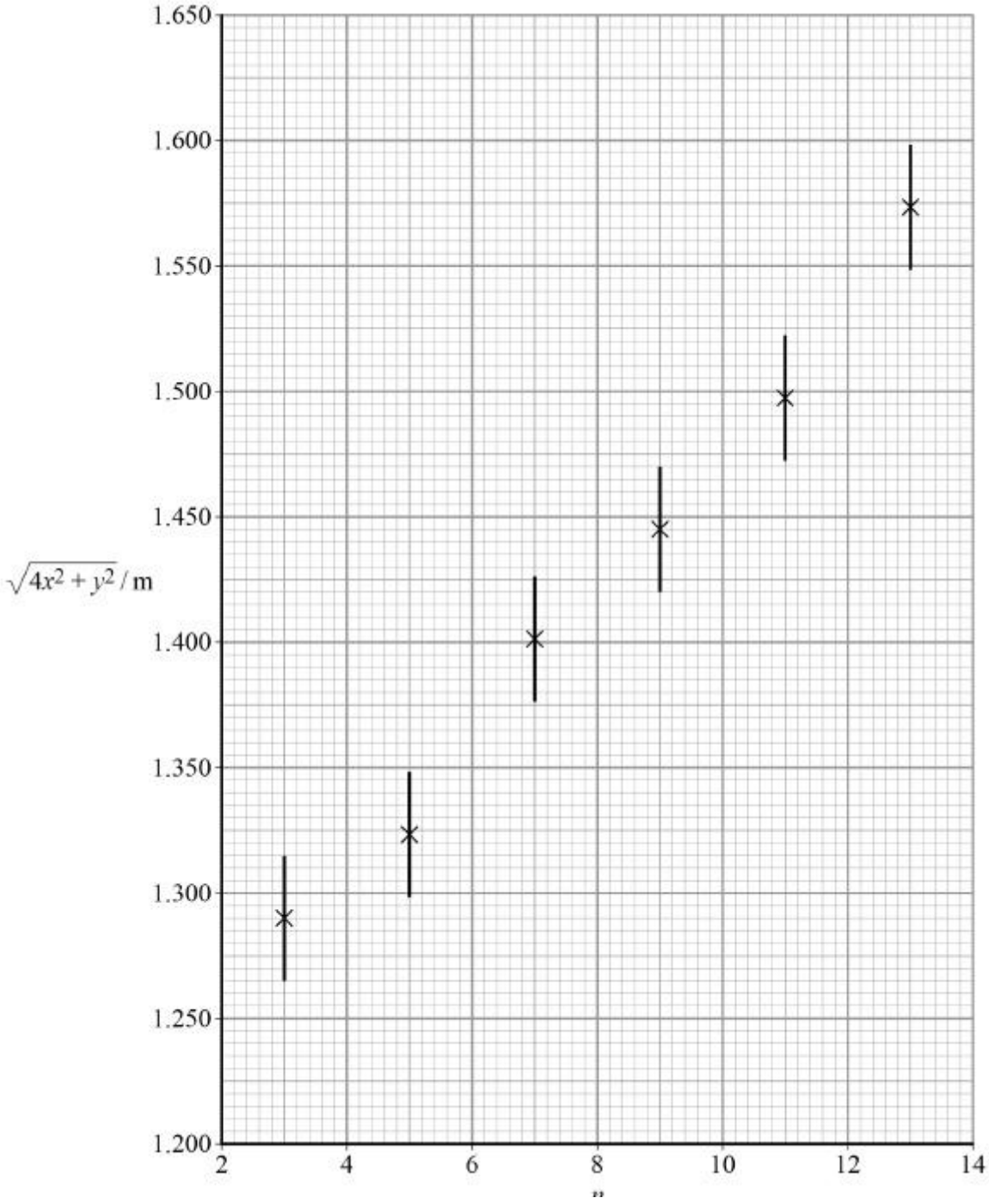
(3)

(e) Determine λ using your results for G_{max} and G_{min}.

λ = _____ m

(2)

Figure 4



(f) Determine the percentage uncertainty in your result for λ.

percentage uncertainty in λ = _____ %

(3)

(g) Explain how the graph in **Figure 4** can be used to obtain the value of y.
You are **not** required to determine y.

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(2)

(h) Suppose that the data for n = 13 had not been plotted on **Figure 4**.

Add a tick (✔) in each row of the table to identify the effect, if any, on the results you would obtain for G_{max}, G_{min}, λ and y.

Result	Reduced	Not affected	increased
G_{max}			
G_{min}			
λ			
y			

(4)

(Total 18 marks)