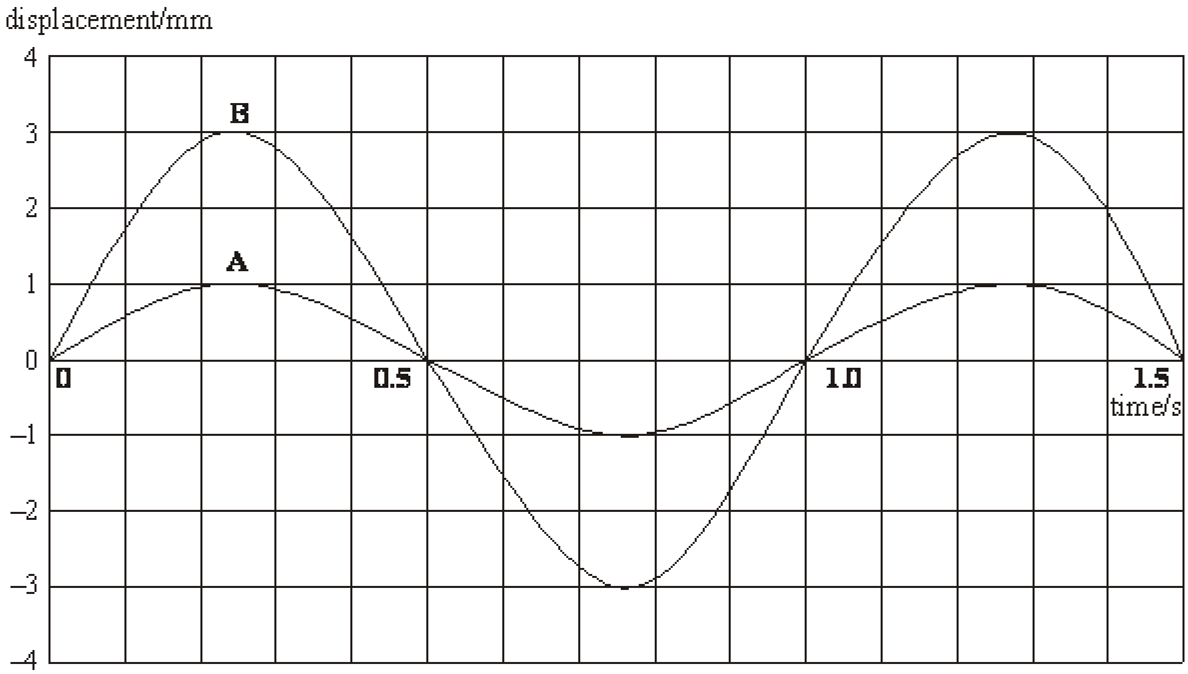
1 The figure below shows a graph of displacement against time for two waves **A** and **B.** These waves meet in phase and add to form a resultant wave.



(a) State the amplitude of the resultant wave

4 mm

(1)

(b) Calculate the ratio

intensity of wave **B** : intensity of wave **A**.

$I \propto A^2$ $A_B : A_A = 3:1$

$\therefore I_B : I_A = 9:1$

(2)

(Total 3 marks)

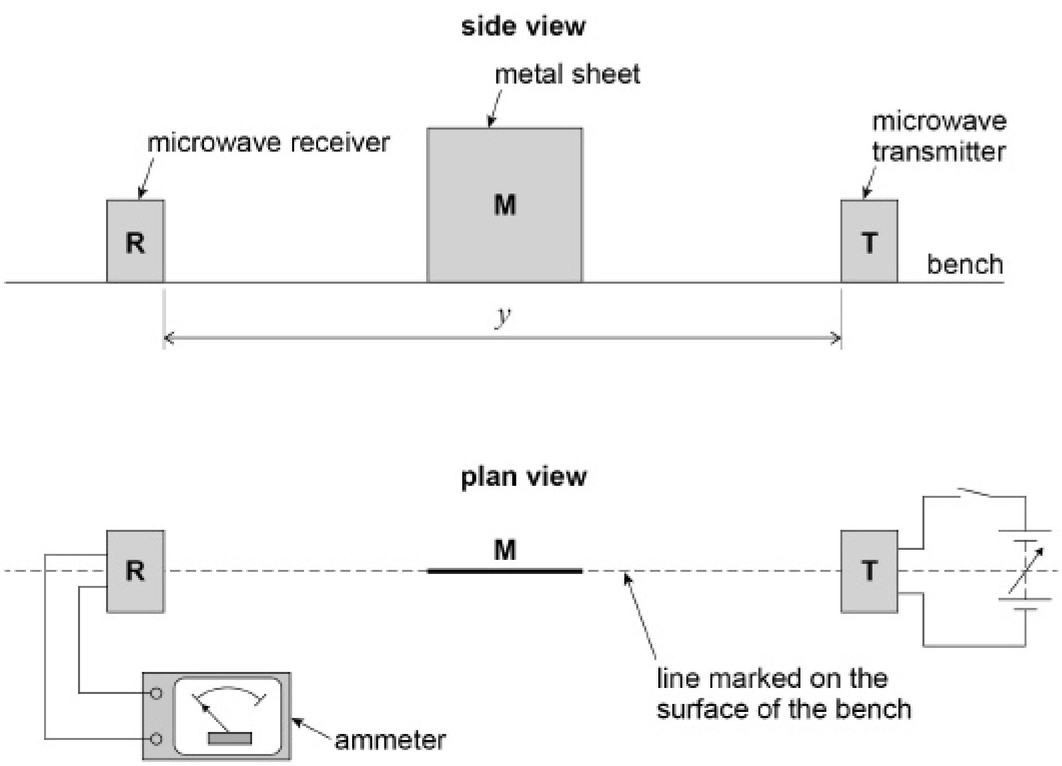
2 This question is about an experiment to measure the wavelength of microwaves.

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.

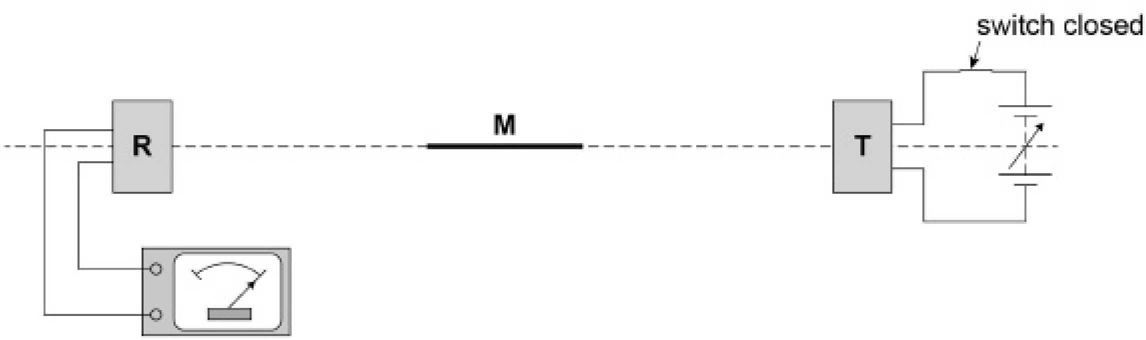
Figure 1



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

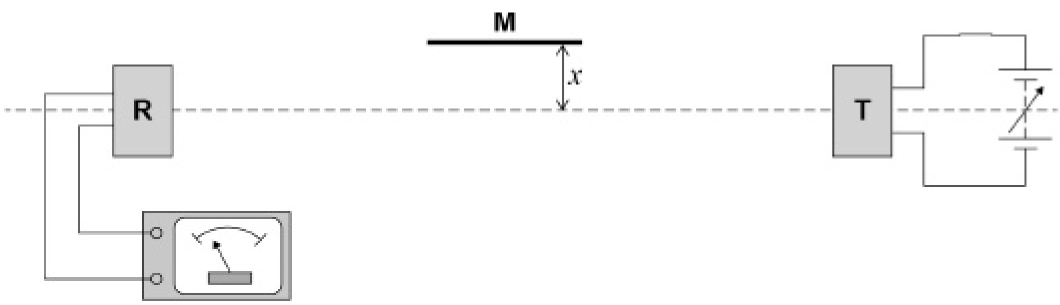
T is switched on and the output from **T** is adjusted so a reading is produced on the ammeter as shown in **Figure 2**.

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.

π rads or 180°

(1)

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

the reflected wave has a smaller amp as some energy lost - probably in reflection though path is longer too

(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.

Use of a set square / ruler or graph paper

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____

____

(2)

Mark schemes

1 (a) 4 mm

B1

1

(b) 3:1; 3/1

C1

9 **or** 9:1

A1

2

[3]

2 (a) 180 degrees

accept ° for degrees

OR

π radians ✓

condone ^{c} *or 'rad' for radian*

reject 'half a cycle'

treat 'π radians in phase' as talk out

1

(b) (idea that) sets of combining waves do not have the same amplitude ✓

condone 'waves do not have same intensity' or 'same energy' or 'some energy is absorbed on reflection' or 'same power' or 'same strength' or idea that non point source or non point receiver would lead to imperfect cancellation

condone the idea that the waves may not be monochromatic

ignore 'some waves travel further' or 'waves do not perfectly cancel out'

reject 'waves may not be 180° out of phase'

1

(c) valid use of a set square or protractor against TR (to ensure perpendicular) $_1$ ✓

measure x at two <u>different</u> points [at each end of M] **<u>and</u>** adjust until [make sure] both <u>distances are the same</u> $_2$ ✓

OR

use of set square to align M with the perpendicular line earns $_2$ ✓

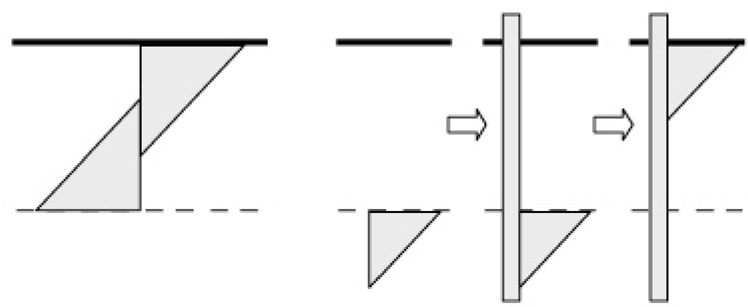
if method used does not allow <u>continuous</u> variation in x then award maximum 1 mark

OR

align <u>graph paper</u> with TR $_1$ ✓

align M with grid lines on graph paper $_2$ ✓

both marks can be earned for suitable sketch showing a viable procedure involving one or more recognisable set squares or protractors; the sketch may also show a recognisable ruler, eg



allow use of scale on set square to measure the perpendicular distances don't penalise incorrect reference to the set square, eg as 'triangular ruler', as long as the sketch shows a recognisable set square

2