

1. State **two** conditions necessary for total internal reflection to occur at an interface between air and water.

Condition 1

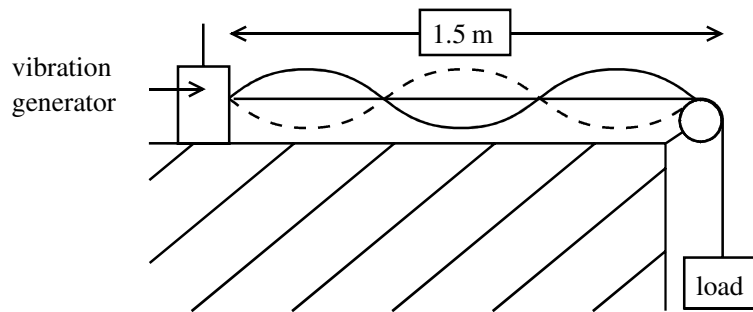
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Condition 2

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(Total 2 marks)

2. The following apparatus is set up. When the frequency of the vibrator is 60 Hz, the standing wave shown in the diagram is produced.



- (a) What is the wavelength of this standing wave?

Wavelength =

(1)

- (b) The frequency of the vibrator is altered until the standing wave has two more nodes. Calculate the new frequency.

Frequency =

(2)

(Total 3 marks)

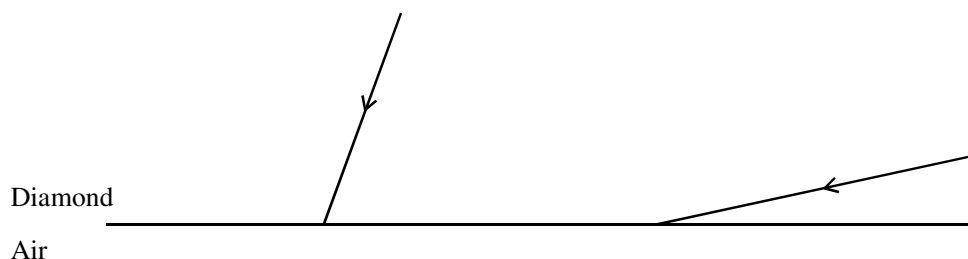
3. Diamonds are one of the most beautiful but expensive jewels available today. Their beauty is due largely to the way in which they sparkle when light falls on them. The way a jewel sparkles is related to how light is reflected inside the jewel which depends upon its refractive index.

(a) (i) Diamond has a refractive index of 2.42. Show that the critical angle C for light passing from diamond into air is about 24° .

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(2)

(ii) Add appropriate normals to the following diagram at the diamond-air interface and then sketch the paths that the two light rays would follow. One of them hits the interface at an angle smaller than C , and the other at an angle greater than C .



(2)

(iii) On the above diagram label

1. an incident angle i ,
2. an angle of refraction r .

(2)

- (iv) Explain how the amount of light reflected inside the jewel depends on the refractive index, using the terms **critical angle** and **total internal reflection**.

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(3)

- (b) There have been many attempts to make imitation diamonds but they have always lacked the sparkle of the real thing. Recently, however, a semiconductor company has manufactured a mineral called moissanite. This has similar properties to diamond, but is much cheaper.

The refractive index of moissanite is about 2.67. Comment on the critical angle and hence the sparkle of this mineral compared with diamond.

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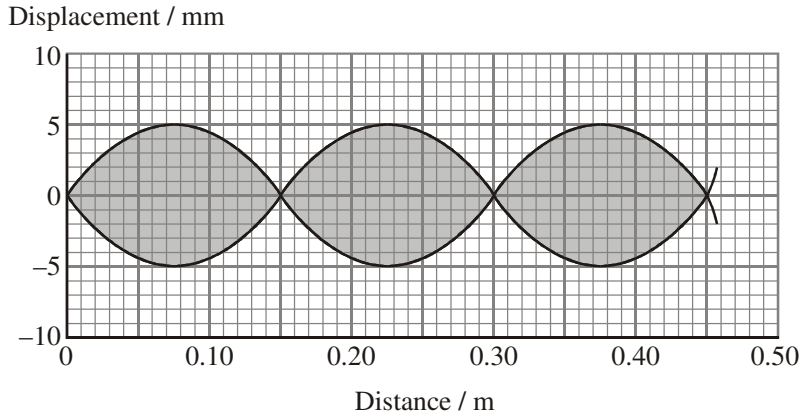
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(1)

(Total 10 marks)

4. A stationary wave is produced on a stretched string by a vibration generator attached to one end. The graph shows part of the wave. The two full lines represent the extreme positions of the string.



State the wavelength of this wave.

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(1)

Mark a letter A on the graph to label an antinode.

(1)

The stationary wave is formed by the superposition of two waves travelling along the string in opposite directions. The frequency of the vibrator is 36.0 Hz. Calculate the speed of the travelling waves.

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Wave speed =

(2)

State the phase relationship between the two travelling waves at an antinode.

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(1)

Determine the amplitude of each of the travelling waves.

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Amplitude =

(1)

(Total 6 marks)

5. The diagrams below illustrate the formation of a rainbow. Figure 1 shows the general arrangement and Figure 2 shows the path of a ray through a raindrop.

Figure 1

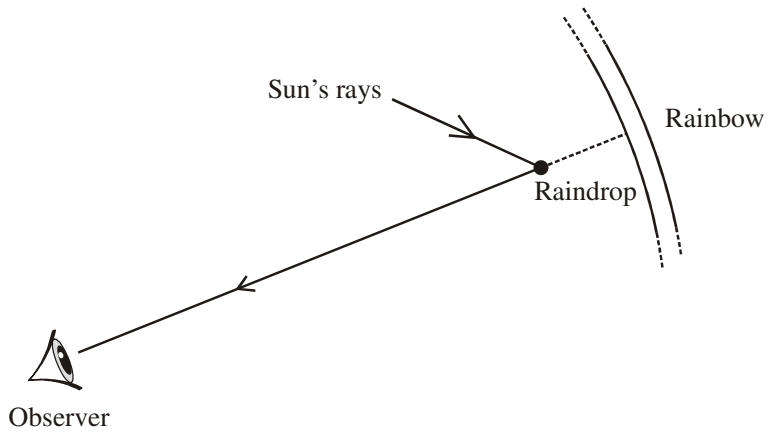
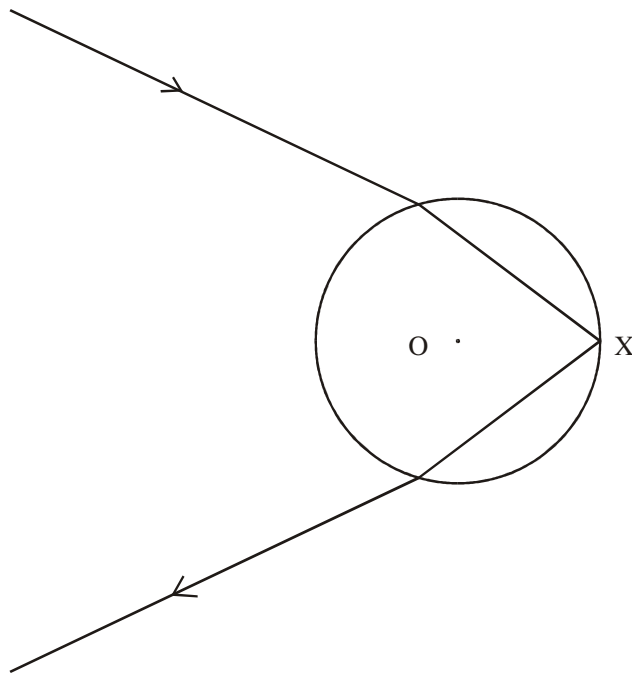


Figure 2



Where the ray enters the raindrop in Figure 2, mark the angle of incidence i and the angle of refraction, r . The centre of the raindrop is labelled O.

(2)

Figure 2 is drawn to scale. By taking suitable measurements, show that the refractive index of water is about 1.3.

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(2)

Calculate the critical angle for water.

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Critical angle =

(2)

Using another measurement from Figure 2, explain whether the reflection of the ray at X is partial or total.

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(3)

A rainbow consists of a spectrum of colours. What does this suggest about the refractive index of water?

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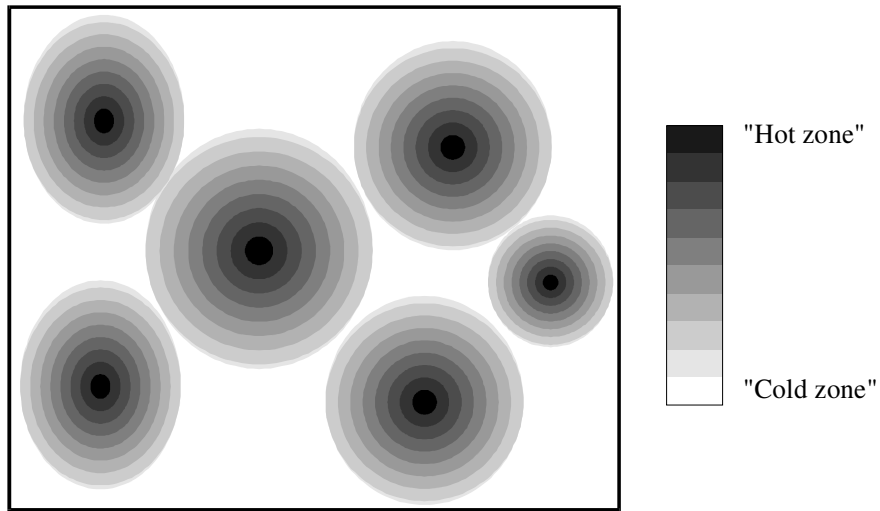
(1)

(Total 10 marks)

6. Babies' food sometimes carries the following warning: "Do not warm feeds in a microwave oven as this may cause uneven heating and could scald your baby's mouth".

An Internet site gives the following explanation:

Coherent microwaves are emitted in all directions from a source within the oven. The waves reflect off the metal walls so that the microwave radiation reaching any particular point arrives from several different directions. The waves interfere and set up *standing* waves. This produces the pattern of hot and cold zones observed in food heated in a microwave oven.



Explain the meanings of the following words from the passage.

Coherent

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(1)

Standing wave

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(2)

On the diagram above, mark a possible position of *one* antinode, and label it **A**.

(1)

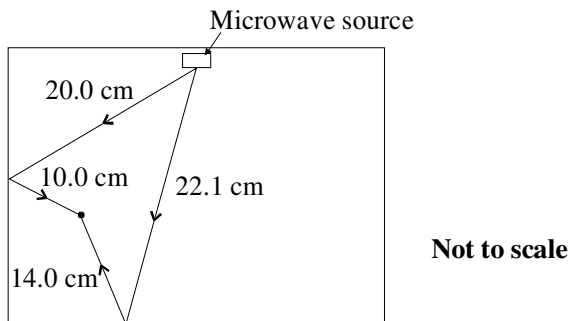
The frequency of the radiation used in a microwave oven is 2.45×10^9 Hz.

Show that the wavelength of the microwave radiation is about 12 cm.

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(1)

The diagram shows two different paths by which microwaves can reach the point X.



Find the path difference for waves reaching point X by the paths shown.

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Path difference =

(1)

Assuming waves do not reach point X along any other path, explain whether you would expect this point to be a microwave node or antinode.

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(3)

Some microwave ovens use two separate microwave frequencies to overcome the problem of uneven heating. Explain how this helps.

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(2)
(Total 11 marks)

7. Describe with the aid of a diagram how you could produce stationary waves on a string.

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(3)

Explain how you could use a stationary wave to determine the speed of travelling waves on the string. You may be awarded a mark for the clarity of your answer.

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(4)
(Total 7 marks)