Waves Questions

1. When you look at the water on a sunny day you often see just the bright surface because of the glare of reflected light. Wearing Polaroid sunglasses can remove this glare and allow you to see the fish swimming beneath the water.

State the difference between polarised and non-polarised light.

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(1)

What do you see if you look at a light source through parallel polaroid filters which are placed so that their planes of polarisation are at 90° to each other (crossed polaroids)?

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(1)

The sunlight is partially polarised on being reflected from the water surface. How can the Polaroid sunglasses remove the glare, allowing the fish to be seen?

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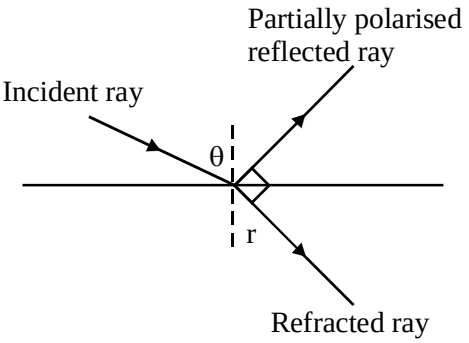
(1)

As the angle of incidence changes, the proportion of the light which is polarised also changes. There is one particular angle, θ, at which the polarisation of the reflected ray is complete. It is also found that at this angle the reflected ray and the refracted ray are at right angles.

($_a\mu_w$, refractive index from air to water = 1.33.)



Explain why the angle of refraction $r = 90 - \theta$.

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Show that θ is about 53°.

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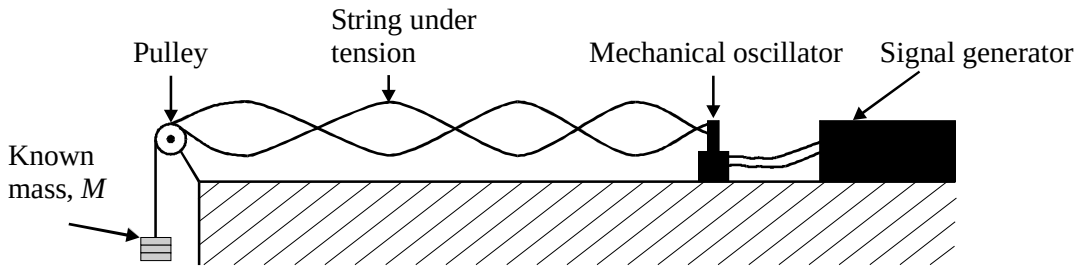
(3)
(Total 6 marks)

3. A student performs an experiment to investigate how the speed v of the waves on a stretched string is affected by the tension T. The tension T is equal to the weight of the mass hanging over a pulley as shown in the diagram.



For a particular mass, the student adjusts the frequency f of the signal generator until a standing wave is established. The frequency f and the wavelength λ are recorded. The procedure is repeated for a range of masses.

The student finds from an A level textbook that v is given by the expression

$$v = \sqrt{\frac{T}{\mu}}$$

Where μ is the mass per unit length of the string.

The student decides to see if the data supports this expression. She starts to process her data and plot it on to a graph.

Use the information in the table to add two more points to the graph. Record the results of your calculations in the table.

M/kg	f/Hz	λ/m			
0.16	30.6	0.37			
0.20	30.0	0.41			

(3)

Draw the line of best fit through the points on the graph.

(1)

Do the student's results support the relationship given above? Justify your answer.

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(2)

Use the graph to obtain a value for μ.

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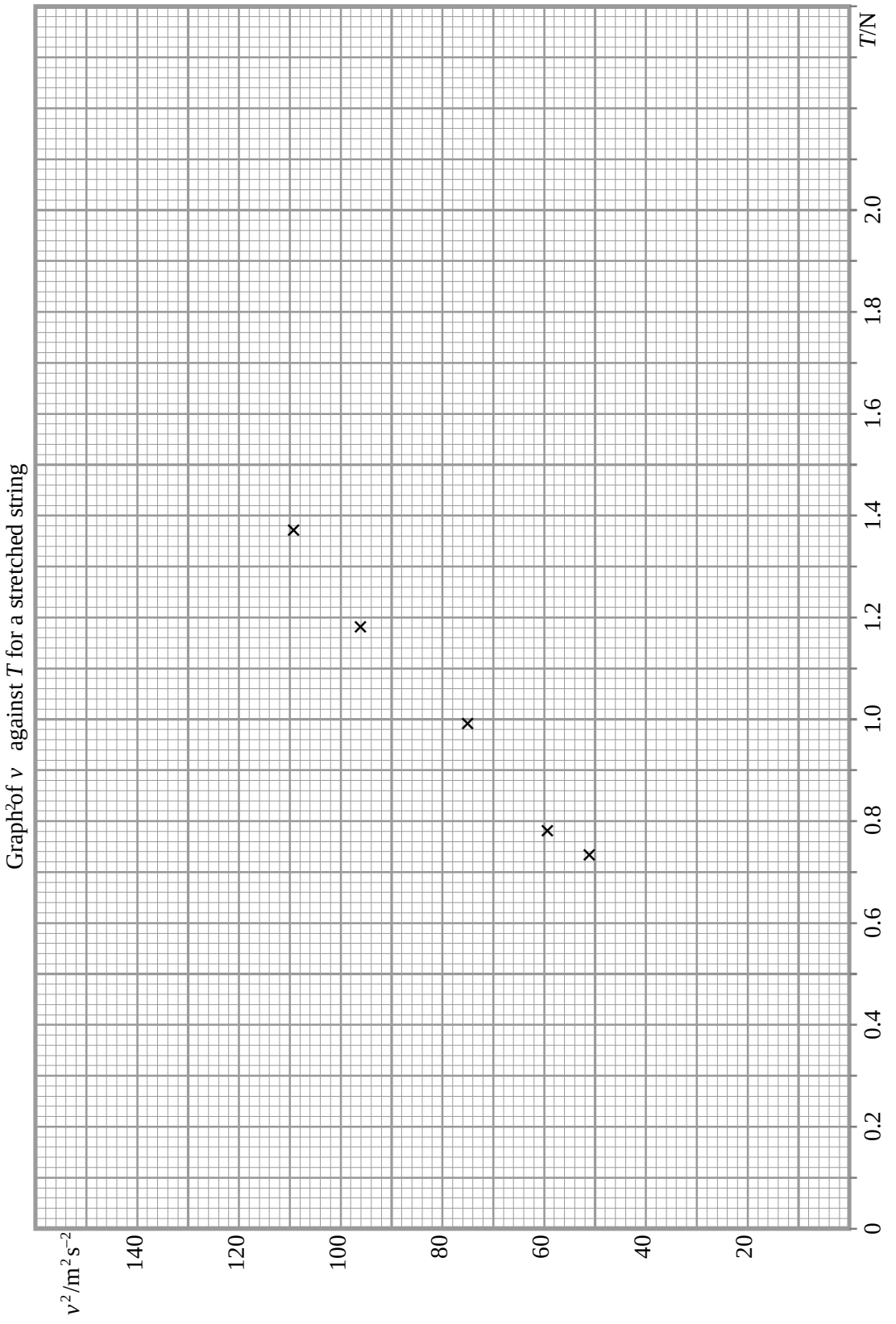
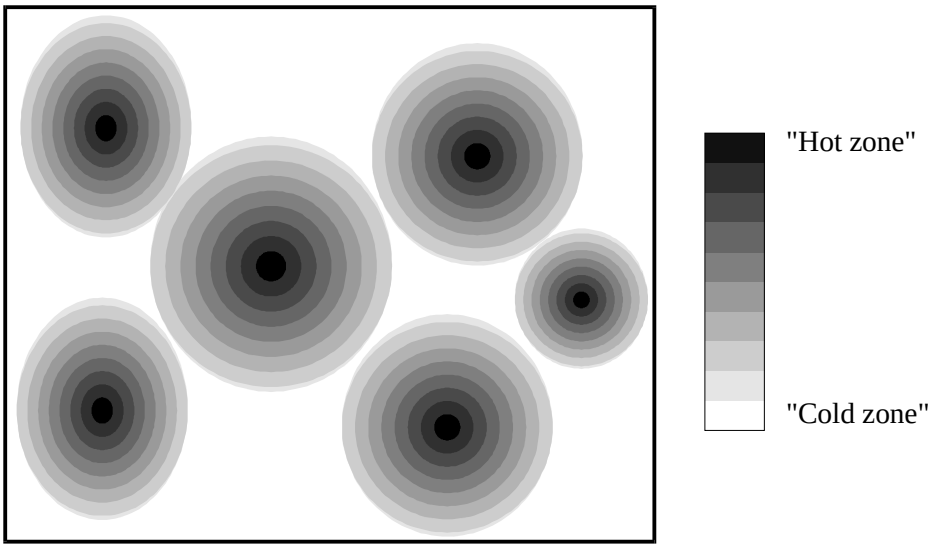


(3)
(Total 9 marks)

4. 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:

> C*oherent* 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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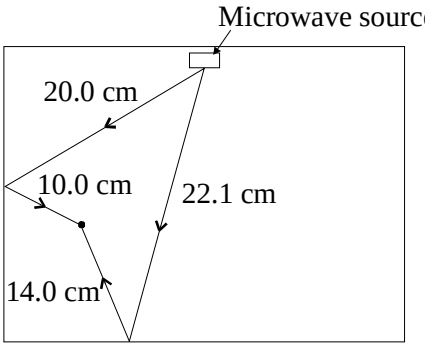
(1)

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



Not to scale

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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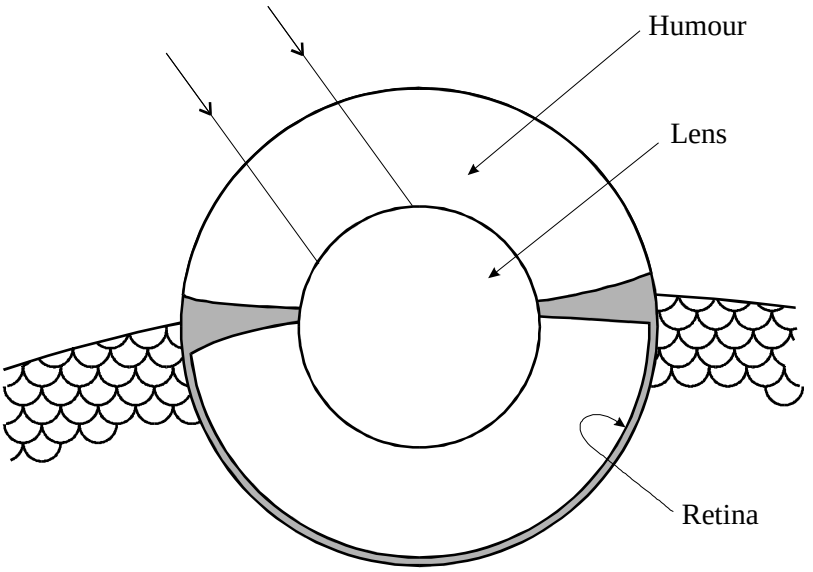
(2)

(Total 11 marks)

5. In the eye of a fish, a transparent crystalline sphere is supported at the centre of a ball of liquid, called humour. The crystalline sphere acts as a lens and forms sharp images on the retina.



Fish eye

The light rays pass without bending from water into the humour. State the value for the refractive index for light travelling from water into the humour, ${}_{w}\mu_{h}$.

${}_{w}\mu_{h}$ = ...

(1)

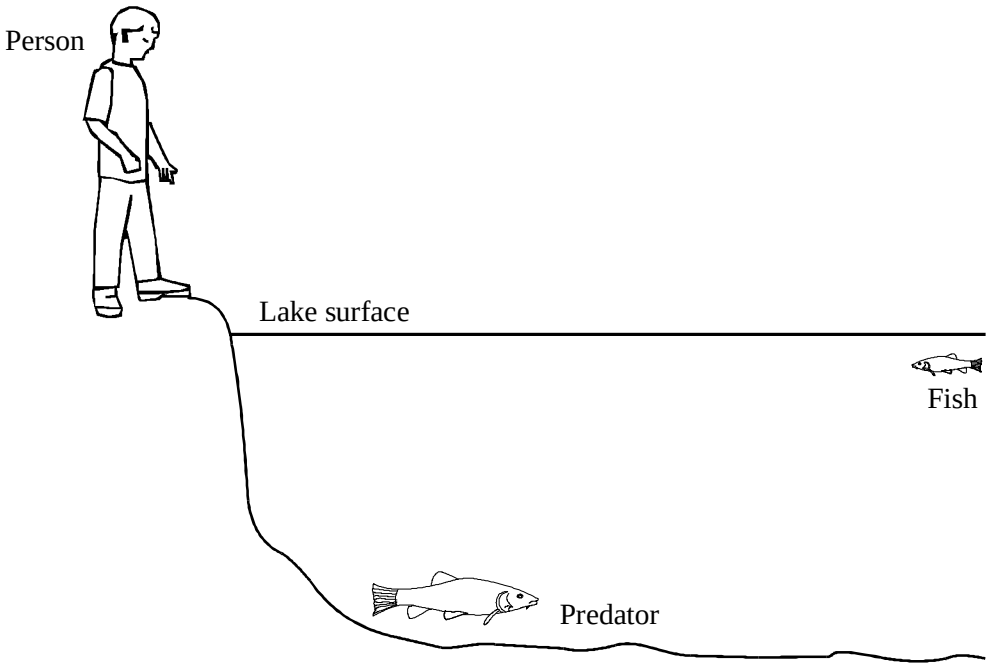
Extend the two rays shown in the diagram to show how they form a sharp image of a distant object on the retina.

(2)

The fish focuses on objects that are at different distances by moving the lens relative to the retina. The fish looks at a distant object then a close one. Use diagrams to explain how the lens must be moved to keep the image in focus.

(3)

Looking **upward** when the surface of the lake is smooth, the fish can see people on the bank and predators near the bottom of the lake.



On the diagram draw one ray of light reaching the fish

(i) from the person's head,

(ii) from the predator.

(3)

Calculate the critical angle for light passing from water to air. The refractive index for light travelling from air into water is 1.33.

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Critical angle = ...

(2)

(Total 11 marks)

6. An advertisement for an active noise cancellation headset for aircraft pilots contains the following information:

Requires 9 V battery
Active noise attenuation over 20 – 800 Hz
Rubberized foam earcups

Explain the physics principles in each statement of this advertisement. You could start by saying why a battery is required and go on to explain how the noise is attenuated.

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(6)

A student asks the following question: “If sound is being introduced to cancel out the noise, then where does the energy go?”

What is the explanation?

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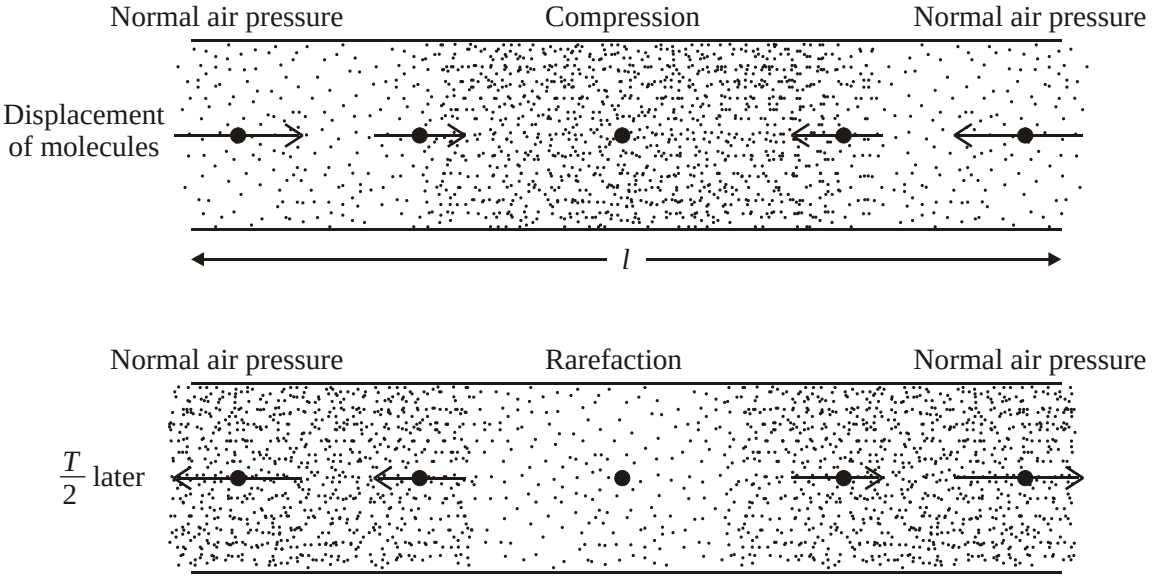
(2)
(Total 8 marks)

7. A recorder, a common musical instrument, can be modelled as a tube of air open at both ends. The air at both ends therefore remains at normal air pressure. The diagrams below show how the air molecules in the recorder are displaced at two different moments during one cycle of the fundamental note. The two moments are separated by $T/2$, where T is the time period.



Explain whether the ends of the recorder have nodes or antinodes for pressure.

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(2)

Write down a relationship between the length l of the recorder and the wavelength λ of the fundamental note it produces.

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(1)

The length *l* of the recorder is 0.28 m. Calculate the fundamental frequency of the note it produces. Speed of sound in air = 330 m s^{-1}.

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Frequency = ...

(3)

Calculate the period *T* of the fundamental note.

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Period = ...

(2)

State one other frequency which might be present in the note produced by this recorder. Explain your choice in terms of nodes and antinodes for pressure along the recorder.

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(3)

(Total 11 marks)