AQA A-LEVEL PHYSICS · 7408

PHYSICS



EXAM QUESTION PACK

3.10.1 PHYSICS OF THE EYE AND 3.10.2 PHYSICS OF THE EAR

SCORE	PERCENTAGE
/77	%

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Q1.

(a) The fovea in a typical human eye consists of cones which have an average diameter of 1.5×10^{-6} m

An eye looks directly at two point sources of light which are 12 mm apart at a distance of 61 m from the centre of the eye lens. The fovea is at the centre of the retina a distance of 21 mm behind the centre of the eye lens.

Deduce whether the eye would be able to resolve the two images formed at the fovea.

_____

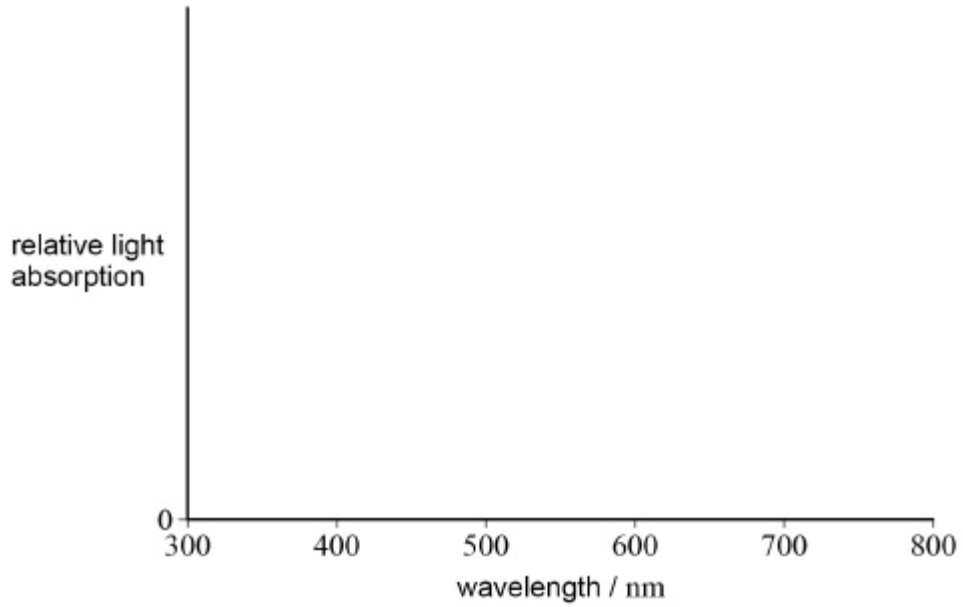
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_____

(4)

(b) Three types of cone are present at the fovea.

On the axis below sketch and clearly label **three** curves to show how the relative light absorption of each type of cone varies with wavelength.



(3)

(Total 7 marks)

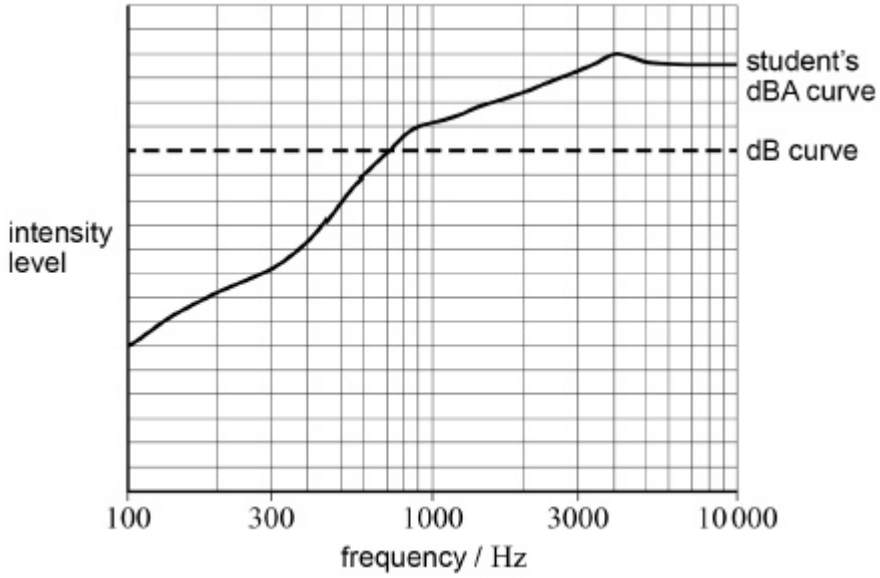
Q2.

(a) A source of constant output power is used to generate a sound which is measured using a sound meter.

The dashed line in the graph shows the intensity level curve over a range of

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frequencies with the meter set to the dB setting.



A student sketches a curve, over the same frequency range, which he thinks would be obtained when the meter is changed to the dBA setting. The curve drawn by the student is shown as the solid line in the graph.

Discuss whether the dBA curve drawn is correct.

(4)

(b) Mesh barriers are set up to keep pedestrians at a safe distance from a noisy drill. The maximum noise level which pedestrians should be subjected to is 110 dB
The drill emits sound with a power of 7.8 W and acts as a point source.
The mesh barriers are set up a distance of 2.0 m from the drill.

Discuss whether this will keep pedestrians at a safe distance from the sound source.

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(4)

(Total 8 marks)

Q3.

A person suffers from hypermetropia (long sight).
Use of a spectacle lens of power +2.0D allows the person to just see clearly an object placed 24 cm away from the eye.

(a) Explain why the unaided defective eye cannot form a clearly focused image of the object placed 24 cm from the eye.

(2)

(b) An object is placed 24 cm from the spectacle lens.

Calculate the distance of the image formed from the spectacle lens.
Give your answer to a suitable number of significant figures.

image distance = _____ cm

(3)

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(c) What is the name for the position where the image is formed by the spectacle lens?

Tick (✓) the correct box.

The eye's aided far point	☐
The eye's aided near point	☐
The eye's unaided far point	☐
The eye's unaided near point	☐

(1)

(d) Draw a ray diagram to show how this spectacle lens forms an image of the object placed 24 cm from the spectacle lens.
On your diagram clearly label the object, image and a principal focus of the lens.
Your diagram does not have to be drawn to scale.

(3)
(Total 9 marks)

Q4.

(a) A converging (convex) lens is placed 0.25 m from an object. The focused image produced is virtual and formed 0.64 m from the lens.

Calculate the power of the lens. Give a suitable unit for your answer.

power = _____ unit = _____

(3)

(b) Calculate the magnification produced.

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magnification _____

(1)

(c) State the defect of vision that this lens can correct.

_____

_____

(1)

(d) A defective eye is found to suffer from astigmatism.

Discuss the cause, effect and correction of astigmatism.

_____

_____

_____

_____

_____

_____

(3)

(e) Give **two** values needed for the manufacture of a lens suitable for the correction of astigmatism.

1. _____

_____

2. _____

_____

(2)

(Total 10 marks)

Q5.

(a) Define the threshold of hearing.

_____

_____

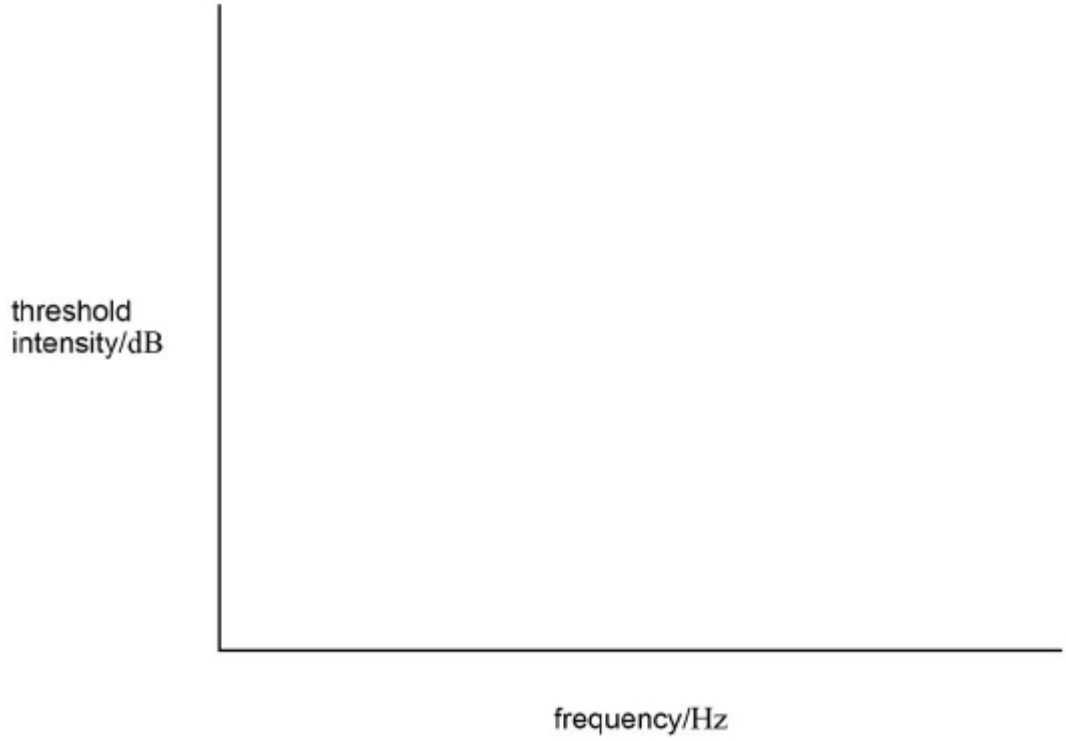
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(2)

(b) Sketch a graph to show how the threshold intensity, measured in dB, varies with frequency for a young person with normal hearing. Include scales on both axes.

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(4)

(c) A sound of intensity 46 mW m^{-2} is incident on a soundmeter set to the dB scale. Calculate the reading on the meter.

reading = _____ dB

(2)

(Total 8 marks)

Q8.

(a) Two bright point sources of light are just resolved as individual images when viewed by a naked eye.

(i) State the condition needed for the images to be resolved by the retina.

_____

_____

(1)

(ii) The images are formed on the retina at the fovea.
Explain which type of receptor in the retina is being used to detect the images.

_____

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_____

_____

(1)

(iii) The sources subtend an angle of 0.13 mrad at the naked eye. The eyeball may be assumed to be spherical with a diameter of 52 mm.
Calculate the maximum diameter of the receptor used.

diameter of receptor = _____ m

(2)

(b) (i) Describe the changes which occur in a normal eye when the eye changes from viewing a near object to viewing a distant object, both objects being viewed in bright light.

_____

_____

_____

_____

(2)

(ii) Describe the changes which occur in a normal eye as the eye changes from viewing an object in bright light to viewing the same object in very dim light.

_____

_____

_____

_____

_____

_____

_____

_____

_____

(3)

(Total 9 marks)

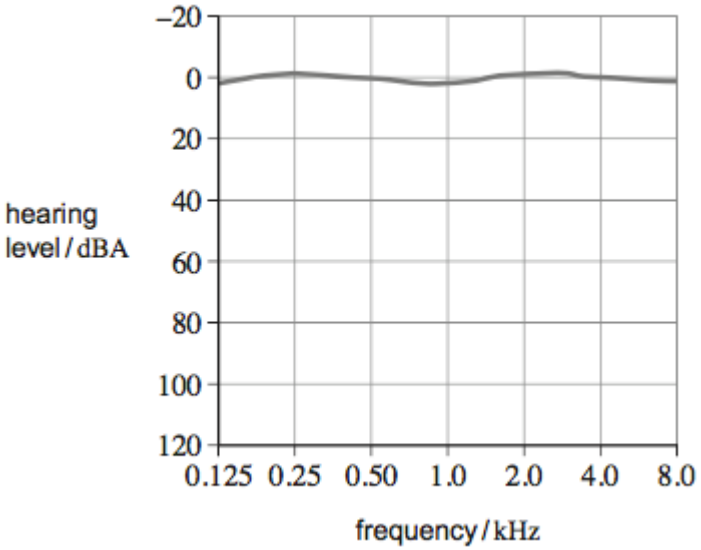
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Q9.

Three people were given routine hearing tests. One person was found to have normal hearing and the other two were found to have defective hearing.

(a) **Figure 1** shows the variation of hearing level with frequency for the person found to have normal hearing.

Figure 1



It is known that the ear of a person with normal hearing is much more sensitive at 3 kHz than at other frequencies.
Explain why the graph indicates little variation with frequency.

_____

_____

_____

_____

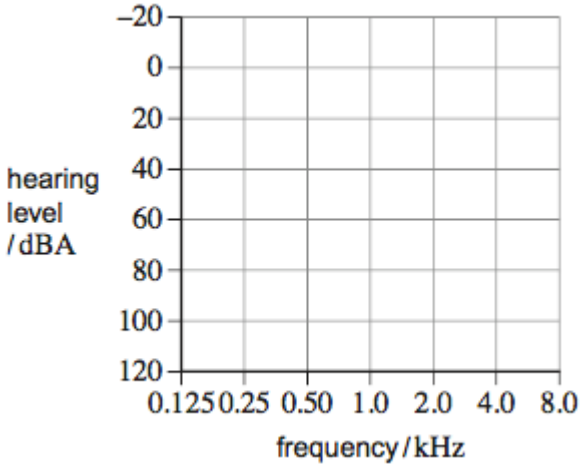
(2)

(b) Of the other two people, one was found to be suffering from age-related hearing loss and the other was found to be suffering from noise-related hearing loss.

(i) Sketch on **Figure 2** the curve you would expect to see for the person suffering from age-related hearing loss.

Figure 2

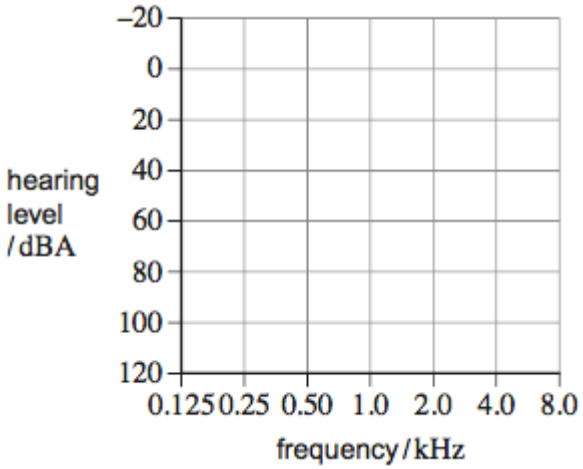
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(1)

(ii) Sketch on **Figure 3** the curve you would expect to see for the person suffering from noise-related hearing loss.

Figure 3



(2)

(c) A foghorn at the top of a cliff produces a sound. A sound meter on the deck of a ship 400 m away from the cliff gives a reading of 92 dB.

(i) Calculate the intensity of the sound incident on the sound meter.

$I_0 = 1.0 \times 10^{-12}$ W m^{-2}

intensity = _____ W m^{-2}

(2)

(ii) The sound from the foghorn is emitted equally in all directions. Assume that the sound is not reflected at the surface of the sea and that there is no attenuation of the sound.

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Estimate the power emitted by the foghorn

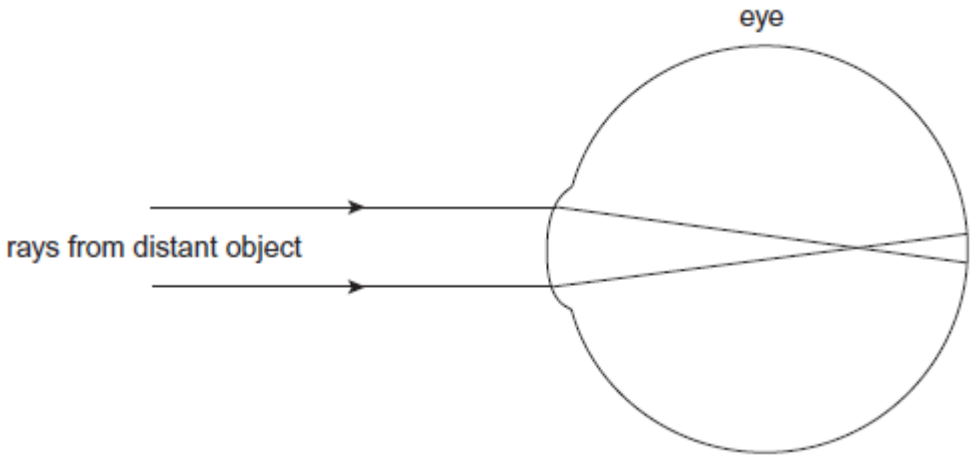
power = _____ W

(2)

(Total 9 marks)

Q10.

(a) The diagram below is a simplified ray diagram which shows light rays from a distant object being focused at a point in front of the retina.



(i) What is this defect of vision?
Tick (✓) the correct answer.

astigmatism	
hypermetropia / long sight	
myopia / short sight	

(1)

(ii) On the diagram above, draw in front of the eye a suitable lens to correct this type of defect of vision.

(1)

(iii) Complete the new diagram by drawing the path of the two rays from the distant object as they pass through the correcting lens and the eye.

(2)

(b) The unaided far point of the defective eye is 0.75 m.

(i) Explain why the focal length of the correcting lens used should be −0.75 m.

_____

_____

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_____

_____

(1)

(ii) Calculate the power of this correcting lens.

power = _____ D

(1)

(iii) The unaided near point of the defective eye is 0.15 m.

Calculate the distance of the aided near point from the eye when the lens of focal length −0.75 m is used. Give your answer to a suitable number of significant figures.

aided near point distance = _____ m

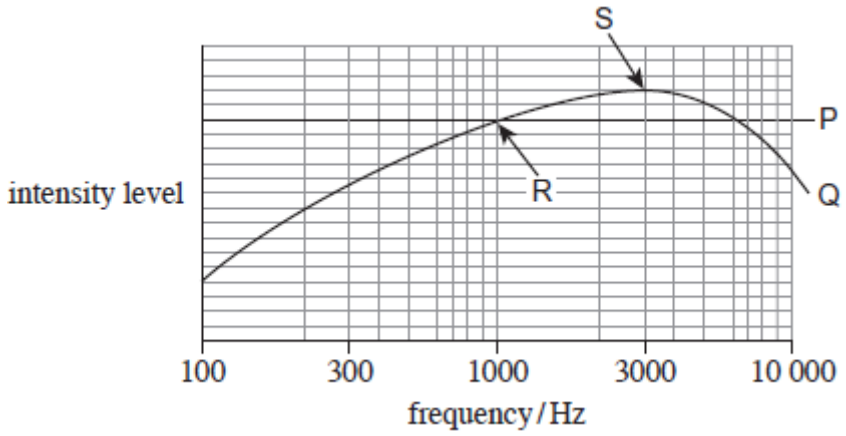
(3)

(Total 9 marks)

Q11.

(a) A variable-frequency sound source produces sound of equal intensity at all frequencies. Two sound meters are placed at equal distances from the source. The two meters are set on different scales. Lines P and Q on the graph show how the intensity level indicated by each meter varies with frequency.

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(i) State and explain which sound meter scale is used for line P.

(2)

(ii) State and explain which sound meter scale is used for line Q.

(2)

(b) (i) Explain the significance of the point R.

(1)

(ii) Explain the significance of the point S.

(1)

(c) A sound of intensity level 95 dB is incident on a human ear.
Calculate the intensity incident on the ear drum.

$I_0 = 1.0 \times 10^{-12}$ W m^{-2}

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intensity = _____ W m^{-2}

(2)

(Total 8 marks)

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