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QUESTION WORKBOOK

The physics of the ear

Medical physics · Year 13

AQA 3.10.2.1, 3.10.2.2, 3.10.2.3

17 questions · 51 marks

NAVY SCREEN EDITION

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SECTION A · Warm-up

A1 State what is meant by the intensity of a sound wave, give the equation defining it, and state its unit. [2]

A2 State what is meant by the threshold of hearing, and give its value. [2]

A3 Describe the path taken by a sound from the air outside the ear to the nerve impulses that leave it, naming the outer, middle and inner sections. [2]

A4 State what an equal loudness curve shows, and state what quantity is plotted on each axis. [2]

A5 Calculate the intensity level of a sound of intensity 1.0×10^{-6} W m^{-2}. [2]

A6 State the approximate range of frequencies that a healthy young person can hear. [1]

SECTION B · Standard

B1 A sound has an intensity of 3.0×10^{-5} W m^{-2}. Calculate its intensity level. [3]

B2 A sound is measured at 85 dB. Calculate its intensity. [3]

B3 A tone of intensity level 66 dB falls on an eardrum of cross-sectional area 55 mm^2. Calculate the power incident on the eardrum. [3]

B4 Explain how the middle ear increases the pressure of the vibration reaching the inner ear, and state why this increase is necessary. [3]

B5 Sound A has an intensity of 4.0×10^{-6} W m^{-2} and sound B an intensity of 8.0×10^{-5} W m^{-2}. Calculate how many decibels louder B is than A. [3]

B6 Explain why sound is measured on a logarithmic scale rather than a linear one. [3]

B7 Describe how an equal loudness curve is produced. [3]

SECTION C · Stretch

C1 On an equal loudness curve, a tone of frequency 100 Hz has to be at an intensity level of 60 dB to sound as loud as a 1 kHz tone at 30 dB. Calculate the ratio of the intensity of the 100 Hz tone to that of the 1 kHz tone, and explain what this shows about the ear. State where on such a curve the ear is most sensitive. [5]

C2 A machine in a workshop produces an intensity level of 92 dB at a bench. A second, identical machine is switched on beside it. Calculate the new intensity level at the bench, and determine how many such machines would be needed to raise the level to 102 dB. [5]

C3 A worker is exposed to a noise of 96 dBA. Ear defenders reduce the intensity reaching the ear by a factor of 250. Calculate the intensity level inside the defenders, and explain why a workplace noise limit is written in dBA rather than in dB. [5]

C4 Compare the equal loudness curves of a person with normal hearing with those of a person who has spent years working in a noisy factory, and explain the practical difficulty the second person is likely to report. [4]