



DEPARTMENT OF MEDICAL PHYSICS AND CLINICAL ENGINEERING

Autumn 2006-2007

PHYSICS OF LIVING SYSTEMS 1

2 HOURS

The paper is divided into two sections: A and B.

The student should answer all questions in section A. One sentence answers are sufficient for all questions in this section.

The student should answer two questions from section B.

TURN OVER

SECTION A

(Answer all questions in this section: 2 marks each)

1. What is the function of myelination?
2. Approximately how much charge is required for nerve stimulation
 - (a) inside an axon;
 - (b) on the surface of a nerve trunk?
3. What stimulus does a chemoreceptor respond to?
4. What stimulus does a photoreceptor respond to?
5. Which of the senses are referred to as the 'chemical senses'?
6. What is the primary taste sensation that is stimulated by
 - (a) coffee;
 - (b) beef steak?
7. What is an adiabatic process?
8. What does the bulk modulus of a substance describe?
9. Name two factors that affect reaction time.
10. What is the approximate resonant frequency of the ear canal?
11. Write down the equation that describes average sound intensity.
12. What is the function of the outer ear?
13. What is the approximate audible frequency range for humans?
14. Approximately what is the pressure fluctuation amplitude of a whisper?
15. Write an equation to describe the energy of a photon of light, frequency ν .
16. What is the approximate visible frequency range for humans?
17. State Snell's law.
18. What is Myopia? How is it corrected?
19. What is a Snellen chart used to assess?
20. Approximately how many rods are found within the human eye?

CONTINUED

SECTION B

(Answer two questions from this section: 30 marks each)

B1.

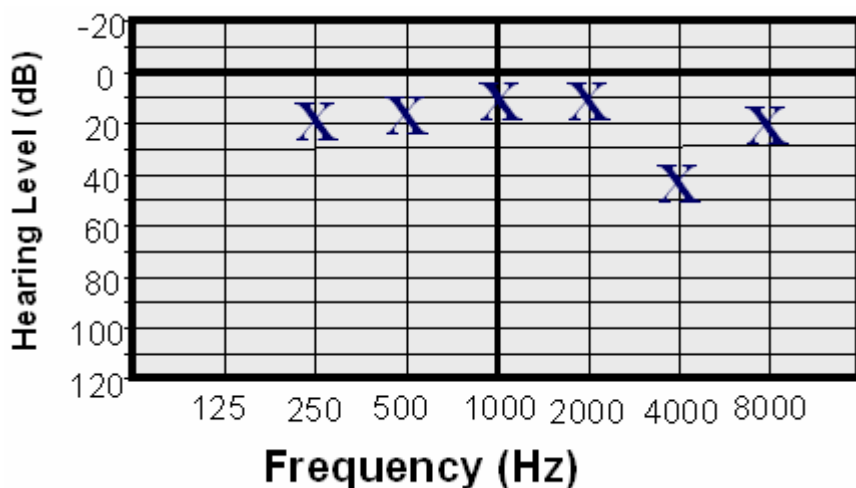
What type of wave is a sound wave? [3]

A pure tone sound has an intensity level of 60dB.
What is its average intensity? [3]

What does a pure tone audiometry test assess? [2]

Sketch a typical audiogram for normal hearing. [4]

Look at the audiogram below. What is the likely diagnosis? [4]



Sketch a typical audiogram for a person with a middle ear deficiency, showing both air conduction and bone conduction. [5]

What effect does masking have on air conduction, and bone conduction tests? When is it used?
What does this tell us about the way sound is transmitted in bone, compared to air? [9]

TURN OVER

B2.

Give an approximate time for an alert person, holding a switch in their hand, to push that switch in reaction to a sound stimulus. [2]

Give an approximate time for an alert person, holding a switch in their hand, to push that switch in reaction to a visual stimulus. [2]

Which reaction time is quicker? Discuss possible reasons. [4]

If the characteristic impedance (Z) of air at room temperature is $440 \text{ kg/m}^2\text{s}$, and the density (ρ) is 1.29 kg/m^3 , what is the speed of sound at room temperature? [2]

A scientist attempts to measure the speed of sound in a laboratory. He has a device that generates a tone, whilst simultaneously starting a timing device. The scientist has a push button control connected to the timer by a wire to stop the timer once he hears the tone.

Initially the scientist stands 5 m from the tone generator. How long will it take the tone to reach the scientist's ear? [4]

Is this a good experiment? Why? How far would the scientist have to stand from the tone generator for his reaction time to be less than 1% of the total measured time? [5]

The scientist doesn't have a long enough wire to conduct this second experiment, but he knows the speed of light. Describe a method for the scientist to conduct the second experiment using a light and discuss experimental errors. [5]

The scientist conducts his experiment on two different days. The first day is very warm and the second day is very cold. He gets different results on each day. What is the relationship between the speed of sound in air, and the temperature of the air? On which day will he get the highest value for the speed of sound? [6]

B3.

(a) Sketch the eye, and label the following parts:

pupil, cornea, iris, retina, lens, ciliary muscle, fovea, optic disk, optic nerve, sclera, choroid. [10]

(b) A man is known to have normal vision. When he is completely immersed in water and attempts to read a book (without goggles) he finds that he is unable to bring the text into focus. Why is this? [2]

Is he effectively myopic or hyperopic under these conditions? Give reasons for your answer. [4]

(c) Another man requires glasses with a strength of 2 dioptres for both eyes: what is the mismatch in focal length of the uncorrected eye? Using the lens-maker's equation and assuming the lens material to have a refractive index of 1.50, suggest suitable radii of curvature for corrective lenses. [6]

(d) What is Glaucoma? Briefly describe the principle of non-invasive measurement using an applanation tonometer. [8]

END OF QUESTION PAPER