A-level PHYSICS (7408/3BB)

Paper 3 – Section B (Medical Physics)

Specimen 2014 Morning Time allowed: 2 hours

Materials
For this paper you must have:
• a pencil
• a ruler
• a calculator
• a data and formulae booklet
• a question paper / answer book for Section A.

Instructions
• Answer all questions.
• Show all your working.
• The total time for both sections of this paper is 2 hours.

Information
• The maximum mark for this section is 35.

Please write clearly, in block capitals, to allow character computer recognition.

Centre number  
Candidate number  
Surname  
Forename(s)  
Candidate signature  

Section B

Answer all questions in this section.

01. State what is meant by the principal focus and the power of a converging lens. [2 marks]

01. Complete the ray diagram below to show the formation of an image of a real object O by a diverging lens. Label the image clearly. [2 marks]

01. State the defect of vision that would be corrected using a diverging lens. [1 mark]
A diverging lens of focal length $-0.33 \, \text{m}$ is used to view a real object placed $0.25 \, \text{m}$ from the lens.

Calculate the distance from the lens to the image. 

\[ \text{distance from lens to image} = \underline{\underline{\text{m}}} \] 

Two point sources of light are viewed by a normal eye and their images are formed at the fovea.

State, in terms of the active receptors, the conditions necessary for two separate images to be seen. 

\[ \underline{\underline{\text{m}}} \]
02.1 Sound waves are incident on a human ear.

Describe how the frequency and amplitude of the vibrations change as the wave is transmitted through the ear to the fluid in the inner ear. [2 marks]

02.2 Explain how the components of the ear act to amplify the pressure changes due to the sound wave. [3 marks]

02.3 A sound intensity meter, set to the dB scale, is placed near to a source of sound. The intensity level reading on the sound meter is 82 dB.

Calculate in, $W \text{ m}^{-2}$, the intensity of the sound at the meter. [3 marks]

intensity = _______________ $W \text{ m}^{-2}$
The sound intensity meter is 2.0 m from the source which is emitting sound equally in all directions.

Calculate the power emitted by the source. [2 marks]

\[ \text{power} = \quad \text{W} \]

Turn over for the next question
Positron Emission Tomography (PET) and ultrasound scans are both used in medical diagnosis. Compare the quality of the information obtained from these scans in terms of:

- patient safety and convenience
- information available to the doctor from the images.

[6 marks]
Explain why the effective half-life of a radionuclide in a biological system is always less than the physical half-life.  

[2 marks]

The physical half-life of a radionuclide is 20 days. The nuclide was administered to a patient. Initially the corrected count rate at the patient's body was 2700 counts s\(^{-1}\). Five days later, the corrected count rate at the same place on the patient was 1200 counts s\(^{-1}\).

Calculate the biological half-life of the nuclide.  

[4 marks]

\[
\text{biological half-life} = \text{_________________________ days}
\]
Table 1 gives the properties of two radionuclides.

<table>
<thead>
<tr>
<th></th>
<th>Technetium 99 m</th>
<th>Iodine 131</th>
</tr>
</thead>
<tbody>
<tr>
<td>emitted radiation</td>
<td>gamma</td>
<td>beta and gamma</td>
</tr>
<tr>
<td>half-life / hours</td>
<td>6.0</td>
<td>190</td>
</tr>
<tr>
<td>energy of gamma ray / keV</td>
<td>140</td>
<td>610</td>
</tr>
</tbody>
</table>

By considering information in Table 1 suggest which of these nuclides is more suitable for use as a tracer in medical diagnosis.

[4 marks]