Rewarding Learning

Centre Number	
71	

Candidate Number

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2009

Physics

Assessment Unit AS 3A

assessing

Module 3A: Medical Physics

[ASY31]

ASY31

FRIDAY 19 JUNE, MORNING

TIME

45 minutes.

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.
Answer **all five** questions.
Write your answers in the spaces provided in this question paper.

INFORMATION FOR CANDIDATES

The total mark for this paper is 45.
Quality of written communication will be assessed in question **5**.
Figures in brackets printed down the right-hand side of pages indicate the marks awarded to each question or part question.
Your attention is drawn to the Data and Formula Sheet which is inside this question paper.
You may use an electronic calculator.

For Examiner's use only	
Question Number	**Marks**
1	
2	
3	
4	
5	
Total Marks	

If you need the values of physical constants to answer any questions in this paper, they may be found on the Data and Formulae Sheet.

Examiner Only	
Marks	Remark

Answer **all five** questions

1 **(a)** **(i)** State the principal components of the eye responsible for focusing.

_____

_____ [2]

(ii) Describe how the eye forms sharp images of objects at different distances from it.

_____

_____ [2]

(b) The eye has a mechanism to control the amount of light entering it. Name the component responsible and describe how this control of light intensity is achieved.

_____

_____

_____

_____

_____ [2]

(c) **(i)** State the range of wavelengths detectable by the eye for a person with normal sight.

Range of wavelengths = _____ nm to _____ nm [1]

(ii) Outline how the eye discriminates between light of different colours in the full detectable range of wavelengths.

_____

_____

_____

_____

_____

_____

_____

_____ [3]

Examiner Only	
Marks	Remark

Examiner Only	
Marks	Remark

2 **(a)** What is meant by the **far point** of the eye?

_____

_____ [1]

(b) **(i)** A person has a far point of 1.20 m and a near point of 0.15 m. What type of lens must be used for her to view clearly objects at infinity?

_____ [1]

(ii) Calculate the power of the corrective lens for this eye to allow objects at infinity to be viewed clearly.

Power of corrective lens = _____

Unit _____ [3]

(iii) This person has an uncorrected near point of 0.15 m. What would be her near point when using the corrective lens in **b(ii)**?

Near point distance = _____ m [3]

Examiner Only	
Marks	Remark

3 **(a)** **(i)** What is meant by the **threshold of hearing**?

_____

_____ [1]

(ii) Distinguish between the terms **sound intensity** and **sound intensity level**.

_____

_____

_____

_____

_____ [3]

(b) During examinations, the sound intensity level in the hall is 37.0 dB. As candidates leave at the end of the examination, the intensity level rises to 76.0 dB.
Calculate the numerical factor by which the sound intensity increases.

Factor = _____ [3]

Examiner Only	
Marks	Remark

4 **(a)** On the axes of **Fig 4.1**, sketch a graph showing how the intensity response of the human ear varies with frequency. Label the vertical axis of your graph with appropriate numerical values.

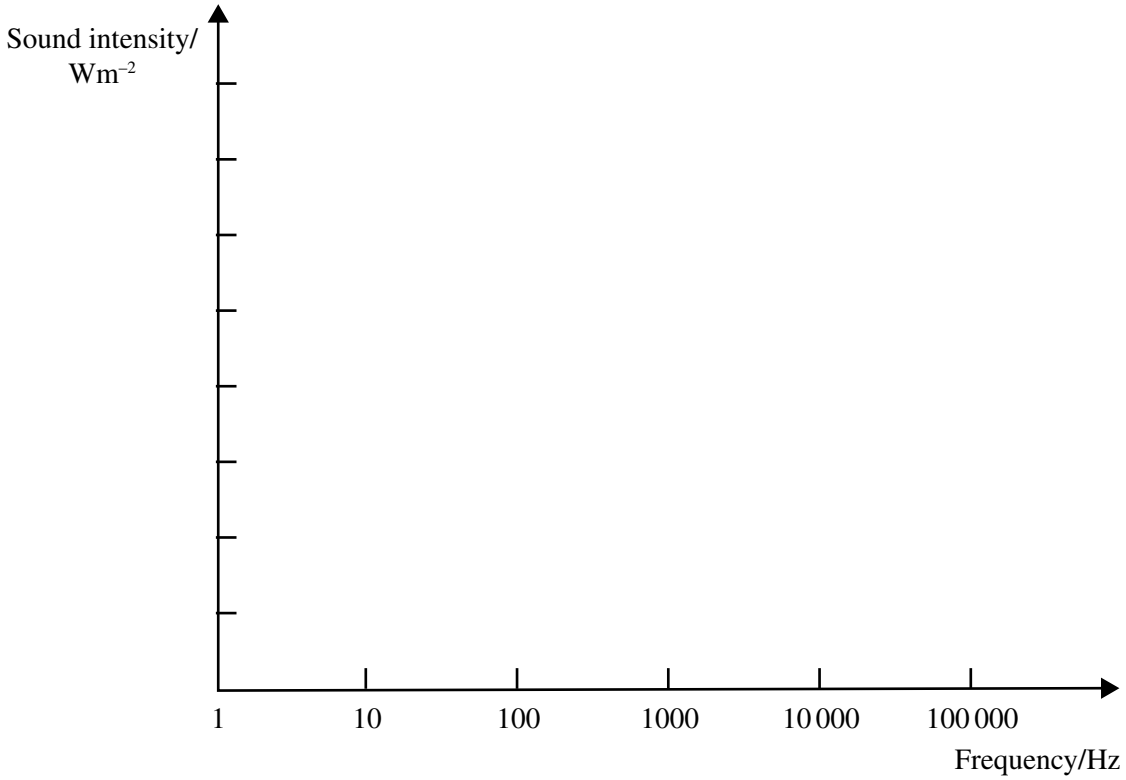

Fig 4.1

[3]

(b) **(i)** State **two** effects of excessive noise on humans.

_____

_____

_____ [2]

(ii) State the minimum value of sound intensity level that constitutes excessive noise for humans.

Sound intensity level = _____ dB [1]

(c) It is possible to buy additions to headphones that reduce background noise, for example traffic, so that the listener does not hear traffic noise with the music. Suggest one reason why these additions are **encouraged** by societies for the deaf and hard of hearing, and one reason why they might be **discouraged** by road safety bodies.

_____

_____

_____

_____ [2]

Examiner Only	
Marks	Remark

Where appropriate in this question, you should answer in continuous prose. You will be assessed on the quality of your written communication.

Examiner Only	
Marks	Remark

5 **(a)** A flexible endoscope contains two different bundles of optical fibres. One bundle is said to be **coherent** and the other bundle **non-coherent**.

(i) Explain the meaning of the term **non-coherent** in this context.

_____

_____ [1]

(ii) Explain the purpose of each type of bundle in the endoscope.

_____

_____

_____

_____ [2]

(b) Give an account of the general principles of magnetic resonance imaging (MRI). Your account should mention some of the problems associated with this technique, and the precautions taken when operating it.

Examiner Only	
Marks	Remark

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_____ [8]

Quality of written communication [1]

THIS IS THE END OF THE QUESTION PAPER

GCE Physics (Advanced Subsidiary and Advanced)

Data and Formulae Sheet

Values of constants

speed of light in a vacuum	$c = 3.00 \times 10^{8}\ \text{m s}^{-1}$
permeability of a vacuum	$\mu_0 = 4\pi \times 10^{-7}\ \text{H m}^{-1}$
permittivity of a vacuum	$\varepsilon_0 = 8.85 \times 10^{-12}\ \text{F m}^{-1}$ $\left(\frac{1}{4\pi\varepsilon_0} = 8.99 \times 10^{9}\ \text{F}^{-1}\ \text{m}\right)$
elementary charge	$e = 1.60 \times 10^{-19}\ \text{C}$
the Planck constant	$h = 6.63 \times 10^{-34}\ \text{J s}$
unified atomic mass unit	$1\ \text{u} = 1.66 \times 10^{-27}\ \text{kg}$
mass of electron	$m_e = 9.11 \times 10^{-31}\ \text{kg}$
mass of proton	$m_p = 1.67 \times 10^{-27}\ \text{kg}$
molar gas constant	$R = 8.31\ \text{J K}^{-1}\ \text{mol}^{-1}$
the Avogadro constant	$N_A = 6.02 \times 10^{23}\ \text{mol}^{-1}$
the Boltzmann constant	$k = 1.38 \times 10^{-23}\ \text{J K}^{-1}$
gravitational constant	$G = 6.67 \times 10^{-11}\ \text{N m}^2\ \text{kg}^{-2}$
acceleration of free fall on the Earth's surface	$g = 9.81\ \text{m s}^{-2}$
electron volt	$1\ \text{eV} = 1.60 \times 10^{-19}\ \text{J}$

USEFUL FORMULAE

The following equations may be useful in answering some of the questions in the examination:

Mechanics

Momentum-impulse relation	$mv - mu = Ft$ for a constant force
Power	$P = Fv$
Conservation of energy	$\frac{1}{2}mv^2 - \frac{1}{2}mu^2 = Fs$ for a constant force

Simple harmonic motion

Displacement	$x = x_0 \cos \omega t$ or $x = x_0 \sin \omega t$
Velocity	$v = \pm\omega\sqrt{x_0^2 - x^2}$
Simple pendulum	$T = 2\pi\sqrt{l/g}$
Loaded helical spring	$T = 2\pi\sqrt{m/k}$

Medical physics

Sound intensity level/dB	$= 10 \lg_{10}(I/I_0)$
Sound intensity difference/dB	$= 10 \lg_{10}(I_2/I_1)$
Resolving power	$\sin \theta = \lambda/D$

Waves

Two-slit interference	$\lambda = ay/d$
Diffraction grating	$d \sin \theta = n\lambda$

Light

Lens formula	$1/u + 1/v = 1/f$

Stress and Strain

Hooke's law	$F = kx$
Strain energy	$E = <F> x$ $(= \frac{1}{2}Fx = \frac{1}{2}kx^2$ if Hooke's law is obeyed)

Electricity

Potential divider	$V_{out} = R_1 V_{in}/(R_1 + R_2)$

Thermal physics

Average kinetic energy of a molecule	$\frac{1}{2}m<c^2> = \frac{3}{2}kT$
Kinetic theory	$pV = \frac{1}{3}Nm<c^2>$

Capacitors

Capacitors in series	$\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$
Capacitors in parallel	$C = C_1 + C_2 + C_3$
Time constant	$\tau = RC$

Electromagnetism

Magnetic flux density due to current in

(i) long straight solenoid	$B = \frac{\mu_0 NI}{l}$
(ii) long straight conductor	$B = \frac{\mu_0 I}{2\pi a}$

Alternating currents

A.c. generator	$E = E_0 \sin \omega t$ $= BAN\omega \sin \omega t$

Particles and photons

Radioactive decay	$A = \lambda N$ $A = A_0 e^{-\lambda t}$
Half life	$t_{\frac{1}{2}} = 0.693/\lambda$
Photoelectric effect	$\frac{1}{2}mv^2_{max} = hf - hf_0$
de Broglie equation	$\lambda = h/p$

Particle Physics

Nuclear radius	$r = r_0 A^{\frac{1}{3}}$