

Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
TOTAL	



General Certificate of Education  
Advanced Level Examination  
June 2015

## Applied Science

## SC08

### Unit 8 Medical Physics

Tuesday 19 May 2015 9.00 am to 10.30 am

**For this paper you must have:**

- a pencil
- a ruler
- a calculator.

**Time allowed**

- 1 hour 30 minutes

**Instructions**

- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- Do all rough work in this book. Cross through any work you do not want to be marked.
- Show the working of your calculations.

**Information**

- The marks for questions are shown in brackets.
- The maximum mark for this paper is 80.
- You will be marked on your ability to:
  - use good English
  - organise information clearly
  - use specialist vocabulary where appropriate.
- You are expected to use a calculator where appropriate.



J U N 1 5 S C 0 8 0 1

Answer **all** questions in the spaces provided.

**1** Medical professionals use different instruments to assess a person's health.

Answer the questions below about some specific instruments and their use.

**1 (a)** Why must the glass walls of the bulb of a clinical thermometer be as thin as possible? **[1 mark]**

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**1 (b)** What aspect of the design of a clinical thermometer maximises its precision? **[1 mark]**

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**1 (c)** State **one** use of electroencephalograms (EEGs). **[1 mark]**

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**1 (d)** What do electrocardiograms (ECGs) measure in order to produce a trace of heart activity? **[1 mark]**

.....  
.....

**1 (e)** What is a spirometer used to investigate? **[1 mark]**

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.....

<b>5</b>



**2** Doctors suggest that healthy adults should have their blood pressure measured every few years.  
People who are unwell or taking certain medication may have their blood pressure measured more often.

**2 (a)** What is the normal value of blood pressure for a healthy young man?  
Circle the correct answer.

**[1 mark]**

- 120/70    125/70    130/70    120/60    125/80    130/80

**2 (b)** What is the heart doing when systolic pressure is recorded?

**[1 mark]**

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**2 (c) (i)** Describe the difference between blood pressure and pulse rate.

**[2 marks]**

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**2 (c) (ii)** Explain why blood pressure measurements are taken at the patient's upper arm, but the pulse rate is measured at the patient's brachial artery or at the wrist.

**[2 marks]**

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**Question 2 continues on the next page**

**Turn over ▶**



2 (d) Blood pressure can be measured using either invasive or non-invasive techniques.

In both techniques, measurements can be made automatically and electronic systems can be set up to sound an alarm if blood pressure goes above or below acceptable levels.

2 (d) (i) State and explain **one advantage** of using an invasive method of measuring blood pressure.

[2 marks]

Advantage.....

.....

Explanation .....

.....

.....

2 (d) (ii) State and explain **one disadvantage** of using an invasive method of measuring blood pressure.

[2 marks]

Disadvantage.....

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Explanation .....

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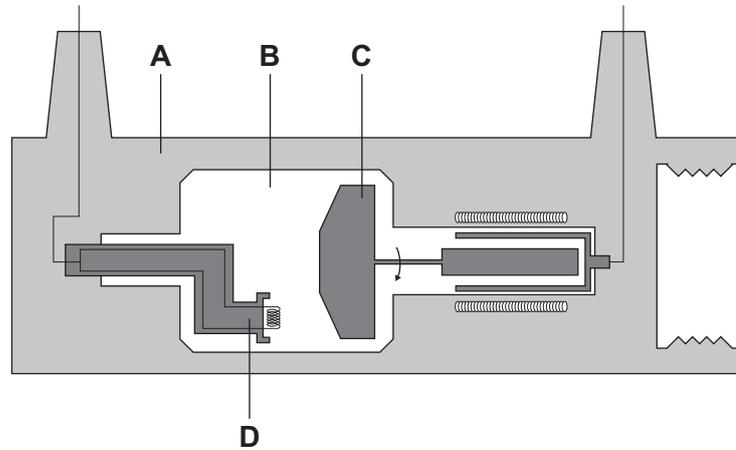
10





3 (b) Figure 1 shows a simplified diagram of an X-ray tube.

Figure 1



Complete **Table 1** by inserting the missing labels, names and functions of each part indicated in **Figure 1**.

[4 marks]

Table 1

Label	Name	Function
		Emits X-rays
A		
	Cathode	
	Evacuated tube	



**3 (c)** X-rays are used to diagnose hard tissue injuries, such as broken bones. X-rays are less effective at detecting injuries to softer tissue, such as muscle. When X-rays are used to investigate soft tissue, a contrast medium is used to make the X-ray images clearer.

Explain how using a 'barium meal' as a contrast medium allows clear X-ray images of the stomach to be produced.

**[3 marks]**

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**3 (d)** Computer aided tomography (CAT) scans use X-rays.

**3 (d) (i)** Why are CAT scans much more dangerous than standard X-ray imaging?

**[1 mark]**

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**3 (d) (ii)** How do CAT scans produce 3-dimensional images of the part of the body they are investigating?

**[2 marks]**

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.....

<b>15</b>

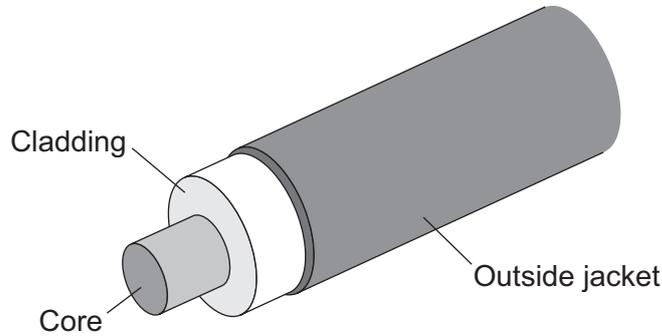
**Turn over ▶**



4 Optical fibres in an endoscope transmit light to parts of the body that are difficult to view.

Optical fibres have a core made from thin strands of glass. This core is covered with cladding, as shown in **Figure 2**.

**Figure 2**



4 (a) Use your knowledge of refraction, optical density, refractive index and total internal reflection to explain why the core is covered in cladding and how the cladding achieves its purpose.

**[4 marks]**

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**4 (b)** The optical fibres in an endoscope are made from glass that has a refractive index of 1.6

Calculate the critical angle for this glass.

**[3 marks]**

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.....  
.....

Critical angle = ..... °

**4 (c)** Doctors use endoscopy and ultrasound for diagnosis.

**4 (c) (i)** Which **one** of the conditions below is **least** likely to be investigated using endoscopy?  
Circle your choice.

**[1 mark]**

- stomach ulcer
- blocked artery
- throat cancer
- kidney stone

**4 (c) (ii)** A patient has a suspected bowel tumour.

State and explain **one** advantage and **one** disadvantage of investigating this using endoscopy rather than ultrasound.

**[4 marks]**

Advantage.....  
.....

Explanation.....  
.....  
.....

Disadvantage.....  
.....

Explanation.....  
.....  
.....

**Question 4 continues on the next page**

**Turn over ▶**



**4 (d)** Ultrasound is not very effective at producing images of the lungs.

Use your knowledge of the structure of the lungs and acoustic impedance to explain why.

**[3 marks]**

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**4 (e)** Physiotherapists may use ultrasound to treat soft tissue injuries.

Use your knowledge of ultrasound to suggest how it may help to repair muscle injuries.

**[1 mark]**

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**4 (f)** Suggest why ultrasound does **not** travel at the same speed through all materials.

**[1 mark]**

.....

.....

17





**5 (a) (ii)** Why would the student need to produce a graph of the results to get an accurate measure of the half-thickness of a material for gamma radiation emitted from iodine-131?

[1 mark]

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**5 (b) (i)** Apart from using a different source, what change would the student need to make to the experimental equipment or procedure to measure the half-thickness of the material when using beta radiation emitted from cobalt-60?

[1 mark]

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.....

**5 (b) (ii)** Explain why this change would be necessary.

[1 mark]

.....

.....

**5 (c)** A medical physicist is investigating a new protective material. She uses gamma radiation emitted from iodine-131 to measure the half-thickness of this material.

The results show that the half-thickness of the new protective material is 0.60 cm.  
The half-thickness of lead for gamma radiation emitted by iodine-131 is 0.24 cm.

Suggest why the medical physicist is **not** likely to recommend using the new material instead of lead in safety shielding.

[1 mark]

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.....



5 (d) Iodine-131 is used as a medical tracer.

5 (d) (i) Which organ of the body is iodine-131 most frequently used to investigate? [1 mark]

.....

5 (d) (ii) Why is iodine-131 particularly suited to investigating that organ? [1 mark]

.....

.....

5 (d) (iii) State **one** property of iodine-131 that makes it suitable for use as a tracer and give **one** reason why that property is important. [2 marks]

Property .....

.....

Reason.....

.....

13
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**Turn over for the next question**

**Turn over ▶**



**6** Doctors can implant suitable radioisotopes to treat soft tissue cancers.

**6 (a)** State **one** reason why a radioisotope used as an implant should emit alpha or beta radiation **only**.

**[1 mark]**

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**6 (b)** A sample of radioisotope **X** had an initial mass of 400 g when placed into a store. After 48 hours only 50 g of radioisotope **X** remained.

Calculate the half-life ( $T_{1/2}$ ) of radioisotope **X**.

**[2 marks]**

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.....

$T_{1/2} = \dots\dots\dots$  hours

**6 (c)** Radioisotope **Y** has a physical half-life of 6 days and an effective half-life of 4 days.

Calculate the biological half-life ( $T_b$ ) of radioisotope **Y**.

**[3 marks]**

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$T_b = \dots\dots\dots$  days



**6 (d)** Surgeons use keyhole surgery to implant radioisotopes. To minimise scarring, the incisions are often made using a laser rather than a traditional scalpel.

Give **one** reason why using a laser is likely to minimise scarring.

**[1 mark]**

.....  
.....

**6 (e)** Operating theatre staff must make sure that there are no reflective surfaces present when lasers are used for surgery.

Use your knowledge of what lasers are and their effects on the body to explain why this is important.

**[2 marks]**

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.....

**6 (f)** A laser beam travelling at a velocity of  $3 \times 10^8 \text{ m s}^{-1}$  has a wavelength of  $7 \times 10^{-7} \text{ m}$ .

Calculate its frequency.

**[2 marks]**

.....  
.....  
.....

Frequency = ..... Hz

11

**Turn over for the next question**

**Turn over ▶**



**7 (a)** Doctors use thermography to diagnose and monitor a range of disorders.

**7 (a) (i)** What is **thermography**?

**[2 marks]**

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**7 (a) (ii)** Why is thermography a completely safe technique?

**[1 mark]**

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**7 (a) (iii)** Patients suffering from diabetes can experience reduced blood flow to their feet.

Explain how the results from thermography could be used to identify lower than normal blood flow to the feet.

**[3 marks]**

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**7 (b)** Magnetic resonance imaging (MRI) scans can also be used to investigate possible problems with blood flow to the feet.

**7 (b) (i)** Which type of radiation interacts with magnetic fields to produce MRI images?  
Circle the correct answer.

[1 mark]

gamma rays      infrared rays      magnetic rays      radio waves      sound waves

**7 (b) (ii)** State **one** advantage of using results from MRI scans rather than thermography to investigate blood flow to the feet.

[1 mark]

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.....

**7 (c)** Computer aided tomography (CAT) scans can be used to investigate a range of medical conditions.

Explain why CAT scans are considered to be more dangerous than MRI scans.

[1 mark]

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9

**END OF QUESTIONS**



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