

Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										



General Certificate of Education  
Advanced Level Examination  
January 2011

# Applied Science

# SC08

## Unit 8 Medical Physics

Monday 17 January 2011 1.30 pm to 3.00 pm

<p><b>For this paper you must have:</b></p> <ul style="list-style-type: none"> <li>• a pencil</li> <li>• a ruler</li> <li>• a calculator.</li> </ul>
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### 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.

For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
TOTAL	



J A N 1 1 S C 0 8 0 1

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

**1** Surgeons often use lasers when operating on patients.

**1 (a)** Explain why a surgeon may prefer to use a laser rather than a scalpel when operating on a patient.

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(2 marks)

**1 (b)** State **two** precautions the surgeon would take when using a laser on a patient.

Precaution 1 .....

.....

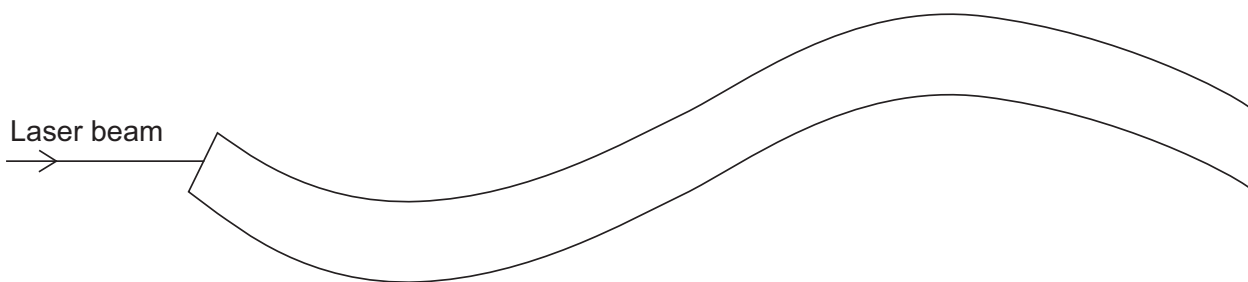
Precaution 2 .....

.....

(2 marks)

**1 (c)** Optical fibres are sometimes used to guide a laser beam.

**1 (c) (i)** Complete the diagram to show the path the laser beam would take through the optical fibre shown.



(2 marks)



1 (c) (ii) In which **one** of the following cases would the surgeon **not** use an optical fibre to guide the laser beam? Tick the correct box.

Removing a tattoo

Cauterising a stomach ulcer

Removing infected tonsils

(1 mark)

1 (d) A particular laser uses light waves with a wavelength of  $6 \times 10^{-6}$  m. The speed of light is  $3 \times 10^8$  m s<sup>-1</sup>. Calculate the frequency of these light waves. State the correct unit in your answer.

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(4 marks)

11
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Turn over for the next question

Turn over ▶



2 A mountain rescue team has found a climber who appears to have hypothermia.

2 (a) To confirm their diagnosis, they use a liquid-in-glass clinical thermometer to measure the climber's core body temperature.

2 (a) (i) What would the climber's core body temperature be if he had hypothermia?

.....  
(1 mark)

2 (a) (ii) Describe how the mountain rescue team would use the liquid-in-glass clinical thermometer to get an accurate measurement of the climber's core body temperature.

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(3 marks)

2 (a) (iii) Apart from his core body temperature, state **two** other symptoms you would expect the climber to show if he had hypothermia.

Symptom 1 .....

.....

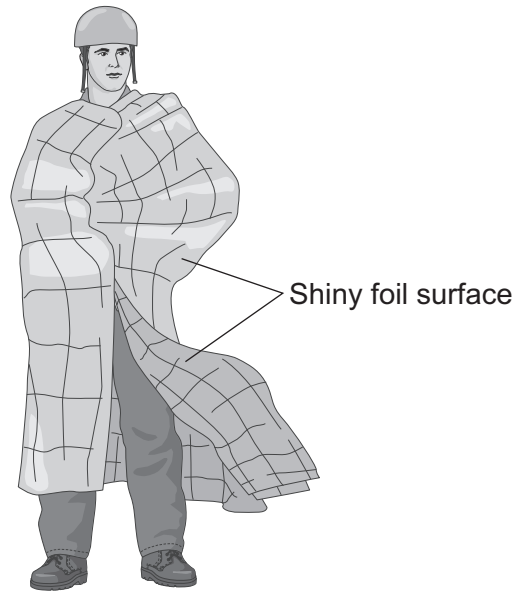
Symptom 2 .....

.....

(2 marks)



**2 (b)** Once the diagnosis has been confirmed, the mountain rescue team wrap the climber in a shiny foil blanket, as shown.



Why will this blanket be effective in helping the climber to recover?  
Use your knowledge of heat transfer mechanisms to explain your answer.

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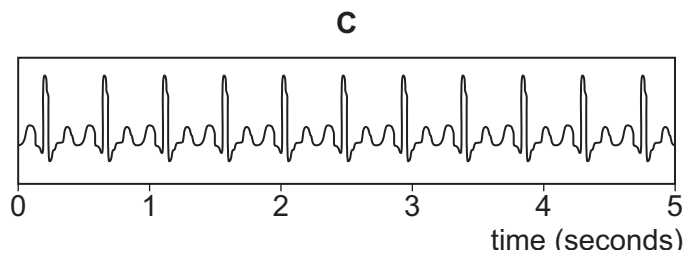
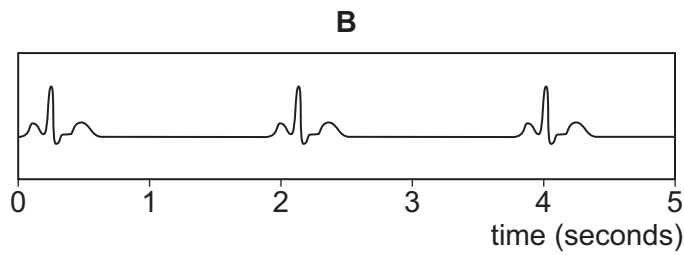
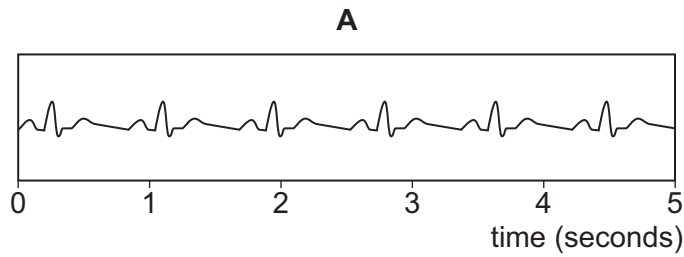
*(3 marks)*

**Question 2 continues on the next page**

**Turn over ▶**



2 (c) When the climber reaches hospital, he is given an electrocardiogram (ECG). Which of the ECG traces **A**, **B** or **C** below would you expect to be produced if the climber had hypothermia?



Trace chosen .....

Reason .....

.....

(2 marks)

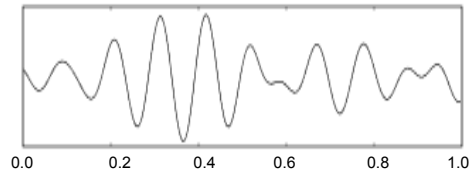
11
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**3** Doctors suspect that a patient has a brain tumour. They arrange for him to have two different diagnostic tests.

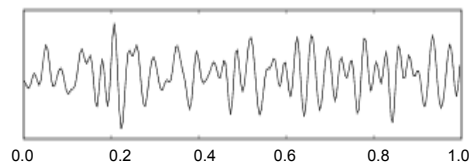
**3 (a)** The first test is an electroencephalogram (EEG).  
There are four main types of brain waves.  
The first two diagrams show normal alpha wave and beta wave traces.

**alpha wave**



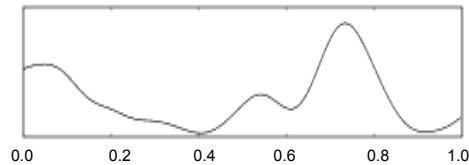
time (seconds)

**beta wave**



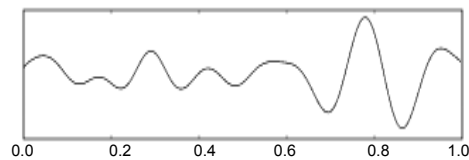
time (seconds)

**X**



time (seconds)

**Y**



time (seconds)

**3 (a) (i)** State the names of the types of waves shown in traces **X** and **Y** above.

**X**.....

**Y**.....

(2 marks)

**Question 3 continues on the next page**

**Turn over ▶**



3 (a) (ii) Draw **one** line from the name of each type of wave to the description of when the wave usually occurs.

**Type of wave**

**When it occurs**

alpha

during deep sleep

beta

in children and in adults under stress

X

when the mind is relaxed

Y

during mental activity

(3 marks)

3 (b) The second test is an MRI scan.

3 (b) (i) What do the initials MRI stand for?

.....  
(1 mark)

3 (b) (ii) Briefly explain the scientific principles of MRI scans.

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(3 marks)





3 (b) (iii) State and explain **two** advantages of using an MRI scan rather than an X-ray to investigate a possible brain tumour.

Advantage 1 .....

.....

Explanation .....

.....

Advantage 2.....

.....

Explanation .....

.....

(4 marks)

3 (b) (iv) State and explain **one** disadvantage of using an MRI scan rather than X-rays to investigate a possible brain tumour.

Disadvantage .....

.....

Explanation .....

.....

(2 marks)

15

Turn over for the next question

Turn over ▶



4 Radiographers use radioactive tracers to diagnose illnesses. These tracers emit gamma radiation that is detected by a gamma camera.

4 (a) Explain why tracers should emit gamma radiation only.

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(3 marks)

4 (b) The radioisotope technetium-99 is often used as a tracer. One reason for this is that it emits only gamma radiation. State **two** other properties of technetium-99 that make it suitable for use as a medical tracer and explain why these properties are important.

Property 1 .....  
.....

Importance .....  
.....

Property 2 .....  
.....

Importance .....  
.....

(4 marks)

7





5 (a) (ii) State **two** precautions you would take to ensure that your results were accurate.

Precaution 1 .....

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Precaution 2.....

.....

(2 marks)

5 (a) (iii) What would you do to ensure that your results were reliable?

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(1 mark)

5 (b) A sample of glass has a refractive index of 1.4.  
Calculate the critical angle of this glass.

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(3 marks)

5 (c) Explain why it is important that the glass used to make an optical fibre has a high refractive index.

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(4 marks)

15



**6** A young woman at risk of having a heart attack has her blood pressure measured monthly by a practice nurse at her local clinic.

**6 (a)** What is the name of the instrument the nurse uses to measure the patient's blood pressure?

.....  
(1 mark)

**6 (b)** The nurse notes the patient's blood pressure as 140/90. State what each of these figures represents.

**6 (b) (i)** 140 represents .....  
(1 mark)

**6 (b) (ii)** 90 represents .....  
(1 mark)

**6 (c)** The practice nurse at the local clinic uses a non-invasive method of measuring blood pressure. When a patient is seriously ill in hospital, their blood pressure may be measured using an invasive method. State and explain **one** advantage and **one** disadvantage of using an invasive method to measure blood pressure.

Advantage .....

Explanation .....

Disadvantage .....

Explanation .....

(4 marks)

7

Turn over ▶



**7** All women aged 50 and over are invited to be screened to check for breast cancer. During screening each breast is X-rayed. A doctor then examines the X-rays to check if there are any abnormalities. This method is called mammography. Mammography is not very successful with younger women because their breast tissue is usually too dense.

A new method of screening for breast cancer is being trialled. This method does not depend on the density of the tissue being examined.

The new method relies on the fact that different types of tumours (cancerous or non-cancerous) contain different types of chemical salts. A chemical is injected into the breast. This chemical reacts differently to the different types of salts.

When it is irradiated with light of the correct frequency, the chemical used will fluoresce (glow) when it binds with the salt contained in cancerous tumours. This means that when light is shone through the breast, any areas where there are cancerous tumours will be illuminated.

**7 (a)** Critically evaluate this new method of breast screening compared with traditional mammography. Make sure you consider at least **one** advantage and **one** disadvantage of the new method in your answer.

You will be assessed on the quality of your written communication in your answer to this question.

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(5 marks)



7 (b) Explain how thermography can be used to screen for breast cancer.

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(3 marks)

8

**Turn over for the next question**



**8** Radioisotopes can be used for both diagnosis and therapy.

**8 (a)** A particular radioisotope, **R**, has a physical half-life of 12 days.  
A 10g sample of radioisotope **R** is left in the laboratory for 36 days.  
How much active radioisotope **R** will be left after 36 days?

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(2 marks)

**8 (b)** Radioisotope **R** has a biological half-life of 6 days.

**8 (b) (i)** Calculate the effective half-life of radioisotope **R**.

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(3 marks)

**8 (b) (ii)** Explain why the effective half-life of a radioisotope is always less than its physical half-life.

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(1 mark)

6

**END OF QUESTIONS**

