

Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

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



General Certificate of Education
Advanced Level Examination
January 2012

Applied Science

SC08

Unit 8 Medical Physics

Wednesday 18 January 2012 1.30 pm to 3.00 pm

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



J A N 1 2 S C 0 8 0 1

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

- 1 (a)** Doctors use a wide range of equipment to help them to diagnose or monitor medical conditions.
 Draw a line from each condition below to the equipment that would be used to diagnose or monitor that condition.

Condition	Monitoring/diagnostic equipment
Bradycardia	Sphygmomanometer
Coma	Electrocardiogram
High blood pressure	Electroencephalogram
Soft tissue injury	MRI scanner

(3 marks)

- 1 (b)** Doctors use X-rays to diagnose many medical conditions.

- 1 (b) (i)** State **one** precaution that would be taken to protect the radiographer when X-rays are being used.

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(1 mark)

- 1 (b) (ii)** Explain how the precaution you have chosen protects the radiographer.

.....

(1 mark)

- 1 (c)** Doctors use lasers to treat many medical conditions.

- 1 (c) (i)** State **one** precaution that would be taken to protect the patient when lasers are being used.

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(1 mark)

- 1 (c) (ii)** Explain how the precaution you have chosen protects the patient.

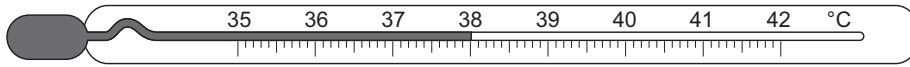
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(1 mark)

7



2 (a) A nurse may measure a patient’s body temperature by placing a liquid-in-glass thermometer into the patient’s mouth.



2 (a) (i) Explain how a liquid-in-glass thermometer can detect and measure temperature changes.

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(3 marks)

2 (a) (ii) Which heat transfer mechanism is responsible for heat travelling through the outer glass casing of the thermometer into the liquid inside?

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(1 mark)

2 (b) (i) A student nurse measured a patient’s core body temperature as 36 °C. He told a doctor that he thought the patient was suffering from hypothermia. Was the student nurse correct? Justify your answer.

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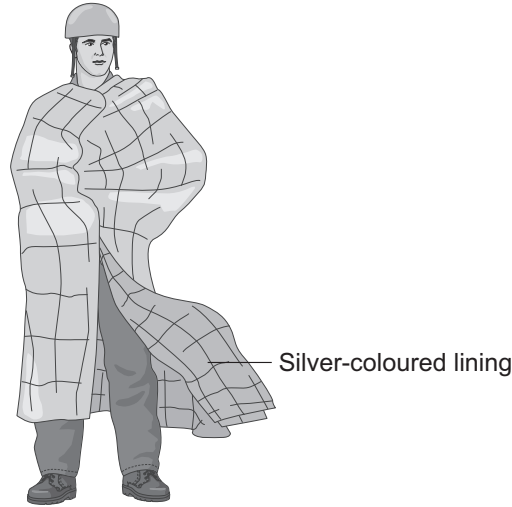
(2 marks)

Question 2 continues on the next page

Turn over ▶



2 (b) (ii) One treatment for patients with hypothermia is to wrap them in a special blanket that has a silver-coloured lining.



Explain how wrapping patients in a blanket like this can help them to recover from hypothermia. Use your knowledge of heat transfer mechanisms in your answer.

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(3 marks)

2 (c) In hospital, medical staff need to closely monitor the core body temperature of a patient with hypothermia.

2 (c) (i) Explain why a liquid-in-glass thermometer is **not** the most effective way of doing this.

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(2 marks)



2 (c) (ii) Suggest a more effective method of closely monitoring the patient's core body temperature. Explain why you have suggested this method.

Suggestion:

Explanation:

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(3 marks)

14

Turn over for the next question

Turn over ▶



3 (a) Radiologists use radioisotopes for both diagnosis and therapy.

The choice of radioisotope for a particular task often depends on the half-life of the radioisotope.

3 (a) (i) What does the term *half-life* mean ?

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(1 mark)

3 (a) (ii) Radioisotope **A** has a half-life of 8 hours.

A hospital has 4 g of active radioisotope **A** available.

Assuming none was used, how much active radioisotope **A** would be left 24 hours later?

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(2 marks)

3 (a) (iii) The hospital usually prepares radioisotope **A** when it is needed, rather than buying and storing it.

Suggest why this is a sensible thing to do.

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(2 marks)



3 (b) A patient has undergone a medical examination in which radioisotope **A** was used as a tracer. He has been told that he should now not be in close contact with other people, especially pregnant women, for 24 hours.

Explain why he has been told to do this.

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(4 marks)

Question 3 continues on the next page

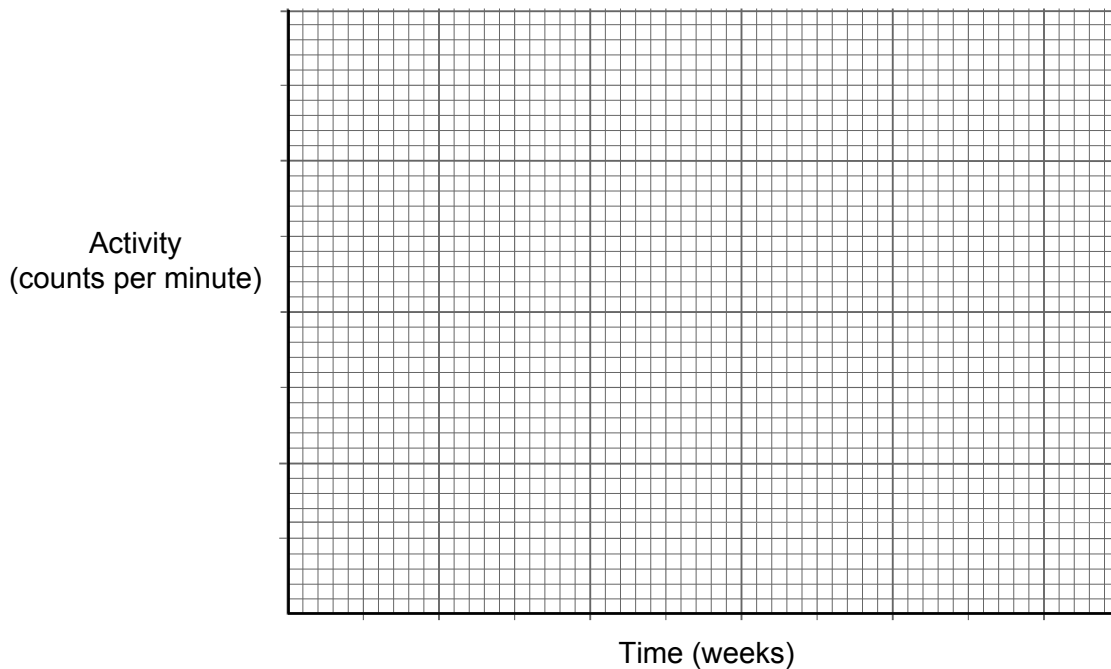
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- 3 (c)** A technician measures the activity of radioisotope **B** at different times in order to measure its half-life.
The results are shown in the table.

Time (weeks)	Activity (counts per minute)
0	140
2	90
4	55
6	35
8	20
10	10

- 3 (c) (i)** Plot these results on the axes below.
Draw a line of best fit.



(3 marks)

- 3 (c) (ii)** Use your graph to find an accurate value for the half-life of radioisotope **B**.

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Half-life of **B** = weeks
(2 marks)



3 (d) Radioisotope **C** has a physical half-life of 6 days and a biological half-life of 4 days.

3 (d) (i) Calculate the effective half-life of radioisotope **C**.

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(2 marks)

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

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(1 mark)

17

Turn over for the next question

Turn over ▶



4 (a) (ii) State a possible source of error in your experiment and suggest how this error could be reduced.

Possible source of error:

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How the error could be reduced:

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(2 marks)

4 (b) Radioisotopes used as implants must emit alpha or beta radiation, and should emit little or no gamma radiation.

Explain why.

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(4 marks)

11

Turn over for the next question

Turn over ▶



5 A technician in a glass-manufacturing company is testing a new type of glass to find out if its refractive index would make it suitable to use to make an endoscope.
The technician found the critical angle, c , to be 41° .

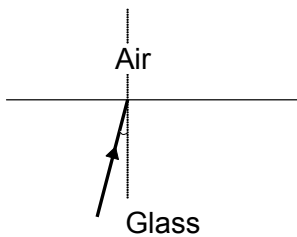
5 (a) Calculate the refractive index, n , for this glass sample.

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$n = \dots\dots\dots$
 (3 marks)

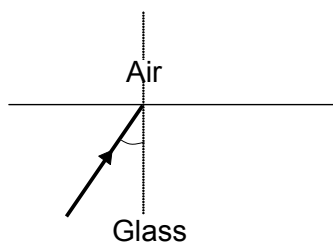
5 (b) Rays of light were shone through the new type of glass. Complete the diagrams below to show what happens to a ray of light that hits the glass–air boundary at the angles shown. You are **not** expected to calculate the angle of refraction.

5 (b) (i) 25°



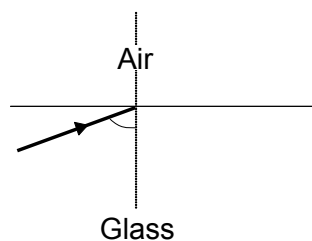
(2 marks)

5 (b) (ii) 41°



(2 marks)

5 (b) (iii) 60°



(2 marks)



6 Doctors use both ultrasound and X-rays to help diagnose illness.

6 (a) What are *X-rays*?

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(2 marks)

6 (b) (i) What is *ultrasound*?

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(2 marks)

6 (b) (ii) An ultrasound machine produces waves with a frequency of 40 000 Hz and a velocity of 320 ms^{-1} .

Calculate the wavelength of the waves produced.

Show all your working and state the correct unit in your answer.

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(3 marks)

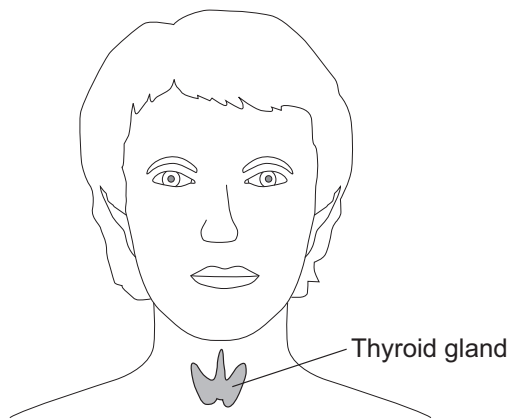


6 (c) Ultrasound and X-rays both send waves into the body. These waves are affected in different ways by the tissues they meet. This results in the formation of an image. What is the main difference in how X-ray and ultrasound images are produced?

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(2 marks)

6 (d) A doctor suspects that a patient has a tumour in her thyroid gland. The doctor decides to use an ultrasound scan to investigate the possible tumour.



State and explain **two** reasons why the doctor does **not** suggest that the patient has an X-ray taken to investigate this condition.

Reason 1:

Explanation:

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.....

Reason 2:

Explanation:

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(4 marks)

Question 6 continues on the next page

Turn over ▶



6 (e) The ultrasound scan shows that the patient has thyroid cancer. The doctor explains that this will be treated with radioactive iodine.
The patient asks why she will be treated with radioactive iodine-131 rather than radioactive iridium-192, which was used to cure her friend's breast cancer.
How would the doctor explain this to the patient?

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(2 marks)

15

END OF QUESTIONS

