

Surname		Other Names	
Centre Number		Candidate Number	
Candidate Signature			

For Examiner's Use

General Certificate of Education
 January 2010
 Advanced Level Examination



APPLIED SCIENCE
Unit 8 Medical Physics

SC08

Monday 18 January 2010 1.30 pm to 3.00 pm

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

Time allowed: 1 hour 30 minutes

Instructions

- Use black ink or black ball-point pen. Use pencil only for drawing.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Answers written in margins or on blank pages will not be marked.
- Do all rough work in this book. Cross through any work that 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.

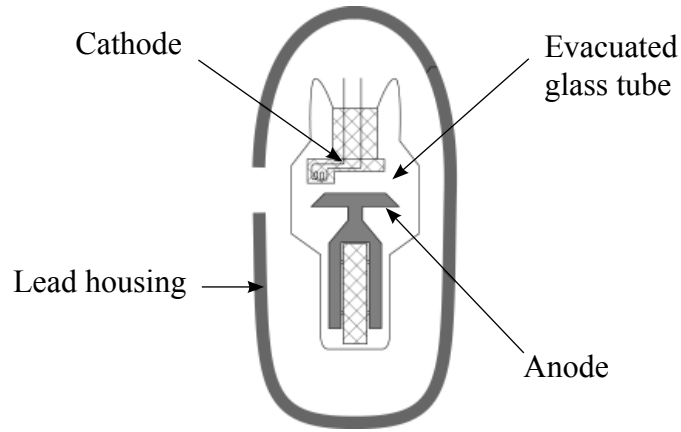
For Examiner's Use			
Question	Mark	Question	Mark
1		5	
2		6	
3			
4			
Total (Column 1)		→	
Total (Column 2)		→	
TOTAL			
Examiner's Initials			



J A N 1 0 S C 0 8 0 1

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

- 1 (a) Radiographers can use X-rays to produce images that help doctors diagnose illnesses. The diagram below shows the structure of an X-ray tube.



- 1 (a) (i) State the function of each of the following parts.

The vacuum in the evacuated glass tube

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The cathode

.....

The lead housing

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The anode

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(4 marks)

- 1 (a) (ii) Use your knowledge of energy transfer to explain why the anode must be rotated.

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(2 marks)



- 1 (b) (i) State **one** precaution a radiographer would take to protect himself against damage due to X-rays.

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 (1 mark)

- 1 (b) (ii) Explain how this precaution protects the radiographer.

.....

 (1 mark)

- 1 (c) Ultrasound and X-rays are both waves which penetrate into the body. These waves are affected by the different tissues they meet in the body. After passing through the body, the waves are used to form an image.

- 1 (c) (i) What property of tissue determines how X-rays and ultrasound respond to it?

.....

 (1 mark)

- 1 (c) (ii) What is the main difference in how X-ray and ultrasound images are produced?

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 (2 marks)

- 1 (d) (i) State the equation which links the velocity, frequency and wavelength of a wave.

.....
 (1 mark)

- 1 (d) (ii) Ultrasound waves travel through a particular type of tissue at a speed of 800 m s^{-1} . Calculate the frequency of an ultrasound wave which has a wavelength of 0.02 m. State the correct unit in your answer.

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 (3 marks)

Turn over ▶

15



- 2 (a) Endoscopes use optical fibres to view inside the body.
Explain how light travels along an optical fibre.

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(2 marks)

- 2 (b) The glass used to make optical fibres must have a high refractive index and a low critical angle.

- 2 (b) (i) What is meant by the *refractive index* of a material?

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(1 mark)

- 2 (b) (ii) Define the term *critical angle*.

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(1 mark)

- 2 (b) (iii) Explain why the glass used to produce optical fibres must have a low critical angle.

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(4 marks)



2 (c) (i) State the equation that links critical angle and refractive index.

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(1 mark)

2 (c) (ii) Calculate the refractive index of a type of glass which has a critical angle of 39° .

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(2 marks)

2 (d) (i) Explain how an endoscope might be used to *diagnose* the presence of a stomach ulcer.

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(2 marks)

2 (d) (ii) Describe how an endoscope might be used in the *treatment* of a stomach ulcer.

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(2 marks)

15

Turn over ▶



3 One job of the practice nurse in a clinic is to measure the blood pressure of patients. One patient, a 20-year-old male, has a blood pressure value of 110/60 mmHg.

3 (a) (i) Is the patient's blood pressure below normal, normal or above normal?

..... (1 mark)

3 (a) (ii) What do the figures 110 and 60 represent?

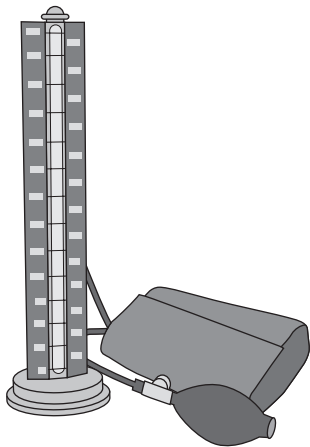
110 is

60 is

(2 marks)

3 (b) Describe how the practice nurse would use a manual sphygmomanometer, similar to the one shown below, to measure the patient's blood pressure.

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



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(5 marks)



3 (c) Patients are sometimes provided with electrical blood pressure monitors to monitor their own blood pressure at home.

3 (c) (i) Suggest why it would **not** be sensible to give patients a manual sphygmomanometer to use themselves at home.

.....
.....
(1 mark)

3 (c) (ii) Suggest why a patient’s blood pressure readings may be lower when measured at home than when measured in the clinic by the practice nurse.

.....
.....
(1 mark)

3 (d) Blood pressure can be measured using either non-invasive methods or invasive methods.
State and explain **one** advantage and **one** disadvantage of using a *non-invasive* method of measuring blood pressure.

Advantage

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Disadvantage

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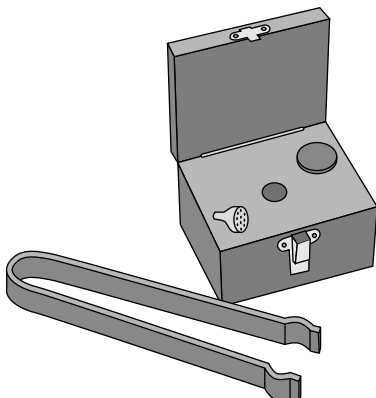
(4 marks)

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Turn over ▶



- 4 When not in use, radioisotopes have to be kept inside a special container. This is to ensure that people are not unnecessarily exposed to radiation.



- 4 (a) You are asked to design an experiment to test the effectiveness of a wooden box made especially for storing radioisotopes.
Explain how you will use the equipment that you choose and how you would decide how effective the wooden box is.

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

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(5 marks)



4 (b) State and explain **two** possible sources of error in your experiment.

Source of error 1

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Source of error 2

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(4 marks)

4 (c) Would you expect a wooden box to be an effective container for radioisotopes?
Explain your answer.

.....

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(2 marks)

4 (d) Apart from keeping the radioisotope in a special container when not in use, state **two** further precautions you would take when working with radioisotopes in the school laboratory.

Precaution 1

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Precaution 2

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(2 marks)

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Turn over ▶

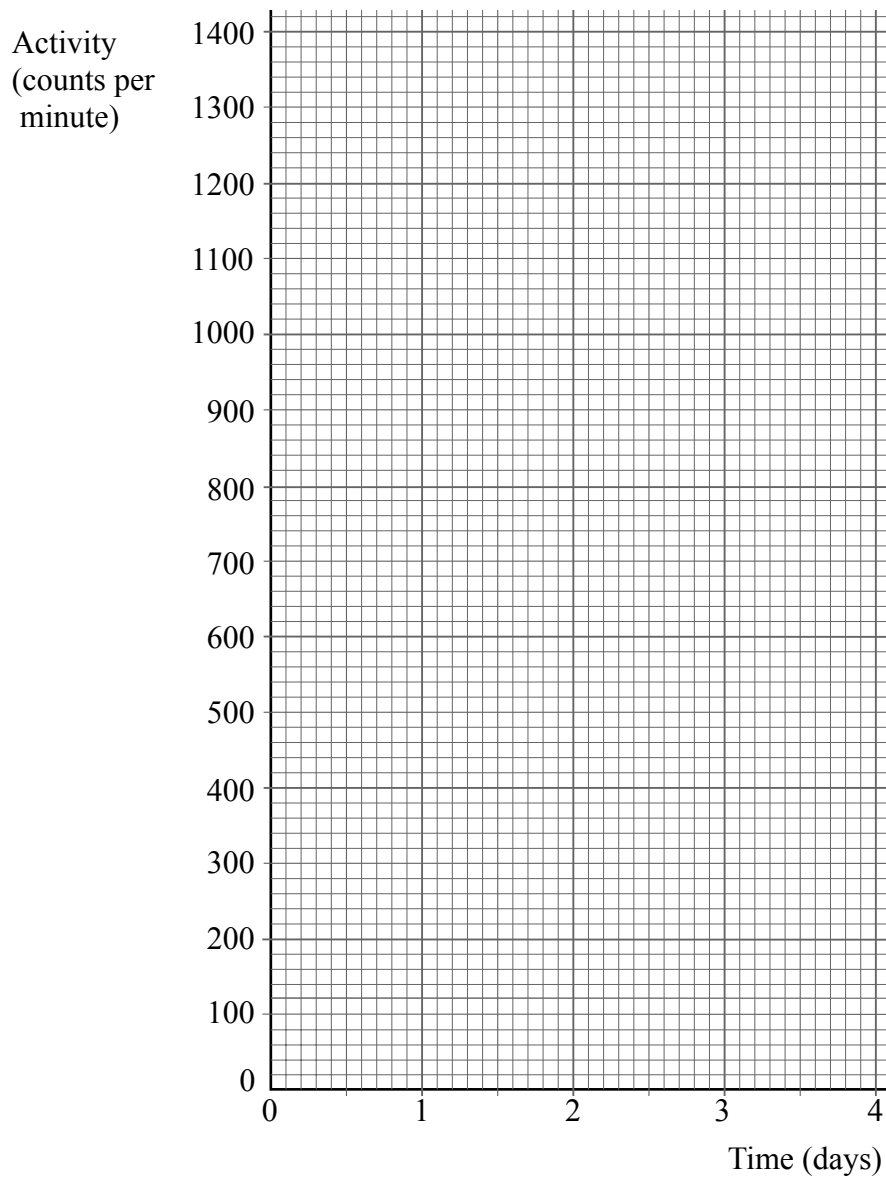


- 5 (a) A medical physics technician takes measurements of the activity of radioisotope **Y** in order to measure its physical half-life.

The results obtained are shown in the table below.

Time (days)	Activity (counts per minute)
0	1400
1	900
2	550
3	350
4	200

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



(2 marks)



- 5 (a) (ii) Use your graph to find an *accurate* value for the physical half-life of radioisotope **Y**.

Physical half-life of radioisotope **Y** =days.

(2 marks)

- 5 (b) (i) Explain what is meant by the *effective* half-life of a radioisotope.

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.....
.....

(1 mark)

- 5 (b) (ii) Radioisotope **Z** has a physical half-life of 3 days and a biological half-life of 6 days.

Calculate the effective half-life of radioisotope **Z**.

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Effective half-life of radioisotope **Z** =days

(2 marks)

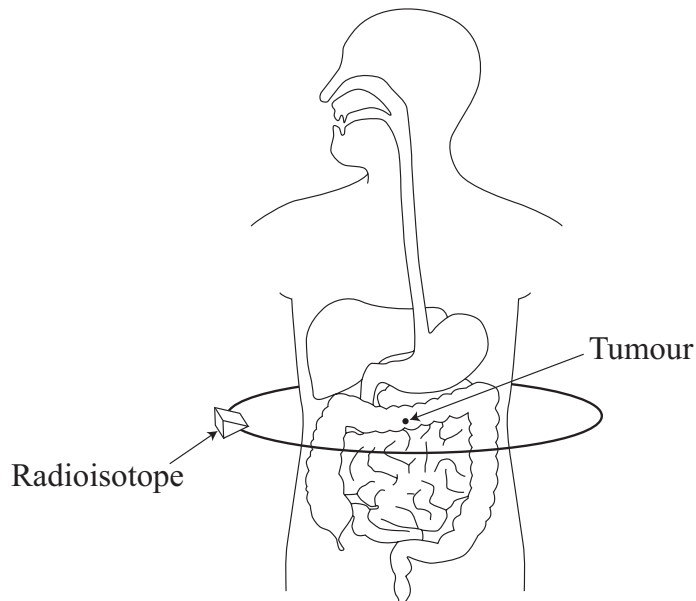
7

Turn over for the next question

Turn over ▶



- 6 There are many ways of treating cancerous tumours within the body. For example, the tumour may be irradiated by radiation emitted by radioisotopes. The diagram shows a tumour being irradiated by an external radioisotope which is rotated around the body.



- 6 (a) Suggest **two** reasons why the radioisotope is rotated around the body rather than being left stationary.

Reason 1

.....

Reason 2

.....

(2 marks)

- 6 (b) (i) Evaluate whether the radioisotope technetium-99 would be a suitable radioisotope to use for this type of external therapy. In your answer make sure you consider both its half-life and the type(s) of radiation it emits.

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(4 marks)



6 (b) (ii) Explain why radioactive iodine-131 is commonly used to treat thyroid cancer.

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(2 marks)

6 (c) Some doctors are trialling a new method of treating cancerous tumours, for example liver cancer.

This method uses microwave radiation to ‘burn’ the tumours.

A small probe, a few millimetres thick, is inserted into the tumour using keyhole surgery and then used to direct the microwaves straight into the tumour. The heat produced destroys the tumour.

An endoscope is used to track the location of the tumour and the position of the probe, and to follow the effects of the treatment on the tumour.

The microwave treatment takes a few minutes and the whole process is completed in a few hours.

6 (c) (i) Suggest and explain **two** advantages of using microwaves rather than external radioisotopes to treat liver cancer.

Advantage 1

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Advantage 2

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(4 marks)

Question 6 continues on the next page

Turn over ▶



6 (c) (ii) Suggest and explain **two** disadvantages of using microwaves rather than external radioisotopes to treat liver cancer.

Disadvantage 1

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Disadvantage 2

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(4 marks)

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END OF QUESTIONS



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