Surname		Other Names	
Centre Number			Candidate Number				
Candidate Signature									

For Examiner's Use

General Certificate of Education
June 2007
Advanced Level Examination

ASSESSMENT and QUALIFICATIONS ALLIANCE

APPLIED SCIENCE **SC08**
Unit 8 Medical Physics

Thursday 7 June 2007 1.30 pm to 3.00 pm

For this paper you must have:
- a pencil and a ruler
- a calculator.

Time allowed: 1 hour 30 minutes

Instructions
- Use blue or black ink or ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- Answer the questions in the spaces provided.
- 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 maximum mark for this paper is 80.
- The marks for questions are shown in brackets.
- You are expected to use a calculator where appropriate.

For Examiner's Use			
Question	Mark	Question	Mark
1		5	
2		6	
3		7	
4		8	
Total (Column 1) →			
Total (Column 2) →			
TOTAL			
Examiner's Initials			

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

1 Many types of equipment are used in hospitals to monitor patients' health.

Draw lines to match each piece of equipment below with the function or structure it is used to monitor.

Equipment	**Function or structure**
CAT scanner	Cancerous tumour
Electrocardiograph (ECG)	Development of a foetus in the womb
Electroencephalograph (EEG)	Skeletal structure
X-ray machine	Heart activity
Ultrasound scanner	Brain activity

(5 marks)

5

2 Both MRI and CAT scans can be used to investigate soft tissue injuries. Both can produce 3-D images with high contrast.

(a) How are MRI scans produced?

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(3 marks)

(b) Explain why MRI scans are considered to be safer than CAT scans.

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(2 marks)

5

Turn over for the next question

3 Body temperature can be measured in several ways. One method is to place a liquid-in-glass thermometer in a patient's mouth. Another is to place a thermistor thermometer on a patient's forehead.

(a) Describe briefly the scientific principles behind how a liquid-in-glass thermometer works.

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(3 marks)

(b) State and explain **one** advantage and **one** disadvantage of measuring a patient's temperature using a liquid-in-glass thermometer in the patient's mouth rather than a thermistor thermometer on the patient's forehead.

Advantage of using a liquid-in-glass thermometer in the patient's mouth.

.....

Explanation .....

.....

Disadvantage of using a liquid-in-glass thermometer in the patient's mouth.

.....

Explanation .....

.....

(4 marks)

(c) The core body temperature of a patient was measured as 32° C.

Place a tick next to the correct statement in the table below.

This patient's body temperature is normal	
This patient's body temperature is below normal but the patient is not suffering from hypothermia	
This patient is suffering from hypothermia	
This patient is suffering from hyperthermia	

(1 mark)

8

Turn over for the next question

4 Ultrasound and X-rays are both used to help diagnose illness.

(a) (i) What is ultrasound?

.....

.....

(2 marks)

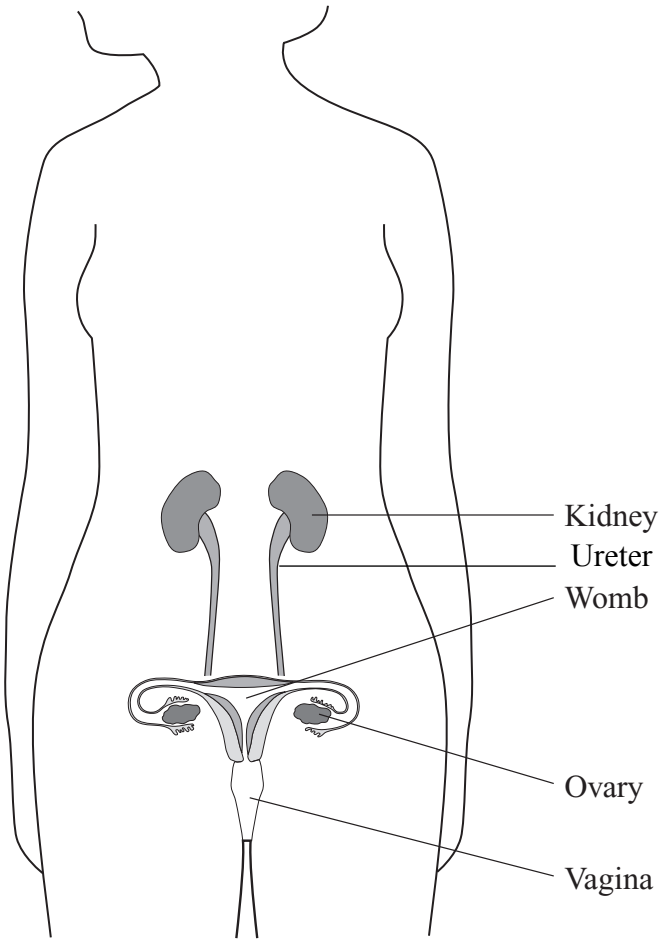
(ii) What are X-rays?

.....

.....

(2 marks)

(b) A doctor suspects that a patient has a tumour on one of her ovaries.
The ovaries are situated low in a woman's pelvis. Eggs are produced in the ovaries.
The doctor decides to use an ultrasound scan to investigate the possible tumour.



State and explain **two** reasons why ultrasound is preferred to X-rays for investigating this condition.

Reason 1 .....

.....

Explanation .....

.....

Reason 2 .....

.....

Explanation .....

.....

(4 marks)

(c) Give **one** example where ultrasound is used for treatment of a medical condition.

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(1 mark)

(d) (i) An ultrasound machine produces waves with a frequency of 160 000 Hz and a velocity of 320 m/s in air.
Calculate the wavelength of the waves produced. State the equation you use. Give the correct unit in your answer.

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(3 marks)

(ii) The ultrasound machine is reset so that the frequency of the waves emitted is doubled. What effect does this have on the velocity of the ultrasound waves produced? Explain your answer.

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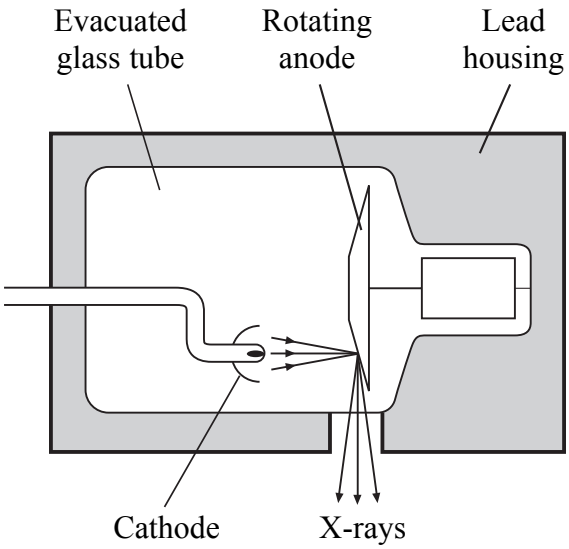
(2 marks)

Question 4 continues on the next page

(e) The diagram below shows the structure of an X-ray tube.



(i) State the function of each of the following parts:

Evacuated glass tube .....

.....

Cathode .....

.....

Lead housing .....

.....

Anode .....

.....

(4 marks)

(ii) Explain why the anode must be rotated.

.....

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(2 marks)

(f) Ultrasound and X-rays both send waves into the body. These waves are affected by the tissues they meet in different ways. 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)

22

Turn over for the next question

5 Endoscopes are frequently used to view inside the body. Endoscopes contain optical fibres.

(a) Explain how light travels along an optical fibre.

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(1 mark)

(b) Explain why the glass used to produce optical fibres needs to have a high refractive index.

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(3 marks)

(c) A sample of glass has a critical angle of 39°. Calculate its refractive index.

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(3 marks)

(d) Briefly describe how you would measure the critical angle of a sample of glass. Include the following points:

- The equipment you would use.
- A brief description of what you would do.
- Any measurements you would make.

You may include a diagram to illustrate your experiment if you wish.

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(4 marks)

11

6 Radiologists may use radioisotopes as tracers to aid diagnosis of medical conditions.

(a) (i) What is meant by a *tracer*?

.....

(1 mark)

(ii) What is meant by *diagnosis*?

.....

(1 mark)

(b) Not all radioisotopes are suitable for use as tracers.

(i) Which type of radiation should a tracer emit? Explain your answer.

Type of radiation .....

Explanation .....

.....

(3 marks)

(ii) Suggest a suitable half-life for a radioisotope which could be used as a tracer. Explain your answer.

Half-life .....

Explanation .....

.....

(3 marks)

(iii) State **two** properties of the radioisotope, other than half-life and type of radiation emitted, that a radiologist would need to consider before deciding whether it would be suitable for use as a medical tracer. Give a reason for choosing each of these properties.

Property 1 .....

Reason .....

.....

Property 2 .....

Reason .....

.....

(4 marks)

12

7 Radioisotopes can be used in the treatment of tumours.
This can be done in a number of ways including implanting the radioisotope or by using an external source to irradiate the tumour.

(a) (i) Radioisotopes used as implants usually emit alpha or beta radiation.
Explain why an alpha or beta emitter is more suitable than a gamma emitter for use as an implant.

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(2 marks)

(ii) Suggest a suitable half-life for a radioisotope that is to be used as an implant.
Explain your answer.

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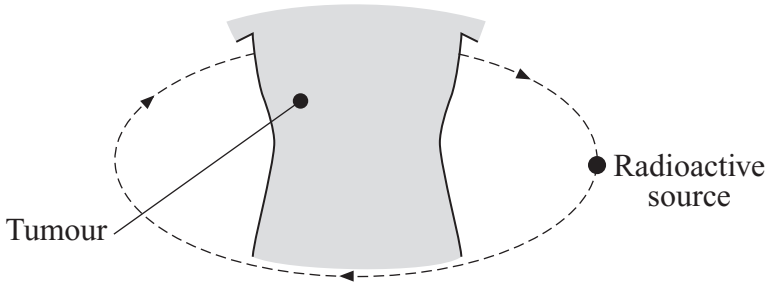
(3 marks)

(b) If an external radioactive source is used to irradiate a patient's tumour, the source is rotated around the body as shown below.



Give **two** reasons why the source is rotated around the patient's body.

Reason 1 .....

.....

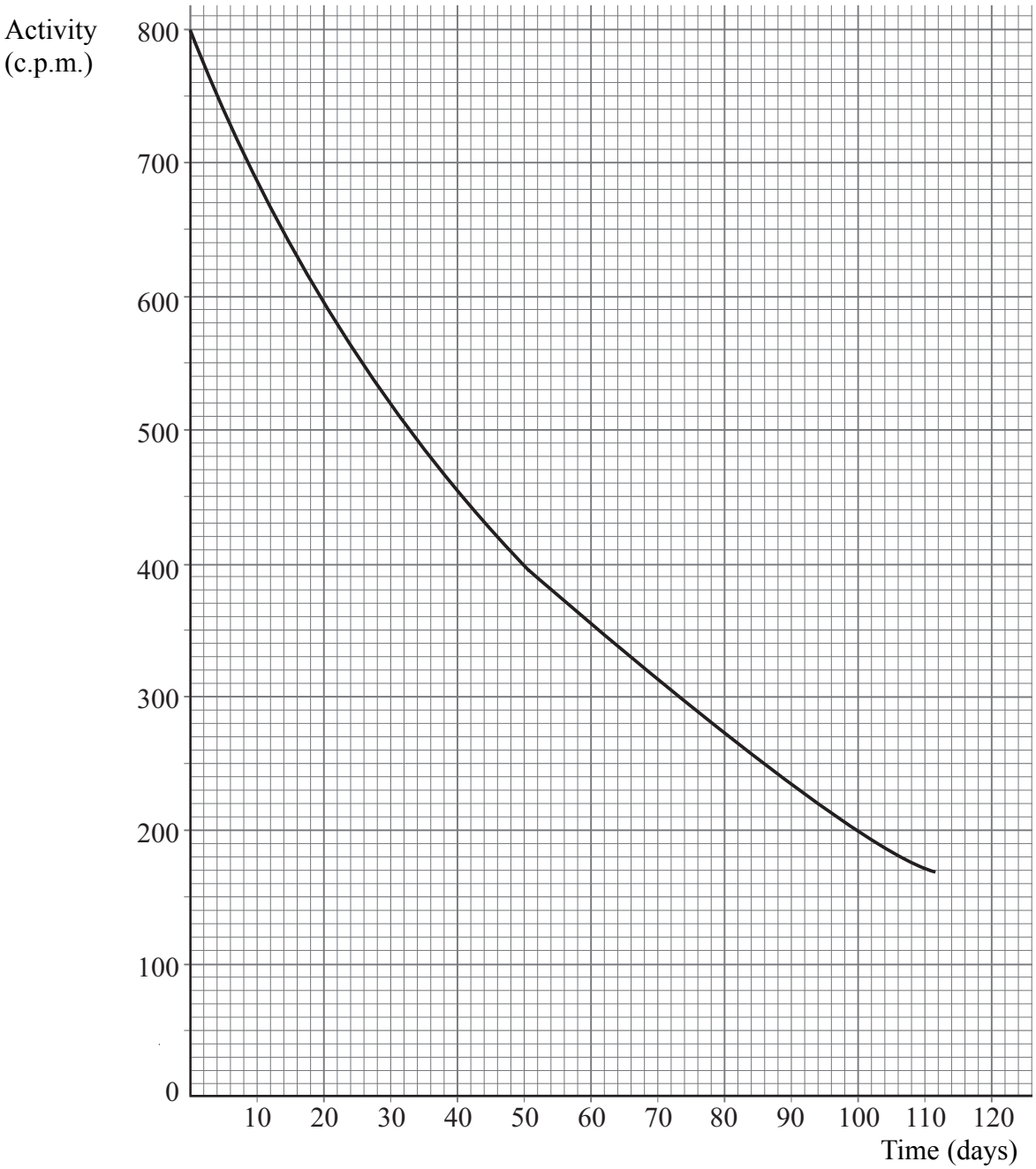
Reason 2 .....

.....

(2 marks)

7

8 A medical physicist checks the half-life of a sample of iridium-192.
To do this, he checks its activity every 30 days. His results are shown in the graph below.



(a) (i) Use the graph to find an accurate value of the half-life of iridium-192.
Show clearly how you obtained your answer.

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(2 marks)

(ii) Critically evaluate the medical physicist's decision to measure the activity of this sample of iridium-192 every 30 days rather than using a longer or shorter time interval.

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(3 marks)

(b) It is possible to measure the physical half-life, biological half-life and the effective half-life of an isotope.

(i) Calculate the effective half-life of a radioisotope that has a physical half-life of 12 days and a biological half-life of 6 days.

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(3 marks)

(ii) Explain why the effective half-life of an isotope is always less than its physical half-life.

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(2 marks)

10

END OF QUESTIONS

There are no questions printed on this page