Surname		Other Names	
Centre Number			Candidate Number				
Candidate Signature									

For Examiner's Use

General Certificate Education
June 2008
Advanced Level Examination

ASSESSMENT and QUALIFICATIONS ALLIANCE

APPLIED SCIENCE **SC08**
Unit 8 Medical Physics

Tuesday 3 June 2008 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 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. Answers written in margins or on blank pages will not be marked.
- 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			
4			
Total (Column 1) →			
Total (Column 2) →			
TOTAL			
Examiner's Initials			

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

1 A nurse can measure a patient's body temperature by placing a liquid-in-glass thermometer into the patient's mouth.

1 (a) (i) Explain how a liquid-in-glass thermometer is able to detect and measure temperature changes.

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(3 marks)

1 (a) (ii) Explain why placing the liquid-in-glass thermometer on the surface of the patient's skin would **not** give an accurate measurement of the patient's body temperature.

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(2 marks)

1 (b) A student nurse measured a patient's body temperature as 35.5 °C.
He informed the doctor that he thought the patient was suffering from hypothermia.
Was the student nurse correct?
Explain your answer.

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(2 marks)

1 (c) A patient has a fever. Medical staff need to monitor the patient's core body temperature closely in order to ensure that the patient does not become critically ill. Using a liquid-in-glass thermometer is not the most effective way of doing this. Suggest a more effective method of closely monitoring the patient's core body temperature.
Explain why the method you have suggested would be more effective.

Suggestion .....

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Explanation .....

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(3 marks)

10

Turn over for the next question

There are no questions printed on this page

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

2 Endoscopes can be used to help doctors diagnose and treat medical conditions. Depending on what they are being used for, endoscopes can transmit either normal light or laser light.

2 (a) (i) Suggest **one** use of transmitting ordinary light through an endoscope.

.....

.....

(1 mark)

2 (a) (ii) Suggest **one** use of transmitting laser light through an endoscope.

.....

.....

(1 mark)

2 (b) Laser light is dangerous. State **two** precautions that should be taken when lasers are being used.

1 .....

.....

2 .....

.....

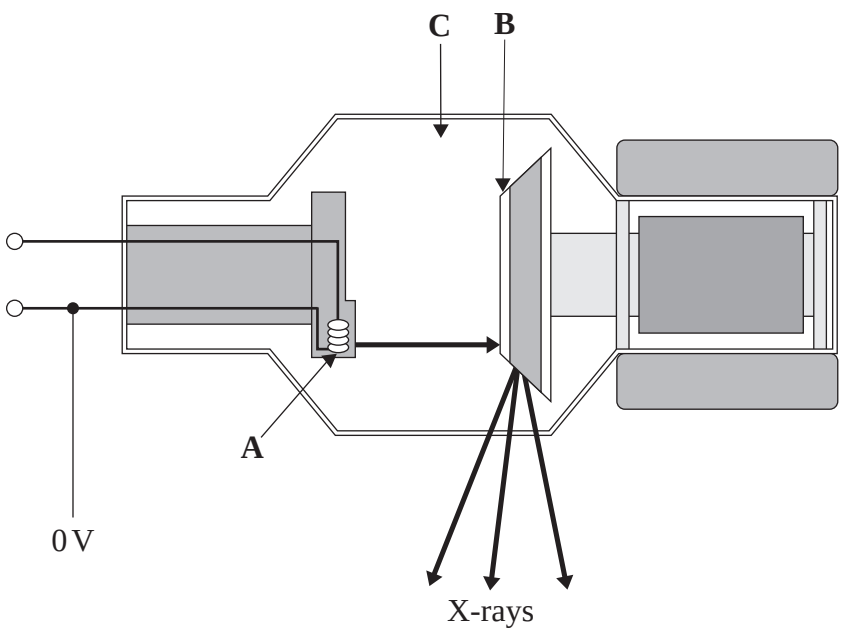
(2 marks)

4

Turn over for the next question

3 Radiographers use X-rays to help diagnose many medical conditions.

3 (a) A diagram of an X-ray machine is shown below.



For the parts labelled **A**, **B** and **C**, complete the table, matching the name of each labelled part with its function.

Label	**Name**	**Function**
B	anode	
		prevents electrons colliding with air particles

(3 marks)

Working with X-rays is dangerous so suitable precautions must be taken.

3 (b) (i) State **one** precaution that radiographers take to protect themselves when using X-rays.

.....

.....

(1 mark)

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

.....

.....

(1 mark)

3 (c) Exposure to X-rays can cause damage.
In each box below, write in the name of the term that matches the definition of each type of damage.

Definition	Term
Damage is caused only to the person exposed to the X-rays. It is not hereditary.	
There is no threshold for damage to occur and the amount of damage caused depends on the extent of the exposure.	

(2 marks)

3 (d) (i) Explain how X-rays produce images of bones.

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(4 marks)

Question 3 continues on the next page

3 (d) (ii) Standard X-ray procedures do not produce high contrast images of soft tissues. When soft tissue needs to be X-rayed, a contrast medium can be used to improve the contrast. Explain how the contrast medium does this.

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(2 marks)

3 (e) CAT scans use X-rays.
State **two** ways in which CAT scans are different from standard X-ray procedures.

Difference 1 .....

.....

Difference 2 .....

.....

(2 marks)

15

4 A hospital technician is using a machine to study a patient's brain activity.
To do this, the technician attaches electrodes to the patient's skin.

4 (a) What is the name of the machine that the technician uses to study brain activity?

.....

(1 mark)

4 (b) The technician smears the patient's skin with gel before attaching the electrodes.
What is this gel for?

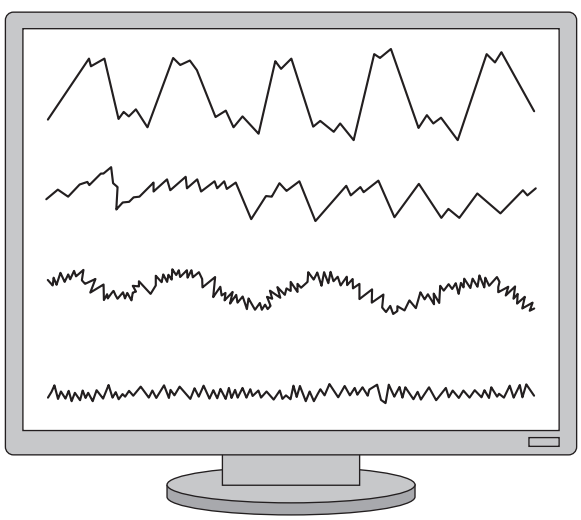
.....

.....

(2 marks)

A typical set of traces of brain activity is shown.

X



4 (c) (i) Which type of wave is shown by trace **X**?

.....

(1 mark)

4 (c) (ii) Which type of wave normally occurs during deep sleep?

.....

(1 mark)

4 (c) (iii) Which type of wave normally occurs during mental activity?

.....

(1 mark)

6

5 Radiologists consider many different factors when selecting a radioisotope to use as an implant. One of these factors is the half-life.

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

.....

(1 mark)

5 (a) (ii) Radioisotope **A** has a half-life of 6 hours.
A hospital has 4 g of active radioisotope **A** available.
Assuming that none of it was actually used, how much active radioisotope **A** would be left 18 hours later?

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(2 marks)

5 (a) (iii) The activity of a second radioisotope, **B**, falls from 200 counts per minute to 50 counts per minute over a period of 8 months. Calculate the half-life of radioisotope **B**.

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.....

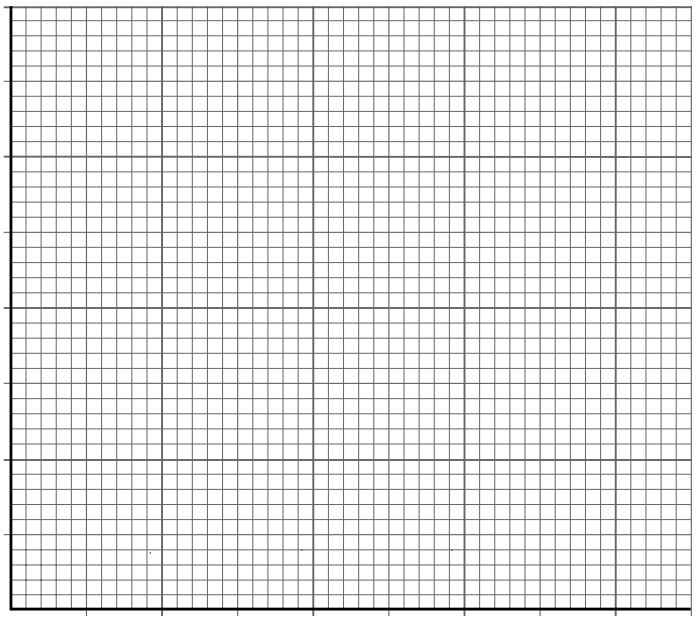
(2 marks)

A technician takes measurements of the activity of radioisotope **C** in order to measure its half-life.
The results obtained are shown in the table.

Time (days)	Activity (counts per minute)
0	350
10	225
20	140
30	90
40	50

5 (b) (i) Plot these results on the axes on **page 11**.
Draw a line of best fit.

Activity
(counts per minute)



(2 marks)

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

.....

Half-life of **C** = ...
(2 marks)

5 (c) The hospital usually prepares one of these three radioisotopes, **A**, **B**, **C**, when it is needed, rather than buying and storing it.
Which radioisotope is this most likely to be?
Explain the reasons for your choice.

Radioisotope .....

Reasons for choice .....

.....

.....

.....
(3 marks)

Question 5 continues on the next page

5 (d) Which **one** of the three radioisotopes, **A**, **B** or **C**, has the most suitable half-life for use as an implant? State **two** reasons for your choice.

Radioisotope .....

Reason 1 .....

.....

Reason 2 .....

.....

(3 marks)

All three radioisotopes **A**, **B** and **C** are thought to emit beta radiation only.

5 (e) (i) Design an experiment you could carry out to decide if a radioisotope emits *only beta* radiation.
State the equipment you would use.
Explain what you would do.
Explain how the results of your experiment would tell you whether the sample emitted beta radiation **only** and not alpha or gamma radiation.
You may use diagrams to illustrate your answer.

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(5 marks)

5 (e) (ii) Suggest and explain a source of error in your experiment.

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(2 marks)

5 (f) Radioisotopes used as implants should emit as little gamma radiation as possible. Explain why.

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(3 marks)

Radioisotope **D** has a physical half-life of 12 days and a biological half-life of 4 days.

5 (g) (i) Calculate the effective half-life of radioisotope **D**.

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(3 marks)

5 (g) (ii) Explain why its effective half-life is less than its physical half-life.

.....

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(1 mark)

29

6 Consultants often recommend ultrasound scans to investigate medical conditions.

6 (a) (i) What is the minimum frequency of a sound wave that can be described as ultrasound?

.....

(1 mark)

6 (a) (ii) Calculate the speed of an ultrasound wave, frequency 60 000 Hz, which has a wavelength of 0.006 m, when it travels through soft tissue.

.....

.....

.....

Speed = ...

(3 marks)

6 (b) (i) During an ultrasound scan a coupling agent is used between the transmitter and the skin.
How should the value of the acoustic impedance, Z, of the coupling agent compare with the value of the acoustic impedance of the patient's skin?

.....

.....

(1 mark)

6 (b) (ii) Use the data below to calculate the intensity reflection coefficient (α) for ultrasound waves travelling from fat into muscle.

Material	**Acoustic impedance Z (kg/m²/s)**
Fat	1.38×10^6
Muscle	1.70×10^6

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(3 marks)

A patient has a heart defect. A consultant recommends that this heart defect is investigated using ultrasound.

6 (c) (i) Suggest **two** reasons why the consultant recommends using ultrasound rather than X-rays to investigate this condition.

Reason 1 .....

.....

Reason 2 .....

.....

(2 marks)

6 (c) (ii) There are two different methods of carrying out an ultrasound scan of the heart.

Method 1: The transmitter is placed on the patient's chest. A coupling agent is used between the transmitter and the patient's skin. The ultrasound scan is then carried out externally.

Method 2: The patient swallows a long insulated cable with the transmitter attached. The transmitter is moved down the gullet until it is level with the heart. The ultrasound scan is then carried out internally.

Suggest and explain **one** advantage of using each method.

Advantage of Method 1 .....

Explanation .....

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Advantage of Method 2 .....

Explanation .....

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(4 marks)

Question 6 continues on the next page

6 (d) Heart defects can also be investigated using thermography rather than ultrasound. State and explain **one** advantage of using thermography rather than ultrasound for investigating this condition.

Advantage .....

Explanation .....

(2 marks)

16

END OF QUESTIONS