Surname		Other Names	
Centre Number			Candidate Number				
Candidate Signature									

For Examiner's Use

General Certificate of Education
January 2007
Advanced Level Examination

ASSESSMENT and QUALIFICATIONS ALLIANCE

APPLIED SCIENCE **SC08**
Unit 8 Medical Physics

Tuesday 23 January 2007 9.00 am to 10.30 am

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			
4			
Total (Column 1) →			
Total (Column 2) →			
TOTAL			
Examiner's Initials			

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

1 A medical technician is using an EEG machine to study a patient's brain activity. To do this, she attaches electrodes to the patient's skin.

(a) How does the technician ensure that there is good electrical contact between the electrodes and the skin?

.....

.....

(1 mark)

(b) Why is it important for the patient to keep still while the EEG is taken?

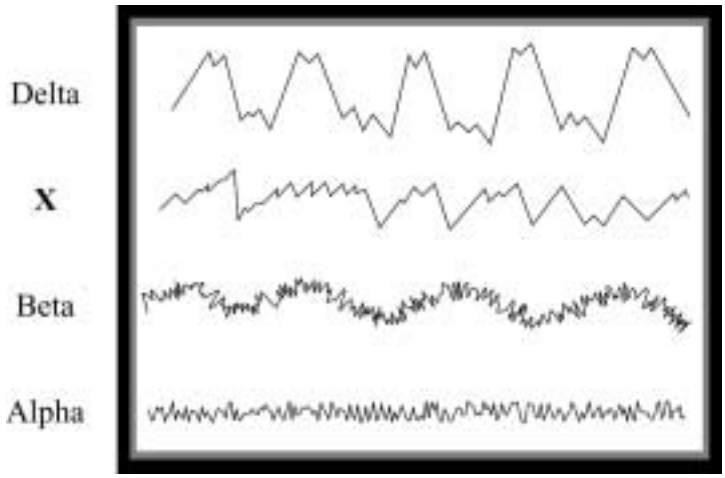
.....

.....

.....

(2 marks)

(c) A typical set of EEG traces is shown below.



(i) What type of wave is shown by trace **X**?

.....

(1 mark)

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(ii) When do beta waves normally occur?

.....

(1 mark)

(iii) When do delta waves normally occur?

.....

(1 mark)

6

Turn over for the next question

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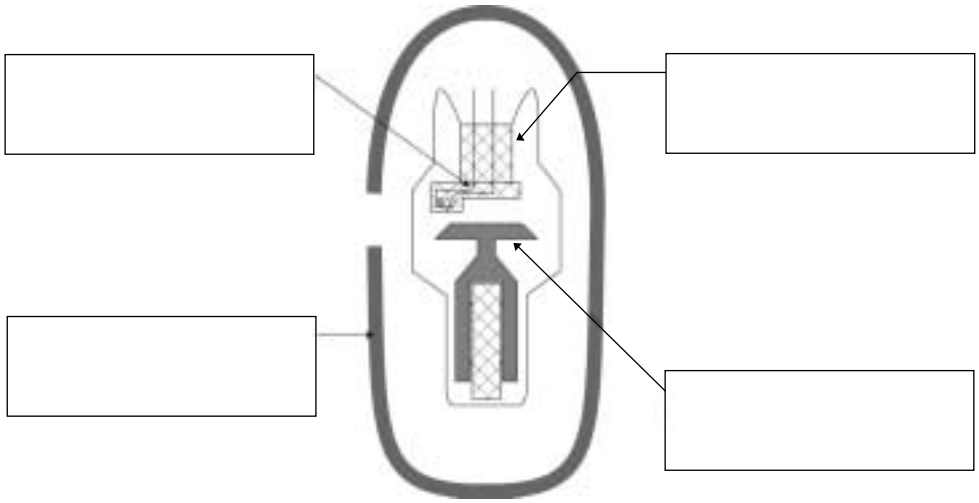
2 Radiographers use X-rays to help diagnose many medical conditions.

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



(i) Add the correct label to each part indicated in the diagram above.

(4 marks)

(ii) Explain how the anode is prevented from overheating.

.....

.....

.....

(2 marks)

(b) X-rays are very dangerous.

(i) State **one** precaution that the radiographer takes to protect the patient who is receiving X-rays.

.....

.....

(1 mark)

(ii) Explain how this precaution protects the patient.

.....

.....

(1 mark)

LEAVE MARGIN BLANK

(iii) State **one** medical problem or condition that can be caused by over exposure to X-rays.

.....

.....

(1 mark)

(iv) The terms *stochastic* and *somatic* can be used to describe the types of damage caused by X-rays.
State what each term means.

Stochastic .....

.....

Somatic .....

.....

(2 marks)

(c) Although X-rays are very dangerous, they are still often the first choice of diagnostic technique because they produce high contrast images.

(i) What is meant by *high contrast*?

.....

.....

(1 mark)

(ii) Explain how high contrast X-ray images are achieved.

.....

.....

.....

(2 marks)

(d) CAT scans make use of X-rays.
State **two** reasons why standard X-rays are used much more frequently than CAT scans.

Reason 1 .....

.....

Reason 2 .....

.....

(2 marks)

16

LEAVE MARGIN BLANK

3 Radiologists use radioisotopes for both diagnosis and therapy.
The choice of radioisotope to be used for a particular task often depends on its half-life.

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

.....

.....

(1 mark)

(ii) Radioisotope **A** has a half-life of 6 hours.
A hospital has 2 g of active radioisotope **A** available at a particular time.
Assuming none was used, how much active radioisotope **A** would be left 24 hours later?

.....

.....

.....

(2 marks)

(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.

.....

.....

.....

(2 marks)

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

Time (months)	**Activity (counts per minute)**
0	700
2	450
4	275
6	175
8	100

(i) Plot these results on the grid on **page 7**.
Draw a line of best fit.

(2 marks)

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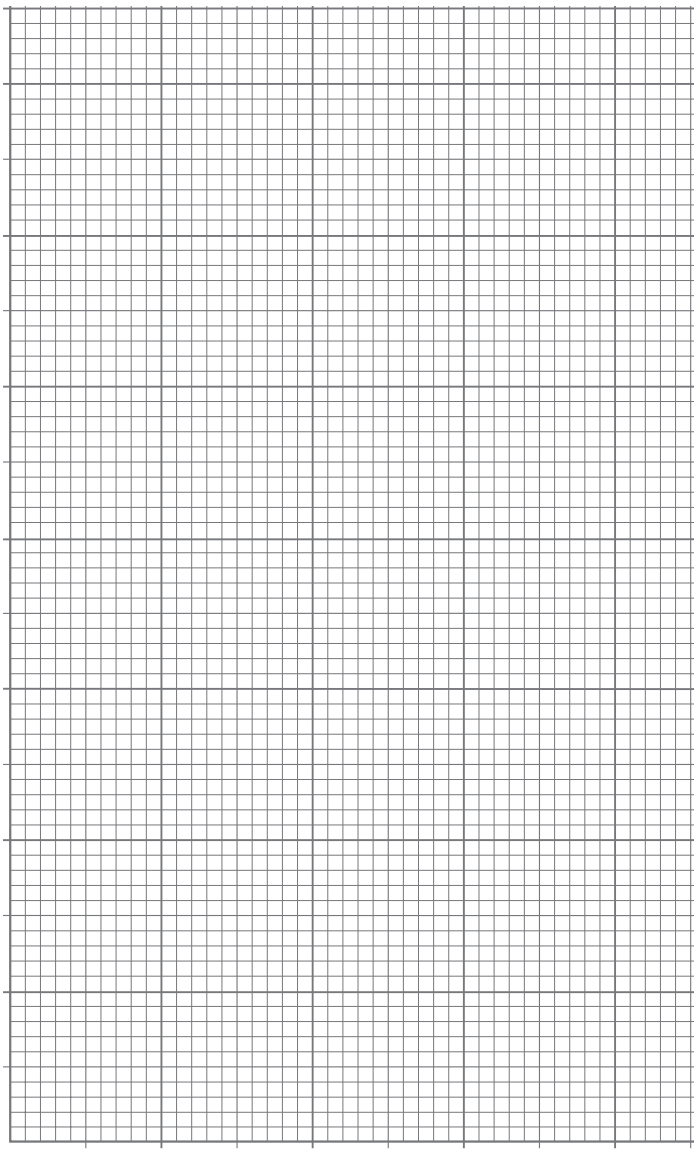
Activity (counts per minute)



Time (months)

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

.....

half-life =.....months

(*2 marks*)

(c) (i) Give **two** reasons why radioisotope **B** has a suitable half-life for use as a tracer.

Reason 1 .....

.....

Reason 2 .....

.....

(2 marks)

Question 3 continues on the next page

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(ii) Both radioisotopes **A** and **B** are believed to emit gamma radiation only.
Design an experiment you could carry out to test whether a radioisotope emits only gamma radiation.

Explain what you would do and how the results of your experiment would tell you whether the sample emitted gamma radiation only and not alpha or beta radiation.
Suggest a possible source of error in your experiment.
You may use diagrams to illustrate your answer.

Experiment .....

.....

.....

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.....

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.....

Possible source of error .....

.....

.....

(4 marks)

LEAVE MARGIN BLANK

(d) Radioisotopes used as tracers must emit gamma radiation and should emit little or no alpha or beta radiation.
Explain why.

.....

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.....

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(4 marks)

(e) Radioisotope **A** has a suitable half-life and emits only gamma radiation. However, a medical physicist decides that it is **not** suitable to use as a tracer.
State and explain **two** possible reasons for this decision.

Reason 1 .....

Explanation .....

.....

Reason 2 .....

Explanation .....

.....

(4 marks)

(f) Radioisotope **C** has a physical half-life of 8 days.
When radioisotope **C** is in the human body its effective half-life is measured as 6 days.
Use this information to calculate the biological half-life of radioisotope **C**.

.....

.....

.....

.....

.....

(3 marks)

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4 Manufacturers of optical instruments know that endoscopes must be made from glass fibres with a high refractive index. A technician is testing a new type of glass to find out if its refractive index would make it suitable to use in an endoscope.

He found the critical angle, *c*, to be 48°.

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

.....

.....

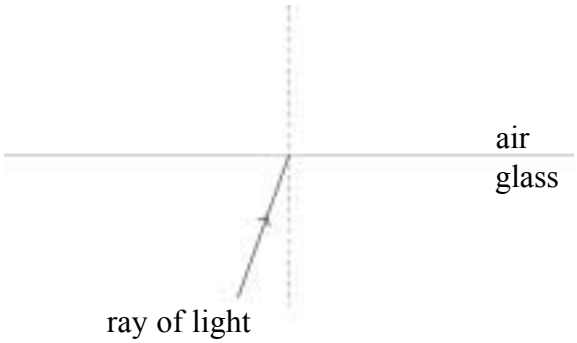
.....

n = ...

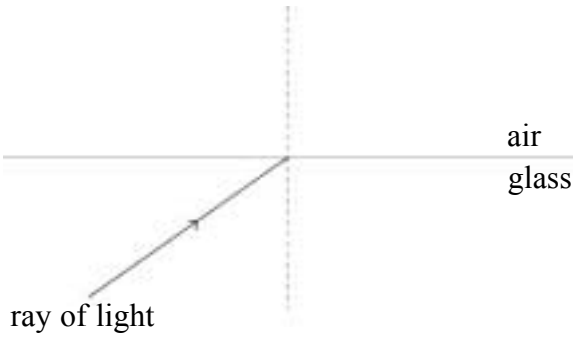
(3 marks)

(b) Complete the diagrams below to show what will happen to a ray of light that hits the glass – air boundary at an angle that is

(i) smaller than the critical angle,



(ii) larger than the critical angle.



(4 marks)

LEAVE MARGIN BLANK

(c) Use your answers to parts (b)(i) and (ii), and ideas about critical angle, to explain why an endoscope would not work well if it were made from glass with a low refractive index.

.....

.....

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(4 marks)

(d) The glass fibres inside endoscopes are coated in cladding.

(i) Why is cladding used?

.....

.....

(1 mark)

(ii) How should the refractive index of the cladding compare with the refractive index of the glass used to make the internal fibres?

.....

.....

(1 mark)

(e) Suggest **one** medical condition that can be investigated using an endoscope.

.....

(1 mark)

14

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5 Ultrasound can be used for both diagnosis and therapy.

(a) Explain what is meant by the term *ultrasound*.

.....

.....

.....

.....

(2 marks)

(b) (i) During a foetal scan a coupling agent is used between the ultrasound transmitter and the skin.
Why is the coupling agent used?

.....

.....

.....

.....

(2 marks)

(ii) Short pulses of ultrasound are sent into the abdomen of a pregnant woman to check on the development and growth of the foetus.
Describe fully how this enables an image of the foetus to be produced.

.....

.....

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.....

(4 marks)

LEAVE MARGIN BLANK

(c) Thermography is becoming an increasingly popular diagnostic technique.

(i) How does thermography work?

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.....

.....

.....

(2 marks)

(ii) Why is thermography considered to be a completely safe diagnostic technique?

.....

.....

(1 mark)

11

Turn over for the next question

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6 A nurse in a health centre frequently measures the blood pressure of patients. One patient, a 20-year-old male, has a blood pressure of 145/90 mmHg.

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

.....

(1 mark)

(ii) What do the figures 145 and 90 represent?

145 is .....

90 is .....

(2 marks)

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

Advantage of using a non-invasive method.

.....

.....

.....

Disadvantage of using a non-invasive method.

.....

.....

.....

(2 marks)

LEAVE MARGIN BLANK

(c) A patient is in intensive care after losing a great deal of blood in a road accident. His blood pressure gives a good indication of whether he is bleeding internally.
Two non-invasive methods of measuring blood pressure are available.
Method **A** involves a nurse measuring the blood pressure regularly then recording it on a chart placed at the foot of the bed.
Method **B** measures the blood pressure electronically. Continuous measurements are taken and displayed on a VDU. It is also possible to connect an audible alarm to the output.
Which method would you recommend for this patient? Explain your choice.

Method .....

Explanation .....

.....

.....

(2 marks)

7

END OF QUESTIONS

There are no questions printed on this page

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