Surname		Other Names	
Centre Number			Candidate Number	
Candidate Signature			

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General Certificate of Education
2010
Advanced Level Examination

AQA
ASSESSMENT and QUALIFICATIONS ALLIANCE

APPLIED SCIENCE SC08
Unit 8 Medical Physics

Specimen Paper

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 space 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 marks for the questions are shown in brackets.
- The maximum mark for this paper is 80.
- You are expected to use a calculator where appropriate.
- You will be marked on your ability to
  - use good English
  - organise information clearly
  - use specialist vocabulary where appropriate.

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

This specimen paper (based on SC08 – June 2008) has been modified to show how quality of written communication (QWC) and stretch and challenge will be incorporated into operational papers from January 2010.

In this paper QWC is assessed in: **Question 4(b) and Question 5(e)(i)**.

There are no discrete marks for QWC and in the final answer QWC will be one of the criteria used to assign a mark. Please refer to the appropriate mark scheme.

SC08

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

1 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.

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

……

(*1 mark*)

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

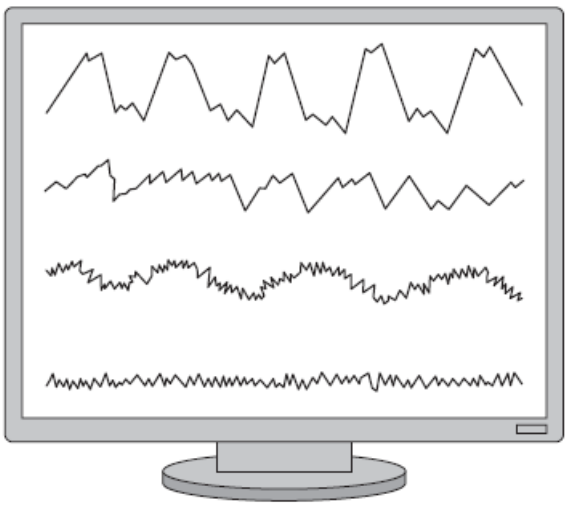
……

……

(*2 marks*)

1 (c) A typical set of traces of brain activity is shown.

X



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

……

(*1 mark*)

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

……

(*1 mark*)

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

……

(*1 mark*)

6

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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.

……

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(*1 mark*)

2 (b) Laser light is dangerous.
Discuss the precautions that should be taken when lasers are being used.

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(*3 marks*)

5

Turn over for the next question

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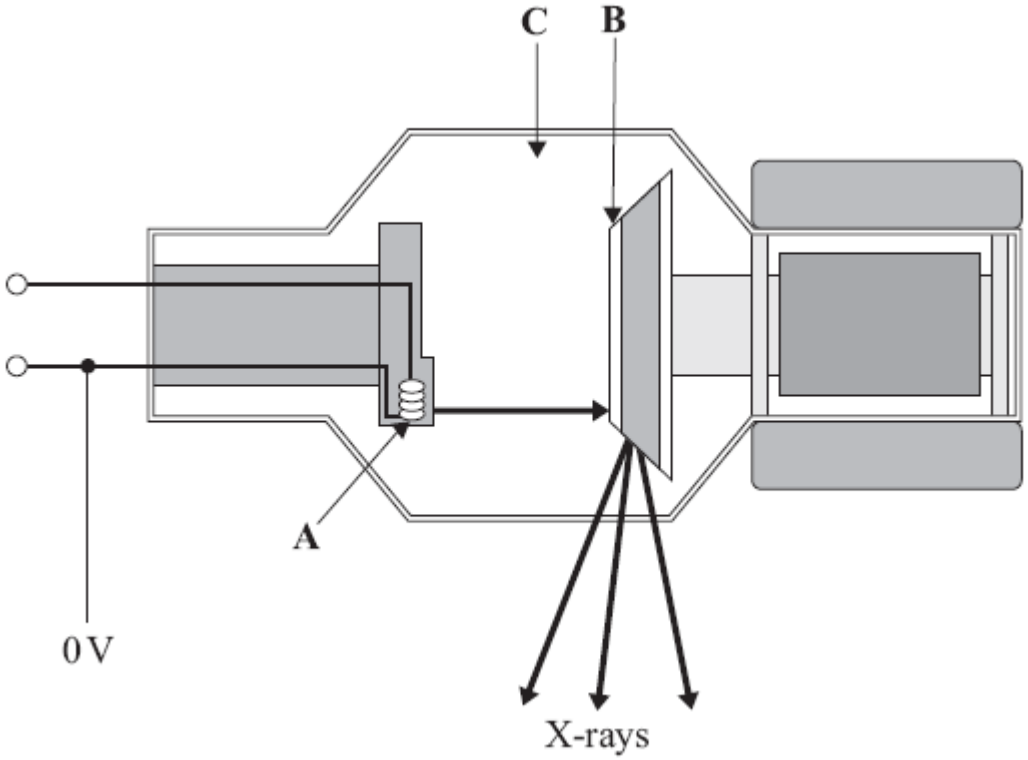
3 Radiographers use X-rays to help diagnose many medical conditions.

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



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

Label	Name	Function
B	anode	
		prevent electrons colliding with air particles

(*3 marks*)

3 (b) Working with X-rays is dangerous so suitable precautions must be taken.

State **one** precaution that the radiographers take to protect themselves when using X-rays.

……

……

(*1 mark*)

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

Definition	Term
Damage is caused to the 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*)

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*)

Question 3 continues on the next page

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3 (e) CAT scans use X-rays.
Briefly compare and contrast CAT scans with standard X-ray procedures.

……

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(*4 marks*)

16

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

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

……

……

……

……

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(*3 marks*)

4 (a) (ii) Use your knowledge of heat transfer to 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.

……

……

……

……

(*2 marks*)

Question 4 continues on the next page

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4 (b) The 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.

A nurse suggests using an electronic digital thermometer, taped to the patient's forehead. The thermometer readings could be automatically recorded and stored and the thermometer could be connected to an audible alarm that would sound if the patient's temperature went outside an acceptable range.

Discuss the nurse's suggestion giving the advantages and disadvantages of using an electronic thermometer compared with using a liquid-in-glass clinical thermometer in this situation.

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

……

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(*5 marks*)

10

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) Radioisotope **A** has a half-life of 6 hours.
A hospital has 4g 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) (ii) 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**.

……

……

……

……

(*2 marks*)

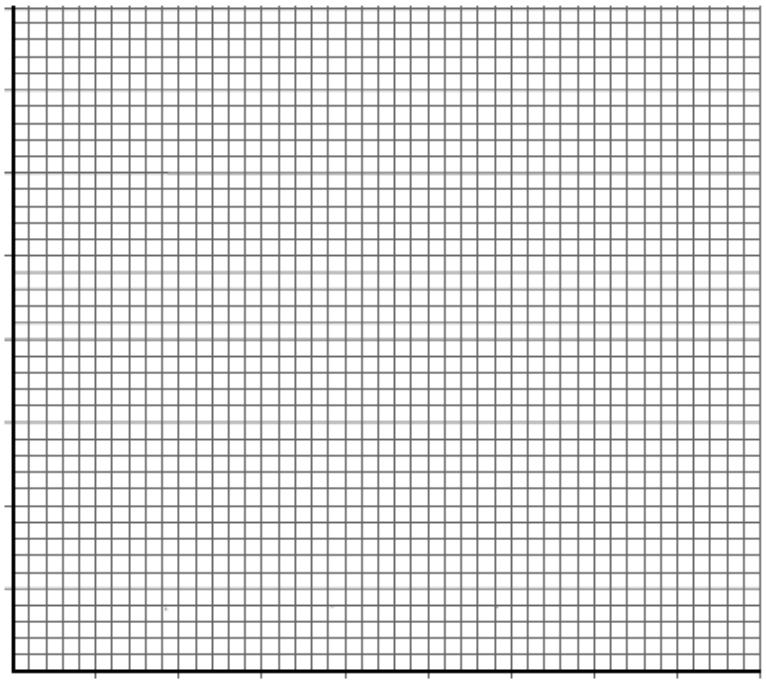
Question 5 continues on the next page

5 (b) 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 below.
Draw a line of best fit.

Activity
(counts per minute)



Time (days)

(*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) 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*)

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

Radioisotope ……

Reasons ……..……

……

……

……

(*3 marks*)

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

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(*5 marks*)

Question 5 continues on the next page

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

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(*2 marks*)

5 (f) Discuss why radioisotopes used as implants should emit as little gamma radiation as possible.

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(*3 marks*)

5 (g) 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*)

27

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 000Hz, which has a wavelength of 0.006m, when it travels through soft tissue.

……

……

……

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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 in the table to calculate the intensity reflection co-efficient (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*)

Question 6 continues on the next page

6 (c) 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.

Compare the advantages of each method.

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(*4 marks*)

LEAVE MARGIN BLANK

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

There are no questions printed on this page

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED