Surname		Other Names	
Centre Number			Candidate Number									
Candidate Signature												

For Examiner's Use

General Certificate of Education
June 2009
Advanced Level Examination

AQA

APPLIED SCIENCE **SC08**
Unit 8 Medical Physics

Tuesday 2 June 2009 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. 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 you do not want to be marked.

Information
- The marks for questions are shown in brackets.
- The maximum mark for this paper is 80.

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 Nurses may monitor body temperature to track the progress of a disease.

1 (a) (i) Tick the box below which best represents the range of normal body temperature.

35.2 to 38 °C		35.2 to 37.2 °C	
36.5 to 37.2 °C		36.5 to 38 °C	

(1 mark)

1 (a) (ii) What name is given to the medical condition in which a patient's core body temperature is too low?

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(1 mark)

1 (a) (iii) Why is it important to measure the patient's core body temperature rather than their surface temperature?

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(2 marks)

1 (b) A liquid-in-glass clinical thermometer can be used to measure body temperature.

1 (b) (i) Explain how a liquid-in-glass clinical thermometer works.

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(2 marks)

1 (b) (ii) Why does a liquid-in-glass clinical thermometer need to have an inner tube with a much narrower bore than a laboratory thermometer?

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(2 marks)

Question 1 continues on the next page

1 (c) Electronic clinical thermometers can be used instead of liquid-in-glass thermometers. An advertisement for one type of electronic clinical thermometer is shown below.

> **The thermometer that has everything you need!**
>
> **Our new electronic digital thermometer has all these fantastic features to make your life easier:**
>
> - ✓ Large, clear LCD display
> - ✓ Records up to 10 readings which it holds in its memory
> - ✓ Can be inserted in the ear or mouth
> - ✓ Measures temperature in one second

1 (c) (i) Use the information in the advertisement to explain why this electronic clinical thermometer might be preferred to a liquid-in-glass thermometer in the following situations.

- Where the patient is a 2-year-old child.

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(2 marks)

- Where the patient has a fever which needs to be monitored regularly.

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(2 marks)

1 (c) (ii) Use the information in the advertisement to suggest **one** precaution the nurse would need to take if he were using the same thermometer on several different patients.

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(1 mark)

1 (d) Most electronic thermometers use thermistors.

1 (d) (i) What property of the thermistor changes with temperature?

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(1 mark)

1 (d) (ii) Explain how this change enables the thermistor to measure different temperatures.

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(2 marks)

1 (e) Electronic thermometers are not necessarily more accurate than liquid-in-glass thermometers.
State **one** factor that determines how accurate the temperature reading given by an electronic thermometer is.

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(1 mark)

17

2 Doctors can use radioisotopes for both diagnosis and therapy.

2 (a) What does the term *radioisotope* mean?

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(1 mark)

2 (b) Draw a line from each radioisotope to show a common use for it.

Radioisotope	**Use**
Iridium-192	General therapy
Cobalt-60	Treating thyroid cancer
Iodine-131	Implants to treat breast cancer

(3 marks)

2 (c) Why is it important that radioisotope implants used to treat cancer have a long half-life?

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(2 marks)

2 (d) Technetium-99 has a physical half-life of 6 hours.

2 (d) (i) Explain why technetium-99 is usually made on site rather than being bought in and stored.

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(1 mark)

2 (d) (ii) Calculate how long it would take for a 200 g sample of active technetium-99 to decay to 25 g of active technetium-99.

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(2 marks)

2 (d) (iii) Suggest why technetium-99 is suitable for use as a medical tracer.

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(2 marks)

Question 2 continues on the next page

2 (e) Other factors make technetium-99 suitable for use as a medical tracer.

Explain why each of the factors below is important for a radioisotope that is used as a medical tracer.

2 (e) (i) It emits gamma radiation.

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(2 marks)

2 (e) (ii) Neither the radioisotope nor its daughter products are toxic.

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(2 marks)

2 (f) Some radioisotopes have an organ affinity.

Explain what the term *organ affinity* means.

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(1 mark)

16

3 There are many techniques that doctors can use to produce images of internal organs.

3 (a) One of these imaging techniques is thermography.
Explain what thermography is and how it can be used to identify medical problems.

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(3 marks)

3 (b) Ultrasound scanning is another imaging technique.
Explain how ultrasound is used to produce an image of internal organs.
Use the terms *transmission*, *reflection*, *density* and *acoustic impedance* in your explanation.

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(5 marks)

Question 3 continues on the next page

3 (c) X-rays can also be used to produce images of internal organs.

3 (c) (i) What is the main difference between the way in which X-ray images are produced and the way in which ultrasound images are produced?

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(2 marks)

3 (c) (ii) Explain why

- X-rays usually produce poor images of soft tissue.

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- the use of contrast media can improve the contrast in X-ray images of soft tissue.

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(3 marks)

3 (c) (iii) X-rays are dangerous. The terms below describe some of the types of effect that X-rays can have on tissue. Explain what each term means.

- *Stochastic*

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- *Somatic*

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(2 marks)

3 (c) (iv) State **two** factors that can affect the amount of damage caused by exposure to X-rays.

1 .....

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2 .....

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(2 marks)

3 (d) X-rays have a velocity of 3×10^8 m/s in a vacuum. Calculate the wavelength of X-rays which have frequency of 2×10^{19} Hz.

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Wavelength = ... m

(3 marks)

3 (e) Explain why thermography is a safer imaging technique than either ultrasound or X-rays.

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(1 mark)

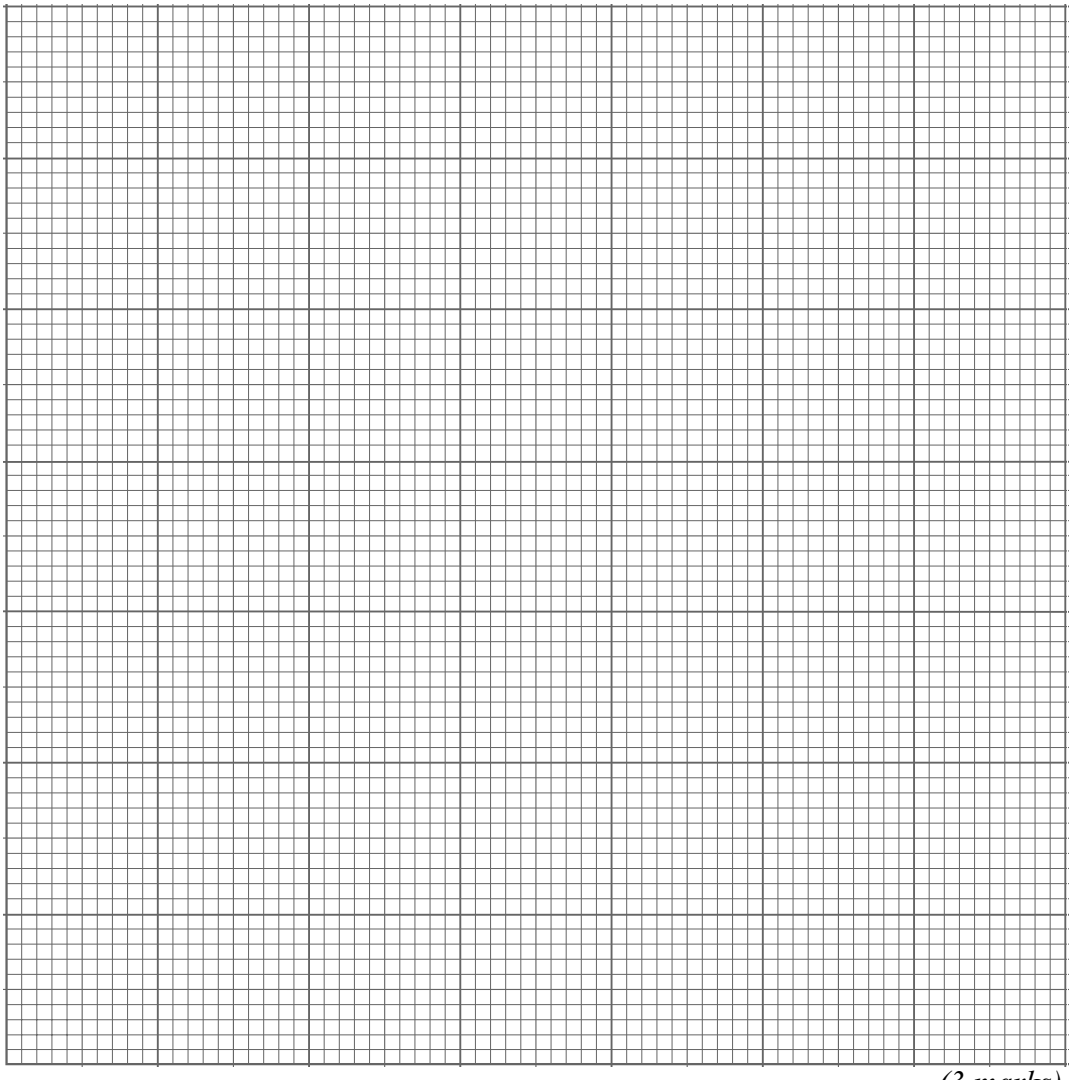
Turn over ▶

21

4 The half-value thickness (HVT) of a material is defined as 'the thickness of the material that reduces the intensity of an X-ray beam to half its original value'.
A materials technician is assessing the HVT of a new material that may be used to make artificial hip joints.
In her experiments, the technician collects the following results.

Thickness of material (mm)	**Intensity of the X-ray beam (keV)**
0	30
1	24
2	18
3	14
4	11
5	9
6	8

4 (a) (i) Plot these results on the grid below.



(3 marks)

4 (a) (ii) Use your graph to find

- the thickness of material that would give an intensity of 20 keV.

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- an accurate value for the HVT of the material.

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(3 marks)

4 (b) (i) Suggest a possible use for a material that has a low HVT value.

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(1 mark)

4 (b) (ii) Explain the reason for your suggestion.

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(1 mark)

8

Turn over for the next question

5 It is important to monitor the vital functions of patients who are seriously ill.
Some hospitals in the USA are trialling a new device that can monitor heart rate and breathing rate continuously.
This device is placed underneath the mattress of a hospital bed.
It is so sensitive that it can detect tiny changes, and can even alert hospital staff if a patient has fallen out of bed.

5 (a) Suggest and explain **two** advantages of using this new device to monitor patients continuously.

Advantage 1 .....

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Advantage 2 .....

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(4 marks)

5 (b) What name is given to the following conditions?

5 (b) (i) An abnormally slow heart rate.

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(1 mark)

5 (b) (ii) An abnormally fast heart rate.

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(1 mark)

6

6 People who work with radioisotopes need to understand the meaning of the term half-life.

6 (a) You have been asked to check the half-life of a radioisotope. According to a data book, this radioisotope has a half-life of 4 hours.

6 (a) (i) In addition to the radioisotope, state the equipment you would use.

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(1 mark)

6 (a) (ii) Draw a diagram to show how you would set up the equipment.

(1 mark)

6 (a) (iii) State how you would carry out your experiment and explain how you would ensure that the measurements you take are valid.

Method .....

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Precaution to ensure validity .....

(2 marks)

6 (a) (iv) State how frequently you would take measurements and explain how you reached this decision.

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(2 marks)

Question 6 continues on the next page

6 (a) (v) Explain how you would use your results to find the half-life of the radioisotope.

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(2 marks)

6 (a) (vi) Explain how you would ensure that your experiment was safe.

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(2 marks)

6 (b) (i) It can be argued that materials with long half-lives are more dangerous than those with short half-lives. Explain why this could be so.

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(1 mark)

6 (b) (ii) It can also be argued that materials with short half-lives are more dangerous than materials with long half-lives. Explain why this could be so.

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(1 mark)

12

END OF QUESTIONS