Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
TOTAL	

General Certificate of Education
Advanced Level Examination
June 2011

Applied Science SC08

Unit 8 Medical Physics

Thursday 26 May 2011 9.00 am to 10.30 am

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

Time allowed
- 1 hour 30 minutes

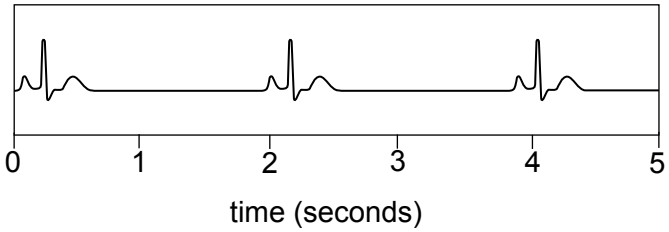
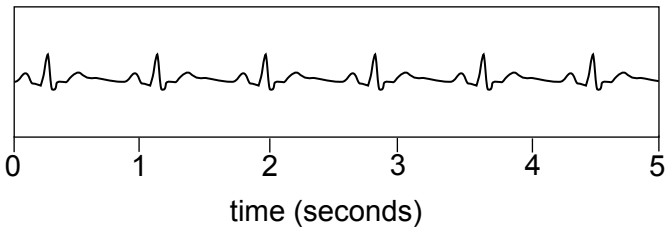
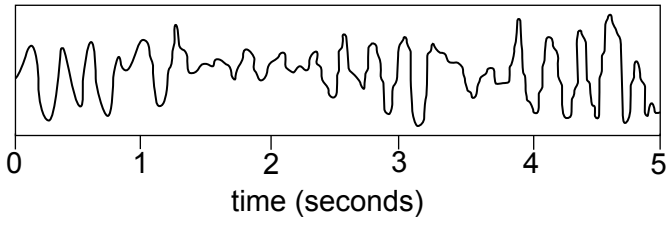
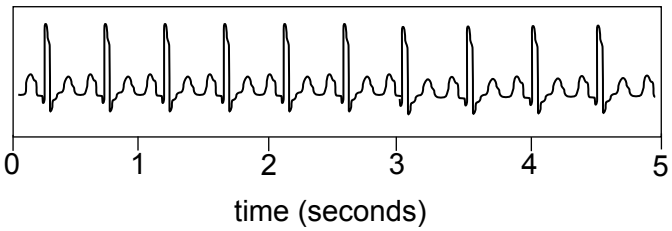
Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- Do all rough work in this book. Cross through any work you do not want to be marked.
- Show the working of your calculations.

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

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

1 A doctor is researching the effect of fright on the human body.
Some healthy university students have taken part.
The doctor carries out two tests on each student.

1 (a) Test 1 is an electrocardiogram test (ECG).
Draw a line from each ECG trace below to the condition it shows.

TRACE	CONDITION
	Ventricular fibrillation
	Tachycardia
	Bradycardia
	Normal heart

(3 marks)

1 (b) Test 2 is measurement of pulse rate.
What is the normal pulse rate range for a healthy young adult?

.....

(1 mark)

1 (c) The doctor considered doing other tests.
What is recorded by the following equipment?

1 (c) (i) Sphygmomanometer

.....

(1 mark)

1 (c) (ii) Spirometer

.....

(1 mark)

1 (c) (iii) Electroencephalograph (EEG)

.....

(1 mark)

7

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 Radiographers use X-rays to help in the diagnosis of many medical conditions.

2 (a) What are X-rays?

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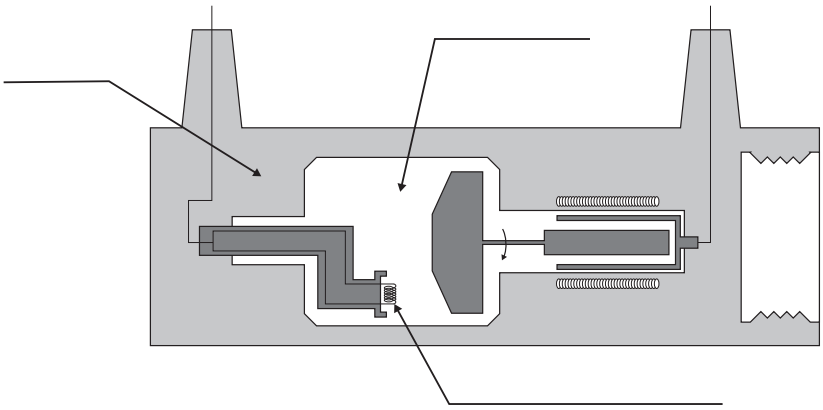
.....

(2 marks)

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



2 (b) (i) Add the correct label to each part indicated.

(3 marks)

2 (b) (ii) Explain why rotating the anode stops the anode overheating.

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.....

.....

(1 mark)

2 (b) (iii) If the anode becomes hot it will lose heat to its surroundings.
Which heat transfer mechanism is most likely to be used to do this?
Explain the reason for your answer.

Heat transfer mechanism used .....

Explanation .....

.....

(2 marks)

8

3 Doctors sometimes use CAT scans to help in diagnosis. CAT scans involve the use of X-rays.

3 (a) What does *diagnosis* mean?

.....

(1 mark)

3 (b) X-rays are very dangerous.

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

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(1 mark)

3 (b) (ii) State **one** precaution a radiographer takes to protect themselves when they are X-raying patients.

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(1 mark)

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

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(1 mark)

3 (b) (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 .....

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Somatic .....

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(2 marks)

3 (c) Although X-rays are very dangerous, they are still commonly used because they produce high contrast images.

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

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(1 mark)

3 (c) (ii) Explain why X-rays can produce high contrast images of bones but cannot produce high contrast images of soft tissue.

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(3 marks)

3 (d) CAT scans make use of X-rays.
Critically evaluate the use of CAT scans compared with the use of standard X-rays to diagnose a spinal injury.
To gain full marks you will need to comment on both the advantages and disadvantages of using CAT scans in these circumstances.

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(4 marks)

14

4 Radiologists and radiographers use a wide range of radioisotopes.
The choice of radioisotope to be used for a particular task often depends on the half-life of the radioisotope.

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

.....

.....

(1 mark)

4 (a) (ii) Radioisotope **A** has a half-life of 12 hours.
A hospital has 4 g of active radioisotope **A** available.
Assuming none was used, how much active radioisotope **A** would be left 48 hours later?

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(2 marks)

4 (a) (iii) The hospital usually prepares radioisotope **A** when it is needed, rather than buying and storing it.
State and explain **one** reason why this is a sensible thing to do.

Reason .....

Explanation .....

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(2 marks)

4 (b) Is radioisotope **A** more likely to be used as a tracer for diagnosis or as an implant for cancer treatment? Explain your answer.

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(2 marks)

4 (c) Explain why radioisotopes used as tracers must emit gamma radiation and should **not** emit any alpha or beta radiation.

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(3 marks)

4 (d) Another radioisotope, **B**, has a half-life that makes it suitable for use as a tracer and it emits gamma radiation only.
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 .....

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Reason 2 .....

Explanation .....

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(4 marks)

14

Turn over for the next question

5 Doctors use many different methods to treat cancerous tumours. These include chemotherapy, surgery and radiotherapy. Radiotherapy may be in the form of external radiotherapy (where an external radioactive source is rotated around the body) or internal radiotherapy (e.g. implants).

All these methods are effective but can have side effects and risks.
For this reason, medical researchers are looking for new types of treatment.

One new method being developed involves injecting tiny tubes, called nanotubes, into the cancerous tumour to be treated. Nanotubes are thousands of times narrower than a single hair and much too small to be seen by the naked eye. Nanotubes are made from a material which is very strong and is a very good conductor of heat.

Once the nanotubes have been implanted, radio waves are sent into the body, aimed at the tumour. The nanotubes become very hot when radio waves hit them. Scientists think a two or three minute burst of radio waves would make the nanotubes become hot enough to destroy the cancerous cells in the tumour.

Radio waves are low frequency electromagnetic waves which penetrate the body easily and have no known damaging effects on the tissues they pass through.

Use the information in the passage above and your own knowledge to answer the questions below.

5 (a) State and explain **one** advantage of:

5 (a) (i) using nanotubes rather than external radiotherapy to treat cancerous tumours.

Advantage .....

Explanation .....

.....

.....

.....

(2 marks)

5 (a) (ii) using nanotubes rather than internal radiotherapy to treat cancerous tumours.

Advantage .....

Explanation .....

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(2 marks)

5 (a) (iii) using nanotubes rather than surgery to treat cancerous tumours.

Advantage .....

Explanation .....

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(2 marks)

5 (b) State **one** advantage of using external radiotherapy rather than internal radiotherapy, surgery or nanotubes to treat cancerous tumours.

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(1 mark)

7

Turn over for the next question

6 Nuclear physicists have discovered a new isotope. It is radioactive and is believed to emit beta radiation only.

6 (a) Design an experiment you could do to test if the radioisotope emits only beta radiation.
Explain what you would do and how the results of your experiment would tell you whether the sample emitted beta radiation only.

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

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(5 marks)

6 (b) Suggest **one** possible source of error in your experiment and explain how this error can be reduced.

Possible source of error .....

How the error can be reduced .....

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.....

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(2 marks)

6 (c) State **two** safety precautions you would take when doing this experiment.

Precaution 1 .....

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Precaution 2 .....

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(2 marks)

9

Turn over for the next question

7 A technician investigated if the refractive index of a new type of glass would make it suitable to use in an endoscope.
To do this, he calculated the critical angle for a sample of the glass.

7 (a) What is meant by *critical angle*?

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(1 mark)

7 (b) The technician looked up the refractive index of the glass sample on the manufacturer's website. The glass sample had a refractive index of 1.25.

Calculate the critical angle, *c*, for this glass sample.

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c = ...

(3 marks)

7 (c) Explain why an endoscope needs to be made from glass that has a small critical angle.

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(3 marks)

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

7 (d) (i) Why is the cladding used?

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(1 mark)

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

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(1 mark)

7 (e) Endoscopes are often used to check if a patient has a stomach ulcer.

7 (e) (i) How would the endoscope be inserted into the body in order to do this?

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(1 mark)

7 (e) (ii) Suggest **one** other method a doctor could use to check if a patient has a stomach ulcer and explain why endoscopy may be preferred to the method you have chosen.

Method: .....

Why endoscopy may be preferred: .....

.....

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.....

(2 marks)

12

Turn over for the next question

8 Doctors often request ultrasound scans so that they can investigate soft tissue damage.

8 (a) Explain what is meant by *ultrasound*.

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(2 marks)

8 (b) (i) What is a coupling agent?

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(1 mark)

8 (b) (ii) Why is a coupling agent used when ultrasound scans are carried out?

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(1 mark)

8 (c) A pregnant woman is having a foetal scan. Short pulses of ultrasound are sent into her abdomen to check on the development and growth of the foetus.
Describe fully how this enables an image of the foetus to be produced.

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

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(5 marks)

9

END OF QUESTIONS