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	
TOTAL	

General Certificate of Education
Advanced Level Examination
June 2010

Applied Science SC08

Unit 8 Medical Physics

Monday 7 June 2010 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 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 Doctors have a wide range of equipment available to help them to diagnose or monitor medical conditions.

1 (a) Draw a line from each condition to the equipment that would be used to diagnose or monitor that condition.

Condition	Diagnostic / monitoring equipment
Heart valve malfunction	Sphygmomanometer
Hypothermia	Spirometer
High blood pressure	Electroencephalogram
Coma	MRI scanner
Breathing difficulty	Thermometer

(5 marks)

1 (b) At what value of core body temperature is a patient diagnosed as having a fever?

..... °C

(1 mark)

1 (c) (i) Heart activity can be monitored using an electrocardiogram (ECG). Explain why patients are asked to keep still, while ECG traces are being taken.

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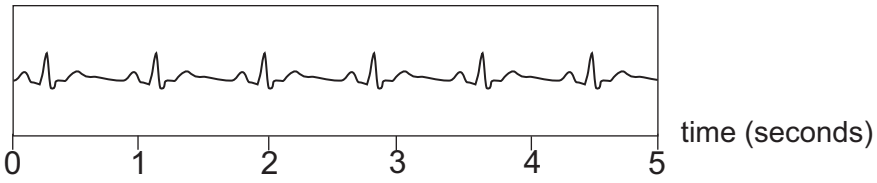
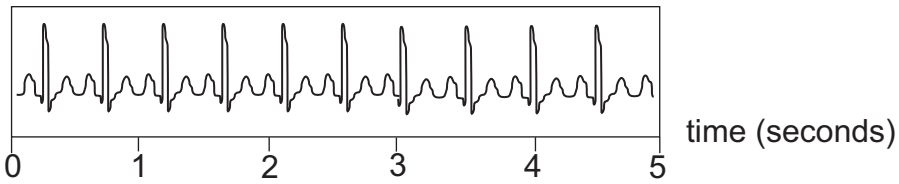
(2 marks)

1 (c) (ii) Which of the ECG traces below, **A**, **B** or **C**, would you expect to see if you were monitoring a patient suffering from bradycardia?

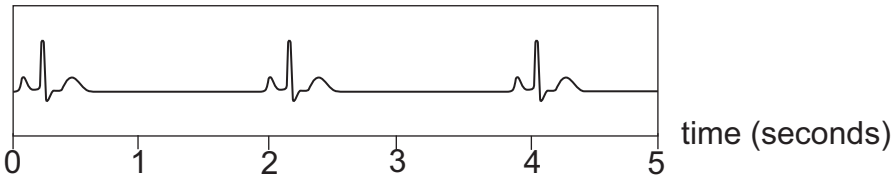
A



B



C



Bradycardia is shown in trace .....

(1 mark)

1 (d) (i) A patient has his blood pressure measured. The nurse tells him it is 120/80. State what each of these values is called.

120 is called the ……. pressure

80 is called the ……pressure *(2 marks)*

1 (d) (ii) Use your knowledge of how the heart works to explain why blood pressure is represented by two numbers rather than one.

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(2 marks)

13

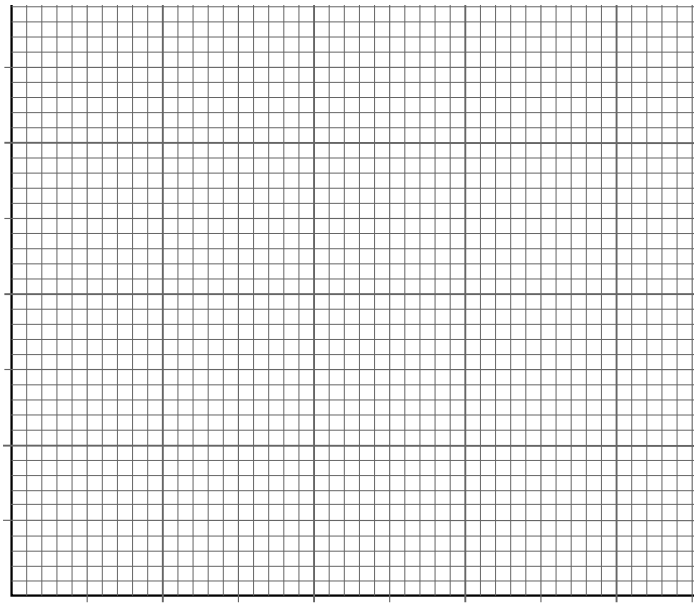
2 A glass-manufacturing company is developing a new type of glass for use in an endoscope.
A materials technologist carried out experiments to measure the refractive index of several types of glass that could be used. To do this she measured the angle of refraction *(r)* produced for different values of angle of incidence *(i*), looked up the sines of these angles and used these to calculate the refractive index *(n).*

The results for one type of glass are shown below

sin *i*	**sin *r***
0.17	0.12
0.34	0.22
0.51	0.36
0.68	0.49
0.85	0.60

2 (a) (i) Plot these results on the axes below. Draw a line of best fit.

sin *r*



sin *i*

(3 marks)

2 (a) (ii) Describe the relationship between sin *i* and sin *r* shown in your graph.

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(1 mark)

2 (b) (i) From these results, the materials technologist calculated that the sample of glass had a refractive index of 1.4.
Calculate the critical angle of the sample of glass.

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(3 marks)

2 (b) (ii) Explain why it is important for the glass used in an endoscope to have a small critical angle.

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(3 marks)

2 (c) (i) Give **one** example of a medical condition that could be diagnosed using an endoscope.

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(1 mark)

2 (c) (ii) Describe and explain how the endoscope is used in the example you have given.

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(2 marks)

13

3 A medical physics researcher needs to check the half-life of a radioisotope. From looking at a data book, she expects the radioisotope to have a half-life of about 4 hours.

3 (a) Design an experiment the researcher could carry out to measure the half-life of this radioisotope.
State the equipment she would use, how she would use it, the measurements she would take and how she would use these measurements to find the half-life of the radioisotope.

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

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(5 marks)

3 (b) Suggest a suitable time interval between the readings taken in this experiment.
Explain the reason for your choice.

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(3 marks)

3 (c) Other than using inappropriate time intervals between readings, state a possible source of error in this experiment and suggest how this error could be reduced.

Possible source of error.....

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Way of reducing the error.....

.....

(2 marks)

3 (d) State **two** safety precautions the researcher should take when carrying out this experiment.

Precaution 1 .....

.....

Precaution 2 .....

.....

(2 marks)

12

Turn over for the next question

4 Every year, several million people in the UK fracture at least one of their bones. Most of these fractures heal well but in some cases the fracture heals slowly or incorrectly.

Doctors need to monitor how well bones are healing after a serious fracture.
This has traditionally been done by recalling the patient to hospital every week or two to X-ray the affected bone.
A radiographer takes an X-ray image of the affected area. This image is then passed on to the doctor who compares it with earlier X-rays in order to decide how well healing is taking place.

A new method of monitoring recovery is now being trialled.
This involves a surgeon implanting an optical fibre device in the affected bone, near the fracture.
This device senses any small movements in the bone which could indicate problems with how the bone is healing. The information from the sensor is sent to a computer through a wireless Internet connection and relayed to the doctor.
Once the fracture has healed, the implanted device is removed.

4 (a) (i) State and explain **two** advantages of the new method compared with the traditional method.

Advantage 1 .....

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Advantage 2 .....

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(4 marks)

4 (a) (ii) State and explain **two** disadvantages of the new method compared with the traditional method.

Disadvantage 1 .....

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Disadvantage 2 .....

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(4 marks)

4 (b) It is also possible for CAT scans to be used to monitor how well fractures are healing.
Discuss the advantages and disadvantages of using CAT scans, rather than other methods, for this purpose.

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(3 marks)

11

Turn over for the next question

5 Ultrasound, MRI and CAT scans are used in hospitals to diagnose medical conditions.

5 (a) What is the minimum frequency of an ultrasound wave?

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(1 mark)

5 (b) MRI scans and CAT scans have several features in common but there are also important features which are different.
Compare and contrast the features of MRI and CAT scans.

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(4 marks)

5

6 Ultrasound scans are often used to investigate soft tissue problems. Ultrasound waves have a velocity of 330 m/s in air.

6 (a) An ultrasound wave with a wavelength of 0.0002 m is used to check the development of a foetus.

Calculate the frequency of the ultrasound wave. Include the correct unit in your answer.

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.....

.....

Frequency = ...

(3 marks)

6 (b) When ultrasound is used for diagnosis, the ultrasound waves reflect off boundaries between materials with different specific acoustic impedances.
The values of specific acoustic impedance for bone and soft tissue are given below:

Z (bone) = 8 000 000 kg m^{-2} s^{-2}
Z (soft tissue) = 1 600 000 kg m^{-2} s^{-2}

Calculate the intensity reflection coefficient (α) when ultrasound waves travel from bone into soft tissue.

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(3 marks)

Question 6 continues on the next page

6 (c) When using ultrasound to investigate soft tissue, a gel is placed on the patient's skin to ensure that there is no air between the ultrasound probe and the skin. Explain why this gel is used and why it is important that the gel has a value of specific acoustic impedance similar to the specific acoustic impedance of skin.

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(2 marks)

6 (d) Explain what X-rays are and why ultrasound is preferred to X-rays for monitoring foetal development.

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

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(5 marks)

13

Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

7 Radioisotopes have many uses in both the diagnosis and the treatment of medical conditions.
Radiographers need to select the most suitable radioisotope for their purpose.
The table gives data about a number of radioisotopes.

Radioisotope	Half-life	Type of radiation emitted
A	3 days	α, γ
B	8 months	α, β, γ
C	10 seconds	β
D	2 years	β
E	2 weeks	α, β, γ
F	1 hour	α, γ
G	1 day	γ
H	25 years	γ

7 (a) Select the radioisotope that is likely to be most suitable for each of the following uses. In each case, explain the reasons for your choice by considering both the half-life and type of radiation emitted by the radioisotope.

7 (a) (i) An implant to treat kidney cancer.

Radioisotope chosen .....

Reason for choice .....

.....

.....

(3 marks)

7 (a) (ii) A tracer to track the progress of blood through a major artery.

Radioisotope chosen .....

Reason for choice .....

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(3 marks)

7 (a) (iii) An external source used to irradiate a brain tumour from outside the body.

Radioisotope chosen .....

Reason for choice .....

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(3 marks)

7 (b) Doctors have to consider other factors when selecting a radioisotope to be used as a tracer or implant. One of these factors is *organ affinity*.

7 (b) (i) State what organ affinity means and explain why it has to be considered when choosing a radioisotope for medical use.

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(2 marks)

7 (b) (ii) Suggest **one** further factor that has to be considered when choosing a radioisotope for medical use and explain why it is important.

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(2 marks)

13

END OF QUESTIONS

There are no questions printed on this page

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