Centre No.						Paper Reference	Surname	Initial(s)
Candidate No.						5 0 4 9 / 0 1	Signature	

Paper Reference(s)

5049/01

Edexcel GCSE

Physics

P3 – Topics 5 and 6

Friday 27 May 2011 – Morning

Time: 1 hour

Examiner's use only

Team Leader's use only

Question Number	Leave Blank
1	
2	
3	
4	
5	
6	
7	
8	
9	
Total	

Materials required for examination	**Items included with question papers**
Calculator	Nil

Instructions to Candidates

In the boxes above, write your centre number, candidate number, your surname, initial(s) and signature.
Check that you have the correct question paper.
Answer ALL the questions. Write your answers in the spaces provided in this question paper.
Do not use pencil. Use blue or black ink.
Some questions must be answered with a cross in a box (☒). If you change your mind about an answer, put a line through the box (☒) and then mark your new answer with a cross (☒).
Show all stages in any calculations and state the units. Calculators may be used.
Include diagrams in your answers where these are helpful.

Information for Candidates

The marks for individual questions and the parts of questions are shown in round brackets: e.g. **(2)**.
There are 9 questions in this question paper. The total mark for this paper is 60.
There are 24 pages in this question paper. Any blank pages are indicated.

Advice to Candidates

You are reminded of the importance of clear English and careful presentation in your answers.

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FORMULAE

You may find the following formulae useful.

$$\frac{\text{pressure}}{\text{temperature (Kelvin)}} = \text{constant} \qquad \frac{P_1}{T_1} = \frac{P_2}{T_2}$$

$$\frac{\text{pressure} \times \text{volume}}{\text{temperature (Kelvin)}} = \text{constant} \qquad \frac{P_1 \times V_1}{T_1} = \frac{P_2 \times V_2}{T_2}$$

kinetic energy = electronic charge × accelerating voltage $\qquad KE = e \times V$

work done = force × distance moved in the direction of the force $\qquad W = F \times s$

$$\text{power} = \frac{\text{work done}}{\text{time taken}} \qquad P = \frac{W}{t}$$

$$\text{frequency} = \frac{1}{\text{time period}} \qquad f = \frac{1}{T}$$

$$\text{intensity} = \frac{\text{power of incident radiation}}{\text{area}} \qquad I = \frac{P}{A}$$

Leave blank

1. Scientists talk about different types of radiation.
Sometimes they mean streams of particles and sometimes they mean high frequency waves.
Draw a line from each description to the radiation it describes.

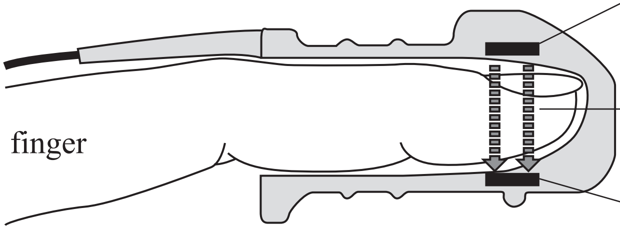
description	**radiation**
	neutron
particles with a negative charge	
	alpha
particles with a positive charge	
	beta
electromagnetic waves	
	gamma

Q1

(Total 3 marks)

Leave blank

2. (a) The diagram shows a pulse oximeter.



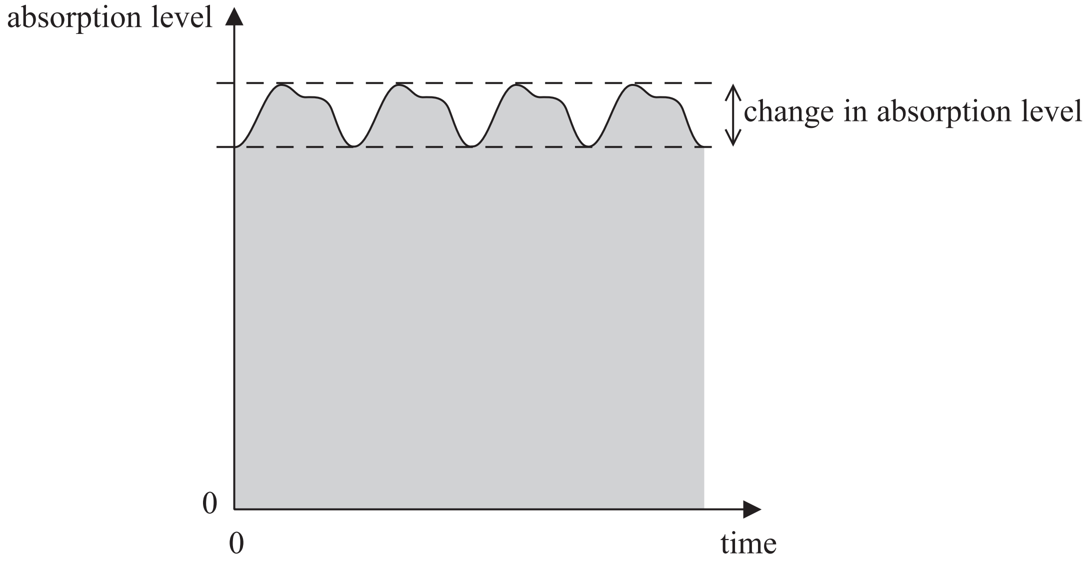
Tessa has described how pulse oximeters work.
She has made a mistake in each row of the table.
Circle the mistake in each row.
Write the corrections in the next column.
The first one has been done for you.

sentence	correction
A pulse oximeter is used to measure the patient's blood pressure.	pulse rate
It is normally attached to the patient's arm.	
It can also measure the percentage of carbon dioxide in the blood.	
It works by shining red and infrared light from detectors through the finger.	
The amount of light reflected indicates the amount of haemoglobin in the blood.	

(4)

Leave blank

(b) The graph shows the change in absorption level for red light from a pulse oximeter.



(i) What causes the change in absorption level labelled on the graph?

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(1)

(ii) Describe how the graph could be used to determine the pulse rate of a patient.

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(1)

Q2

(Total 6 marks)

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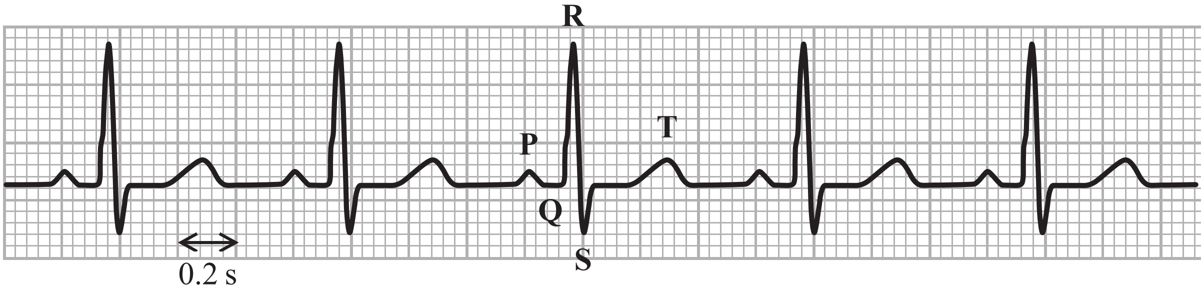
3. (a) The following is a section of a normal ECG trace.



(i) Determine the time period of this trace.

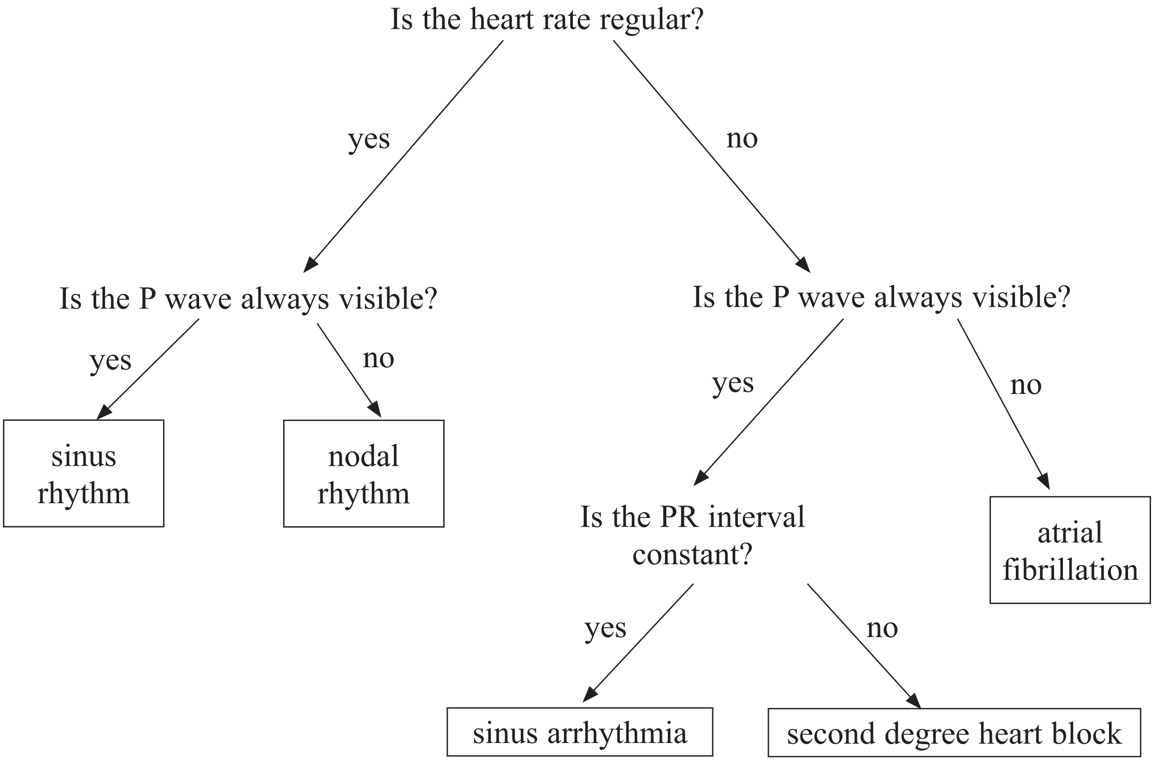
Period = ... s
(1)

(ii) Calculate the frequency of the heart rate in beats per minute.

Frequency = ... beats/min
(2)

(b) A patient has chest pains.
A paramedic attaches the patient to an ECG machine and obtains this trace.

Use the flow chart and the ECG trace to identify the patient's heart problem.



The ECG trace indicates ....

(1)

Q3

(Total 4 marks)

Leave blank

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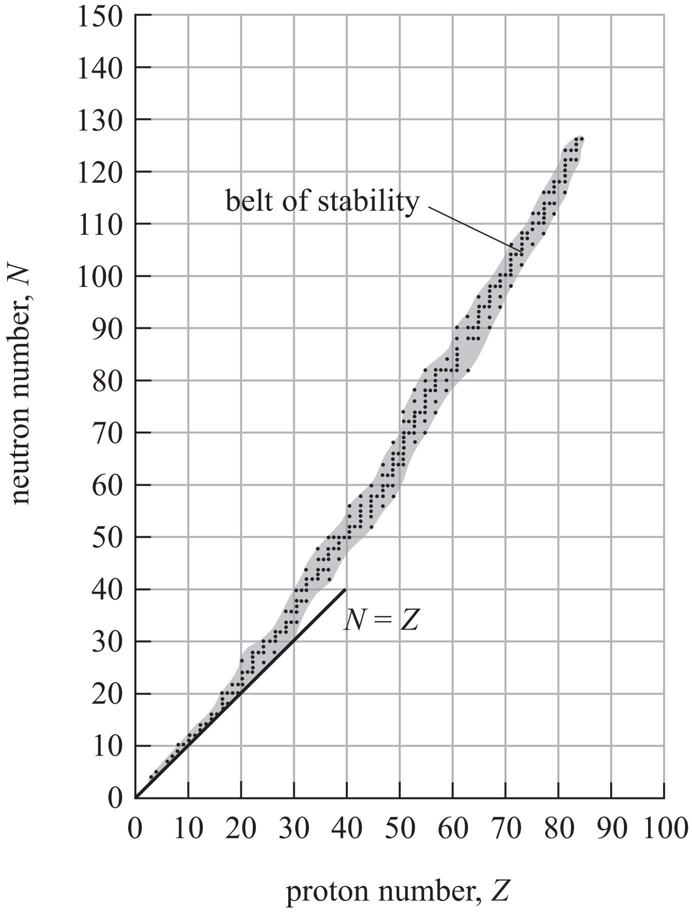
4. The graph shows the number of neutrons plotted against the number of protons for the nuclei of stable isotopes.



(a) The symbol for a nucleus of uranium-235 is

$$^{235}_{92}\text{U}$$

Mark with an **X** on the graph the position of uranium-235.

(1)

(b) Complete the following sentence by putting a cross (☒) in the correct box.

An unstable isotope with more than 82 protons usually decays by emitting

- α **particles.** ☐
- β^- **particles.** ☐
- β^+ **particles.** ☐

(1)

P 3 9 0 1 0 A 0 8 2 4

Leave blank

(c) What happens to the nucleus of an atom when it emits a gamma ray?

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(2)

Q4

(Total 4 marks)

Leave blank

5. The photograph shows a solar airship.

Air is scooped into a large black plastic balloon.
The balloon is securely tied at both ends and left in warm sunshine for some time.
The two diagrams show the balloon before and after it has been in the sunshine.

(a) The trapped air exerts a pressure on the inside of the balloon.
Explain how this pressure is caused in terms of particles.

....

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(3)

Leave blank

(b) When the balloon is sealed, the temperature of the air in the balloon is 17 ºC.

(i) What is this temperature in kelvin?

temperature = ... K

(1)

(ii) At this temperature, the volume of air in the balloon is 2.10 m^3 and the pressure of the air is 101 kPa.
After 5 minutes in the sunshine, the volume increases to 2.20 m^3 and the pressure increases to 102 kPa.
Calculate the new temperature, in kelvin, of the air in the balloon.

temperature = ... K

(3)

Q5

(Total 7 marks)

Leave blank

6. In 1964, Murray Gell-Mann proposed that protons and neutrons were not **fundamental** particles.

(a) Give one example of a fundamental particle, assuming Murray Gell-Mann's proposals are correct.

....

(1)

(b) Murray Gell-Mann proposed that protons and neutrons consist of up (u) quarks and down (d) quarks.

A proton has 2 u and 1 d
A neutron has 1 u and 2 d

State the size and sign of the charge on an up quark and that on a down quark.

Charge on an up quark = ...

Charge on a down quark = ...

(2)

(c) Explain beta-plus (β^+) decay in terms of protons, neutrons and quarks.

....

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(2)

Leave blank

(d) Explain how a beta-plus emitter can be used with a PET scanner to locate a brain tumour.
You may draw a diagram if it helps your answer.

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(3) **Q6**

(Total 8 marks)

P 3 9 0 1 0 A 0 1 3 2 4

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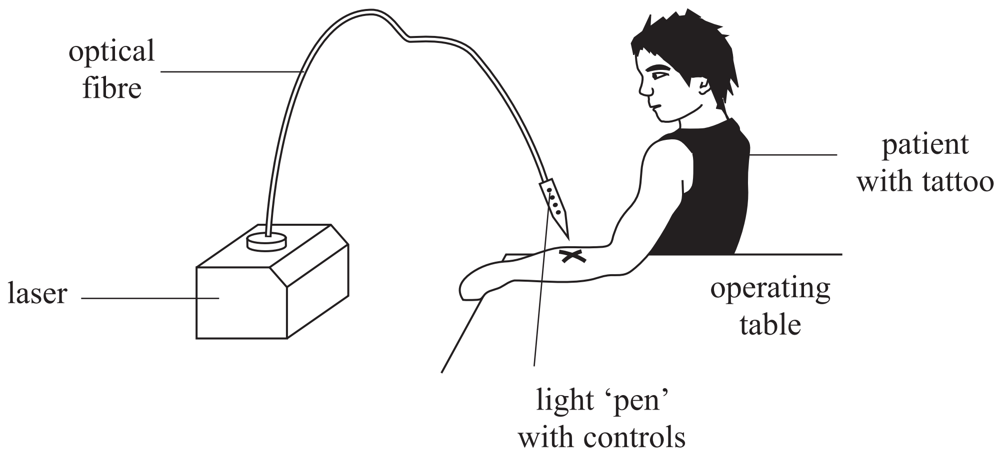
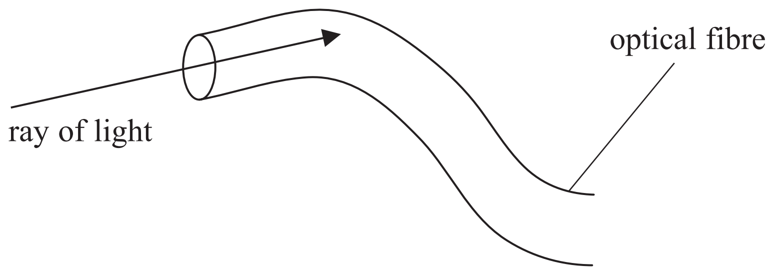
7. Some people have tattoos but later want them removed.
This can be done using a laser light source.
The diagram shows how this is done.



(a) Complete the diagram below to show the path of the ray of light through the optical fibre.
An **accurate** diagram is required.



(2)

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(b) The information in the box outlines how a laser removes a tattoo.

- Laser light is directed on to the tattoo in a series of very short pulses.
- The pulses occur once a second and each pulse lasts for 5.0 ns (5.0×10^{-9} s).
- The light is absorbed by the tattoo ink.
- The temperature of the ink quickly increases to 300 °C.
- This causes rapid expansion and a thermal shock wave.
- The ink shatters into tiny particles which are then removed by the body's defence system.
- The doctor can alter the energy and the diameter of the pulses.

(i) The doctor sets the energy of each 5.0 ns pulse to 800 mJ.
Show that the power of each 5.0 ns pulse is 160 MW.

(2)

(ii) The average beam power is 0.8 W.
Explain why the average beam power is much lower than the pulse power.

....

....

....
(1)

(iii) Suggest why the laser light is only on once a second for 5 ns each time.

....

....

....
(1)

Leave blank

(iv) The diameter of each pulse is 8 mm.
The area of each pulse is 5.0×10^{-5} m^2.
Calculate the intensity of a circular pulse of power 160 MW.

intensity = ... W/m^2
(2)

(v) What happens to the intensity of a pulse when its diameter is reduced from 8 mm to 4 mm?

....

....

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....
(2)

Q7

(Total 10 marks)

P 3 9 0 1 0 A 0 1 7 2 4

Turn over

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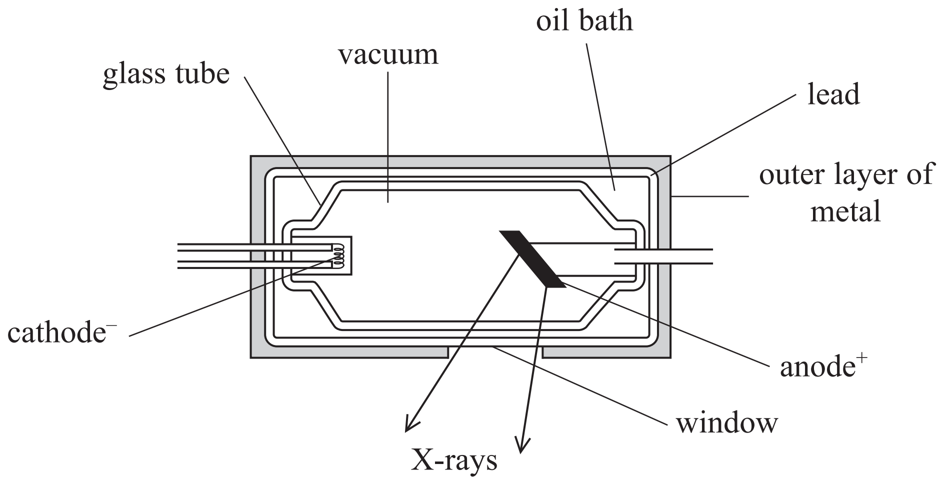
8. The diagram shows the main features of an X-ray machine.
Electrons are emitted by the cathode and accelerated by a high voltage towards the anode.
When the electrons collide with the anode, a beam of X-rays is produced.



(a) The size of the charge on an electron is 1.60×10^{-19} C.
The kinetic energy gained by an electron from the accelerating voltage is 2.08×10^{-15} J.
Calculate the accelerating voltage.

accelerating voltage = ... V
(3)

(b) In one second, 1.25×10^{18} electrons reach the anode.
Calculate the current between the cathode and the anode.

current = ... A
(2)

Leave blank

(c) The electrons are stopped by the anode.
Show that the total kinetic energy lost by the electrons is more than 2500 J each second.

(2) **Q8**

(Total 7 marks)

P 3 9 0 1 0 A 0 1 9 2 4

Turn over

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9. Grave's disease affects the thyroid gland in the neck.
When a patient has Grave's disease, many small nodules form on the thyroid gland.
The nodules produce an abnormally high level of thyroid hormones.
This causes the patient to become severely ill.

The table outlines the main methods of diagnosing Grave's disease.

using ultrasound	**using a radioactive tracer isotope**
• procedure takes ½ hour	• procedure involves tests at 6-hour intervals for at least one day
• can be done at a clinic	• done at specialist hospital
• ultrasound probe used externally	• radioactive iodine injected into patient

(a) Give **two** reasons why ultrasound diagnosis is preferred.

1 ....

....

2 ....

....

(2)

(b) Ultrasound is a high frequency sound radiation.
Explain how ultrasound can be used to determine the presence of the nodules on the thyroid gland.
You may draw a diagram if it helps your answer.

....

....

....

....

....

(2)

Leave blank

(c) The thyroid gland absorbs iodine.
Radioactive iodine can be used as either a tracer for diagnosis or as a therapy.

The table shows some information about four radioactive isotopes of iodine.

isotope	**iodine –123**	**iodine –125**	**iodine –129**	**iodine –131**
half-life	13 hours	59 days	16 million years	8 days
type of beta emitted and energy in keV	none	none	beta-minus 154	beta-minus 606
energy of gamma emitted in keV	159	35	40	364
production method	proton bombardment in a cyclotron	neutron bombardment in a nuclear reactor	occurs naturally	fission product

(i) Which of the above isotopes is **most** appropriate for use as a tracer?

Isotope = ...
(1)

Explain the reason for your choice.

....

....
(1)

(ii) Once the nodules have been located, they can be destroyed.
Which isotope in the table is **most** appropriate for this?
Give **two** reasons for using this isotope.

Isotope = ...

Reason 1 ....

....

Reason 2 ....

....
(2)

(iii) Complete the nuclear equation for the production of iodine-125 by neutron bombardment of xenon-124.

$$^{124}_{54}\text{Xe} + ^{\square}_{\square}\text{n} \rightarrow ^{125}_{\square}\text{Xe} \rightarrow ^{\square}_{53}\text{I} + ^{\square}_{\square}\beta+$$

(3)

Q9

(Total 11 marks)

TOTAL FOR PAPER: 60 MARKS

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