EDEXCEL GCSE PHYSICS (360SCIENCE)

PHYSICS



EXAM QUESTION PACK

UNIT P3 5049 PAPERS

STEMUP

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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
Calculator

Items included with question papers
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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Turn over

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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 $\qquad W = F \times s$

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

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

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

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

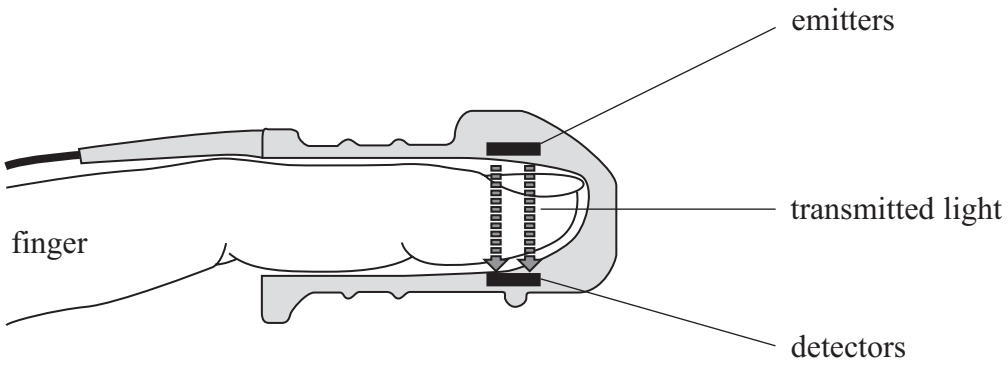
Q1

(Total 3 marks)

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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.

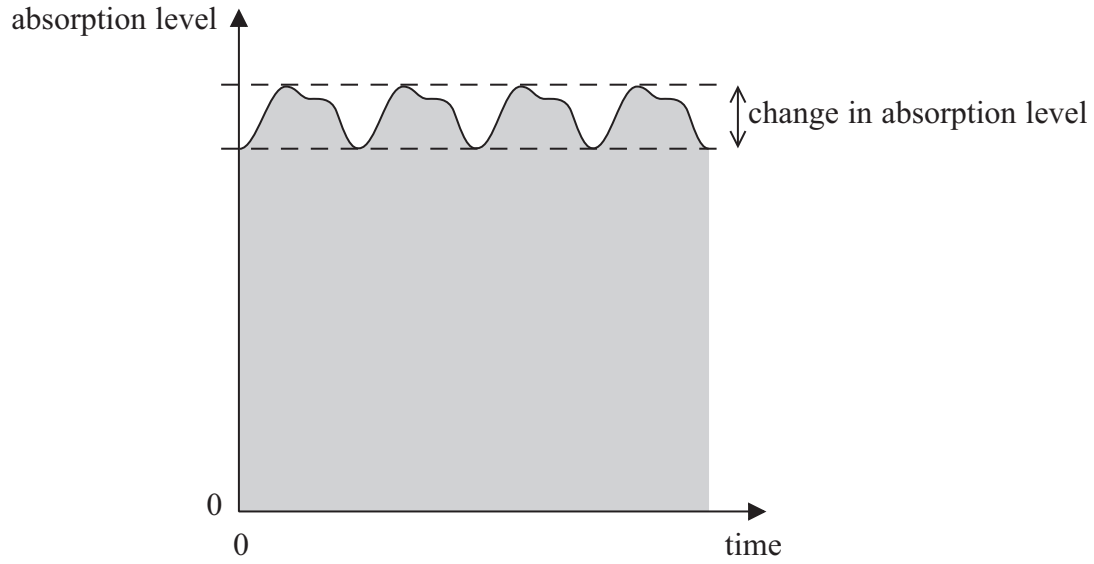
sentence	correction
A pulse oximeter is used to measure the patient's (blood pressure.)	pulse rate
It is normally attached to the patient's arm.	
It can also measure the percentage of carbon dioxide in the blood.	
It works by shining red and infrared light from detectors through the finger.	
The amount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

(4)

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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?

.....

.....

(1)

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

.....

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(1)

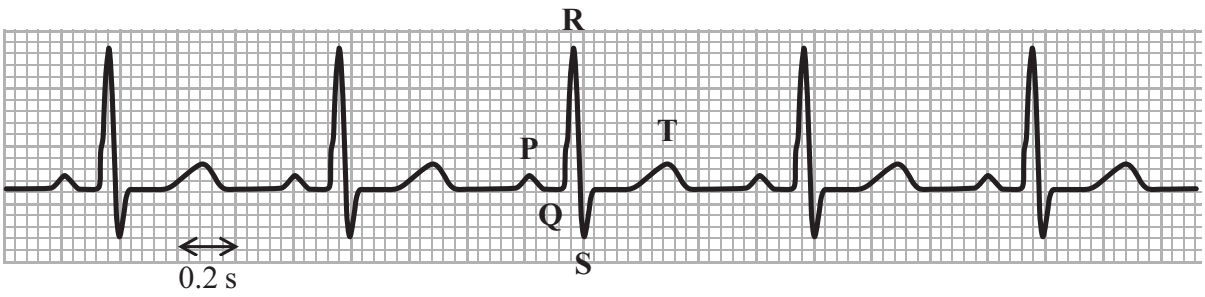
Q2

(Total 6 marks)

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Leave blank

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)

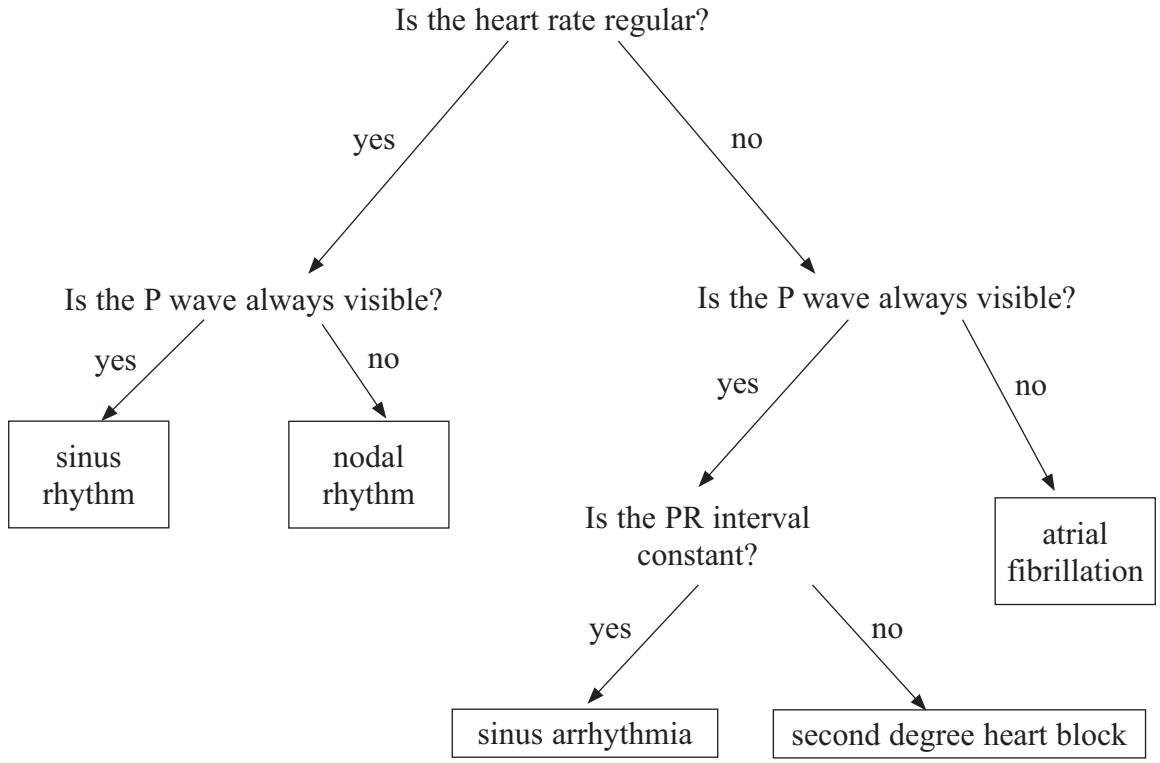
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(b) A patient has chest pains.
A paramedic attaches the patient to an ECG machine and obtains this trace.



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



The ECG trace indicates .....

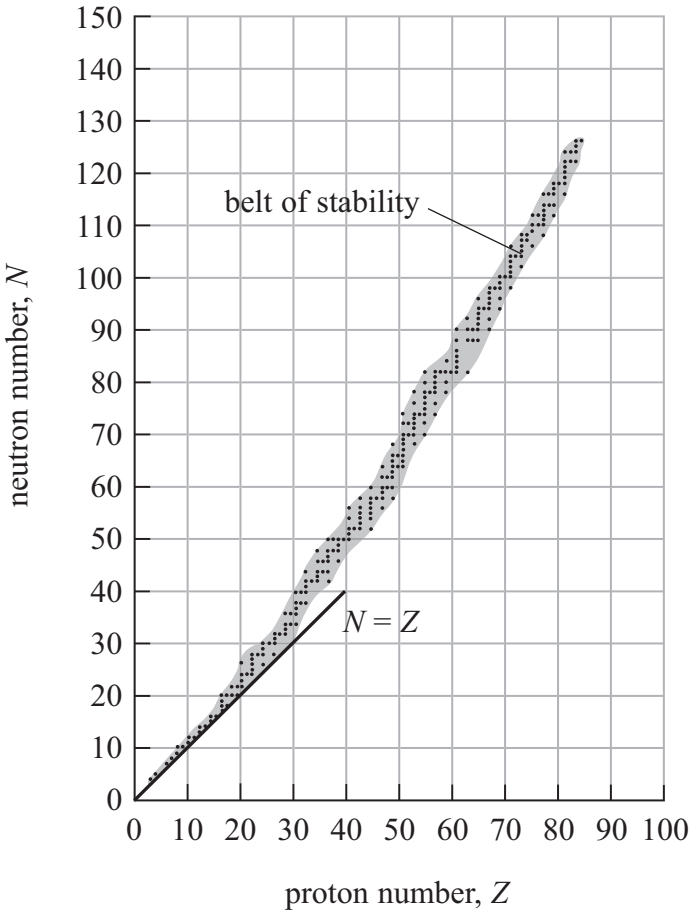
(1) Q3

(Total 4 marks)

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Leave blank

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

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

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)

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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)

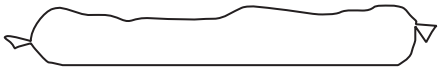
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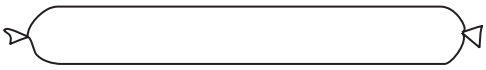
5. The photograph shows a solar airship.



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.



at start



some time later

(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)

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Leave blank

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

(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)

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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)

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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)

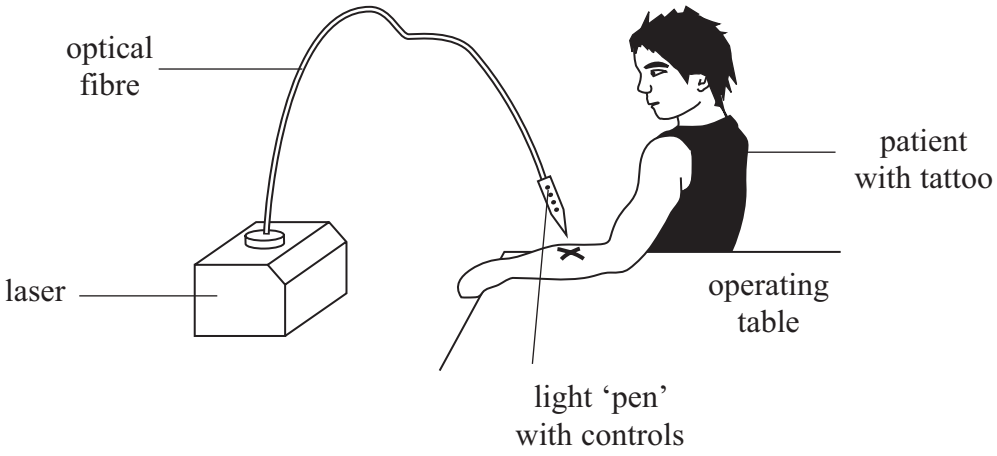
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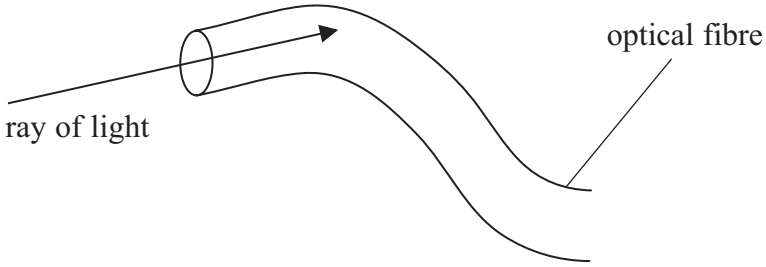
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7. Some people have tattoos but later want them removed.
This can be done using a laser light source.
The diagram shows how this is done.



(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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Leave blank

(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)

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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)

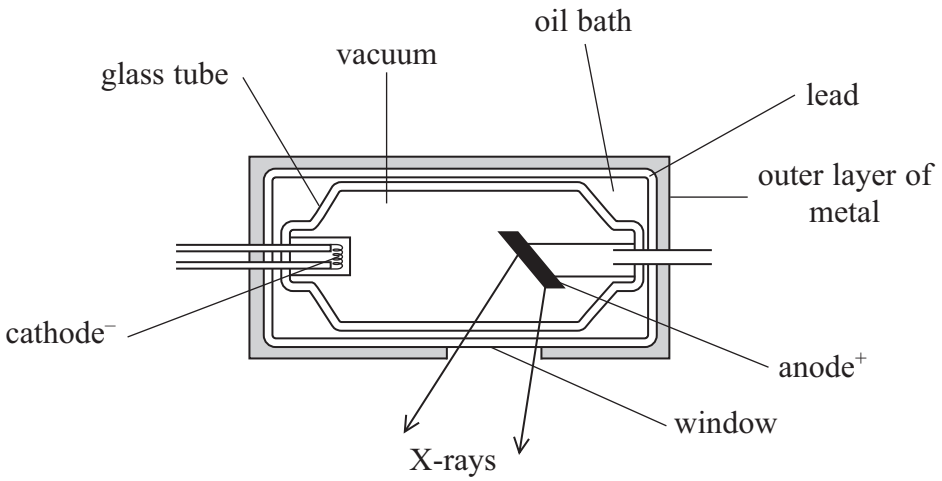
Q7

(Total 10 marks)

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Leave blank

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)

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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)

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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.

.....

.....

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.....

.....

(2)

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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)

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Leave blank

(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

END

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Mark Scheme (Results)

June 2011

360Science

GCSE Physics
Structured Paper P3 (5049/01)

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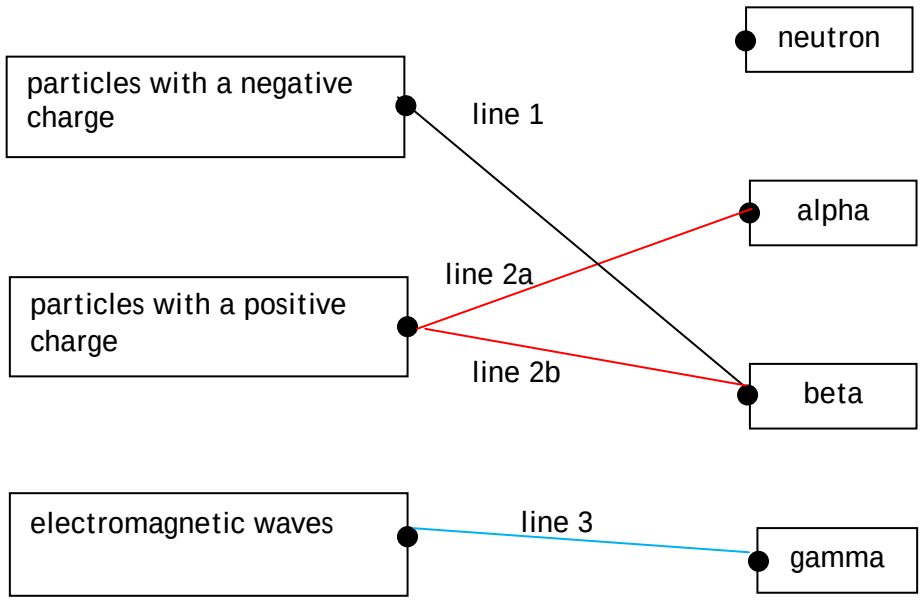
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5049 Mark Scheme
June 2011

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1	**description**  **Note:** from top box ……...line 1; from middle box….either line 2a or lines 2a AND 2b; from lower box …….line 3; more than 1 line from top 1….loses that mark more than 1 line from lower box……loses that mark		**radiation**	**(3)**

Question Number	**Answer**		Acceptable answers	Ignore	Reject	Mark
2(a)	**Note:** 7 / 8 correct = 4 marks 5/6 correct = 3 marks 3/ 4 correct = 2 marks 1/ 2 correct = 1 mark					
	the following words should be ringed arm ; carbon dioxide ; detectors / from ; reflected ;	replaced by finger (tip) oxygen emitters / to transmitted/	finger, ear, O_2 / O / O^2 LED / diode(s) / transmitters absorbed / passed through / detected / received			**(4)**

Question Number	Answer	Acceptable answers	Ignore	Reject	Mark
2(b)(i)	the pulse ;	pulse rate heart / heart beat / heart rate arterial blood / pumped blood	mention of blood flow venous		**(1)**

Question Number	Answer	Acceptable answers	Ignore	Reject	Mark
2(b)(ii)	idea of counting number of pulses in given time period (converting to pulse rate in minute)/eq ;		refs to heart monitors		**(1)**

Question Number	Answer	Acceptable answers	Ignore	Reject	Mark
3(a)(i)	0.8 (s)				**(1)**

Question Number	Answer		Acceptable answers	Ignore	Reject	Mark
3(a)(ii)	substitution evaluation	f= 1/T=1/0.8 (1.25 x 60 =) 75	e.c.f from (a)(i) 1.25 (Hz) for 1 mark bald correct ans = 2 marks allow alternative methods			**(2)**

Question Number	Answer	Acceptable answers	Ignore	Reject	Mark
3(b)	(second degree) heart block ;		other possible answers from key		**(1)**

Question Number	Answer	Acceptable answers	Ignore	Reject	Mark
4(a)	X in top right hand "box" of graph;	dot in this box with an X marked nearby			**(1)**

Question Number	Answer	Acceptable answers	Ignore	Reject	Mark
4(b)	alpha ;				**(1)**

Question Number	Answer	Acceptable answers	Ignore	Reject	Mark
4(c)	loses/releases energy ; PLUS any **one** from: 1. undergoes (more) rearrangement ; 2. becomes stable ; 3. no change in p or n number/eq;	 no p lost/ no n lost	refs to • (electronic) charge • electrons • mass • 'nucleus stays the same' • Confusion with PET scanner		**(2)**

Question Number	Answer	Acceptable answers	Ignore	Reject	Mark
5(a)	Any **three** from: 1. (particles) moving ; 2. randomly ; 3. colliding ; 4. with side of (balloon) ; 5. (exerting) force ;	must be in the context of particles....air is insufficient...allow molecules/atoms allow have kinetic energy hitting, bumping into	 bald 'energy' freely impacts with other particles push		**(3)**

Question Number	Answer	Acceptable answers	Ignore	Reject	Mark
5(b)(i)	290 (K) ;	290.15 (K)			**(1)**

Question Number	Answer		Acceptable answers	Ignore	Reject	Mark
5(b)(ii)	$\frac{101 \times 2.1}{290} = \frac{102 \times 2.2}{T_2}$;	**substitution**			incorrect equation	
	$T_2 = \frac{102 \times 2.2}{101 \times 2.1} \times 290$;	**transpose**				
	= 306.8 (K) ;	**evaluation**	allow ans which rounds to 307			
	Note: allow substitution and transpose in either order allow e.c.f from (a)(i) bald correct answer = 3 marks					**(3)**

Question Number	Answer	Acceptable answers	Ignore	Reject	Mark
6(a)	Any **one** from: 1. electron(s) ; 2. quark(s) ; 3. neutrino(s) ;	anti-particles any specified quark correct symbols			**(1)**

Question Number	Answer	Acceptable answers	Ignore	Reject	Mark
6(b)	(+) 2/3 (e) - 1/3 (e) ;;	Allow sensible use of thirds factor **OR** correct signs for 1 mark			**(2)**

Question Number	Answer	Acceptable answers	Ignore	Reject	Mark
6(c)	u changes to d ; p changes to n ;	allow uud →udd/eq p number decreases by 1, n number increases by 1	• positrons emitted from nucleus • refs to electrons		**(2)**

Question Number	Answer	Acceptable answers	Ignore	Reject	Mark
6(d)	Any **three** from: 1. (F-18/isotope) attached to glucose/ glucose goes to site; 2. beta+ annihilates electron ; 3. (2) gamma produced ; 4. 2 gamma in opposite directions ; 5. detected simultaneously ; 6. 'triangulation' idea ;	check diagram for details biological details for 1 mark max β^+ annihilates β^- at 180 ^{o}	react		**(3)**

Question Number	Answer	Acceptable answers	Ignore	Reject	Mark
7(a)	first and second reflection accurately drawn; decent progression down tube without light escape from fibre on the sides;				**(2)**

Question Number	Answer		Acceptable answers	Ignore	Reject	Mark
7(b)(i)	For 2 marks = 0.8 /5x10^{-9} ;;					
	substitution	(power =)8 / 5 ;	800/5 gets 1 mark			
	evaluation of the powers	correct use of powers of 10 ;	must correctly change 800mJ to 0.8 J and 5ns to 5 X10^{-9} to get the second mark			**(2)**

Question Number	Answer	Acceptable answers	Ignore	Reject	Mark
7(b)(ii)	time for pulse is very small ;	gap time is (much) longer than pulse time allow to be shown by calculation	references to • danger to patient • energy loses as heat/light • confusion with body's pulse		**(1)**

Question Number	Answer	Acceptable answers	Ignore	Reject	Mark
7(b)(iii)	sensible suggestion e.g. 1. idea of limiting damage to (nearby) skin (cells) 2. to allow doctor to move to next section of tattoo 3. 0.8 W is sustainable from power supply (160MW is not)	preventing damage/burns to skin	implication of radioactive damage or ionisation		**(1)**

Question Number	Answer	Acceptable answers	Ignore	Reject	Mark
7(b)(iv)	3.2×10^{12} (W/m^2) ;; CAO for 1 mark, a sub of 'a power/an area' must be seen e.g. $\frac{160\ 000\ 000}{5 \times 10^{-5}}$; OR $\frac{160}{5 \times 10^{-5}}$			incorrect equation	**(2)**

Question Number	Answer	Acceptable answers	Ignore	Reject	Mark
7(b)(v)	increases; by factor of 4;	for 1 mark only more concentrated / doubles	stronger refs to power		**(2)**

Question Number	Answer		Acceptable answers	Ignore	Reject	Mark
8(a)	$2.08 \times 10^{-15} = V \times 1.60 \times 10^{-19}$; $V = \frac{2.08 \times 10^{-15}}{1.60 \times 10^{-19}}$; 13 000 (V) ;	**substitution** **transpose** **evaluation**	Sub or transpose in either order k.e. (=V) charge			**(3)**

Question Number	Answer		Acceptable answers	Ignore	Reject	Mark
8(b)	$1.25 \times 10^{18} \times 1.60 \times 10^{-19}$; 0.200 (A) ;	**substitution** **evaluation**	no of e (per s) X charge I=ne/t	ans as fractions		**(2)**

Question Number	Answer	Acceptable answers	Ignore	Reject	Mark
8(c)	$2.08 \times 10^{-15} \times 1.25 \times 10^{18}$; 2600 (J) ; **OR** ans to(a) x ans to (b); 2600(J);	k.e. of one e X no of e / s statement that first line is > 2500 (voltage X current) statement that this is > 2500 evaluated ecf			**(2)**

Question Number	Answer	Acceptable answers	Ignore	Reject	Mark
9(a)	Any **two** from: 1. any one problem associated with radioactivity / benefit of ultrasound; 2. any 2nd problem associated with radioactivity / benefit of ultrasound; 3. comparison of time required ; 4. benefit of ultrasound based on line 2 of the table 5. non-invasive or non-intrusive	allow perception of danger US is non-ionising ultrasound is quicker • ultrasound is cheaper • personnel in clinic not need to be as well trained / skilled/qualified • easier for patient to get to clinic	• **repeat of the data in the stem** • real time image • soft tissue • locally		**(2)**

Question Number	Answer	Acceptable answers	Ignore	Reject	Mark
9(b)	Any **two** from: 1. ultrasound wave emitted from probe / to thyroid ; 2. **reflects** from nodules (to probe); 3. (at the boundary of) different densities of material; 4. idea that image is synthesised from (reflected) data; 5. reason for use of gel;	check diagram for details allow for nodules body / tissues / inside (of body) time analysed (reflected) waves build up image at PC/on screen		for both marks implication that US is radioactive for MP4 implication that US is transmitted	**(2)**

Question Number	Answer	Acceptable answers	Ignore	Reject	Mark
9(c)(i)	iodine -123;	'123'			**(1)**

Question Number	Answer	Acceptable answers	Ignore	Reject	Mark
9(c)(i)	Consequential marking Any **one** from: 1. half life is the **shortest;** 2. energy emitted is not too high and not too low ; 3. gamma emitted (not beta)	• **most** suitable half life • half life is **only** 13 hrs • energy emitted is most suitable	• **repeat of the data in the stem** • comments on production method		**(1)**

Question Number	Answer	Acceptable answers	Ignore	Reject	Mark
9(c)(ii)	iodine-131....no mark Any **two** from: 1. correct discussion/mention of type of source or ionisation needed ; 2. correct discussion of <u>energy</u> level needed in the context of beta; 3. correct comparison of half life needed; 4. correct discussion of production method linked to hospital; If the isotope is incorrect, then max of 1 mark	Gives off beta-minus has a high ionisation <u>energy</u> is high	• comments about gamma • power or strength • high levels		**(2)**

Question Number	Answer	Acceptable answers	Ignore	Reject	Mark
9(c)(iii)	any 2 right for 1 mark; any 4 right for 2 marks; all 6 right for 3 marks; $^{124}_{54}Xe + {}^{1}_{0}n \rightarrow {}^{125}_{54}Xe \rightarrow {}^{125}_{53}I + {}^{0}_{1}\beta+$			-1 in β+ lower box	**(3)**

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Physics 5049/01
P3 Mark Scheme

<table>
<tr><th>Question Number</th><th>Answer</th><th>Mark</th></tr>
<tr><td>1(a)</td><td>one mark for each;
if 4 ticks :3 correct and 1 wrong = 2 marks: 2 correct and 2 wrong = 1 mark ,if all boxes ticked no marks can be awarded

<table>
<tr><th>statement</th><th>True?</th></tr>
<tr><td>as the temperature increases the volume increases</td><td>✓</td></tr>
<tr><td>as the temperature increases the pressure increases</td><td></td></tr>
<tr><td>the mass of the gas is constant</td><td>✓</td></tr>
<tr><td>the pressure of the gas is constant</td><td>✓</td></tr>
<tr><td>when the temperature in °C doubles the volume doubles</td><td></td></tr>
</table>
</td><td>(3)</td></tr>
</table>

Question Number	Answer	Accept	Mark
1(b)(i)	speed up ;		**(1)**

Question Number	Answer	Accept	Mark
1(b)(ii)	more frequently ;		**(1)**

Question Number	Answer	Accept	Mark
1(b)(iii)	the temperature in K;		**(1)**

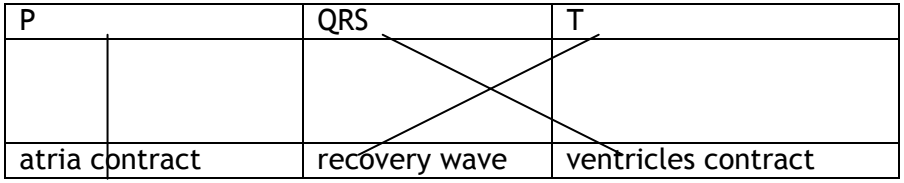
Question Number	Answer	Accept	Mark
1(c)	373 (K)	allow degrees sign allow additional K 373.14 or 373.15	**(1)**

Question Number	Answer	Accept	Ignore	Reject	Mark
1(d)	movement ceases;	• the particles stop moving /OWTTE • no KE • particles at their lowest (vibrational) speed • particles are still • idea of smallest possible movement	particles slow down completely frozen	don't have much E or movement	**(1)**

Question Number	Answer	Mark
2	all correct = 3 marks 2 correct = 2 marks 1 correct = 1 mark	**(3)**

action	Number?
two gamma rays are produced	**4**
the radioactive isotope emits positrons	2 given
gamma rays are detected	**5**
a computer puts the images together	**6**
positrons annihilate electrons	3 given
a 3-D image is produced	7 given
the patient is injected with a radioactive isotope	**1**

Question Number	Answer	Accept	Ignore	Reject	Mark
3(a)	One from • action potential (caused by heart muscle) • p.d. / voltage (of the heart) with respect to time • **electrical** activity (of the heart);	• p.d./ voltage across the skin caused by heart activity • heart rate/ pulse rate • heart activity	heart beat pulse ignore heart action		**(1)**

Question Number	Answer	Accept	Reject	Mark
3(b)	 P = atria contract; QRS = ventricles contract; T = recovery wave;	all three correct = 2 marks any one correct = 1 mark		**(2)**

Question Number	Answer	Accept	Ignore	Reject	Mark
3(c)	in order heart beats too slow/eq; heart beats too fast/eq; heart beat is irregular/eq;	allow descriptions in terms of • the frequency or period of the heart beats • specific section of the wave being too long/short for 3rd mark accept abnormal or (fast but) missing a beat	random		**(3)**

Question Number	Answer	Accept	Ignore	Reject	Mark
4(a)	A shown to the right of Z= 82; B shown above the curve; P shown below the curve;	correct symbols instead of the letters α for A no part of letter A to go below Z=70 β or β^- or B $^-$ or e^- for B P^+ or e^+ or β^+ for P if in doubt, check the symbol vertically against the stability belt for P or B, and horizontally for A mark according to the specification		β^+ or B^+ above the line	**(3)**

Question Number	Answer	Mark
4(b)	top line correct; lower line correct; accept for 1 mark any two of the 'particles' completely correct	**(2)**

38			**38**			**0**			**0**	
	S	→		Cl	+		β	+		γ
16			**17**			**-1**			**0**	

Question Number	Answer	Accept	Ignore	Reject	Mark
4(c)(i)	(Excess) energy emitted OR nuclear rearrangement (leading to emission of energy);	photon for energy change from metastable /excited to stable state/eq	repeat of stem e.g. emits γ		**(1)**

Question Number	Answer	Accept	Ignore	Reject	Mark
4(c)(ii)	neutron changes into proton (with emission of electron/ beta minus);	description in terms of nucleon/mass and proton no.s	repeat of stem e.g. emits beta or electron	Beta plus decay	**(1)**

Question Number	Answer	Accept	Ignore	Reject	Mark
4(c)(iii)	a down quark → an up quark;	2 down and 1 up → 2 up and 1 down 2D +1U → 2u + 1D *MARK CORRECT ANSWERS WHERE-EVER SEEN IN (I), (II), (III)*	quarks will become opposites Ignore charges on quarks	implication of turning around or direction change	**(1)**

Question Number	Answer	Accept	Reject	Mark
4(d)	electron;	quark (any flavour) antineutrino	positron neutrons protons	**(1)**

<table>
<tr><th>Question Number</th><th>Answer</th><th></th><th>Accept</th><th>Comments</th><th>Reject</th><th>Mark</th></tr>
<tr>
<td>5</td>
<td>calc. of distance (in m or in cm);

substitution;

answer in correct units;</td>
<td>3.3(m)
330(cm)

3.3 × 805

2 660 J
2656.5(J)
2.656 kJ</td>
<td>No alternatives

Acceptable Substitutions:

<table>
<tr><th>Distance (m)</th><th>Ans</th><th>Distance (cm)</th><th>Ans</th></tr>
<tr><td>3.3 (or ecf)</td><td>2656</td><td>330 (or ecf)</td><td>265650</td></tr>
<tr><td>0.9</td><td>725</td><td>90</td><td>72450</td></tr>
<tr><td>1.4</td><td>1127</td><td>140</td><td>112700</td></tr>
<tr><td>1.8</td><td>1449</td><td>180</td><td>144900</td></tr>
<tr><td>1.9</td><td>1530</td><td>190</td><td>152950</td></tr>
<tr><td>2.4</td><td>1932</td><td>240</td><td>193200</td></tr>
<tr><td>2.8</td><td>2254</td><td>280</td><td>225400</td></tr>
<tr><td>Unit:</td><td>J or Nm</td><td></td><td>Ncm</td></tr>
</table>
(Allow ecf into answers for 3.3m or 330cm)

ecf from substitution, as shown in above table. Answer plus correct unit.</td>
<td>check the diagram for the calc of distance method</td>
<td>incorrect units for one mark
e.g. N/m</td>
<td>(3)</td>
</tr>
</table>

Question Number	Answer	Accept	Ignore	Reject	Mark
6(a)(i)	very high frequency/pitch sound (or longitudinal) radiation;	• high frequency sound radiation • correct description in terms of stated frequency or wavelength • sound above the threshold of human hearing	Inaudible wave (could be infrasound) high sound description in terms of its mode of use	lack of precision leading to confusion of frequency and intensity electromagnetic wave transverse wave	**(1)**

Question Number	Answer	Accept	Ignore	Reject	Mark
6(a)(ii)	Cameron = non-ionising radiation /reduction in (healthy) cell damage; consultant = real-time image/soft tissue image;	Credit 'safety' or 'cell damage' or 'harmful radiation' idea only once • ultrasound does not cause (healthy) cell damage /ORA; • reduction in radiation that can damage (healthy) cells • idea of 'can see what he is doing at the time' • does not make his patient worse • safer for consultant • cheaper if qualified (comparison made on running or set-up costs) • ultrasound (machines) are more portable • 3D image	waffle statements such as 'safer' unless qualified ultrasound can target the area ultrasound not as penetrating easier to find tumour		**(2)**

Question Number	Answer	Mark
6(b)(i)	**one mark for either alpha or beta or both; ticks in any other boxes then no marks** ;; source type / suitable for the 'seeds'? alpha ✓ beta ✓ gamma neutron photon	**(1)**

Question Number	Answer	Accept	Ignore	Mark
6(b)(ii)	any **one** explanation in terms of EITHER range OR ionisation	Consequential marking….only sources allowed are alpha, beta or both look for reverse arguments → therefore only alpha and beta suitable correct description of • range/ penetration of particle • required range needed for treatment • ionisation ability of particle • ionisation required needed for treatment	Photon in the list of sources	**(1)**

Question Number	Answer	Accept	Further guidance	Mark
6(b)(iii)	any 2 from • half life • toxicity/side effects • decay product • energy emitted/damage done to healthy cells • activity level • range • ionisation • elimination of isotope; • any **two** correct **reasons/ explanations or consequences** re the above list;;	All marks independent of answers to bi and bii allow cost, emission of other particles/radiation, MUST have statement **and** reasons/ explanations or consequences to be awarded second and/or third mark e.g. • (half life=) long enough to have an effect/does not want to stay radioactive for too long; • (toxicity =) should not be toxic/make patient more unwell • (consideration of energy =) should not be too high as this may cause damage to healthy cells • (activity level=)should not be too high as this may cause damage to healthy cells	So for **1 mark** can have EITHER 2 stated properties without reasons OR 1 property with a reason plus nothing else For **2 marks** 1 property with reason plus 1 other property For **3 marks** 2 properties with reasons	**(3)**

Question Number	Answer	Accept		Mark
6(b)(iv)	any **three** from: 1. getting the highest dose at the tumour/concentrating radiation on the tumour 2. idea of intensity $\propto$ 1/distance 3. not dosing other regions 4. slow at tumour to increase time there 5. longer it is there the bigger the dose;;;	not necessary to have intensity $\propto$ 1/distance ^{2} • reduction in damage to other cells/body parts • dose proportionate to time • repeat to allow normal cells to recover		**(3)**

Question Number	Answer	Accept	Ignore	Mark
6(c)	any suitable advantage; any suitable disadvantage;	NOTE this is about ANY newer treatment, not just methods above • idea of newer is possibly better/safer • may give increased chance of cure • more likely to get highly skilled/qualified consultant • mention of specific example relating to the question above e.g. radioactive source not left inside the patient • it can go wrong/maybe not as reliable • they don't know what they are doing • possible side effects • mention of specific example relating to the question above e.g. radioactive source is left inside the patient in older method **only credit the source inside/outside the patient once**	Cost unless well reasoned, (can be either for or against), only credit once Bald newer technology	**(2)**

Question Number	Answer		Accept	Comments	Mark
7	Conversion C into K; subst.; rearrangement; ans;	27C = 300K $\frac{1.01 \times 10^5 \times 14}{300} = \frac{23.8 \times 10^5 \times 2}{T}$ $T = \frac{23.8 \times 10^5 \times 2 \times 300}{1.01 \times 10^5 \times 14}$ T= 1010 K (737 C)	• if temps in C used, max of 3 marks • rearrangement and subst. in either order • can use T_2 or T_1 instead of T • allow for earlier cancelling e.g. 10^5 or 2/14 = 1/7 • if bald correct ans seen award all marks • not necessary to change back into C	91 (90.0 /90.89) is worth 3 4713.3 = $\frac{1.01 \times 10^5 \times 14}{300}$ If you see 476/4713 allow three marks Ans= 0.000990196 K is worth 2 (=1/T)	**(4)**

Question Number	Answer	Accept	Ignore /Comments	Reject	Mark
8(a)	a correct *explanation* about **one** of the following gamma properties • range • ionisation • deviation of radiation • energy emitted • decay chain	Examples • range must be long to *exit* body or range long so can be detected • small ionisation (weak interaction with matter) so no damage to cells • gamma rays do not have deviation in their path (less scattered than alpha or beta), so exit the body • no localised heating in body cells so less damage • does not produce daughter nuclei so does not make the patient radioactive/ill; *look for ORA for alpha or beta sources*	• half-life by itself • penetration by itself • ease of detection The emphasis is on an explanation, **bald statements are not enough at this level**.	• incorrect physics • ans where the radiation is going the wrong way (i.e. into the patient)	**(1)**

Question Number	Answer	Accept	Ignore/ Comments		Mark
8(b)	*no mark for bald isotope choice* each must have **reason** / **explanation of the consequences** of the properties • Short half-life /OWTTE; • Low(ish) energy emitted; • Ionisation produced	**conditional marking** **only allow if barium or technetium** e.g. must not stay active in body for long as would damage healthy cells, allow a goldilocks answer 'not too short not too long' **only allow if iodine or technetium** e.g. low energy to reduce damage to healthy cells **for any source** e.g. (gamma emitter, so) low ionisation so little damage to patient/ radiation exits to detector	The emphasis is on an explanation, **bald statements are not enough at this level; the candidates must write more than 'short half life' 'low energy' or quote data from table**		**(2)**

Question Number	Answer	Accept	Ignore		Mark
8(c)(i)	Idea of reduction of discomfort for the patient;	treatment given to **reduce pain** but not cure /OWTTE improve quality of life treating the symptoms without curing	to cure cancer to reduce spread of cancer		**(1)**

Question Number	Answer	Mark
8(c)(ii)	any **row** or **column** correct; all four correct;; **88** Sr + **1** n → 89 Sr **38** **0** 38 NOT the two numbers in the corners	**(2)**

Question Number	Answer	Accept		Mark
9(a)	thermionic emission;	incorrect but recognisable spellings e.g. emition or emision for emission	Thermionic decay	**(1)**

Question Number	Answer	Accept	Ignore	Reject	Mark
9(b)(i)	Idea of increase in (K)E / speed PLUS direction of attraction / movement	they are attracted towards the anode;	bald 'moves (quickly)towards the anode'	Increase in thermal energy	**(1)**

Question Number	Answer	Accept			Mark
9(b)(ii)	subst.; ans; unit;	$10\,000 \times 1.6 \times 10^{-19}$ 1.6×10^{-15} J (VC)	j or Joules		**(3)**

Question Number	Answer	Accept	Comments/ Allow	Reject	Mark
9(c)	statement that current is rate of flow of charge (I=Q/t);	allow equation instead of statement $I = \frac{N \times e}{T}$	For 1 mark, correct use of time (division by 10)		
	subst. or rearrangement;	$20\times10^{-3}=\frac{N\times1.6\times10^{-19}}{10}$ $N=\frac{20\times10^{-3}}{1.6\times10^{-19}}$	subst. and rearrangement in any order		
	ans;	$N=1.25\times10^{18}$	BEWARE of fudging!!!!		
	OR for last 2 marks	$I = \frac{1.22\times10^{18}\times1.6\times10^{-19}}{10}$; $I= 1.952\times10^{-2}$ A =19.52 mA;	alternative method for the calculation		**(3)**

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