Write your name here

Surname	Other names

Edexcel GCSE

Centre Number	Candidate Number

Physics

Unit P3: Applications of Physics

Higher Tier

Sample Assessment Material
Time: 1 hour

Paper Reference
5PH3H/01

You do not need any other materials.

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided
  – *there may be more space than you need.*

Information

- The total mark for this paper is 60.
- The marks for **each** question are shown in brackets
  – *use this as a guide as to how much time to spend on each question.*
- Questions labelled with an **asterisk** (*) are ones where the quality of your written communication will be assessed
  – *you should take particular care with your spelling, punctuation and grammar, as well as the clarity of expression, on these questions.*

Advice

- Read each question carefully before you start to answer it.
- Keep an eye on the time.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

S39988A

©2010 Edexcel Limited.

S 3 9 9 8 8 A 0 1 1 8

edexcel
advancing learning, changing lives

FORMULAE

You may find the following formulae useful

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

power of lens = $\frac{1}{\text{focal length}}$

The relationship between focal length, object and image distance $\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$

current = number of particles per second × charge on each particle $I = Nq$

kinetic energy = electronic charge × accelerating potential difference $\text{KE} = \frac{1}{2} mv^2 = e \times V$

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

The relationship between temperature and volume for a gas $V_1 = \frac{V_2 T_1}{T_2}$

The relationship between volume and pressure for a gas $V_1 P_1 = V_2 P_2$

The relationship between the volume, pressure and temperature for a gas $\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$

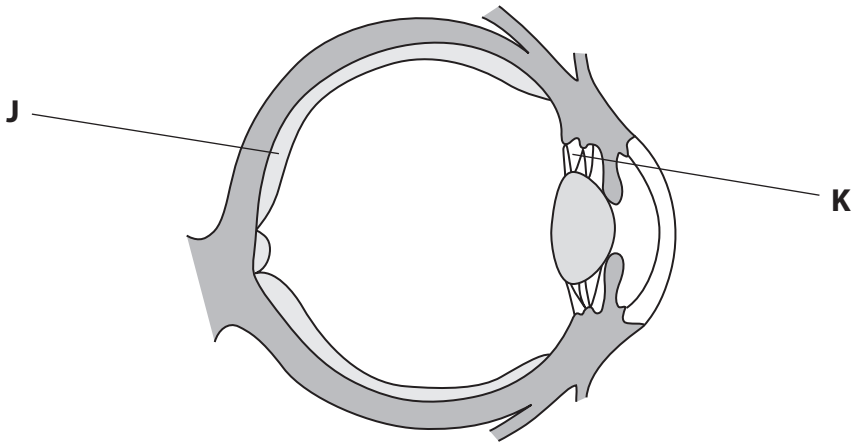
 © Edexcel Limited 2011

Answer ALL questions

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 ☒.

Eye problems

1 The diagram shows a human eye.



(a) Complete the sentences by putting a cross (☒) in the box next to your answer.

(i) The part labelled **J** on the diagram is called the

(1)

☒ **A** eyeball

☒ **B** image

☒ **C** optic nerve

☒ **D** retina

(ii) The part labelled **K** on the diagram is called the

(1)

☒ **A** ciliary muscle

☒ **B** cornea

☒ **C** eyelash

☒ **D** pupil

(iii) Long sight and short sight are two common eye problems.

State **one** difference between long sight and short sight.

(1)

.....

.....

.....

.....

(b) James is a keen cricket player but is finding that he is unable to play as well as he used to because his eyesight is deteriorating. He decides a visit to the optician is necessary.

The optician prescribes spectacles with lenses of +1.25 D for James.

(i) What type of lens is this?

(1)

.....

.....

(ii) Calculate the focal length of a lens with a power of +1.25 D.
State the unit.

(2)

focal length = ... unit .....

(c) James does not want to wear spectacles.
His optician suggests that he considers contact lenses or laser correction as alternatives to wearing spectacles.

Choose one of these alternative methods and evaluate how suitable it would be for James.

(2)

.....

.....

.....

.....

(Total for Question 1 = 8 marks)

 © Edexcel Limited 2011

2 Sabina used a ray box to investigate light travelling through different glass blocks.

(a) Diagram 1 shows a ray of red light incident onto a rectangular glass block.

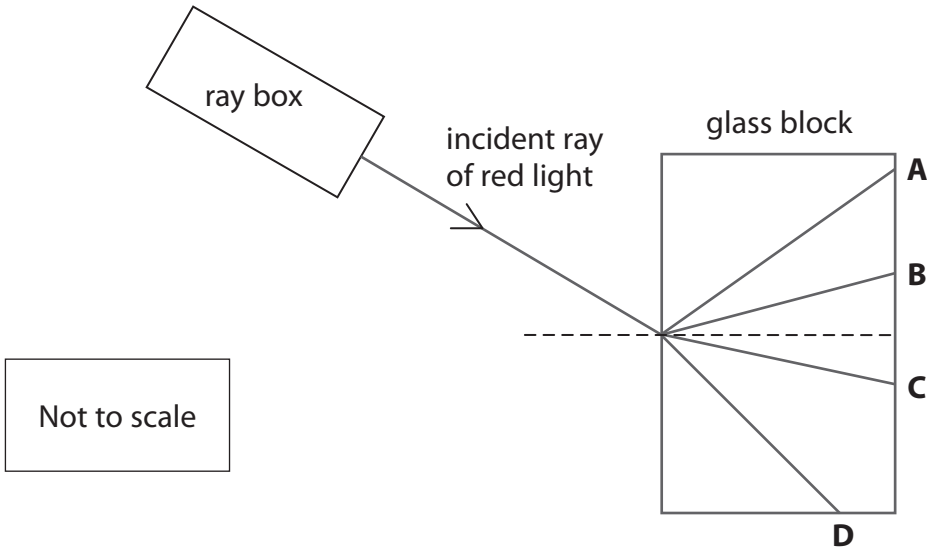


Diagram 1

(i) Which line gives the correct path for light inside the block?

(1)

Put a cross (☒) in the box next to your answer.

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(ii) What happens to the speed of the light as it enters the glass block?

(1)

.....

.....

(b) Sabina then shines a ray of red light onto a semicircular glass block.
Diagram 2 shows the path of the ray into the block.

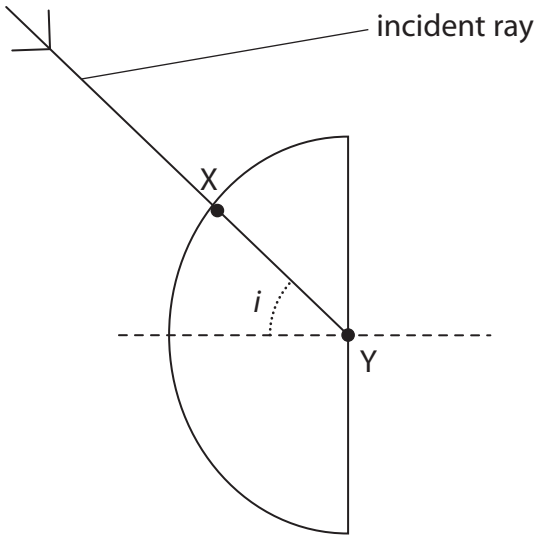


Diagram 2

(i) The incident ray does **not** change direction as it enters the glass block at point X.
Give a reason for this.

(1)

.....

.....

.....

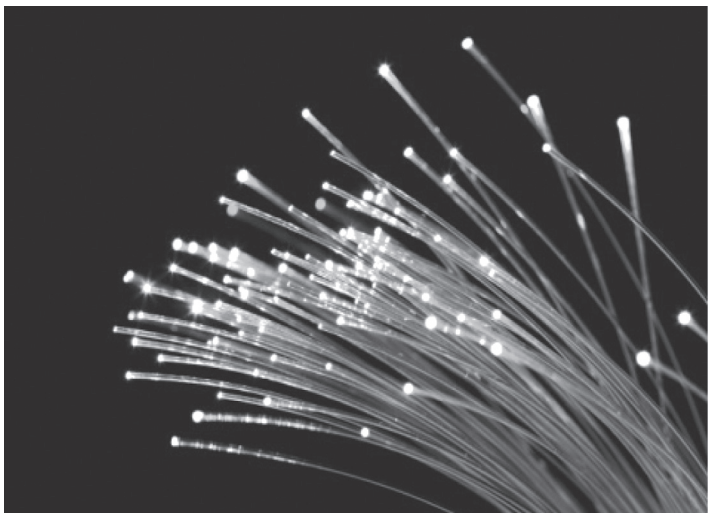
(ii) The angle *i* is greater than the critical angle for this glass-air boundary.

Continue the ray on Diagram 2 to show its path as it leaves the glass block.

(2)

 © Edexcel Limited 2011

(c) Sabina now experiments with optical fibres and notices that the light travels along the fibres and shines out of the ends.
The photograph shows light shining from an optical fibre.



Shutterstock

Explain how an optical fibre works.

Draw a labelled diagram to help with your answer.

(3)

(Total for Question 2 = 8 marks)

Uses and dangers of radiation

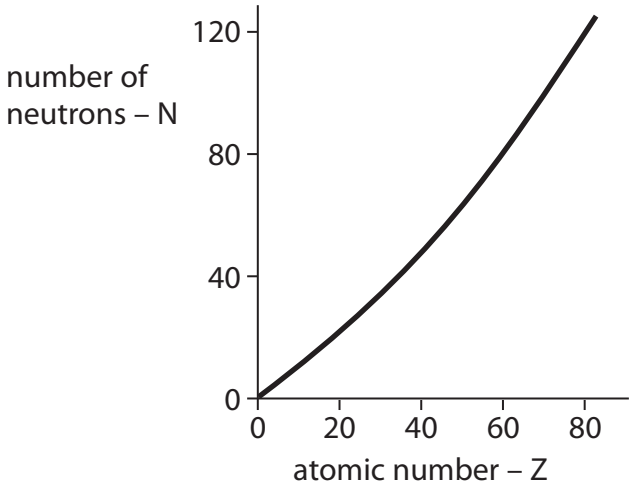
3 Many of the diagnoses and treatments in hospitals are carried out using **unstable** isotopes.

These isotopes produce ionising radiations which are potentially dangerous to human health.

(a) Describe how medical personnel limit their exposure to these emissions.

(2)

(b) The line on the graph below shows the relationship between the number of neutrons (N) and the atomic number (Z) for **stable** isotopes.



(i) Why does the line on the graph stop at Z = 82?

(1)

 © Edexcel Limited 2011

(ii) Label the graph with the letter B to show the region in which unstable isotopes are most likely to show beta-minus (β^-) decay.

(1)

(iii) Explain why beta-minus (β^-) decay takes place in unstable isotopes in this region.

(2)

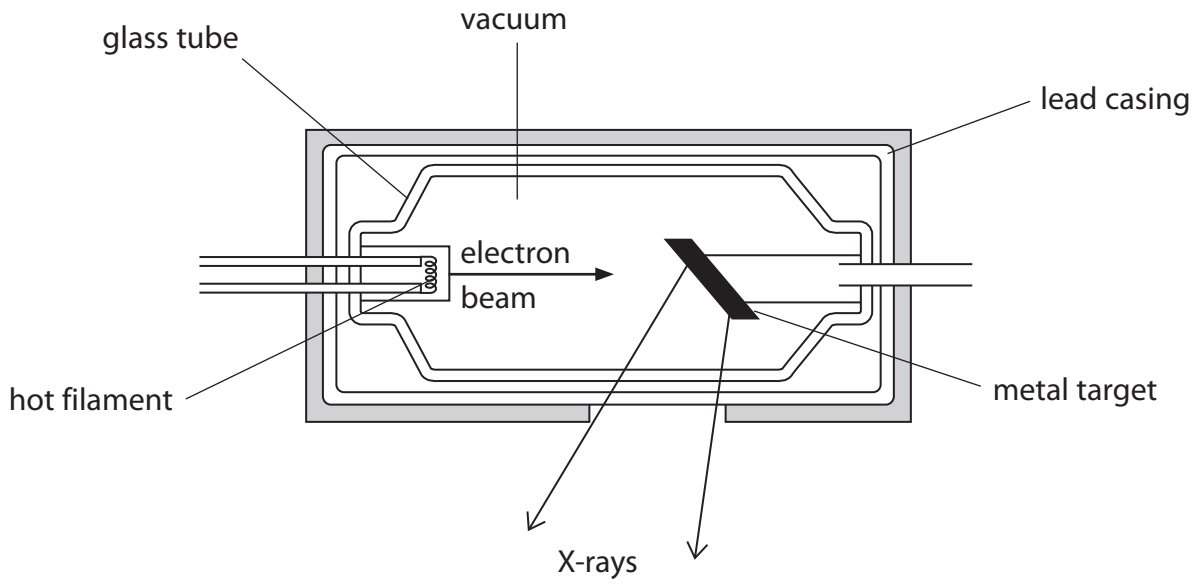
(c) Explain why radioisotopes are increasingly being used in the diagnosis and treatment of many forms of disease.

(3)

(Total for Question 3 = 9 marks)

4 (a) X-rays can be used in hospitals to look at broken bones.
X-rays are produced by firing electrons at a metal target in an X-ray tube.

The diagram shows an X-ray tube.



(i) The beam of electrons forms an electric current.

Calculate the current when 6.25×10^{14} electrons flow per second.

(2)

1.6×10^{-19} C

The charge on each electron is

.....

.....

.....

.....

current = ... A

(ii) The kinetic energy gained by each electron is 9.6×10^{-15} Joules.

Calculate the accelerating potential difference.

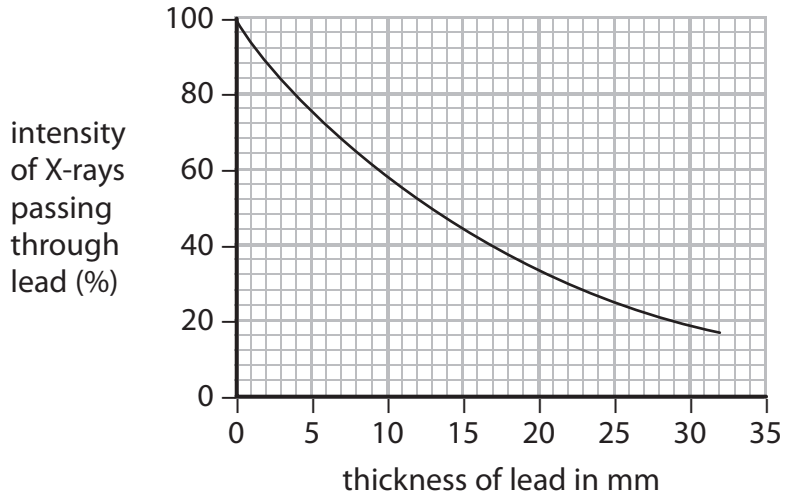
The charge on each electron is 1.6×10^{-19} C.

(3)

accelerating potential difference = ... V

 © Edexcel Limited 2011

(iii) X-rays are absorbed by the lead casing of the X-ray tube.
The graph shows how the intensity of X-rays passing through lead depends on its thickness.



What thickness of lead would **absorb** 60% of the X-rays.

(1)

Put a cross (☒) in the box next to your answer.

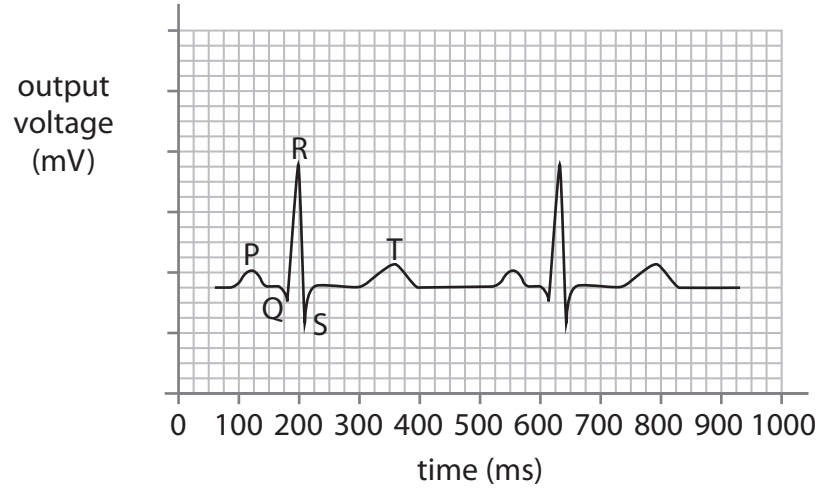
☒ **A** 10mm

☒ **B** 12mm

☒ **C** 18mm

☒ **D** 33mm

(b) The action of the heart can be investigated using an electrocardiogram (ECG).
The graph shows the ECG of a normal heart, for two heart beats.



(i) Which section of the graph represents the contraction of the heart to pump blood around the body?

Put a cross (☒) in the box next to your answer.

(1)

☒ **A** P

☒ **B** PR

☒ **C** QRS

☒ **D** ST

(ii) Use the graph to calculate the number of beats **per minute** for this heart.

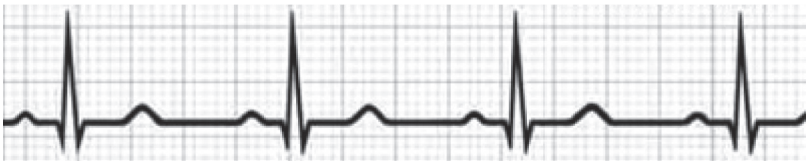
(2)

number of beats = ... per minute

 © Edexcel Limited 2011

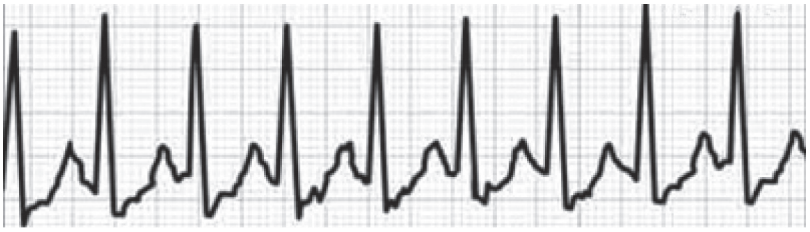
(c) Here are three ECGs from different patients, Jose, Kathryn and Leona.

Jose



Kathryn

Leona



Describe what these ECGs show about the hearts of Kathryn and Leona.

(2)

.....

.....

.....

.....

(Total for Question 4 = 11 marks)

Using positrons

5 Positron emission by isotopes of different elements is used in different ways to diagnose medical problems.

(a) When carbon-11 decays, it emits a positron.
This type of decay is known as beta-plus (β^+) decay.

(i) What happens in the nucleus of a carbon-11 atom during β^+ decay?

(1)

.....

.....

(ii) What happens to the quarks in the nucleus of a carbon-11 atom during β^+ decay?

(1)

.....

.....

(b) A positron is the antiparticle of an electron.

Describe what happens when a particle meets its antiparticle.

(2)

.....

.....

.....

.....

 © Edexcel Limited 2011

(c) Sarah has a suspected brain tumour.
Her consultant sends her for a PET scan.

stock photo

During the PET scan, Sarah is injected with an isotope which emits positrons as it decays.

The table gives some data about three isotopes.

isotope	decays by emission of	half-life in minutes	emission energy in MeV
carbon-11	β^+	20	0.5
oxygen-15	β^+	2	3.0
fluorine-18	β^+	110	1.7

Sarah's consultant decides to use fluorine-18.

(i) Explain why fluorine-18 is the most suitable choice.

(2)

*(ii) The fluorine-18 is built into molecules which act like glucose.
Tumour cells use more glucose than ordinary cells.
Fluorine-18 collects in the tumour cells, where it decays and emits positrons.

Explain how positron emission enables the tumour to be located accurately to help the consultant with his assessment.

You may use a labelled diagram to help your answer.

(6)

(Total for Question 5 = 12 marks)

 © Edexcel Limited 2011

Medical gases

6 (a) Oxygen is carried by ambulances in pressurised cylinders such as the one in the photograph.

Shutterstock

The table gives some technical details about the oxygen cylinders in ambulances.

internal volume of cylinder	volume of oxygen compressed into the cylinder	maximum flow rate	minimum flow rate	construction
1.2 litres	300 litres	5 litres per minute	0.1 litres per minute	steel wrapped with carbon fibres

(i) Calculate the time taken to empty a full cylinder at a flow rate of 2 litres per minute.

(2)

time = ... minutes

(ii) Use the equation $P_1V_1 = P_2V_2$ to calculate the pressure of the oxygen inside a full cylinder.

(2)

pressure = ... atmospheres

(iii) Explain what would happen to the pressure of the gas inside the cylinder as the temperature became higher during the day.

(2)

*(b) The oxygen cylinders used in a hospital are different from the cylinders used in an ambulance.

Hospital oxygen cylinders are larger, made of aluminium and need a separate device to adjust the flow rate. These cylinders also contain more oxygen but work at a lower pressure.

Oxygen cylinders used on an ambulance are often made from steel, but the latest ones are carbon fibre reinforced aluminium. The device to adjust the flow rate is built into the cylinder.

Explain how the different cylinders make them suited to their use.

(6)

(Total for Question 6 = 12 marks)

TOTAL FOR PAPER = 60 MARKS

© Edexcel Limited 2011

Sample Mark Scheme

Unit P3: Applications of Physics (Higher Tier)

Question number	Answer	Mark
1(a)(i)	**D**	**(1)**

Question number	Answer	Mark
1(a)(ii)	**A**	**(1)**

Question number	Answer	Acceptable answers	Mark
1(a)(iii)	answer must include information on **both** long and short sight long: can't focus on near objects short: can't focus on distant objects long: ciliary muscles cannot relax enough (for focus) short: ciliary muscles cannot contract enough (for focus)	 long: lens can't flatten enough (for focus) short: lens can't bulge enough (for focus)	**(1)**

Question number	Answer	Mark
1(b)(i)	convex/converging	**(1)**

Question number	Answer		Acceptable answers	Mark
1(b)(ii)	subs (1)	1/1.25	accept 100/1.25	
	evaluation in a correct unit (1)	0.8 m OR 80 cm	unit must be correct for second mark unit is not an independent mark	**(2)**

Question number	Answer	Acceptable answers	Mark
1(c)	an evaluation linking the following: laser correction gives permanent improvement/no glasses needed (1) (but) has a recovery time/is expensive (1)	 contact lenses are convenient/disposable/relatively cheap (1) (but) may fall out during James' sporting activity (1)	**(2)**

TOTAL: 8 MARKS

Question number	Answer	Mark
2(a)(i)	**C**	**(1)**

Question number	Answer	Acceptable answers	Mark
2(a)(ii)	it slows down	Gets less	**(1)**

Question number	Answer	Acceptable answers	Mark
2(b)(i)	angle of incidence zero/along the normal/incident at 90° to surface	accept along a radius	**(1)**

Question number	Answer	Acceptable answers	Mark
2(b)(ii)	line reflects with $i = r$ (1) line emerges from curved surface without further deviation/along a normal (1)	judge by eye in both cases	**(2)**

Question number	Answer	Mark
2(c)	diagram showing TIR (1) an explanation linking the following points: TIR at internal surface (1) angle in glass greater than critical angle (1)	**(3)**

TOTAL: 8 MARKS

 © Edexcel Limited 2011

Question number	Answer	Acceptable answers	Mark
3(a)	a description including **two** of the following points: give the lowest dosage that is viable to patient (1) lead shielding (1) remote control of equipment (1)	 irradiate localised areas (1)	 **(2)**

Question number	Answer	Mark
3(b)(i)	**all** isotopes from elements above Z = 82 are unstable	**(1)**

Question number	Answer	Acceptable answers	Mark
3(b)(ii)	on the left of the line of stability	not above N = 120	**(1)**

Question number	Answer	Mark
3(b)(iii)	an explanation linking a pair of the following: isotopes emit radiation to become more stable/a neutron becomes a proton (1) (leads to) isotope moving (to the right) closer to the line of stability (1)	 **(2)**

Question number	Answer	Acceptable answers	Mark
3(c)	an explanation linking any **three** of the following points: (because they) help accurate diagnosis to ensure correct treatment (1) (because they) give early diagnosis before external symptoms are apparent (1) (therefore they) increase the possibility of a complete cure (1) (therefore doctors can) provide treatment which lengthens life expectancy (1)	(therefore doctors can) provide palliative treatment which can improve quality of life	**(3)**

TOTAL: 9 MARKS

 © Edexcel Limited 2011

Question number	Answer	Acceptable answers	Mark
4(a)(i)	selection of equation and substitution (1) = 1 x 10^{-4} A (1)	(6.25×10^{14}) x (1.6×10^{-19}) = 0.1 x 10^{-3} A or 0.1 mA	**(2)**

Question number	Answer	Acceptable answers	Mark
4(a)(ii)	selection of equation and substitution (1) transposition of equation (1) 60 000 V (1)	$9.6 \times 10^{-15} = 1.6 \times 10^{-19} \times V$ (9.6×10^{-15}) ÷ (1.6×10^{-19}) = 60 kV	**(3)**

Question number	Answer	Mark
4(a)(iii)	**C**	**(1)**

Question number	Answer	Mark
4(b)(i)	**C**	**(1)**

Question number	Answer	Acceptable answers	Mark
4(b)(ii)	one beat in 425 ms (1) 60/0.450 = 141 beats per minute (1)	accept 400 – 450 ms award both marks for an answer in the range of 133 to 150 (beats per minute)	**(2)**

Question number	Answer	Mark
4(c)	a description including the following: Kathryn: bradycardia/pulse too slow (compared to Jose) (1) Leona: tachycardia/pulse too fast (compared to Jose) (1)	**(2)**

TOTAL: 11 MARKS

Question number	Answer	Acceptable answers	Mark
5(a)(i)	proton decays/becomes neutron plus positron	accept beta + for positron	**(1)**

Question number	Answer	Acceptable answers	Mark
5(a)(ii)	one up becomes a down	accept description in terms of arrows accept if mentioned in (a)(i)	**(1)**

Question number	Answer	Acceptable answers	Mark
5(b)	a description including **one** of the following pairs: (because the) particles have opposite charges (1) two (uncharged) photons/gamma rays are created (1) OR two (uncharged) photons/gamma rays are created (1) to conserve momentum (and energy) (1)	 the two particles annihilate (and) two gamma rays are created	**(2)**

Question number	Answer	Acceptable answers	Mark
5(c)(i)	an explanation linking the following: F-18 has a longer half-life (1) (so) need not be made on site (1)	 others have too short a half-life (so) decay too quickly to be used ignore arguments with respect to energy emitted	**(2)**

 © Edexcel Limited 2011

Question number		Indicative content	Mark
***5(c)(ii) QWC**		an explanation including some of: • annihilation of electron • 2 gamma emitted • opposite directions/at 180° apart • simultaneous detection • on opposite sides of head • tumour is along path between detectors • three events to locate accurately (triangulation) accept labels on diagram	**(6)**
Level	**0**	No rewardable material	
1	**1-2**	• there is a limited explanation of how the positron emission process operates, with reference to a few of the steps, although they may not all be in the correct order • the answer communicates ideas using simple language and uses some scientific terminology • spelling, punctuation and grammar are used with limited accuracy	
2	**3-4**	• there is a explanation of most of the key processes in the positron emission process operates, although they may not all be in the correct order • the answer communicates ideas showing some evidence of clarity and organisation and uses scientific terminology appropriately • spelling, punctuation and grammar are used with some accuracy	
3	**5-6**	• there is a clear explanation of the key processes in the positron emission process operates, in the correct order • the answer communicates ideas clearly and uses a range of scientific terminology appropriately • spelling, punctuation and grammar are used with few errors	

TOTAL: 12 MARKS

Question number	Answer	Acceptable answers	Mark
6(a)(i)	(300 - 1.2) (1) ÷ 2 (= 149.4 min) (1)	if 1.2 litres left in the container not included: 300/2 =150 gets 1 mark	 **(2)**

Question number	Answer		Acceptable answers	Mark
6(a)(ii)	sub and transposition (1)	1.2 x P = 300 x 1 P = 300/1.2	allow sub and transpose in either order	
	answer (1)	250 (atm)		**(2)**

Question number	Answer	Mark
6(a)(iii)	an explanation linking the following: (small/slight) rise in pressure (1) (due to) increase in KE/speed of molecules (1)	 **(2)**

 © Edexcel Limited 2011

Question number		Indicative content	Mark
***6(b) QWC**		an explanation involving a discussion of the relevant needs of ***each*** situation and matching the needs to the properties of the respective cylinder This could include: • a comparison of the volume and pressure of each type of cylinder • mass of the cylinders • strength of cylinder related to internal pressure and their • necessary robustness in an ambulance and in a hospital • need to have integrated regulator or not • a description of pressure in terms of kinetic theory	**(6)**
Level	**0**	No rewardable material	
1	**1-2**	• there are some basic comparisons made between the cylinders, with little or no reference to the suitability to different uses • the answer communicates ideas using simple language and uses some scientific terminology • spelling, punctuation and grammar are used with limited accuracy	
2	**3-4**	• there are comparisons of key differences between cylinders, with some reference to the suitability to different uses • the answer communicates ideas showing some evidence of clarity and organisation and uses scientific terminology appropriately • spelling, punctuation and grammar are used with some accuracy	
3	**5-6**	• there is a clear explanation of the differences between the cylinders, which may include reference to pressure in terms of KT. There is clear reference to the suitability to different uses • the answer communicates ideas clearly and uses a range of scientific terminology appropriately • spelling, punctuation and grammar are used with few errors	

TOTAL: 12 MARKS