Write your name here

Surname	Other names

Edexcel GCSE

Centre Number	Candidate Number

Physics

Unit P3: Applications of Physics

Foundation Tier

Sample Assessment Material
Time: 1 hour

Paper Reference
5PH3F/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 ▶

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FORMULAE

You may find the following formulae useful

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

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

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

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 $V_1 P_1 = V_2 P_2$

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 ☒.

Beta minus (β^-) radiation

1 Beta minus (β^-) radiation is emitted by caesium-137.

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

(i) β^- radiation consists of

(1)

☒ **A** electromagnetic waves

☒ **B** fast electrons

☒ **C** radioactive isotopes

☒ **D** unstable nuclei

(ii) β^- radiation is emitted by

(1)

☒ **A** charged insulators

☒ **B** excited atoms

☒ **C** unstable nuclei

☒ **D** X-ray machines

(b) When caesium-137 decays, it emits a beta minus (β^-) particle.
This affects the atomic (proton) number and the mass (nucleon) number.
A barium nucleus is formed.

(i) Complete the symbol for the barium (Ba) nucleus below to show what happens.

(2)

$$^{137}_{55}\text{Cs} \longrightarrow {}^{0}_{-1}\beta^- + {}^{\square}_{\square}\text{Ba}$$

The barium nucleus is rearranged and it emits further radiation.

(ii) Explain the effect of this further emission of radiation on the barium nucleus.

(2)

.....

.....

.....

.....

(c) Beta minus (β^-) radiation can be used to treat bone cancer.
Radioactive chemicals that emit beta particles are injected into the patient.

Explain why it is more effective to put the radioactive source inside the patient.

(2)

.....

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.....

(Total for Question 1 = 8 marks)

Improving eyesight

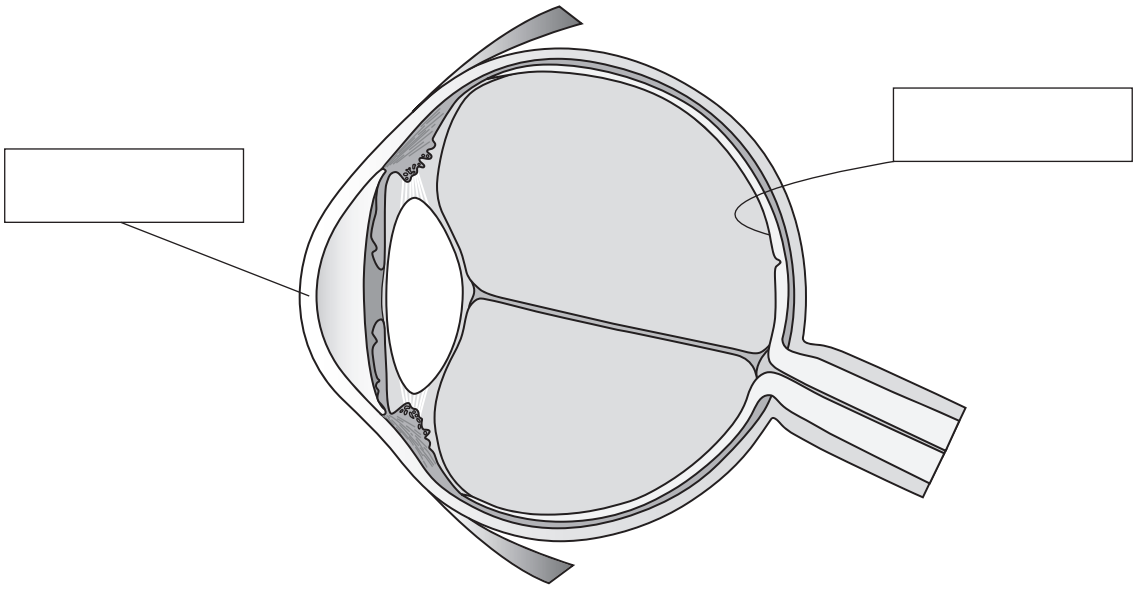
2 The human eye is sensitive to visible light.

(a) Use words from the box to answer **both** part (i) and part (ii).
Each word may be used once, more than once or not at all.

cornea	iris	lens	optic nerve	pupil	retina

(i) Complete the labels on the diagram of the eye.

(2)



(ii) Which **two** parts of the eye focus light?

(2)

1 .....

2 .....

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

For people who make lenses, the dioptre is an important unit.

(1)

The dioptre is a measure of

☒ **A** the focal length of a lens

☒ **B** the diameter of a lens

☒ **C** the power of a lens

☒ **D** the thickness of a lens

(c) Russell becomes long-sighted as he gets older.

Explain how a change to Russell's eyes may cause him to become long-sighted.

(2)

(d) Russell needs to wear glasses to correct his long sight.

Describe how the lenses in Russell's glasses help him to see better.

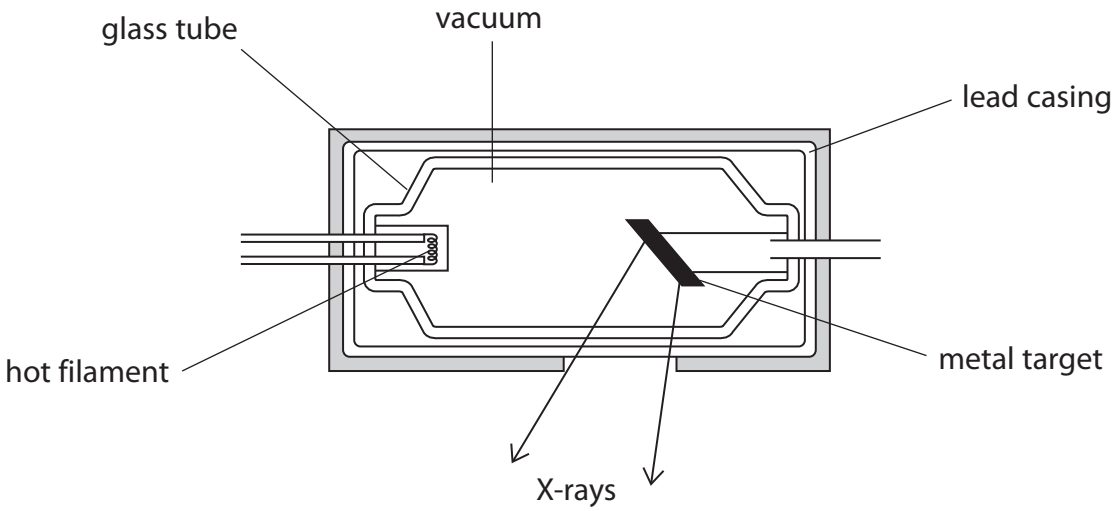
(2)

(Total for Question 2 = 9 marks)

Using X-rays

3 Josie injures her hand and goes to hospital.
A doctor takes an X-ray of Josie's hand.

(a) X-ray tubes are used to produce X-rays.
X-rays are produced by firing electrons at a metal target.
The diagram shows an X-ray tube.



(i) Electrons are produced from the hot filament.

What is the name given to the emission of these electrons?

(1)

.....

.....

(ii) Why is a vacuum needed?

(1)

.....

.....

(iii) Electrons are accelerated towards the metal target by a potential difference.
Which of these shows the correct polarity for the hot filament and the metal target?

(1)

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

	hot filament	**metal target**
☒ **A**	positive	negative
☒ **B**	positive	positive
☒ **C**	negative	positive
☒ **D**	negative	negative

(b) Explain why the doctor stands far away from the X-ray tube while it is switched on.

(2)

(c) The image shows the X-ray of Josie's hand.
The image is produced on photographic film.

istock photo

Key

- lots of X-rays reach film
- some X-rays reach film
- few X-rays reach film

The X-rays pass through Josie's hand to reach the film.

Explain why different parts of Josie's hand are different shades of grey on the X-ray image.

(2)

(d) X-rays can be dangerous.

Explain why the doctor decides to X-ray Josie's hand, even though this could harm Josie.

(2)

(Total for Question 3 = 9 marks)

Alpha particles

4 Some radioisotopes emit alpha particles.

(a) Alpha particles have mass and charge.

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

(i) Compared to the mass of a proton, the mass of an alpha particle is

(1)

☒ **A** half as much

☒ **B** the same

☒ **C** twice as much

☒ **D** four times as much

(ii) Compared to the charge on a proton, the amount of charge on an alpha particle is

(1)

☒ **A** half as much

☒ **B** the same

☒ **C** twice as much

☒ **D** four times as much

(b) An alpha particle is the nucleus of a helium atom.

Describe a helium atom.
You may wish to draw a diagram to help with your answer.

(2)

(c) An accelerator emits a beam of alpha particles.
A beam of alpha particles is equivalent to an electric current.

There are 12 million million (12×10^{12}) alpha particles per second in the beam.
The beam current is 3.84 microamps.

(i) The number of alpha particles in the beam changes to 24 million million per second.

What happens to the beam current?

(1)

.....

.....

(ii) Another accelerator emits 12 million million beta minus (β^-) particles.

What beam current does this produce?

(2)

current = ... microamps

(d) Alan has an old camera.
The glass lens contains some radioactive thorium-232.
Thorium-232 emits alpha particles.

Discuss whether it is sensible for Alan to use the camera.

(3)

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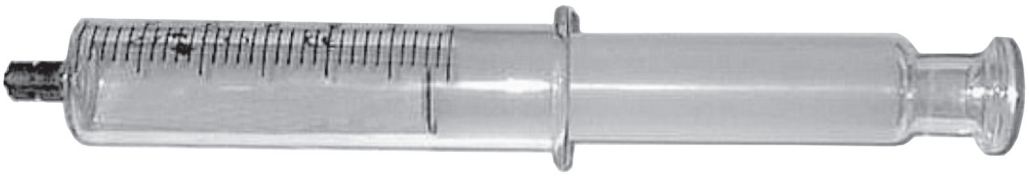
(Total for Question 4 = 10 marks)

Temperature and volume of gases

5 Joshim investigates how changing the temperature of a gas affects its volume.
He starts with some gas in the syringe and seals it.

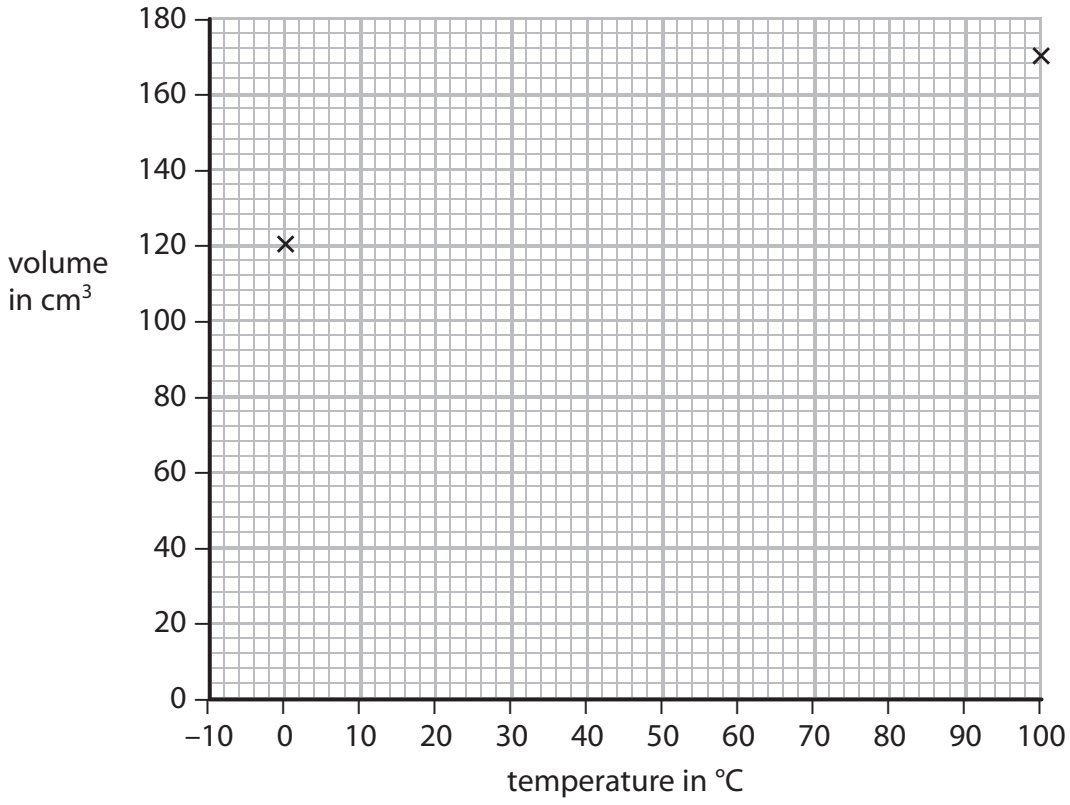


The table shows Joshim's results.

temperature in °C	0	20	45	55	70	90	100
volume in cm^3	120	130	140	150	160	160	170

(a) Joshim plots two points on the grid below.
Finish plotting the results and draw a straight line of best fit.

(3)



(b) Joshim thinks about what would happen if he cooled the gas.

Describe what happens to gas molecules as the gas is cooled from 0 °C to absolute zero.

(2)

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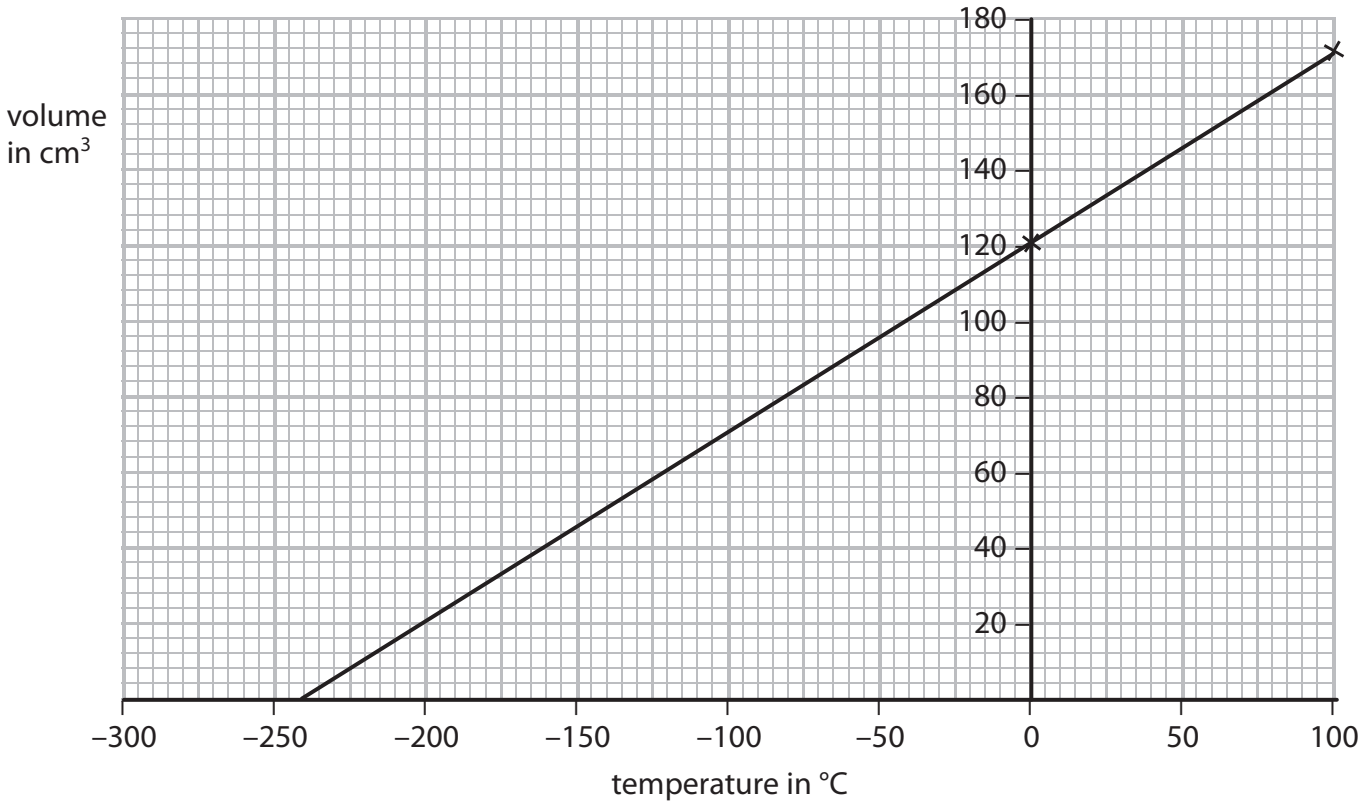
(c) Joshim extends his graph to the left and draws a line like this.



He concludes that the value for absolute zero is –240 °C.
This is not the correct value.

(i) What is the correct value for absolute zero?

(1)

absolute zero = ... °C

*(ii) Suggest how Joshim should improve his experiment to produce a result closer to the correct value.

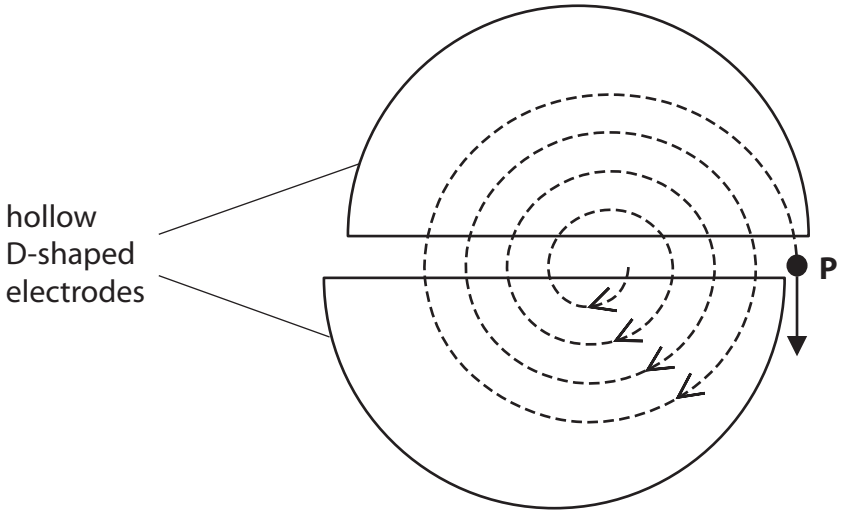
(6)

(Total for Question 5 = 12 marks)

Cyclotrons and radioactive isotopes

6 Some radioactive isotopes used in hospitals are made using a cyclotron.

(a) The dotted line shows the path of proton **P** in the cyclotron.



the proton spends the same time in each D-shaped electrode

The proton starts at the centre of the cyclotron and moves in a spiral.
The proton is shown coming out of the cyclotron.

Explain how the motion of the proton changes as it moves in the spiral.

(2)

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.....

(b) A cyclotron can be used to produce radioactive isotopes for PET scanners.

(i) Describe how radioactive isotopes are made using a cyclotron.

(2)

(ii) What particles are emitted by the isotope in a PET scanner?

(1)

(iii) Why must a radioactive isotope used for PET scans have a short half-life?

(1)

*(c) When the cyclotron is working, it produces dangerous radiation.
Hospital workers are at risk from the radioactive isotopes and from radiation produced when the cyclotron is working.

Explain how these risks can be reduced for hospital workers.

(6)

(Total for Question 6 = 12 marks)

TOTAL FOR PAPER = 60 MARKS

Sample Mark Scheme

Unit P3: Applications of Physics (Foundation Tier)

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

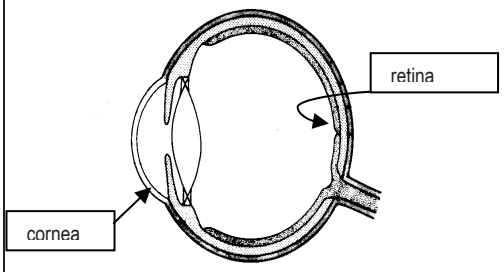
Question number	Answer	Mark
1(a)(ii)	**C**	**(1)**

Question number	Answer	Acceptable answers	Mark
1(b)(i)	137 **Ba** 56	one mark for each correct entry in the boxes	**(2)**

Question number	Answer	Acceptable answers	Mark
1(b)(ii)	an explanation linking the following: nucleus loses energy (1) (because) it emits a gamma (ray) (1)	recognisable symbol (γ-ray)	**(2)**

Question number	Answer	Acceptable answers	Mark
1(c)	an explanation linking a pair of the following: beta particles inside the body travel less far to target (1) (so) more particles reach target before they are absorbed (1) beta particles from outside (the body) would be absorbed (1) (so) would not reach the target (1)	 range in tissue is very short (so) tumour not affected	**(2)**

TOTAL: 8 MARKS

Question number	Answer	Acceptable answers	Mark
2(a)(i)		1 mark for each correct label	**(2)**

Question number	Answer	Acceptable answers	Mark
2(a)(ii)	cornea lens	answers can be in either order	**(2)**

Question number	Answer	Mark
2(b)	**C**	**(1)**

Question number	Answer	Acceptable answers	Mark
2(c)	an explanation linking a pair of the following: eye cannot focus so closely (1) (because) lens becomes more crystalline (1) lens no longer bends light as much (1) (because) ciliary muscles cannot tighten enough (1)	 near point has moved further away eye lens has become less powerful lens becomes stiffer ciliary muscles weaken	**(2)**

Question number	Answer	Acceptable answers	Mark
2(d)	a description including: use of convex/positive/+ (lens) (1) and any one from: to bring near point closer (1) increase (overall) lens power (1)	 a lens that is thicker in the middle he can focus on near objects/(together) the lenses bend/refract the light more	**(2)**

TOTAL: 9 MARKS

Question number	Answer	Mark
3(a)(i)	thermionic emission	**(1)**

Question number	Answer	Acceptable answers	Mark
3(a)(ii)	to prevent collisions (with air particles)	to prevent scattering of electrons so the electrons can reach the target	**(1)**

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

Question number	Answer	Acceptable answers	Mark
3(b)	an explanation linking the following: decreasing intensity with distance (1) (so) protected from the X-rays (1)	 it is safer (1) (because) further away, the X-rays are weaker (1)	**(2)**

Question number	Answer	Mark
3(c)	an explanation linking the following: different (thicknesses of) materials absorb different amounts/different materials have different densities (1) (so) different amounts of X-rays reach the photographic film (1)	**(2)**

Question number	Answer	Acceptable answers	Mark
3(d)	an explanation linking a pair of the following: dose is low/Josie can be shielded/idea of need to check if injury is severe (1) (so) benefit outweighs risk/risk is small and acceptable (1)	 doctor can make an expert judgement	**(2)**

TOTAL: 9 MARKS

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

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

Question number	Answer	Acceptable answers	Mark
4(b)	a description including the following: nucleus containing two protons and two neutrons (1) two electrons outside the nucleus (1)	 this may be shown on a correctly labelled diagram	 **(2)**

Question number	Answer	Mark
4(c)(i)	7.68 (μA)/double the amount	**(1)**

Question number	Answer	Acceptable answers	Mark
4(c)(ii)	beta minus charge = ½ alpha charge (1) 1.92 (μA) (1)	charge is less charge is smaller current would be halved	 **(2)**

Question number	Answer	Acceptable answers	Mark
4(d)	a discussion linking **three** from the following: possible level of activity of source (1) range of alpha particles in air (1) absorption of alpha particles by parts of the camera (1) effects of prolonged exposure/frequency of use (1) ionising effect of alpha particles/possible harm to people (user and/or others) (1) possible effect on photographic material (1) NB The candidate may conclude that it is safe or is not safe to use the camera	 e.g. camera is old, so source has lost most of its activity e.g. alpha particles have short range in air e.g. alpha particles absorbed by metal of camera frame e.g. camera only used occasionally so risk is low e.g. alpha particles can cause tissue damage e.g. radiation may “fog” the film	**(3)**

TOTAL: 10 MARKS

Question number	Answer	Acceptable answers	Mark
5(a)	correct plotting (max 2 marks) straight line of best fit (1)	all 5 points correctly plotted = 2 marks any 4 points correctly plotted = 1 mark gauge quality of line by eye	**(3)**

Question number	Answer	Mark
5(b)	a description including the following: (molecules) slow down (1) until they stop (1)	**(2)**

Question number	Answer	Acceptable answers	Mark
5(c)(i)	-273 (°C)	'minus' 273 (°C) -273.15 (°C)	**(1)**

Question number		Indicative content	Mark
***5(c)(ii) QWC**		an analysis of the considerations appropriate to improving a basic investigation so that it can better achieve its aim – covering both practical and theoretical aspects. • idea of extrapolating the graph • line should reach temperature axis • extrapolated line should be straight • rechecking the plotting • repeating the readings • sharing the results of several experiments • further interpolated readings • extending the range of readings downwards below 0°C • checking that atmospheric pressure remains constant • use of more precise equipment • taking readings for as low a temperature as equipment allows	**(6)**
Level	**0**	No rewardable material	
1	**1-2**	• a simple analysis including basic ways to obtain a value for absolute zero such as: carefully extrapolating the line using a ruler, taking the value where the line crosses the temperature axis, taking an average of class results • the student uses everyday language and the response lacks clarity and organisation • spelling, punctuation and the rules of grammar are used with limited accuracy	
2	**3-4**	• a more detailed analysis that also includes some sensible suggestions regarding the reliability of the procedure: rechecking the plotting, repeating the readings, plotting further interpolated readings • the student uses some technical terms and shows some clarity and organisation • spelling, punctuation and the rules of grammar are used with some accuracy	
3	**5-6**	• a full analysis including some appropriate methods to improve the accuracy of the outcome, such as: extending the range of readings, using more precise equipment, considering the control of appropriate variables • the student uses a range of technical terms and shows good clarity and organisation • spelling, punctuation and the rules of grammar are used with considerable accuracy	

TOTAL: 12 MARKS

Question number	Answer	Acceptable answers	Mark
6(a)	an explanation linking **one** of the following pairs: gains speed/velocity (1) because it goes further in the same time (1) changes direction (1) due to magnetic field (1)	 accelerates due to centripetal force	 **(2)**

Question number	Answer	Acceptable answers	Mark
6(b)(i)	a description including the following: stable isotopes (1) (are) bombarded with protons (1)	named stable isotope, e.g. N-14 allow alpha particle bombardment	 **(2)**

Question number	Answer	Mark
6(b)(ii)	positron(s)	**(1)**

Question number	Answer	Acceptable answers	Mark
6(b)(iii)	idea of need to minimise exposure	e.g. to minimise dose to patient e.g. to minimise dose to patient's contacts (e.g. family) e.g. to minimise duration of stay in hospital	 **(1)**

Question number		Indicative content	Mark
***6(c) QWC**		an explanation of the radiation protection considerations appropriate to working with radioactive sources in a hospital – covering both practical and theoretical aspects. • people working with radioactive material should minimise their exposure to the ionising radiation • appropriate working practices should be adopted - protective clothing and handling systems should be used • intensity of radiation decreases according to the nature of the medium through which it is travelling • intensity of radiation decreases with distance frome the source • energy from the ionising radiation is absorbed by the human body • prolonged exposure to radiation can cause tissue damage and possible mutation • personal radiation dose should be monitored	**(6)**
Level	**0**	No rewardable material	
1	**1-2**	• a simple explanation including basic ways to minimise the dose such as: using appropriate shielding, ensuring adequate separation between worker and source, reducing exposure time • the student uses everyday language and the response lacks clarity and organisation • spelling, punctuation and the rules of grammar are used with limited accuracy	
2	**3-4**	• a more detailed explanation that also includes some sensible suggestions regarding working practice such as: adopting work patterns that minimise exposure (through place and time), safe handling of radioactive materials, wearing appropriate protective clothing • the student uses some technical terms and shows some clarity and organisation • spelling, punctuation and the rules of grammar are used with some accuracy	
3	**5-6**	• a full explanation including appropriate physics in the reasoning, such as: the idea of absorption by the medium of the shield, the idea that the intensity of the radiation decreases with distance from the source, the idea that prolonged exposure can cause tissue damage, the idea of monitoring personal radiation dose • the student uses a range of technical terms and shows good clarity and organisation • spelling, punctuation and the rules of grammar are used with considerable accuracy.	

TOTAL: 12 MARKS