EDEXCEL GCSE PHYSICS

PHYSICS



EXAM QUESTION PACK

UNIT P3 HIGHER TIER 5PH3H PAPERS

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Write your name here

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Pearson Edexcel GCSE

Centre Number	Candidate Number

Physics

Unit P3: Applications of Physics

Higher Tier

Friday 23 June 2017 – Morning **Time: 1 hour**	Paper Reference **5PH3H/01**

You must have:
Calculator, ruler

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.
- 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.

energy = mass × (speed of light)^2 $\quad E = mc^2$

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

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

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

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

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

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

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

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

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

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Questions begin on next page.

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 ☒.

Using a lens to aid vision

1 A coin collector looks at the detail of a pound coin through a converging lens (magnifying glass).



(a) The focal length of the lens is 10 cm.

Calculate the power of the lens.

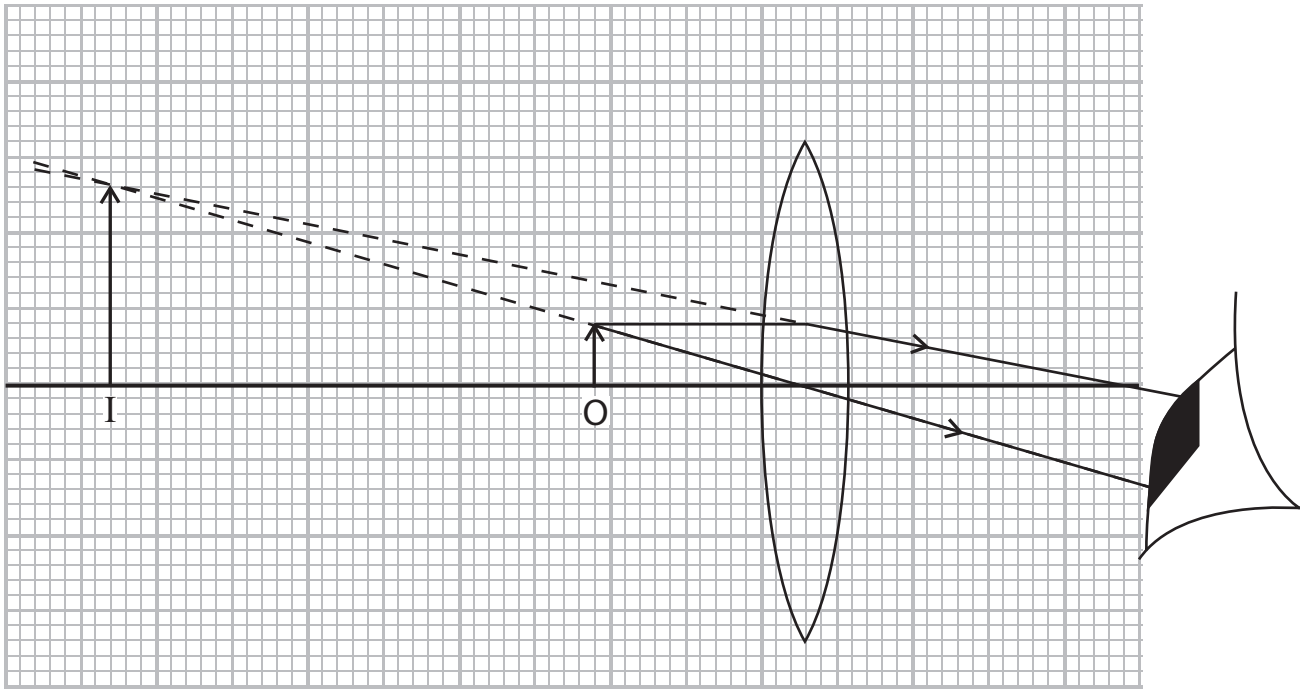
State the unit.

(4)

power = ... unit .....

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(b) A scale ray diagram of how the collector uses the magnifying lens to see the coin is shown.



(i) Mark and label the focal length of the lens on the diagram.

(1)

(ii) Use the drawing to calculate the magnification produced by the lens.

(2)

magnification = ...

(iii) The image distance, in this case, should be negative.

What does this tell you about the image?

(1)

.....

.....

(Total for Question 1 = 8 marks)

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Uses and dangers of ionising radiation

2 Radioactive sources are used in hospitals for both diagnosis and treatment of medical conditions.

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

(1)

Exposure of patients to ionising radiation will

☒ **A** decrease the probability of causing mutation of DNA in cells

☒ **B** always cause burns

☒ **C** never cause mutation of DNA in cells

☒ **D** increase the probability of causing mutation of DNA in cells

(b) Describe ways that medical staff can be protected from exposure to ionising radiation.

(3)

(c) Explain how cancer tumours can be treated using a radiation source placed inside the patient.

(3)

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(d) The isotope Tc-99m has these properties

- it is a gamma emitter
- it has a half-life of 6.03 hours

Doctors sometimes inject patients with this isotope to diagnose kidney problems.

Explain why the properties of the isotope make it suitable as a tracer.

(2)

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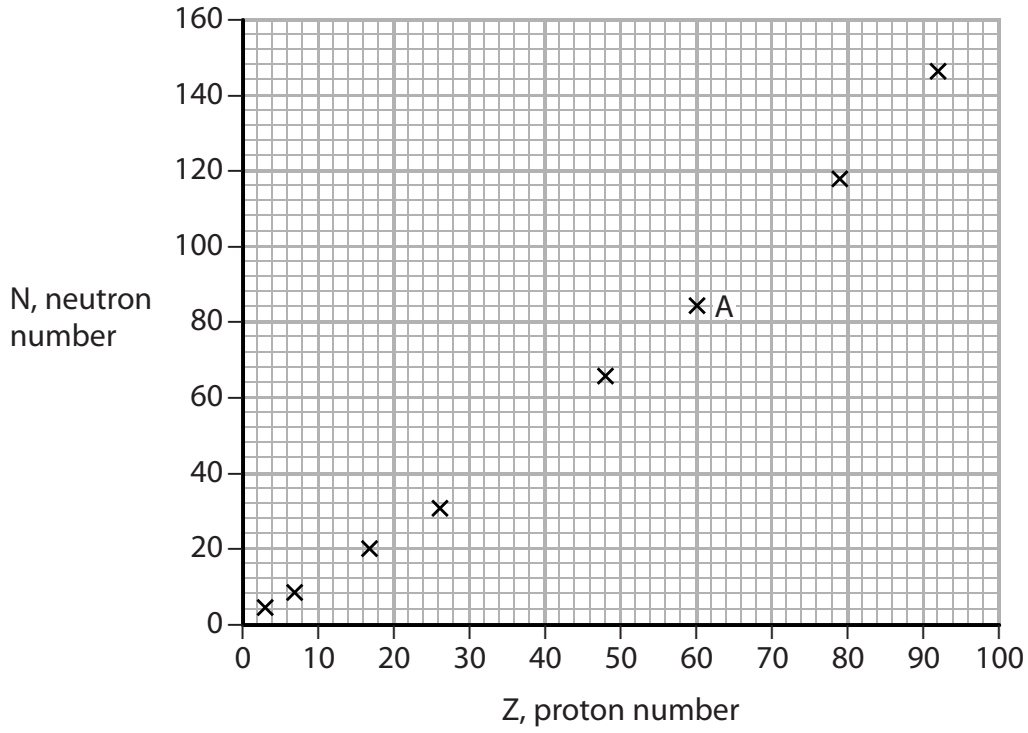
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(Total for Question 2 = 9 marks)

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Radioactivity

3 (a) The graph shows a plot of N, neutron number, against Z, proton number, for 8 **stable** nuclei.



(i) One of the nuclei is marked A on the graph.
Complete the symbol for the nucleus A.

(2)

_____
__ A
_____

(ii) Two other stable nuclei have the following properties.

Nucleus	Proton number	Neutron number
Hafnium	72	108
Yttrium	39	50

Plot the points on the graph that represent these two nuclei.

(2)

(iii) Draw a best fit curve.

(1)

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(b) State where a beta-minus particle emitter lies in relation to the curve.

(1)

.....

.....

(c) Which of the following statements is correct about β^+ decay?

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

(1)

β^+ decay involves a

☒ **A** neutron becoming a proton and an electron

☒ **B** neutron becoming a proton and a positron

☒ **C** proton becoming a neutron and an electron

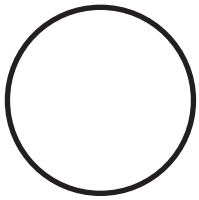
☒ **D** proton becoming a neutron and a positron

(d) Protons and neutrons are made of quarks.

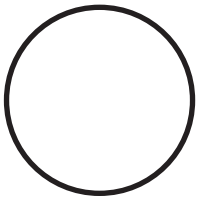
Draw the arrangement of quarks in a proton and a neutron using 'u' for up quarks and 'd' for down quarks.

(2)

NEUTRON



PROTON



(Total for Question 3 = 9 marks)

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Kinetic theory and the gas laws

4 Kinetic theory describes the behaviour of particles in solids, liquids and gases.

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

(1)

In the liquid state, particles are

☒ **A** a long way apart

☒ **B** can move past each other

☒ **C** in a regular pattern

☒ **D** stationary

(b) Gases are stored in cylinders at high pressure for use in hospitals.

(i) Explain how the gas in the cylinder exerts pressure.

(3)

(ii) Explain why the pressure of the gas inside the cylinder increases if the cylinder gets hot.

(2)

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(c) The diagram shows a diver using a gas bottle to provide air for a dive 50 m below the surface of the sea.



When the diver breathes out, small bubbles of air are produced that rise to the surface.

Every 10 m increase in the depth of seawater gives an increase of pressure of 101 kPa.

Normal atmospheric pressure at the surface is 101 kPa.

(i) Show that the pressure at a depth of 50 m is about 6×10^5 Pa.

(1)

(ii) As the diver breathes out, bubbles are produced.
At a depth of 50 m, one particular bubble has a volume of 1.25×10^{-6} m^3.

Calculate the volume of this bubble when it reaches the surface.
Assume that the temperature of the bubble remains constant and that it doesn't lose or gain any molecules in the process.

(3)

volume of bubble at the surface = ... m^3

(Total for Question 4 = 10 marks)

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Optical fibres and ultrasound

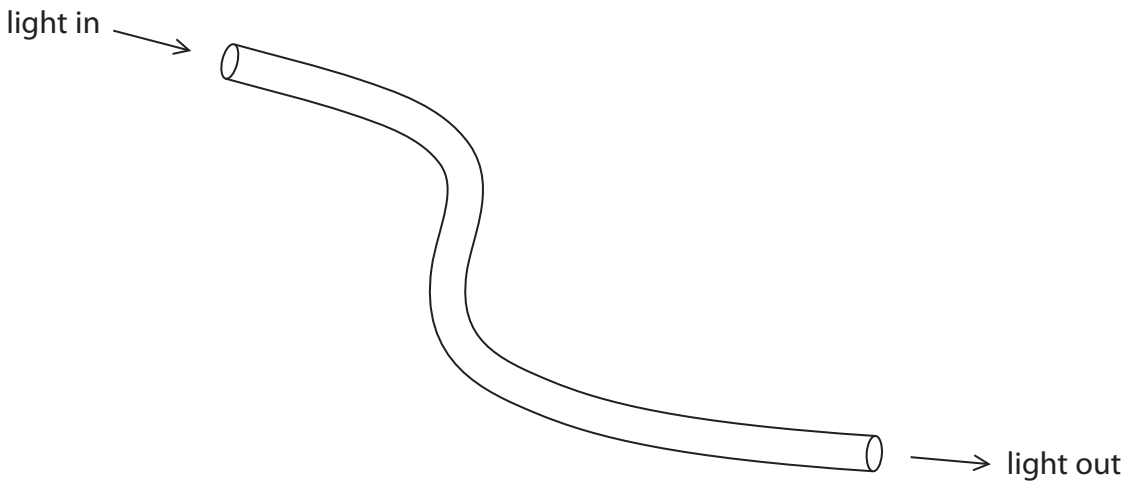
5 (a) State one medical use for optical fibres.

(1)

.....

.....

(b) Light is shone down an optical fibre as shown.



The intensity of the light coming out of the fibre is 5.0 W/m^2.

(i) 1% of the intensity is lost as it travels through the fibre.

Calculate the intensity of the light as it enters the fibre.

(1)

intensity = ... W/m^2

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(ii) The cross-sectional area of the fibre is $6.2 \times 10^{-7} m^2$.

Calculate the power of the light as it comes out of the fibre.

(3)

power = ... W

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

(1)

Intensity of light decreases as it travels down an optical fibre cable because

☒ **A** light obeys an inverse square law

☒ **B** light obeys Snell's law about refraction

☒ **C** light slows down as it travels through the fibre

☒ **D** light scatters off impurity atoms at a wide range of angles

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*(c) Ultrasound is used in hospitals.

Describe how ultrasound is used to produce scans for diagnosis and also to treat some medical conditions.

(6)

(Total for Question 5 = 12 marks)

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Cyclotrons and PET scanners

6 Cyclotrons produce fast-moving charged particles.

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

(1)

A cyclotron makes protons move in a spiral because there is a

☒ **A** force away from the centre of the circle due to an electric field

☒ **B** force away from the centre of the circle due to a magnetic field

☒ **C** force towards the centre of the circle due to an electric field

☒ **D** force towards the centre of the circle due to a magnetic field

(ii) State what is used to accelerate the protons across the gap in the cyclotron.

(1)

.....

.....

(iii) Suggest why a neutron cannot be accelerated in a cyclotron.

(1)

.....

.....

(iv) Describe how the fast-moving protons are used to produce radioactive nuclei.

(3)

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*(b) The radioactive isotope fluorine-18 emits beta-plus particles.

This isotope is used in PET (Positron Emission Tomography) scans.

Fluorine-18 is attached to a glucose molecule, injected into a patient and gets to the site of a tumour.

Explain how gamma rays are then produced and detected to enable the position of a tumour to be located.

You may draw a diagram if it helps your answer.

(6)

(Total for Question 6 = 12 marks)

TOTAL FOR PAPER = 60 MARKS

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Mark Scheme (Standardisation)

Summer 2017

Pearson Edexcel GCSE

In Physics (5PH3H) Paper 3H

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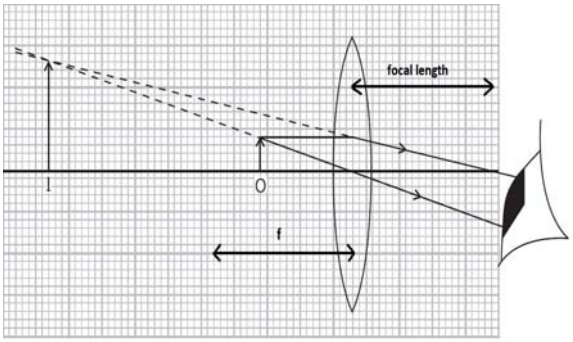
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General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

Question number	Answer	Notes	Marks
1 (a)	unit conversion(1) 10 cm to 0.1 m substitution (1) power = 1 ÷ 0.10 evaluation (1) = 10 units (1) dioptres / D	 Allow unconverted value for substitution and evaluation marks: 1/10 (1 mark) = 0.1 (1 mark) separate unit mark ignore lower-case 'd' Allow small spelling errors (but not 'diodes' for example) 1/10 = 0.1 D gets 3 marks 10 D is a correct answer for 4 marks	 **(4)**

Question number	Answer	Notes	Marks
1 (b) (i)	 focal length as shown – judge length by eye	May label focal length as 'f' but must be labelled this may be shown to the right or to the left of the lens (~21 small squares) **Distance shown must be a horizontal distance.**	 **(1)**

Question number	Answer	Notes	Marks
1 (b) (ii)	any attempt to measure the image or object height (1) magnification = 3.3 ± 0.3 (1)	Accept similar triangle approach or using distances from lens An answer in this range scores 2	**(2)**

Question number	Answer	Notes	Marks
1 (b) (iii)	The image is virtual	Accept 'not real' / cannot be captured on a screen	**(1)**

Total for question 1= 8 marks

Question Number	Answer	Acceptable answers	Mark
2(a)(i)	☒ D increase the probability of causing mutation of DNA in cells **The only correct answer is D** **A** is not correct because radiation increases, not decreases, the probability of causing mutation of DNA in cells **B** is not correct because ionising radiation does not always cause burns; lesser damage than this occurs often **C** is not correct because radiation **may** cause the mutation of DNA in cells		**(1)**

Question Number	Answer	Acceptable answers / notes	Mark
2 (b)	Description including any three from: Increasing/safe **distance** from source (1) wearing **lead**-(lined) apron / clothing (1) Specified shielding other than clothing (1) minimising **time** spent using sources (1) checking exposure using radiation badges / monitors (1) use of lead-(lined) boxes (1)	Idea of being removed from the source, including being in a different room / use of tongs / handling equipment ignore 'protective clothing' or 'shielding' (unqualified) Accept lead glass or concrete Ignore 'barrier' without qualification Accept Geiger counters	**(3)**

Question Number	Answer	Acceptable answers	Mark
2(c)	An explanation linking any three from: radioactive **source** next to tumour (1) <u>alpha and/or beta</u> (particles emitted) (1) ionising radiation (1) alpha has a low penetration / range (1) **(radiation)** mutate the DNA in (cancerous) cells (1)	Do not allow points if only referring to gamma radiation next to / in cancer alt. valid comment about beta range **(radiation)** damages/destroys/ kills / shrinks / the (tumour / cancer) cells stops it growing as long as not mentioned with gamma	**(3)**

Question Number	Answer	Acceptable answers	Mark
2(d)	An explanation from one of the following alternatives: (A) gamma radiation/it is very penetrating (1) gamma radiation/it can be detected outside the body (1) OR (B) short half life (1) reducing radiation exposure time / danger(1) OR (C) long enough half life (hours) (1) to complete the investigation (in) (1) OR (D) gamma is not very ionising (1) so does not damage cells (1)		**(2)**

Total for question 2= 9 marks

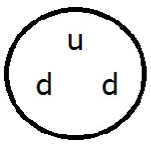
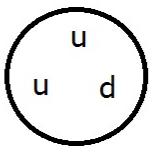
Question number	Answer	Notes	Marks
3 (a) (i)	144 60 A one mark for each correct number		**(2)**

Question number	Answer	Notes	Marks
3 (a) (ii)	Plot the points: • 72, 108 (1) • 39, 50 (1)	Allow within one square tolerance	**(2)**

Question number	Answer	Notes	Marks
3 (a) (iii)	Best fit curve passing through / near to most points (1)	Reject any straight lines, shaky drawing point to point and tramlining (multiple curves) Make allowances for rubbing out pencil lines	**(1)**

Question number	Answer	Notes	Marks
3 (b)	emitters lie to the left / above the curve		**(1)**

Question number	Answer	Notes	Marks
3 (c)	☒ **D** proton becoming a neutron and a positron **The only correct answer is D** **A** is not correct because that shows β $^-$decay **B** is not correct because then you would get 2 positive charges coming out of an original particle of 0 charge; not possible **C** is not correct because you can't have a negatively charged electron coming out of a positively charged proton like that		**(1)**

Question number	Answer	Notes	Marks
3 (d)	NEUTRON  (1) PROTON  (1)	u's and d's in any order within each circle	**(2)**

Total for question 3 = 9 marks

Question Number	Answer	Acceptable answers	Mark
4(a)	☒ B can move past each other **The only correct answer is B** **A** is not correct because that description applies to the gaseous state **C** is not correct because that description applies to a solid (crystalline) state **D** is not correct because particles are in continual movement in the liquid sate (Brownian motion)		**(1)**

Question Number	Answer	Acceptable answers / notes	Mark
4(b)(i)	Explanation including <u>particles</u> with: collide with walls / container (1) exert a force (1) pressure = force / area (1)	atoms / molecules / eq <u>no reference to particles (or alt.) no marks</u> hit, bombard, bounce off In the absence of any of these three marks award 1 for any reference to particles moving	**(3)**

Question Number	Answer	Acceptable answers	Mark
4(b)(ii)	An explanation including. (as) temperature rises particles move faster/ have more <u>kinetic</u> energy (1) hit the walls more frequently / harder (1)	(accept answer in terms of change of momentum) ignore 'move around more' accept more collisions / greater force	**(2)**

Question Number	Answer	Acceptable answers	Mark
4(c)(i)	Adds 101 kPa to 5 x 101 kPa, giving <u>606</u> kPa = <u>6.06</u> x 10^5 Pa	Award the mark for 6.06 x 10^5 Pa seen anywhere by itself Beware of conjuring with numbers to come up with 6.06 x 10^5	**(1)**

Question Number	Answer	Acceptable answers	Mark
4(c)(ii)	substitution (1) $6.06x10^5$ x 1.25 $x10^{-6}$= V_2 x$1.01x10^5$ transformation (1) <u>$6.06x10^5$ x 1.25 $x10^{-6}$</u>= (V_2) $1.01x10^5$ Evaluation (1) 7.5(0) $x10^{-6}$ (m^3)	transformation or substitution in either order Allow ecf from here for sensible value of pressure* $V_2 = \frac{P_1 \times V_1}{P_2}$ Using $6x10^5$ (for pressure) gives 7.4(3)$x10^{-6}$(m^3) accept 7.42$x10^{-6}$ also * Using p=5.05 x 10^5 => 6.25 x 10^{-6}(m^3) scores 2 marks power of ten error loses a mark correct answer by itself scores 3 marks	**(3)**

Total for question 4 = 10 marks

Question number	Answer	Notes	Marks
5 (a)	Any one from endoscope / looking into (named part of) body / keyhole surgery		**(1)**

Question number	Answer	Notes	Marks
5 (b) (i)	5.05 (W/m^2) (1)	Accept 5.0505	**(1)**

Question number	Answer	Notes	Marks
5 (b) (ii)	Substitution (1) $5.0 = P \div 6.2 \times 10^{-7}$ transformation (1) $5.0 \times 6.2 \times 10^{-7}$ Evaluation (1) $= 3.1 \times 10^{-6}$ (W)	accept P = I X A transformation and substitution in either order ignore powers of 10 until evaluation (Allow use of any intensity between 4.95 and 5.05) full marks for the correct answer (which rounds to 3.1×10^{-6})	**(3)**

Question number	Answer	Notes	Marks
5 (b) (iii)	☒ **D** light scatters off impurity atoms at a wide range of angles **The only correct answer is D** **A** is not correct because that description describes light in a vacuum, not in a material **B** is not correct because whilst light does obey Snell's law this does not at all explain the decrease of intensity in a medium **C** is not correct because light does not get slower **as it travels through** the medium (it slows down as it moves from air into glass but the statement does not say that and that does not provide an explanation for intensity decrease, as asked for)		**(1)**

Question number		Answer	Marks
5 (c)		A description including some of the following points: USES to produce scans in diagnosis • a gel is applied to the abdomen • which allows the ultrasound to enter the body • where it reflects off organs (etc.) • is detected and used to make an image • shows organs up, including the heart, kidneys etc • used to examine unborn babies (foetuses) may be used to diagnose kidney / heart problems etc accept use in diagnosis for other soft tissue organs apart from those in the unborn USES in treatment • used for shattering / breaking up kidney stones • by emitting pulses of ultrasound • which shatter the outer layers of the stones • the broken bits may be carried off (in urine) • accept treatments for sports injuries (ligaments, tendons etc.)	**(6)**

Level	0	No rewardable content
1	**1 - 2**	• a limited description of how ultrasound works / what it is used for e.g. ultrasound waves enter the skin OR used to get rid of kidney stones • the answer communicates ideas using simple language and uses limited scientific terminology • spelling, punctuation and grammar are used with limited accuracy
2	**3 - 4**	• a simple description of how ultrasound is used in diagnosis **and** treatment OR a more detailed description of one of them e.g. ultrasound waves enter the skin and reflect off organs **and** used to break up kidney stones OR (for treatment) used for breaking up kidney stones as ultrasound vibrations (in pulses) can shatter the stones • 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**	• a detailed description of how ultrasound is used in BOTH diagnosis and treatment e.g. used to examine unborn babies/foetuses using a gel applied to the abdomen allowing ultrasound to enter the body where it then reflects off internal organs and it is detected outside the body AND used for breaking up kidney stones as ultrasound vibrations (in pulses) can shatter the stones • the answer communicates ideas clearly and coherently uses a range of scientific terminology accurately • spelling, punctuation and grammar are used with few errors

SUMMARY, for guidance

Level 1	Level 2	Level 3
Limited description Some diagnosis or some treatment	Simple descriptions SOME diagnosis AND SOME treatment OR a more detailed description of one of them	Discussion of both diagnosis and treatment with, for example, DETAILED descriptions in one area AND SOME descriptions in the other

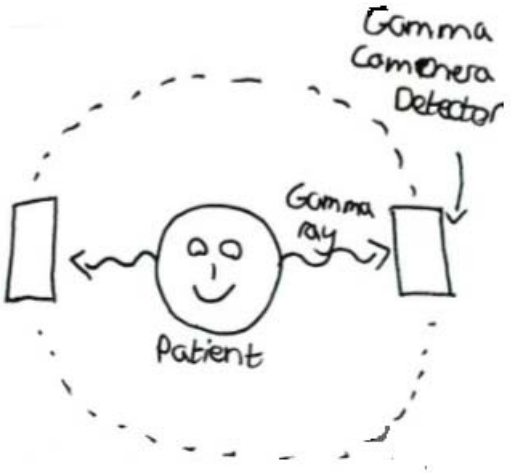
Total for question 5= 12 marks

Question Number	Answer	Acceptable answers	Mark
6(a)(i)	☒ **D** force towards the centre of the circle due to a magnetic field **The only correct answer is D** **A** is not correct because the centripetal force is not directed **away** from the centre of the circle, and it is not a result of the electric field **B** is not correct the centripetal force is not directed **away** from the centre of the circle **C** is not correct because the force is not a result of the electric field		**(1)**

Question Number	Answer	Acceptable answers	Mark
6(a) (ii)	(alternating) **voltage** / potential difference (P.D.) (1)	Electric / electrostatic field (s) / use of electrodes Condone (allow) magnetic (field/ force) / magnets Ignore current but accept A.C. supply	**(1)**

Question Number	Answer	Notes	Mark
6(a)(iii)	(neutron) has no charge	Zero charge / only works with charged particles Ignore 'neutral (charge)'	**(1)**

Question Number	Answer	Acceptable answers / Notes	Mark
6(a) (iv)	Description including: protons/they absorbed by nuclei (1) of **stable** nuclei (1) (to produce) **unstable** nuclei (1)	Accept atoms / particles /elements / isotopes for nuclei **throughout** Protons/charged particle/they collide with / hit / fired into nuclei Do not accept electron ignore 'fired at' / 'shot at' / 'bombarded' Protons colliding with protons gets 1 mark if no other mark awarded	**(3)**

Question Number		Indicative Content	Mark
QWC	***6 (b)**	An explanation including some of the following points : Producing gamma rays • electron-positron (B^+)annihilation produces gamma rays • labelled diagram of electron-positron annihilation • **two** gamma rays must be produced • conservation of momentum • conservation of charge • conservation of mass-energy • gamma rays produced in opposite directions Detection of gamma rays producing an image • the detectors are in a (non-rotating) ring around the patient • gamma rays are detected by scintillation counters/gamma cameras • gamma ray pairs are detected • gamma rays that are not in pairs are ignored • pairs of gamma rays that arrive at the same time are used • the computer/system works out where the gamma rays came from (produces an image which shows the position of the tumour) • triangulation Credit picture e.g.  	**(6)**

Level	0	No rewardable content
1	1 - 2	• a limited explanation of how the gamma rays are produced OR detected e.g. positrons collide with electrons, there is annihilation and gamma rays are produced OR gamma ray pairs are detected by a ring of gamma cameras around the patient • the answer communicates ideas using simple language and uses limited scientific terminology • spelling, punctuation and grammar are used with limited accuracy
2	3 - 4	• a simple explanation of how the gamma rays are produced and detected OR a more detailed explanation of one of these. e.g. when positrons collide with electrons there is annihilation and gamma rays are produced **and** gamma ray pairs are detected by a ring of gamma cameras around the patient OR, for production, when positrons collide with electrons there is annihilation and two gamma rays are produced OR, for detection, the computer detects pairs of gamma rays that arrive at the same time, producing an image • 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	• a detailed explanation of how the gamma rays are produced AND detected e.g B^+ particles are positrons, when positrons collide with electrons there is annihilation and gamma rays are produced. As momentum is conserved, the gamma rays travel in opposite directions. The gamma ray pairs are detected by a ring of gamma cameras around the patient. • the answer communicates ideas clearly and coherently uses a range of scientific terminology accurately • spelling, punctuation and grammar are used with few errors

SUMMARY, for guidance

Level 1	Level 2	Level 3
Limited explanation → idea(s) re. production OR idea(s) re. detection	**Simple explanations of production and detection** **OR more detailed explanations of either production or detection**	**Detailed explanations of production and detection**

Total for question 6 =12 marks

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Surname	Other names

Pearson Edexcel GCSE

Centre Number	Candidate Number

Physics

Unit P3: Applications of Physics

Higher Tier

Friday 24 June 2016 – Morning
Time: 1 hour

Paper Reference
5PH3H/01

You must have:
Calculator, ruler

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.
- 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.

energy = mass × (speed of light)^2 $E = mc^2$

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 $KE = \frac{1}{2} mv^2 = e \times V$

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 $\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$

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Questions begin on next page.

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 ☒.

Collisions and momentum

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

(1)

Momentum is conserved in collisions provided that

☒ **A** no crumpling of objects occurs

☒ **B** no energy is lost as heat or sound

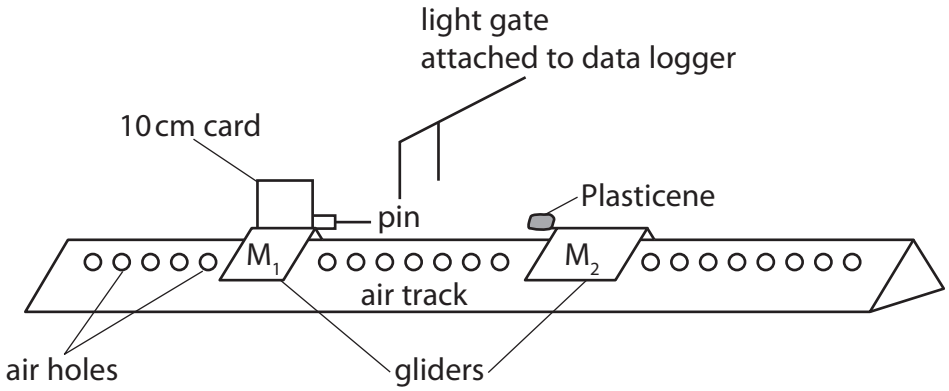
☒ **C** no external forces act

☒ **D** no friction is involved

(b) A student uses a horizontal air track to investigate collisions.

The air track blows air through a series of small holes.

Two small gliders, M_1 and M_2, float on a cushion of air.



The student pushes the first glider M_1 towards glider M_2, which is stationary.

As the glider M_1 goes through the light gate, its velocity is measured.

Glider M_1 hits and sticks to glider M_2 and they move off together.

The student takes the following measurements.

mass of glider M_1	0.21 kg
mass of glider M_2	0.21 kg
velocity measured by the light gate	0.47 m/s

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(i) Show that the momentum of glider M_1 before the collision is about 0.10 kg m/s.

(2)

(ii) The total momentum before the collision is equal to the total momentum after the collision.

Calculate the velocity of the two gliders combined after the collision.

(3)

velocity after the collision = ... m/s

(iii) The total kinetic energy before collision = 0.023 J.

The total kinetic energy after collision = 0.012 J.

Discuss whether the collision is elastic or inelastic.

(2)

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(Total for Question 1 = 8 marks)

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2 (a) An electron has a charge of -1.6×10^{-19} C.

An alpha (α) particle is a helium nucleus.

A beta particle is a fast moving electron.

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

(1)

The charge carried by an alpha particle is

☒ **A** -1.6×10^{-19} C

☒ **B** $+1.6 \times 10^{-19}$ C

☒ **C** -3.2×10^{-19} C

☒ **D** $+3.2 \times 10^{-19}$ C

(b) (i) Explain why alpha (α) particles only travel a few centimetres in air.

(2)

.....

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(ii) State why beta particles can travel further in air than alpha particles.

(1)

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(iii) The kinetic energy of an alpha particle is 8.1×10^{-13} J.

The mass of the alpha particle is 6.6×10^{-27} kg.

Calculate the speed of the alpha particle.

(3)

speed = ... m/s

(iv) State the speed of gamma rays emitted by an unstable nucleus.

(1)

.....

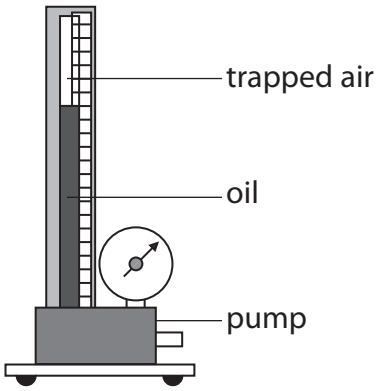
(Total for Question 2 = 8 marks)

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3 A student uses this apparatus to investigate how the volume of air changes with pressure.



He obtains these results and starts to plot a graph.

Pressure / kPa	Volume, V / cm^3	1/ V / 1/ cm^3
190	14.9	0.067
168	16.6	0.060
156	18.1	0.055
139	20.7	0.048
119	23.7	0.042
95	30.1	0.033

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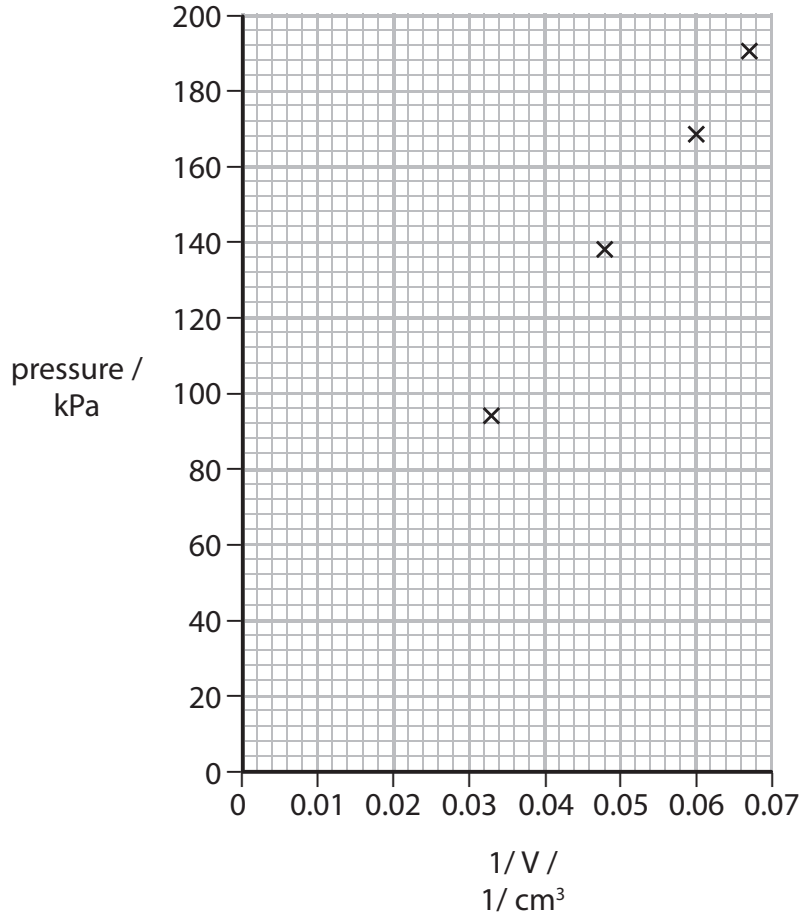
(a) (i) The two sets of results not plotted on the graph are shaded in the table.

Complete the graph by plotting these results.

(2)

(ii) Draw a line of best fit.

(1)



(iii) Describe the relationship shown by the graph.

(2)

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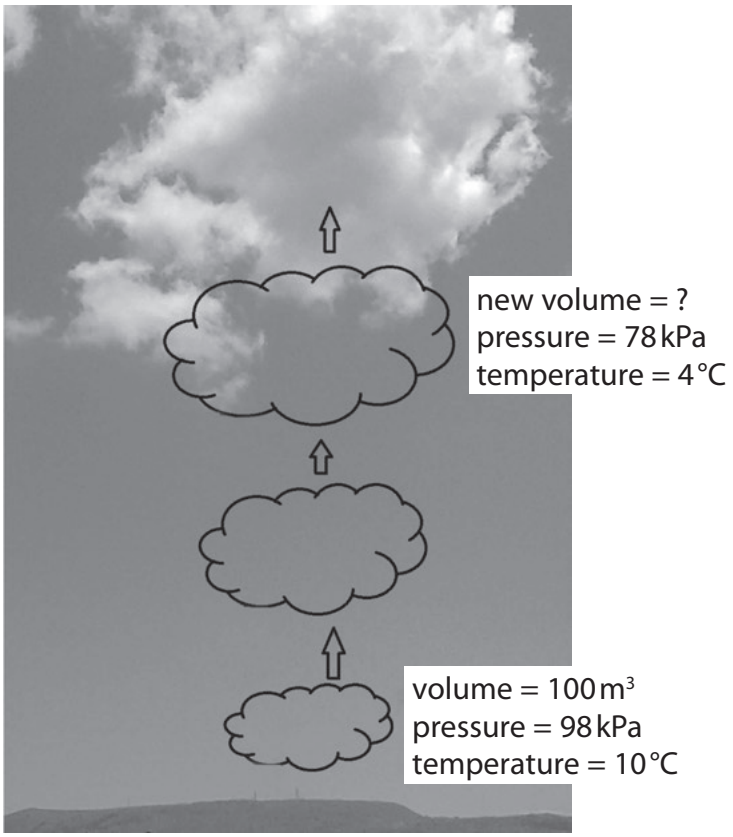
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(b) The diagram shows a bubble of air rising in the atmosphere.

The mass of the bubble of air remains constant.



(i) State what 10 °C is in kelvin.

(1)

..... K

(ii) Use the data in the diagram to calculate the volume of the air bubble when its pressure is 78 kPa.

(3)

volume = ... m³

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(iii) Which of these statements is correct?

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

(1)

As the bubble of air rises into the sky, the average kinetic energy of its molecules

☒ **A** increases

☒ **B** decreases

☒ **C** stays the same

☒ **D** cannot be determined from the data given

(Total for Question 3 = 10 marks)

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Sight problems

4 Defects of vision can be corrected by changing the paths of light rays.

(a) Explain why light refracts towards the normal when it passes from air into glass or water.

(2)

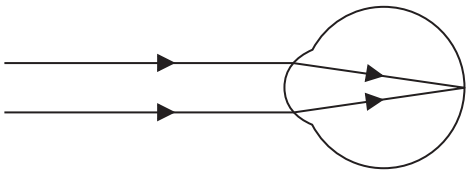
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(b) The diagram shows light from a distant object being brought to a focus on the retina of a normal eye.



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

(1)

Light is brought to a focus on the retina after refraction by the

☒ **A** cornea and iris

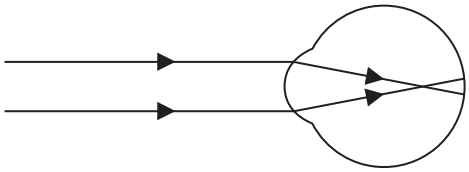
☒ **B** lens and cornea

☒ **C** lens and iris

☒ **D** pupil and iris

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(c) This diagram shows light from a distant object being brought to a focus in front of the retina of an eye with a defect of vision.



(i) State the name of this defect of vision.

(1)

.....

(ii) Explain how this defect of vision can be corrected with a lens.

You may add to the diagram above or draw another diagram to help with your answer.

(2)

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(iii) Describe how this defect of vision can be corrected using laser surgery.

(2)

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(iv) The image shows a laser beam incident on an eye.



The power of the laser is 40 mW.

The beam covers an area of 1.8×10^{-6} m^2.

Calculate the intensity of the laser beam.

(2)

intensity of laser beam = ... W/m^2

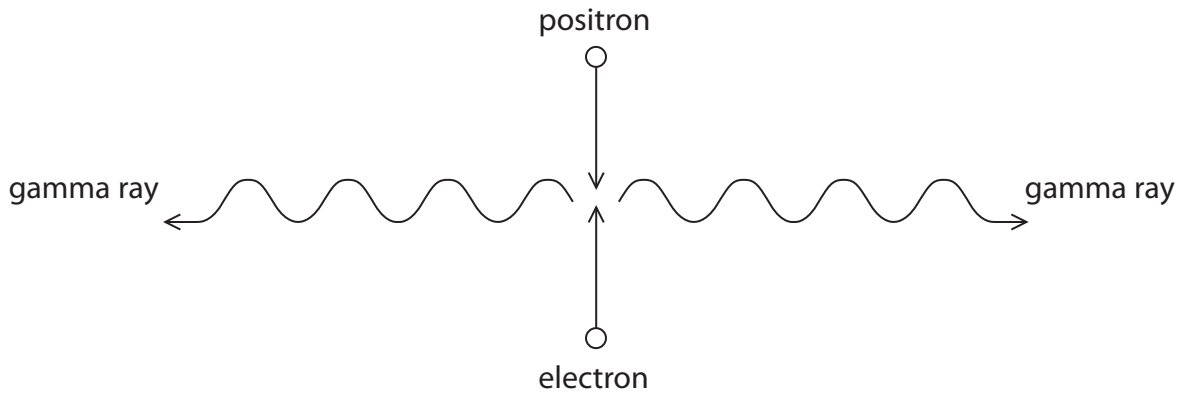
(Total for Question 4 = 10 marks)

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PET scanner

5 The diagram shows what happens when a positron and electron collide.



(a) (i) What is the name given to this interaction between a positron and an electron?

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

(1)

☒ **A** annihilation

☒ **B** beta decay

☒ **C** cosmic background radiation

☒ **D** ionisation

(ii) A PET scanner uses positrons.

What does a PET scanner use to produce positrons?

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

(1)

☒ **A** alpha particles

☒ **B** gamma cameras

☒ **C** positive ions

☒ **D** radioactive isotopes

(b) (i) Both the positron and electron have mass.

The gamma rays do not have any mass.

State what happens to the mass in a positron-electron interaction.

(1)

.....

.....

(ii) Calculate the energy of an electron of mass 9.1×10^{-31} kg.

The speed of light, $c = 3.0 \times 10^{8}$ m/s.

(2)

energy = ... J

(iii) Suggest a reason why PET scanners need to be located near a cyclotron.

(1)

.....

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*(c) A patient with a brain tumour is given a fluorine-18 injection.

The patient is then given a PET scan.

Explain the steps in the PET scan process used to locate the brain tumour.

You may draw a diagram if it helps your answer.

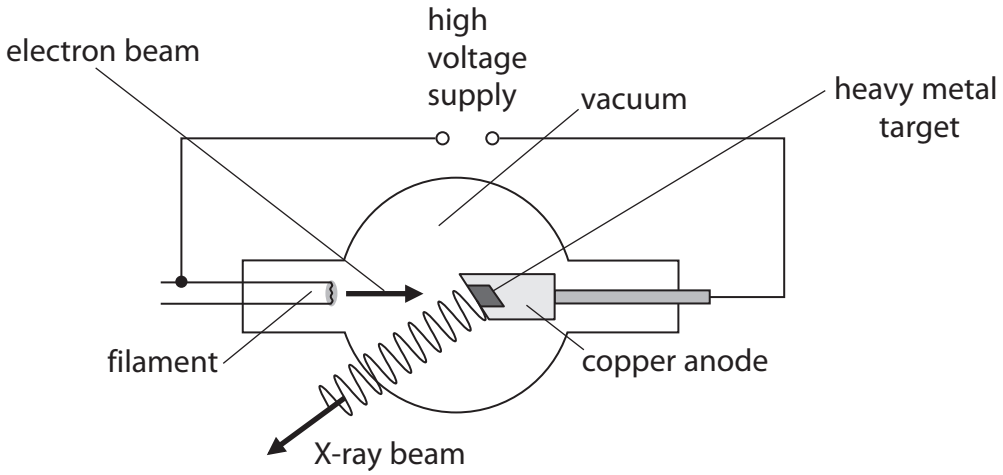
(6)

(Total for Question 5 = 12 marks)

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X-rays

6 (a) The diagram shows the main parts of an X-ray tube.



(i) The electrons in the beam escape from a hot filament.

State the name of the process by which electrons escape from a hot filament.

(1)

.....

(ii) Explain why there must be a vacuum inside the X-ray tube.

(2)

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(iii) 3.0×10^{17} electrons reach the target every second.

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

Calculate the current in the circuit.

(2)

current = ...A

(iv) The intensity, *I*, of X-rays varies with the distance, *d*, from the source of the X-rays.

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

(1)

The relationship between *I* and *d* for a point source is

☒ **A** *I* is inversely proportional to *d*

☒ **B** *I* is proportional to *d*

☒ **C** *I* is inversely proportional to d^2

☒ **D** *I* is proportional to d^2

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*(b) CAT scanners and fluoroscopes both use X-rays.

CAT scanners and fluoroscopes can be used by doctors to investigate medical conditions.

Discuss when it is more appropriate to use CAT scanners and when it is more appropriate to use fluoroscopes to investigate medical conditions.

(6)

(Total for Question 6 = 12 marks)

TOTAL FOR PAPER = 60 MARKS

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Mark Scheme (Results)

Summer 2016

Pearson Edexcel GCSE in Physics (5PH3H) Paper 01
Unit P3: Applications of Physics

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General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- For questions worth more than one mark, the answer column shows how partial credit can be allocated. This has been done by the inclusion of part marks eg (1).
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

Quality of Written Communication

Questions which involve the writing of continuous prose will expect candidates to:

- Write legibly, with accurate spelling, grammar and punctuation in order to make the meaning clear
- Select and use a form and style of writing appropriate to purpose and to complex subject matter
- Organise information clearly and coherently, using specialist vocabulary when appropriate.

Full marks will be awarded if the candidate has demonstrated the above abilities.

Questions where QWC is likely to be particularly important are indicated (QWC) in the mark scheme, but this does not preclude others.

Question number	Answer	Notes	Marks
1 (a)	**C** no external forces act		(1)

Question number	Answer	Notes	Marks
1 (b) (i)	Substitution (1) Momentum before = 0.21 X 0.47 Evaluation (1) = 0.099	This is a 'show that' so must see working accept 0.0987 or 0.09 9.87×10^{-2} Do not allow spurious conjuring with numbers to arrive at 0.10	(2)

Question number	Answer	Notes	Marks
1 (b) (ii)	substitution (1) 0.1 = 0.42 x v transposition (1) 0.10/0.42 Evaluation (1) 0.24 (m/s)	accept 0.099 = 0.42 x v If 0.21 kg used then max 2 marks (gives 0.476 m/s) Transposition and substitution can be in any order Accept 0.235, 0.236 and 0.238 Full marks are awarded for the correct numerical answer with no working	(3)

Question number	Answer	Notes	Marks
1 (b) (iii)	• It's inelastic (1) • **<u>Kinetic</u>** energy has been lost / **<u>KE</u>** not conserved / **<u>KE</u>** transferred to other forms of energy (1)	decreases	(2)

Question number	Answer	Notes	Marks
2 (a)	**D** + 3.2 x 10^{-19} C (1)		(1)

Question number	Answer	Notes	Marks
2 (b) (i)	An explanation linking **any** two of the following. • (they) lose energy (quickly) / slow down (1) (because they) • are highly ionising (1) • have (many) **<u>collisions</u>** (with other atoms) (1) • are massive particles (1)	Ignore less penetrating Do not allow 'ionising' without correct qualification Allow heavy / large(r) Accept big(ger)	(2)

Question number	Answer	Notes	Marks
2 (b) (ii)	Beta particles are less ionising (1)	Accept beta particles are travelling a lot faster / have less mass /lighter / smaller Accept less collisions Ignore more penetrating	(1)

Question number	Answer	Notes	Marks
2 (b) (iii)	substitution (1) $8.1 \times 10^{-13} = ½ \times 6.6 \times 10^{-27} \times v^2$ transposition (1) $(v^2) = \frac{2 \times 8.1 \times 10^{-13}}{6.6 \times 10^{-27}}$ ($= 2.5 \times 10^{14}$) evaluation (1) $v = 1.6 \times 10^7$ (m/s)	Substitution and transposition in any order (2.45×10^{14}) Full marks are awarded for the correct numerical answer with no working (1.57×10^7 (m/s)) (no sf penalty) Any power of ten mistake would lose one mark in the process Use of $E = mc^2$ or mv^2 no marks (not K.E.)	(3)

Question number	Answer	Notes	Marks
2 (b) (iv)	speed / velocity of light / 3×10^8 (m/s)	Allow 3×10^8 with no units but reject when with wrong unit	(1)

Question number	Answer	Notes	Marks
3 (a) (i)	Plot the points: • 0.055, 156 (1) • 0.042, 119 (1)	Allow within one square tolerance (±1 square)	(3)
(ii)	Best fit straight line drawn (1)	Allowed with no extra points plotted; does not need to be extended to origin	

Question number	Answer	Notes	Marks
3 (a) (iii)	A description including: • As pressure increases 1/V increases Alternatively P and 1/V are positively correlated(1)	Alternatively as pressure increases Volume (V) decreases	(1)
	• Goes up in equal steps/ constant increase / steady rate etc. (1)	**Pressure and 1/V** are proportional gets 2 by itself (subsumes MP1). Allow they (P and V) are 'inversely proportional' for 2 marks	(1)
	DO NOT ALLOW 'they are proportional' since the question asks for the relationship shown by the graph	Do not allow 'positive correlation' by itself	

Question number	Answer	Notes	Marks
3 (b) (i)	283 (K) (1)		(1)

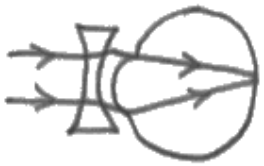
Question number	Answer	Notes	Marks
3 (b) (ii)	• transposition $V_2 = \frac{p_1V_1T_2}{P_2T_1}$ (1) • substitution $V_2 = \frac{98 \times 100 \times 277}{78 \times 283}$ (1) • evaluation = 123 (m^3) (1)	transposition and substitution can be given in either order Accept 120, ignore sf Correct answer without working gets all 3 marks. if °C is used or there is a wrong conversion to K, one mark max (both in °C gives 50 m^3, both subtracting 273 gives 128.5)	(3)

Question number	Answer	Notes	Marks
3 (b) (iii)	**B** decreases		(1)

Question number	Answer	Notes	Marks
4 (a)	An explanation including any two of the following. • light/it changes speed/velocity (1) • correct change in speed (1) • wavelength gets smaller (1) • from lower refractive index to higher refractive index OR from lower <u>optical density</u> to higher <u>optical density</u> (1)	light travels slower (in glass / water compared to air) 2 marks Any reference to density must be qualified as **optical** density	(2)

Question number	Answer	Notes	Marks
4 (b)	**B** lens and cornea		(1)

Question number	Answer	Notes	Marks
4 (c) (i)	myopia/short sight/short sightedness (1)	do not accept near sightedness	(1)

Question number	Answer	Notes	Marks
4 (c) (ii)	An explanation linking two points. • a concave / diverging lens (placed in front of the eye) (1) • diverges the light / focuses the image further back / on the retina (1)	accept correct lens on diagram by itself for one mark e.g.  accept spreads light out for diverges accept increases the focal length Do not allow contradiction of wrong lens choice followed by diverges i.e. 2nd mark linked to first	(2)

Question number	Answer	Notes	Marks
4 (c) (iii)	• cornea (1) **and** one from • reshaped (1) • (curvature adjusted to form) image on retina (1)	Reject other parts of eye e.g. lens 2nd mark dependent on first ignore thinner	(2)

Question number	Answer	Notes	Marks
4 (c) (iv)	substitution (1) $\frac{40 \times 10^{-3}}{1.8 \times 10^{-6}}$ evaluation (1) 22000 (W m $^{-2}$)	 22 x 10^{3} (W m $^{-2}$) (2.2 x 10^{4}) 22222 W m $^{-2}$ Power of ten error, e.g. 2.2 x 10^{7} max 1 mark Correct answer without working gets 2 marks	(2)

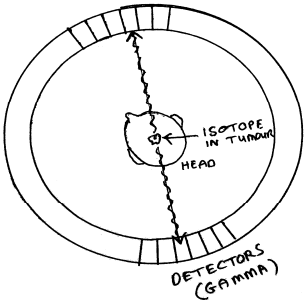
Question number	Answer	Notes	Marks
5 (a) (i)	**A** annihilation		(1)

Question number	Answer	Notes	Marks
5 (a) (ii)	**D** radioactive isotopes		(1)

Question number	Answer	Notes	Marks
5 (b) (i)	It / mass is converted to energy (of gamma)	may quote Einstein $E = m c^2$ / correct equivalence idea	(1)

Question number	Answer	Notes	Marks
5 (b) (ii)	substitution (1) $9.1 \times 10^{-31} \times (3.0 \times 10^8)^2$ evaluation (1) 8.2×10^{-14} (J)	 accept 8.19×10^{-14} (J)	(2)

Question number	Answer	Notes	Marks
5 (b) (iii)	idea that **isotopes** (used) have a short half-life (1)	accept 'they don't last very long' or words to that effect The focus needs to be on the time (not just convenience).	(1)

Question number	Answer	Marks
5 (c)	A description including some of the following points :- Step1 • radioisotope / fluorine -18 is beta + emitter (positron emitter) / attached to glucose • goes to site of tumour / radiation emitted from tumour site **Step 2** • patient lies inside scanner (detector array) • annihilations occur • (two) gammas are emitted • in opposite directions **Step 3** • gammas are detected (on opposite sides) • simultaneous detection used • idea of triangulation • image reconstructed by computer • brain tumours found by calculating positions of where the gamma rays were emitted from • credit labelled diagram such as:  	(6)

Level		
0		No rewardable content
1	1 - 2	• a limited description of how PET scans are produced (**from one step of the process**) e.g. detecting gamma rays from (within) the patient OR describing how the images are formed in a limited way (use of (gamma) cameras). (Do not credit where the gamma rays seem to be coming from some source outside the body, as with an X-ray tube) • the answer communicates ideas using simple language and uses limited scientific terminology • spelling, punctuation and grammar are used with limited accuracy
2	3 - 4	• a simple description of how PET scans are produced, using isotopes which are beta+ emitters and detecting the gamma rays. (**linking any two steps of the process**) e.g. detecting gamma rays from (within) the patient AND describing how the images are formed in a limited way (use of (gamma) cameras). • 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**	• a <u>detailed</u> description of how PET scans are produced involving appropriate isotopes and annihilations giving off gamma rays in opposite directions which are detected (by a gamma camera). (**linking all three steps of the process**) • the answer communicates ideas clearly and coherently uses a range of scientific terminology accurately • spelling, punctuation and grammar are used with few errors

Question number	Answer	Notes	Marks
6 (a) (i)	Thermionic emission (1)	Ignore any spelling mistakes	(1)

Question number	Answer	Notes	Marks
6 (a) (ii)	An explanation linking any two of the following: **<u>Electrons:</u>** • will not collide with gas molecules / atoms / particles in air • will not slow down • will not lose energy • will reach the anode / target	No mention of electrons – zero marks Accept stops collisions (occurring) Do not accept 'react' maintain speed (enables) electrons to reach anode knock off course (change direction insufficient)	(2)

Question number	Answer	Notes	Marks
6 (a) (iii)	Substitution $(I) = 3.0 \times 10^{17} \times 1.6 \times 10^{-19}$ (1) evaluation (1) I = 0.048 (A)	 4.8×10^{-2} (A), 48mA Full marks are awarded for the correct numerical answer with no working Do not allow evaluation mark for 0.05A (with no working)	(2)

Question number	Answer	Notes	Marks
6 (a) (iv)	**C** I is inversely proportional to d^2 (1)		(1)

Question number	Answer	Marks
6 (b)	Uses, could include some of the following points • CAT scans can be used to detect tumour in brain / abdomen / blood vessels (around heart) • They are used because the tissues show up well (in detail) with this type of scan • (2-D) slices taken • to construct 3-D images • They may be associated with a higher radiation dose with consequences (e.g. avoid with pregnancy etc.) • They give a higher quality image (with uses) • May use dyes to show up blood vessels • Fluoroscopes used to give 2-D {moving / live /real} images / showing up the (relevant) tissues (May refer to contrast media e.g. barium meal etc.) / reveals function • Fluoroscopes used to enable medical personnel to see the flow of fluid through the gut / intestines / to accurately place devices inside the body / to look at blood vessels and organs	(6)

Level		
0	**0**	No rewardable content
1	**1 - 2**	• a limited discussion to include either the uses of one type of scan e.g. a CAT scan is used to diagnose cancer in head OR fluoroscopes used for moving images • the answer communicates ideas using simple language and uses limited scientific terminology • spelling, punctuation and grammar are used with limited accuracy
2	**3 -**	• a simple discussion to include uses for both scans OR detailed use of one scan e.g. CAT scan is used to

	4	diagnose cancer in a named organ AND Fluoroscopes used for moving images OR CAT scan is used to detect tumours in particular parts of the body, showing up the tissues involved well • 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**	• a detailed discussion to include both scans with at least one of them in detail e.g. CAT scan are used to detect tumours in particular parts of the body, showing up the tissues involved well AND fluoroscopes are for moving images. • the answer communicates ideas clearly and coherently uses a range of scientific terminology accurately • spelling, punctuation and grammar are used with few errors

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Surname	Other names

Pearson Edexcel GCSE

Centre Number	Candidate Number

Physics

Unit P3: Applications of Physics

Higher Tier

Friday 19 June 2015 – Morning
Time: 1 hour

Paper Reference
5PH3H/01

You must have:
Calculator, ruler

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.

energy = mass × (speed of light)^2 $E = mc^2$

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 $KE = \frac{1}{2} mv^2 = e \times V$

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 $\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$

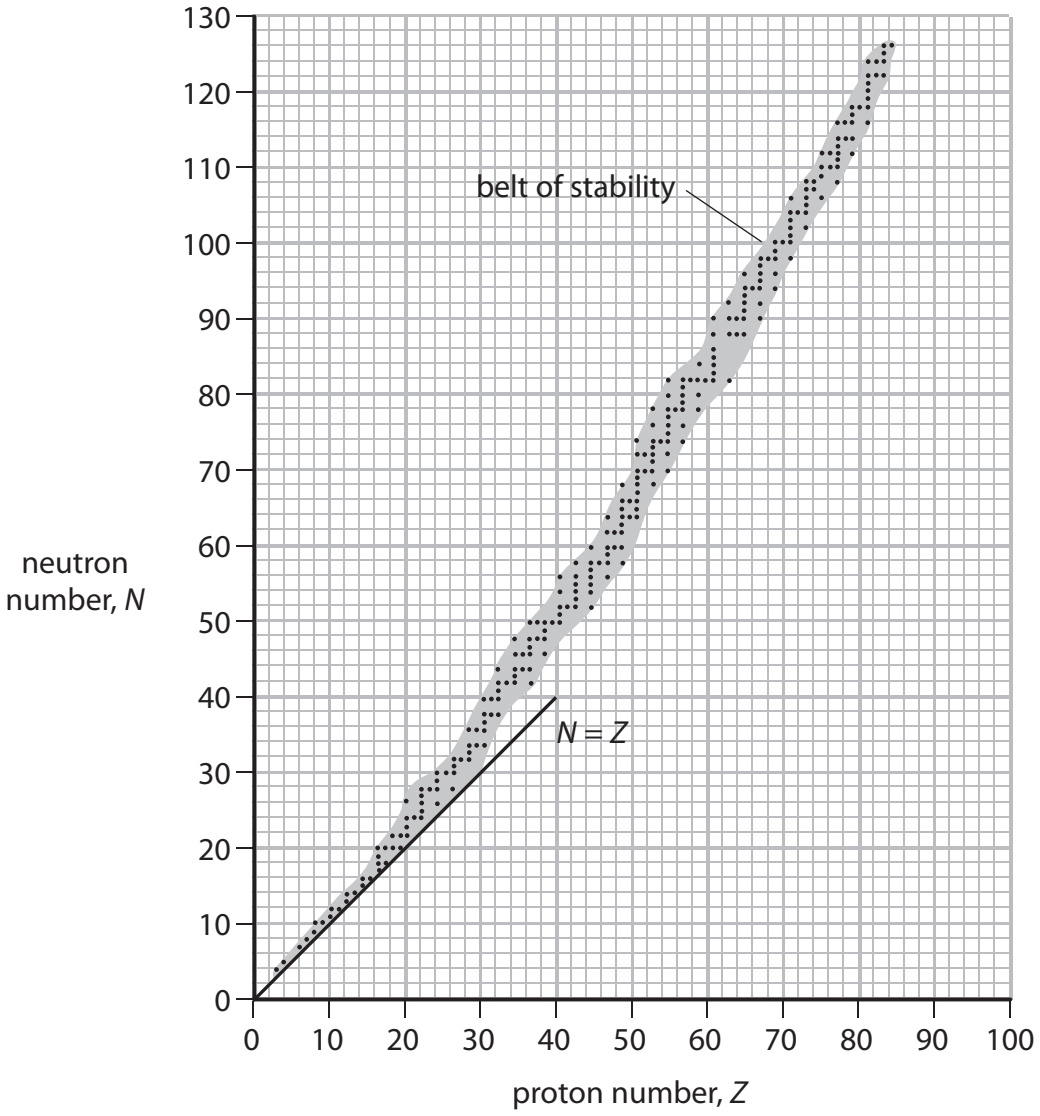
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Answer ALL questions.

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 decay and quarks

1 (a) The diagram shows the stability curve for nuclear isotopes.



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

An isotope above the curve will undergo β^- decay because it has

(1)

☒ **A** too few protons

☒ **B** too many protons

☒ **C** too few neutrons

☒ **D** too many neutrons

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(b) Which statement is correct for β^+ and β^- particles?

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

(1)

☒ **A** a β^+ is positively charged and a β^- is negatively charged

☒ **B** the mass of a β^+ is 1800 times the mass of a β^-

☒ **C** the charge on a β^+ is twice the charge on a β^-

☒ **D** a β^+ is a proton and a β^- is an electron

(c) Carbon-14 decays by emitting a β^- particle to form an isotope of nitrogen.

Complete the nuclear equation for this decay by filling in the boxes.

(2)

$$^{14}_{6}C \rightarrow \begin{array}{|c|}\hline\\\hline\\\hline\end\, N + \begin{array}{|c|}\hline\\\hline\\\hline\end\, \beta^-$$

(d) Protons and neutrons both contain quarks.

Describe the arrangement of quarks in a proton.

(2)

.....

.....

.....

.....

(e) Explain what happens to a nucleus during β^+ decay.

(2)

.....

.....

.....

.....

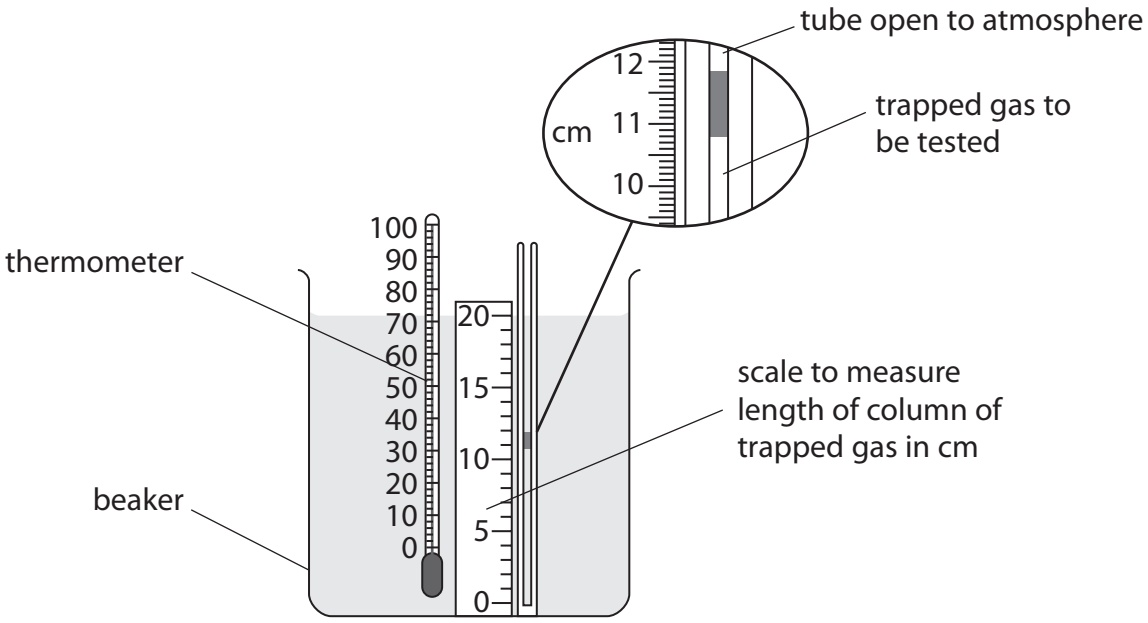
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(Total for Question 1 = 8 marks)

Gas laws

2 A student investigates how the volume of a gas changes when its temperature increases.

The diagram shows the equipment used and the length of the trapped gas at 25 °C.



(a) (i) Use the scale to estimate the length of the column of trapped gas.

(1)

length of column of trapped gas = ... cm

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

The cross-sectional area of the capillary tube is 1.94×10^{-3} cm^2.

The volume of the column of trapped gas at 25 °C is about

(1)

☒ **A** $5.6 \times 10^{+3}$ cm^3

☒ **B** 2.1×10^{-2} cm^3

☒ **C** 2.1×10^{-3} cm^3

☒ **D** 5.6×10^{-4} cm^3

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(iii) The gas is heated to 50 °C.

The volume of the trapped gas at 50 °C is 2.31×10^{-2} cm^3.

Calculate the volume of the trapped gas at 100 °C.

(3)

volume of the trapped gas = ... cm^3

(b) Describe how the average kinetic energy of the particles of the gas changes as the temperature of the gas changes.

(3)

.....

.....

.....

.....

(Total for Question 2 = 8 marks)

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Lenses

3 Lenses are used in spectacles to treat some vision defects.
The two main lens types are converging lenses and diverging lenses.

(a) (i) Diverging lenses always produce virtual, diminished images.

Which row of the table describes the images produced by a converging lens?

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

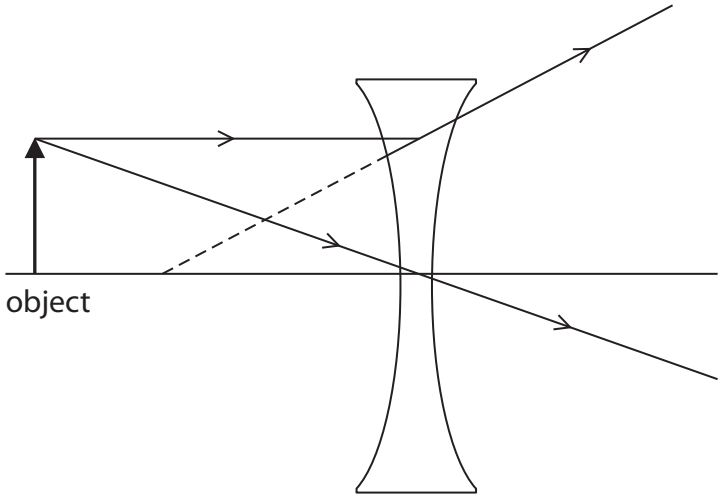
(1)

	type of image	size of image
☒ **A**	only real	only magnified
☒ **B**	either real or virtual	either magnified or diminished
☒ **C**	either real or virtual	only magnified
☒ **D**	only virtual	only diminished

(ii) Describe how the power of a lens is related to its shape.
You may draw labelled diagrams if it helps your answer.

(2)

(b) The diagram shows the formation of an image produced by one type of lens.



(i) On the diagram, draw and label the image produced.

(1)

(ii) On the diagram, show and label the focal length of the lens.

(1)

(iii) The type of lens shown in the diagram is used to correct a vision defect.

Name this vision defect.

(1)

.....

(iv) This lens has a focal length of –0.33 m.
An object is 0.50 m in front of the lens.

Calculate the distance of the image from the lens.

(4)

distance of image from lens = ... m

(Total for Question 3 = 10 marks)

Medical uses of radiation

4 (a) Many different types of radioactive isotope are used for the diagnosis and treatment of medical conditions.

(i) Iodine-123 is used as a radioactive tracer to diagnose thyroid problems.

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

This tracer must have a half-life of

(1)

☒ **A** a few days

☒ **B** a few hours

☒ **C** less than a second

☒ **D** several weeks

(ii) Pellets which contain radium-223 can be put inside the body to treat cancers.

Radium-223 has a half-life of 11.4 days and emits alpha radiation.

Explain why radium-223 is suitable for use inside the body to treat cancers.

(3)

(b) Radiotherapy is often used for palliative care when cancers are incurable.

Explain how using radiotherapy in this way is helpful to patients.

(2)

(c) The table gives the average dose of radiation a person received from various sources.

radiation source	average radiation dose (arbitrary units)
average yearly background	3000
one chest X-ray	20
one CT scan of the chest	6000
one whole body CT scan	20000
one PET scan	6000

(i) Explain why a CT scan of the chest gives a much higher dose of radiation than a chest X-ray.

(2)

.....

.....

.....

.....

(ii) Justify the use of medical procedures which give patients large doses of radiation.

(2)

.....

.....

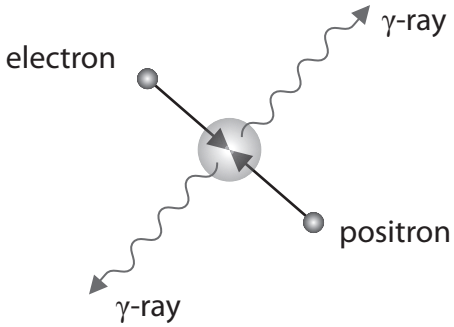
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(Total for Question 4 = 10 marks)

Collisions and accelerators

5 (a) The diagram shows the gamma rays produced when positrons and electrons collide and annihilate.



(i) The total momentum of the electron and positron before the annihilation is zero.

State the total momentum of the gamma rays after the annihilation.

(1)

.....

.....

(ii) The total energy of the two gamma rays produced is 1.6×10^{-13} J.

Calculate the total mass of the positron and electron before annihilation.
The velocity of light is 3.0×10^{8} m/s.

(3)

total mass of positron and electron = ... kg

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(iii) Explain how charge is conserved in a positron-electron annihilation.

(2)

*(b) Compare the design and use of particle accelerators used in international scientific research with particle accelerators used in hospitals.

(6)

(Total for Question 5 = 12 marks)

Pulse oximeters and ECGs (electrocardiograms)

6 Pulse oximeters and ECGs are used to monitor the blood oxygen levels and heart activity of a patient.

(a) Pulse oximeters are often attached to a finger.
They use both red and infrared light.

Which of these is correct for red light and infrared radiation?

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

(1)

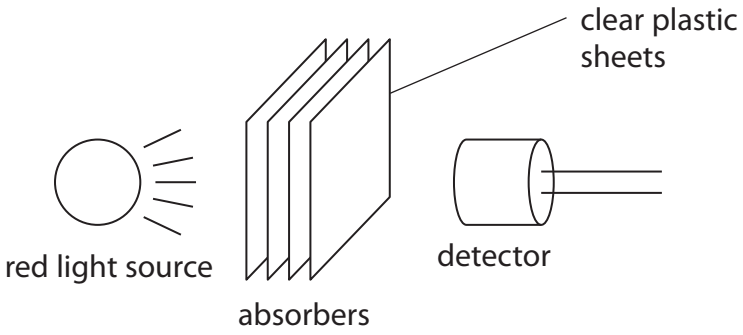
☒ **A** infrared radiation is ionising, red light is not ionising

☒ **B** red light can travel through a finger, infrared cannot travel through a finger

☒ **C** red light has a shorter wavelength than infrared

☒ **D** red light is ionising, infrared is not ionising

(b) A student investigates absorption of light.



Here are the results obtained, showing the intensity of light at the detector for different thicknesses of absorber.

thickness / mm	0.0	7.5	15.0	22.5	30.0
intensity / mW / cm^2	0.23	0.16	0.11	0.08	0.06

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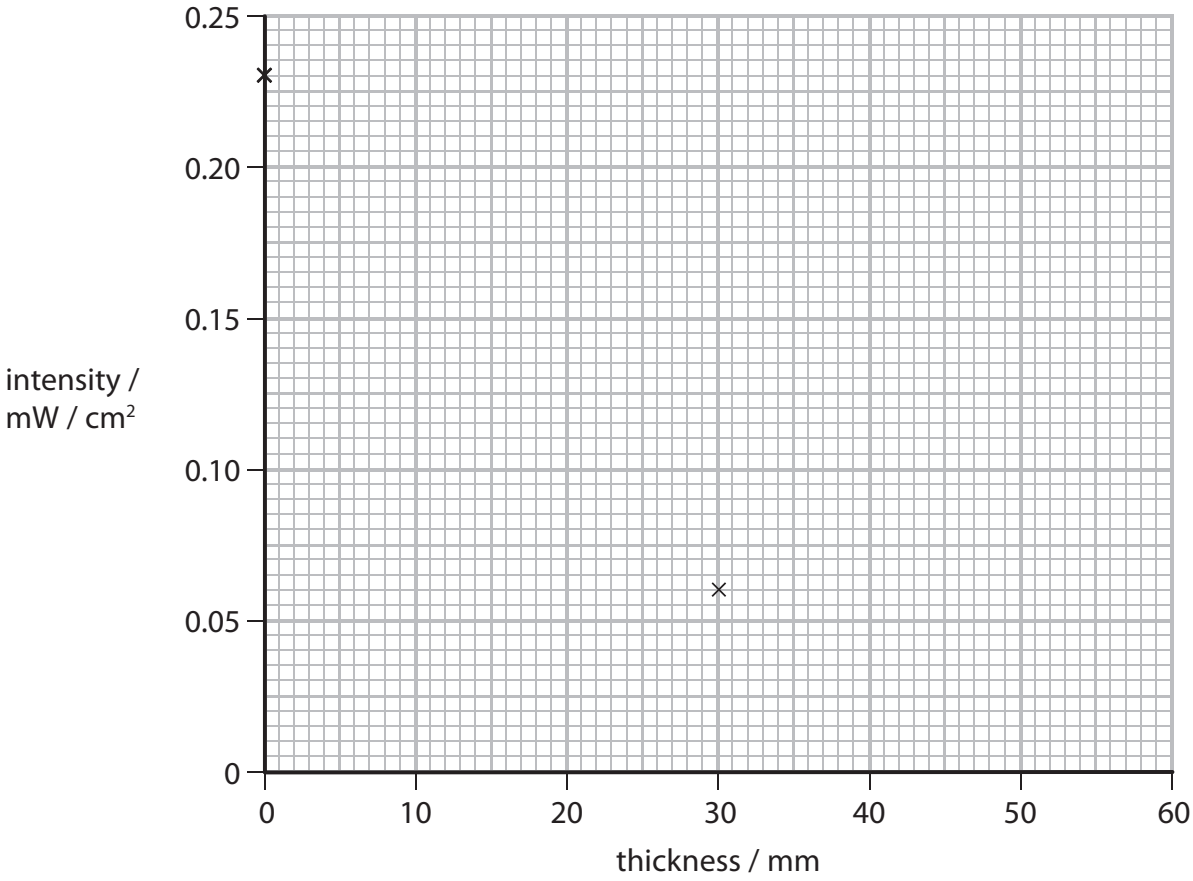
Complete the graph of intensity (*y*-axis) against thickness (*x*-axis).
Two points have been plotted.

(i) Plot the remaining points.

(2)

(ii) Draw a curve of best fit.

(1)



(iii) Find the thickness of the absorber that reduces the intensity of the light to 50% of its original value.

(1)

.....mm

(iv) Estimate the intensity of the background light during the investigation.

(1)

.....mW/cm²

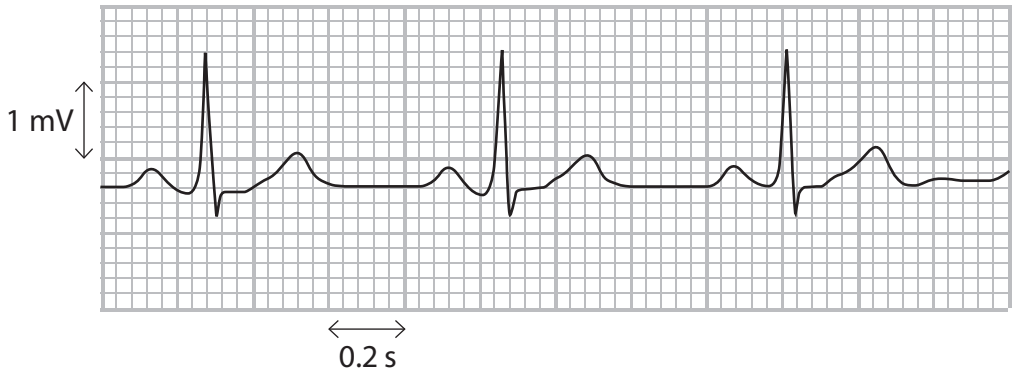
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*(c) The diagram shows an electrocardiogram (ECG) trace with values given for the horizontal and vertical scales used.

Describe how the characteristic shape of the curve and the distance between peaks relates to the way the heart works.

You may add to the diagram to help with your answer.

(6)



(Total for Question 6 = 12 marks)

TOTAL FOR PAPER = 60 MARKS

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Mark Scheme (Results)

Summer 2015

Pearson Edexcel GCSE in Physics (5PH3H) Paper 01 Unit P3: Applications of Physics

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General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- For questions worth more than one mark, the answer column shows how partial credit can be allocated. This has been done by the inclusion of part marks eg (1).
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

Quality of Written Communication

Questions which involve the writing of continuous prose will expect candidates to:

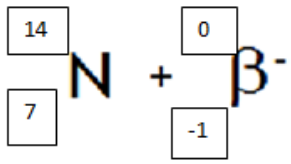
- Write legibly, with accurate spelling, grammar and punctuation in order to make the meaning clear
- Select and use a form and style of writing appropriate to purpose and to complex subject matter
- Organise information clearly and coherently, using specialist vocabulary when appropriate.

Full marks will be awarded if the candidate has demonstrated the above abilities.

Questions where QWC is likely to be particularly important are indicated (QWC) in the mark scheme, but this does not preclude others.

Question Number	Answer	Acceptable answers	Mark
1(a)	☒ **D** too many neutrons.		**(1)**

Question Number	Answer	Acceptable answers	Mark
1(b)	☒ **A** a β^+ is positively charged and a β^- is negatively charged		**(1)**

Question Number	Answer	Acceptable answers	Mark
1 (c)	 Any two numbers correct (1) All four numbers correct (2)		**(2)**

Question Number	Answer	Acceptable answers	Mark
1 (d)	A description to include: Up and down (quarks) / Three (quarks) (1) Correct arrangement (quarks) (1)	Accept for two marks: uud up, up, down two up quarks and one down quark Ignore charges	**(2)**

Question Number	Answer	Acceptable answers	Mark
1 (e)	An explanation linking the following: **Either** proton changes to a neutron (1) positron/anti-electron (emitted) (1) OR up quark changes to a down quark (1) positron/anti-electron (emitted) (1) **OR** proton number goes down by one / neutron number goes up by one (1) number of nucleons stays the same (1)	Accept any correct set of statements for two marks $P \rightarrow n + \beta^+$ (1) Ignore positive electron atomic number goes down by one mass number is constant	**(2)**

Total for Question 1 = 8 marks

Question Number	Answer	Acceptable answers	Mark
2(a)(i)	10.8 + or – 0.2 (cm)	Any value between 10.6(cm) and 11.0 (cm) Accept 11 cm	**(1)**

Question Number	Answer	Acceptable answers	Mark
2 (a)(ii)	B $2.1 \times 10^{-2}\ cm^3$		**(1)**

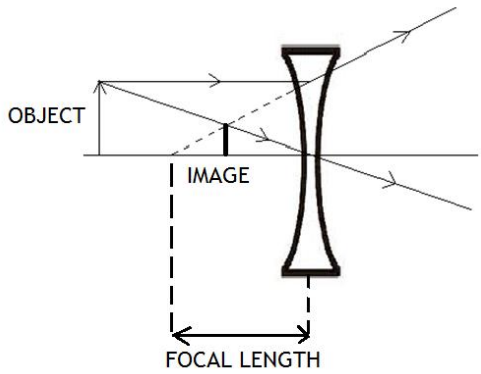
Question Number	Answer	Acceptable answers	Mark
2(a)(iii)	Temperature conversion to K 50°C to 323K **OR** 100°C to 373K (1) Substitution $V_1 = \frac{2.31 \times 10^{-2} \times 373}{323}$ (1) Evaluation $2.67 \times 10^{-2}\ (cm^3)$ (1)	 If equation is transformed to give V_2, allow correct substitution mark. $0.0267(cm^3)$, $2.7 \times 10^{-2}\ (cm^3)$, $0.027(cm^3)$, $2.67 \times 10^{-8}\ m^3$, $2.7 \times 10^{-8}\ m^3$ Allow power of ten error for 2 marks e.g. 267 Allow 2.6×10^{-2} for 3 marks Full marks for correct answer with no working If temperature is not converted to Kelvin, maximum two marks e.g. $V_1 = \frac{2.31 \times 10^{-2} \times 100}{50}$ $4.62 \times 10^{-2}(cm^3)$ Allow power of ten error for 1 mark e.g. 4.62 2 marks for $4.62 \times 10^{-2}\ (cm^3)$ with no working	**(3)**

Question Number	Answer	Acceptable answers	Mark
2(b)	A description including: (Average) KE/it increases as the temperature increases (1) Idea of proportionality / KE doubles when the temperature doubles (1) (when) temperature in Kelvin /K (1)	Allow energy for kinetic energy Or reverse argument (Average) KE/it is (directly) proportional to the Kelvin temperature gets all three marks (Average) KE/it is (directly) proportional to the temperature gets first two marks Allow absolute scale	**(3)**

Total for Question 2= 8 marks

Question Number	Answer	Acceptable answers	Mark
3(a)(i)	**B** either real or virtual | either magnified or diminished		**(1)**

Question Number	Answer	Acceptable answers	Mark
3(a)(ii)	A description including:- Effect of change in shape (1) AND Gives greater/ larger power (1) The second mark is dependent on the first	 greater refraction/ more bending (of light) greater curvature / fatter / more curved/ thicker lens shorter focal length / shorter f Or reverse argument Credit clear labelled diagrams that show this difference.	**(2)**

Question Number	Answer	Acceptable answers	Mark
3(b)		Accept symbols I and f Ignore arrow on image	**(2)**
(i)	Image, line at right angles to principal axis to where rays cross. Judge by eye (1)		
(ii)	Focal length, distance from where virtual ray crosses principal axis to centre of concave lens. Judge by eye (1)		

Question Number	Answer	Acceptable answers	Mark
3(b)(iii)	Short sight / short sightedness	Myopia/ myopic/ near sight	**(1)**

Question Number	Answer	Acceptable answers	Mark
3(b)(iv)	Substitution $\frac{1}{0.5} + \frac{1}{v} = \frac{1}{-0.33}$ (1) Transformation $\frac{1}{-0.33} - \frac{1}{0.5}$ (1) Evaluation $\left(\frac{1}{v}\right) = -3 - 2 = -5$ (1) $\left(v\right) = -0.2$ (m) (1)	Substitution and transformation in any order -5.03 gets 3 marks +5, +5.03 gets 2 marks Any value that rounds up to + or - 0.2 m/ + or - 20 cm gets 4 marks Allow power of ten error for 3 marks Correct answer with no working awarded 4 marks	**(4)**

Total for Question 3 = 10 marks

Question Number	Answer	Acceptable answers	Mark
4(a)(i)	**B** a few hours		**(1)**

Question Number	Answer	Acceptable answers	Mark
4(a)(ii)	An explanation including three of the following: MP1 alpha/the radiation is (highly) ionising (1) MP2 the radiation destroys cancers/tumours (1) MP3 alpha particles/ do not penetrate very far in the body/inserted close to the cancer (1) MP4 half-life is long enough for the treatment to take effect (1) MP5 half-life is short enough so that the pellets do not need to be removed (1)	 kills/ destroys/mutates cells mutates DNA alpha particles do not/ get out of the organ being treated/ damage cells in other organ Ignore patients being radioactive Ignore replacement of pellets	**(3)**

Question Number	Answer	Acceptable answers	Mark
4(b)	An explanation to include: reduces the size of tumours/cancers (1) reduces pain/ relieves symptoms / extends life expectancy / Improves quality of life (1)	 stops tumours growing/ slows rate of growth or spread of cancer	**(2)**

Question Number	Answer	Acceptable answers	Mark
4(c)(i)	An explanation linking two of the following:- CT scan lasts much longer / X-ray short exposure (1) CT scan is many X-ray (slices) (1) The intensity of radiation for CT scans is higher than for normal X-rays (1)	 For CT scan X-ray machine moves (slowly) around the body many pictures / series of X-rays/ 3D image	**(2)**

Question Number	Answer	Acceptable answers	Mark
4(c)(ii)	Justification including:- appreciation that there would be risks (1) ONE from:- non-invasive/ not painful (1) OR more accurate/better/earlier diagnosis (1) OR life-saving/ provide cure (1)	 the benefits outweigh the risks/drawbacks/concerns/dangers gives more useful information	**(2)**

Total for question 4 = 10 marks

Question Number	Answer	Acceptable answers	Mark
5(a)(i)	zero	nothing, they have none, 0	**(1)**

Question Number	Answer	Acceptable answers	Mark
5(a)(ii)	substitution $1.6 \times 10^{-13} = m\ (3.0 \times 10^{8})^2$ (1) transformation $\frac{1.6 \times 10^{-13}}{(3.0 \times 10^{8})^2}$ (1) Evaluation 1.8×10^{-30} (kg) (1)	transformation and substitution in any order 1.77 recurring $\times 10^{-30}$ (kg) gets full marks. Ignore number of significant figures 1.78×10^{-30} or any correctly rounded number of significant figures gets full marks 0.18×10^{-29} (kg), 18×10^{-31} (kg) 2×10^{-30} (kg) Correct answer with no working gets full marks.	**(3)**

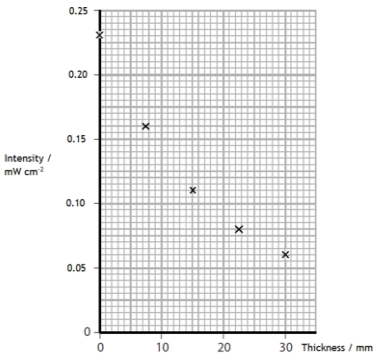
Question Number	Answer	Acceptable answers	Mark
5(a)(iii)	An explanation linking:- BEFORE positron charge is +1, electron charge is -1 (+e and –e) (1) OR total charge is zero before (annihilation) (1) AFTER gamma rays have no charge (1)	 +1 + -1 = 0 photons have no charge	**(2)**

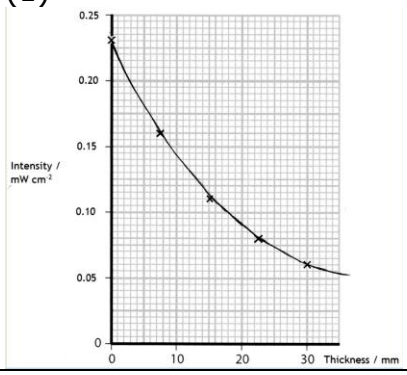
Question Number		Indicative Content	Mark
QWC	***5 (b)**	A comparison and similarity including some of the following points :- particle accelerators use:- • charged particles • magnetic fields • high frequency alternating voltages • collisions • centripetal force hospital particle accelerators • cyclotrons • small, size of a garage • fast moving particle hit targets • particles absorbed by nuclei • produce isotopes with short half lives • only a few people needed to work them research particle accelerators • cyclotrons, synchrotrons, • Large Hadron Collider, CERN • very large, LHC more than 2 km across • use superconducting electromagnets • accelerate particles to close to the speed of light • use hundreds of research scientists • make particles collide • try to discover new particles (Higgs Boson)	**(6)**

Level		
	0	No rewardable content
1	1 - 2	• a limited comparison including a difference OR similarity OR two separate statements e.g. The hospital one is small and the research accelerator is big (one difference) / Cyclotrons use a magnetic field (one similarity)/ The Large Hadron Collider is used for research and small cyclotrons are used in hospitals (one difference)/ The hospital accelerator is small and makes isotopes (two statements). • the answer communicates ideas using simple language and uses limited scientific terminology • spelling, punctuation and grammar are used with limited accuracy
2	3 - 4	• a simple comparison including differences and/or similarities that include BOTH sorts of accelerators e.g. Cyclotrons use magnetic fields and use high frequency alternating voltages (two similarities)/ Hospital cyclotrons are small and produce isotopes. Research ones are large and used to discover new particles (different size and different purpose)/ The research one uses collisions to discover new particles, and the hospital one uses collisions to make isotopes (one similarity and one difference). • 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	a detailed comparison including differences AND/OR a similarities between BOTH sorts of accelerators that includes further qualified detail on one e.g. Cyclotrons use magnetic fields to make particles move in circles and use high frequency alternating voltages (two similarities with extra detail)/ Hospital cyclotrons are small and produce isotopes with short half-lives. Research ones are large and used to discover new particles (different size and different purpose with extra detail)/ The research one uses collisions to discover new particles such as the Higgs Boson, and the hospital one uses collisions to make isotopes (one similarity and one difference). • the answer communicates ideas clearly and coherently uses a range of scientific terminology accurately • spelling, punctuation and grammar are used with few errors

Total for question 5 = 12 marks

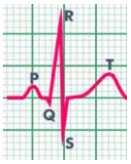
Question Number	Answer	Acceptable answers	Mark
6(a)	**C** Red light has a shorter wavelength than infra-red.		**(1)**

Question Number	Answer	Acceptable answers	Mark
6(b) (i)	All 3 points correctly plotted to +or- half a square (2)  	Any 2 points correctly plotted 1 mark Just one point gains 0 marks The extra points are: thickness 7.5 15.0 22.5 intensity 0.16 0.11 0.08	**(2)**

Question Number	Answer	Acceptable answers	Mark
6(b)(ii)	Line of best fit (1)  	Gauge quality of line by eye according to points plotted Ignore line beyond 30 mm	**(1)**

Question Number	Answer	Acceptable answers	Mark
6(b)(iii)	14±1 (mm) (1)	Any value between 13.0 (mm) and 15.0 (mm)	**(1)**

Question Number	Answer	Acceptable answers	Mark
6(b)(iv)	Accept values from 0.02 to 0.05 (mW/cm^2) (1)		**(1)**

Question Number		Indicative Content	Mark
QWC	***6 (c)**	An explanation including some of the following points :- Shape • standard labelling for electrocardiogram signal  • pattern shows heart action • all shapes are the same so no heart irregularity • patterns shows the parts of the heart pumping blood • pattern produced reflects the electrical activity of the heart • changes in the shape can show weaknesses in different parts of the heart (heart attacks) • the trace shows potential differences across different parts of the heart when the muscles contract and relax • action potentials (electrical signals) originate in the right atrium of the heart • P wave shows muscle contraction spreading through the atria (depolarisation) • QRS shows the ventricles contracting to pump blood to lungs and the rest of the body • T wave is repolarisation when ventricles fill with blood Distance between peaks • shows heart rate.(60 to 90 beats per minute considered normal) • the time for one beat of the heart is represented by the distance between the peaks (could be shown on diagram) • one beat is 0.78s to 0.82s • frequency of 1.25Hz to 1.3 Hz • beats per minute 74 to 80	**(6)**

Level	0	No rewardable content
1	1 - 2	• a limited explanation about the signal shape OR the distance between peaks e.g. The distance between peaks shows how fast the heart is beating. / The trace shows the electrical signals which make the heart pump. • the answer communicates ideas using simple language and uses limited scientific terminology • spelling, punctuation and grammar are used with limited accuracy
2	3 - 4	• a simple explanation about the signal shape AND the distance between peaks OR a detailed explanation of one e.g. Action potentials originate in the right atrium and happen about every second.(shape and distance) / The ventricles contracting gives the QRS trace, and one heart beat takes about 0.8 s (shape and distance) / The distance between P waves shows the time between heart beats is 0.8s giving a frequency of 1.25 Hz. (detailed distance) / The change in potential difference shows when the muscles contract and relax to pump blood around the body. (detailed shape) • 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	• a detailed explanation about the signal shape AND a quantitative discussion of the distance between the peaks e.g. The ventricles contracting gives the QRS trace, and one heart beat takes about 0.8 s giving 75 beats per minute. / The action potentials show voltages across muscles of the heart. One heart beat take 0.78 s this is a frequency of 1.28 Hz giving 77 beats each minute. • the answer communicates ideas clearly and coherently uses a range of scientific terminology accurately • spelling, punctuation and grammar are used with few errors

Total for question 6 =12 marks

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Write your name here

Surname	Other names

Pearson Edexcel GCSE

Centre Number | | | | | |

Candidate Number | | | | |

Physics

Unit P3: Applications of Physics

Higher Tier

Monday 23 June 2014 – Morning
Time: 1 hour

Paper Reference
5PH3H/01

You must have:
Calculator, ruler

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.

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 $\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$

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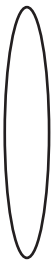
Questions begin on next page.

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 ☒.

Lenses

1 The lens shown in the diagram has a focal length of 12.0 cm.



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

(i) This lens can produce

(1)

☒ **A** only inverted images

☒ **B** only real images

☒ **C** only virtual images

☒ **D** both real and virtual images

(ii) The power of the lens is

(1)

☒ **A** 8.3 dioptre

☒ **B** 8.3×10^{-1} dioptre

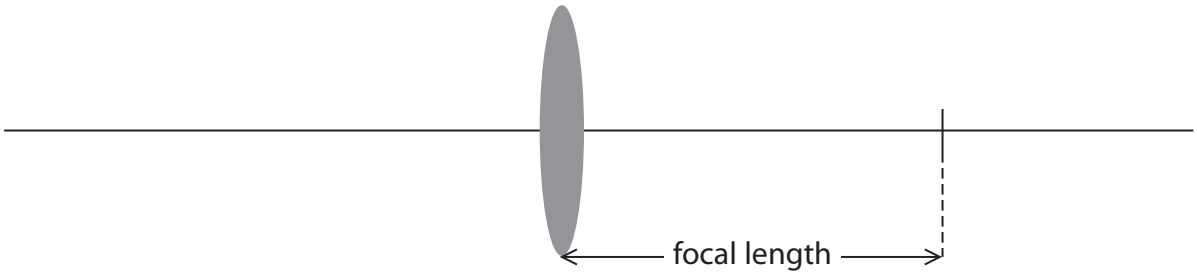
☒ **C** 8.3×10^{-2} dioptre

☒ **D** 8.3×10^{-3} dioptre

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(iii) The diagram shows a converging lens with its focal length marked. Over this diagram draw a converging lens of greater power and mark in its focal length.

(2)



(b) An object is placed 8.5 cm in front of a converging lens of focal length 12.0 cm.

Calculate the image distance.

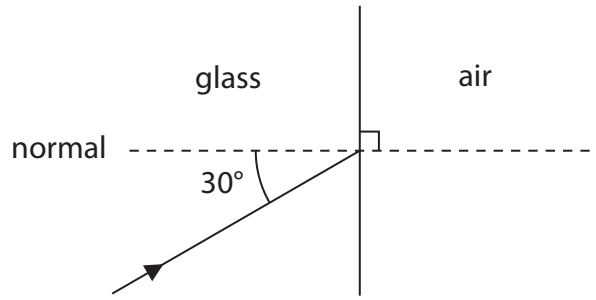
(4)

image distance = ... cm

(Total for Question 1 = 8 marks)

Critical angle

2 (a) The diagram shows a ray of light incident on a boundary between air and glass.



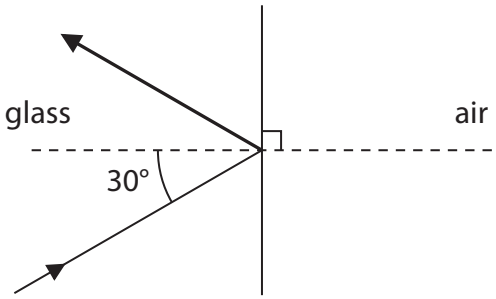
The critical angle for glass in air is 42°.

Which of these diagrams shows the ray of light after it meets the boundary between glass and air?

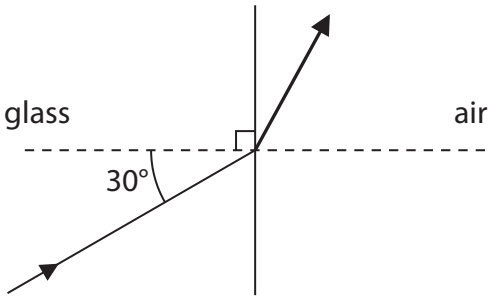
Put a cross (☒) in the box next to your answer.

(1)

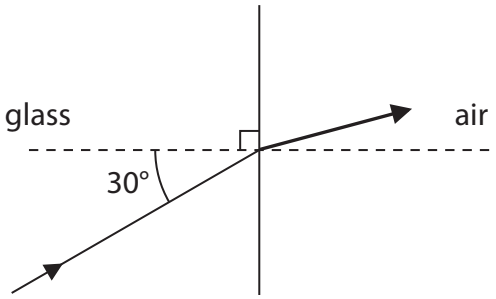
☒ **A**



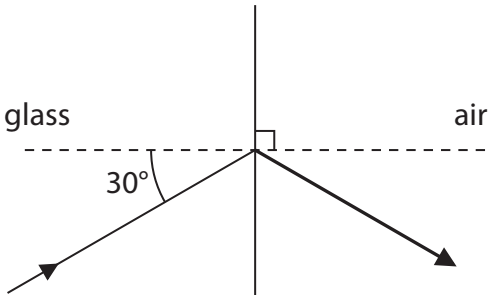
☒ **B**



☒ **C**

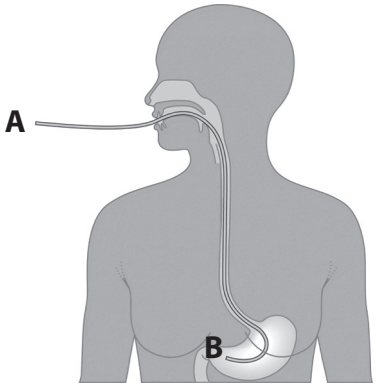


☒ **D**



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(b) The diagram shows how an endoscope is used to see inside a person's stomach.
Light is shone into the optical fibres in the endoscope at A and it comes out at B.



(i) The cross-sectional area of an optical fibre is 6.3×10^{-6} m^2.
The intensity of the light entering the optical fibre is 3.2×10^{7} W/m^2.

Calculate the power of the light entering the optical fibre.

(3)

power = ... W

(ii) Explain why the power of the light at B is the same as the power of the light at A.

(2)

.....

.....

.....

.....

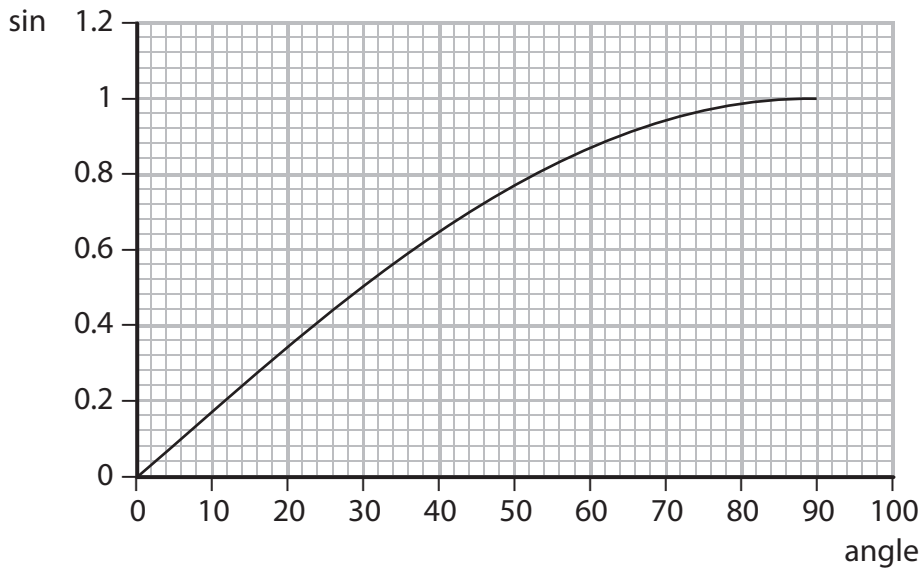
(c) The optical fibre cable in an endoscope has a refractive index of 1.70.

The critical angle for a material can be calculated using the equation

$$\sin c = \frac{1}{n}$$

where c is the critical angle
and n is the refractive index

The graph shows the relationship between an angle and the sine of the angle.



Use the equation and the graph to calculate the critical angle for the optical fibre.

(2)

critical angle = ... °

(Total for Question 2 = 8 marks)

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X-rays

3 The photograph shows the security check-in at an airport.



An X-ray machine is used to scan luggage for dangerous items.
A metal detector is used to check people for dangerous items.

(a) (i) Suggest why people are not scanned with X-rays in an airport but have X-rays in a hospital.

(2)

.....

.....

.....

.....

(ii) The security people work near the X-ray machine.

Explain how they are protected from the X-rays.

(2)

.....

.....

.....

.....

(b) X-rays are produced when fast moving electrons collide with a metal anode in a vacuum tube.

(i) The electrons come from the cathode by the process of thermionic emission.

Explain what is meant by thermionic emission.

(2)

.....

.....

.....

.....

(ii) The current in the vacuum tube is 7.0 mA.
The charge on an electron is 1.6×10^{-19} C.

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

The number of electrons colliding with the metal anode in one second is

(1)

☒ **A** 2.3×10^{-20}

☒ **B** 2.3×10^{-17}

☒ **C** 4.4×10^{16}

☒ **D** 4.4×10^{19}

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(iii) In order to produce X-rays which can penetrate the luggage, each electron must have at least an energy of 1.4×10^{-14} J.
The charge on an electron is 1.6×10^{-19} C.

Calculate the accelerating potential difference which will produce electrons of this energy.

(3)

accelerating potential difference = ... V

(Total for Question 3 = 10 marks)

Kinetic theory of gases

4 Kinetic theory describes the behaviour of gas particles.

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

At –273 °C the particles in a gas are

(1)

☒ **A** moving rapidly

☒ **B** moving slowly

☒ **C** stationary

☒ **D** vibrating

(ii) The temperature of a gas changes from 300 K to 150 K.

State how the average kinetic energy of the gas particles changes.

(1)

.....

.....

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(b) The photograph shows a weather balloon filled with helium.
When released the balloon rises rapidly to a height of 30 000 m above the Earth.



Explain how the helium gas exerts a pressure on the balloon.

(3)

(c) On the surface of the Earth the weather balloon has a volume of 9.1 m^3, when the temperature is 0 °C and the pressure inside the balloon is 101 kPa.

At 30 000 m above the Earth, the temperature is –46 °C and the pressure inside the balloon is 1.12 kPa.

(i) Show that –46 °C is 227 K.

(1)

(ii) Calculate the volume of the weather balloon when it is at a height of 30 000 m.

(3)

volume = ... m^3

(iii) Suggest what will happen to the balloon as it carries on rising above 30 000 m.

(1)

.....

.....

(Total for Question 4 = 10 marks)

Antiparticles

5 (a) Positrons are antiparticles of electrons.
The photograph shows a PET scanner that uses positrons to locate the site of a brain tumour.



Positrons are emitted by the radioactive isotope fluorine-18.
The fluorine-18 is attached to glucose.
The glucose is injected into the patient's blood stream and collects at the site of the tumour.

(i) Fluorine-18 has a half-life of 1.8 hours.
State one advantage and one disadvantage of using a substance with such a short half-life.

1. Advantage

(1)

2. Disadvantage

(1)

(ii) When a positron meets an electron they annihilate each other.
Explain how this enables the site of the tumour to be located.

(4)

*(b) Positrons (β^+ particles) are emitted from the nuclei of some atoms.
Electrons (β^- particles) are emitted from the nuclei of other atoms.

The table gives some information about quarks.

quark	charge (compared to the charge on a proton)
u	+2/3
d	–1/3

Describe, in terms of quarks, how β^+ particles are emitted from the nuclei of some atoms and β^- particles are emitted from the nuclei of others.

(6)

(Total for Question 5 = 12 marks)

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Cyclotrons and Collisions

6 (a) A cyclotron accelerates charged particles.

(i) Describe the shape of the path a charged particle takes in the cyclotron.

(1)

(ii) Explain how radioactive isotopes can be produced using cyclotrons.

(3)

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

In an **inelastic** collision there is conservation of

(1)

- ☒ **A** kinetic energy
- ☒ **B** momentum
- ☒ **C** kinetic energy and momentum
- ☒ **D** velocity

(ii) State why momentum has the unit kg.m/s.

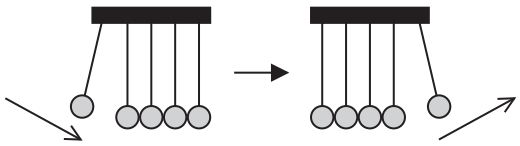
(1)

*(iii) Different types of collision are shown in the diagrams.

Analyse both collisions in terms of momentum and kinetic energy.



collision 1



collision 2

(6)

(Total for Question 6 = 12 marks)

TOTAL FOR PAPER = 60 MARKS

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Mark Scheme (Results)

Summer 2014

Pearson Edexcel GCSE in Physics (5PH3H) Paper 01

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Summer 2014
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General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- For questions worth more than one mark, the answer column shows how partial credit can be allocated. This has been done by the inclusion of part marks eg (1).
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

Quality of Written Communication

Questions which involve the writing of continuous prose will expect candidates to:

- Write legibly, with accurate spelling, grammar and punctuation in order to make the meaning clear
- Select and use a form and style of writing appropriate to purpose and to complex subject matter
- Organise information clearly and coherently, using specialist vocabulary when appropriate.

Full marks will be awarded if the candidate has demonstrated the above abilities.

Questions where QWC is likely to be particularly important are indicated (QWC) in the mark scheme, but this does not preclude others.

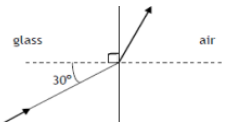
Question Number	Answer	Acceptable answers	Mark
1(a)(i)	D both real and virtual images		**(1)**

Question Number	Answer	Acceptable answers	Mark
1 (a)(ii)	A 8.3 dioptre		**(1)**

Question Number	Answer	Acceptable answers	Mark
1(a)(iii)	Diagram showing Convex lens, wider at the centre and more curved (1) shorter focal length identifiable (1)	Lens can be redrawn anywhere on the diagram	**(2)**

Question Number	Answer	Acceptable answers	Mark
1 (b)	substitution (1) 1/12= 1/8.5 + 1/v transposition (1) (1/v) = 1/12 - 1/8.5 evaluation (1) (1/v) = -0.034 Inversion (1) v = -29(cm)	substitution and transposition in any order 0.034,-7/204,7/204, 0.03,-0.03 (3) Ignore signs until final value of v is given. -29.1(cm) -29.14(cm) Allow answers that can be rounded down to -29(cm) full marks for the correct numerical answer with no working (-)204/7 or 29(cm) with no working gains 3 marks	**(4)**

(Total marks for question 1 = 8 marks)

Question Number	Answer	Acceptable answers	Mark
2(a)	B 		**(1)**

Question Number	Answer	Acceptable answers	Mark
2 (b)(i)	substitution: (1) 3.2×10^{7} = power/6.3×10^{-6} transposition (1) (power) = $3.2 \times 10^{7} \times 6.3 \times 10^{-6}$ evaluation: (1) 200 (W)	substitution and transposition in any order ignore powers of 10 until evaluation 202(W) or 201.6(W) or 201(W) full marks for the correct numerical answer without working	**(3)**

Question Number	Answer	Acceptable answers	Mark
2 (b)(ii)	An explanation linking: EITHER • no light / energy is lost (1) OR • no <u>light</u> is refracted (out) (1) WITH • (because) idea of (total) internal reflection (1)	Ignore references to power No light / energy escapes All <u>light</u> stays in (the fibre) TIR Accept "<u>All light</u> is internally reflected" for 2 marks	**(2)**

Question Number	Answer	Acceptable answers	Mark
2 (c)	substitute and evaluate (sin c) = 1/1.7 (sin c) = 0.59 (1) from graph or calculation c = any value between 34° and 38° (1)	 0.588, 0.58, 0.6 full marks for the correct numerical answer without working	**(2)**

(Total marks for question 2 = 8 marks)

Question Number	Answer	Acceptable answers	Mark
3 (a)(i)	A suggestion linking two of: • (X-rays/they) are harmful to health (1) • airport use non-essential/ hospital use essential (1) • idea that benefits outweigh risk in hospitals (1)	Dangerous to health/damage cells/ can cause cancer/mutate cells/ionising ORA Ignore references to risks of frequent flyers	**(2)**

Question Number	Answer	Acceptable answers	Mark
3 (a)(ii)	A suggestion linking: lead casing / shielding (1) <u>absorbs</u> X-rays (1)	metal casing/shielding (security workers) out of range Ignore references to lead suits/aprons etc.	**(2)**

Question Number	Answer	Acceptable answers	Mark
3 (b)(i)	Explanation linking two of the following:- • cathode is heated (1) • (electrons) given enough energy (1) • (electrons) escape (from the surface) (1)	filament/wire is heated boiled off / released / emitted Ignore emission	**(2)**

Question Number	Answer	Acceptable answers	Mark
3 (b)(ii)	C 4.4×10^{16} (1)		**(1)**

Question Number	Answer	Acceptable answers	Mark
3 (b)(iii)	substitution: (1) $1.4 \times 10^{-14} = 1.6 \times 10^{-19} \times V$ Transposition (1) $(V) = 1.4 \times 10^{-14} / 1.6 \times 10^{-19}$ evaluation: (1) 88 000 (V) /88 x 10^3 (V)/ 8.8 x 10^4 (V)	substitution and transposition in any order ignore powers of 10 until evaluation 87 500(V), 9 x 10^4 (V) 88 kV, 87.5 kV, 90kV full marks for the correct numerical answer without working	**(3)**

(Total marks for question 3 = 10 marks)

Question Number	Answer	Acceptable answers	Mark
4 (a)(i)	C stationary		**(1)**

Question Number	Answer	Acceptable answers	Mark
4(a)(ii)	(Average KE/it is) halved	divided by 2,multiplied by 0.5	**(1)**

Question Number	Answer	Acceptable answers	Mark
4 (b)	Explanation in terms of particles linking the following:- • particles collide with / hit /strike / bombard (1) • the wall / sides of the balloon (1) • (causing a) force / (rate of) change in momentum (1)	 Accept "molecules/atoms" for particles Must mention particles etc to gain this mark Ignore "push"	**(3)**

Question Number	Answer	Acceptable answers	Mark
4 (c)(i)	-46 + 273 (1)	273-46 / any use of 273	**(1)**

Question Number	Answer	Acceptable answers	Mark
4 (c)(ii)	substitution: (1) $\frac{101 \times 9.1}{273} = \frac{1.12 \times V_2}{227}$ Transposition (1) $V_2 = \frac{101 \times 9.1 \times 227}{273 \times 1.12}$ evaluation: (1) 682 (m^3)	Accept either Pa or kPa for substitution substitution and transposition in any order ignore power of ten error until evaluation 680 (m^3), 682.4 (m^3), 682.35 (m^3) full marks for the correct numerical answer without working	**(3)**

Question Number	Answer	Acceptable answers	Mark
4 (c)(iii)	bursts/explodes or words to that effect		**(1)**

(Total marks for question 4 = 10 marks)

Question Number	Answer	Acceptable answers	Mark
5 (a)(i)	1. advantage (1) minimises patient's exposure to radioactivity 2. disadvantage (1) (has to be produced) close to the {place / time} of use	Does not stay in the (patient's) body for a long time / Decays quickly Any time constraint (in diagnosis/scanning/treatment) Ignore confusion between biological and physical half-life	**(2)**

Question Number	Answer	Acceptable answers	Mark
5 (a)(ii)	An explanation linking four from: • gamma (rays emitted) (1) • <u>two</u> (gamma rays) (1) • in opposite directions (1) • (because) momentum is conserved (1) • detectors / sensors placed around the patient (1) • simultaneous detection (1)	pair at 180°(to each other) gamma cameras/scintillation crystals idea of triangulation	**(4)**

Question Number		Indicative Content	Mark
QWC	***5(b)**	An explanation including some of the following points • protons and neutrons are made up of quarks • quarks can change (flavour) • proton made up of uud • neutron made up of udd • for β^+ a u changes to a d • for β^- a d changes to a u • for β^+ a p changes to a n • for β^- a n changes to a p	**(6)**
Level	**0**	No rewardable content	
1	**1 - 2**	• a limited description e.g. for β^+ a proton changes to a neutron OR protons and neutrons are made up of quarks which can change (flavour) • the answer communicates ideas using simple language and uses limited scientific terminology • spelling, punctuation and grammar are used with limited accuracy	
2	**3 - 4**	• a simple description including both processes but with significant error(s) e.g. 'a d changes to a u' [error], changing a proton to a neutron and emitting a β^+. A u changes to a d [error] changing a neutron to a proton and a β^- [errors in u and d] OR one of the processes with the correct detail e.g. A u goes to a d therefore a proton goes to a neutron and emits a β^+ • 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**	• a detailed, accurate description of both processes e.g. A u goes to a d therefore a proton goes to a neutron and emits a β^+. A d goes to a u therefore a neutron goes to a proton and emits a β^-. • the answer communicates ideas clearly and coherently uses a range of scientific terminology accurately • spelling, punctuation and grammar are used with few errors	

(Total marks for question 5 = 12 marks)

Question Number	Answer	Acceptable answers	Mark
6(a)(i)	Circular/spiral/circle		**(1)**

Question Number	Answer	Acceptable answers	Mark
6 (a)(ii)	An explanation linking three of the following. • (fast moving) <u>protons</u> (1) • absorbed by (1) • nuclei (1) • (produces)unstable nuclei (1)	bombard / hit /strike / collide with stable atoms / stable element	**(3)**

Question Number	Answer	Acceptable answers	Mark
6 (b)(i)	B momentum		**(1)**

Question Number	Answer	Acceptable answers	Mark
6 (b)(ii)	(Momentum/it)equals mass x <u>velocity</u>	p = m x v kilograms / kg is the mass and metres per second / m/s is the <u>velocity</u> Accept "times" for x	**(1)**

Question Number		Indicative Content	Mark
QWC	***6(b)(iii)**	An explanation including some of the following points Diagram 1 • Moving in opposite directions before collision • inelastic collision • stationary after collision • momentum zero after collision • (therefore) total momentum must have been zero before collision • (therefore) cars were moving at the same speed in opposite directions (assuming cars have equal mass) • both cars had kinetic energy before the collision • KE zero after collision • KE converted into heat, sound, elastic potential energy etc. Diagram 2 • Elastic collision / almost elastic collision • Momentum conserved • Momentum transferred from first to last sphere • KE conserved / almost conserved • (because)last sphere reaches same height as first sphere • Three spheres always have zero momentum • Small amount of energy transferred to sound/heat	**(6)**

Level	0	No rewardable content
1	1 - 2	• A limited analysis of ONE collision which is given by a correct statement e.g. In collision 1, kinetic energy has been lost OR In collision 2 momentum is transferred from the first to the last sphere. • the answer communicates ideas using simple language and uses limited scientific terminology • spelling, punctuation and grammar are used with limited accuracy
2	3 - 4	• a simple analysis of BOTH collisions considering BOTH momentum AND kinetic energy correctly for each one e.g. In collision 1, momentum is conserved and the kinetic energy of the cars changes. In collision 2, momentum and the kinetic energy is conserved. • 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	• a detailed analysis of BOTH collisions considering momentum AND kinetic energy for each collision correctly for each AND detailed reference to EITHER diagram. e.g. In collision 1, the momentum before and after the collision is zero because momentum is always conserved, but the KE is lost. In collision 2, all the momentum and KE is transferred to the last sphere because it gets to the same height as the first one. • the answer communicates ideas clearly and coherently uses a range of scientific terminology accurately • spelling, punctuation and grammar are used with few errors

(Total marks for question 6 = 12 marks)

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Write your name here

Surname	Other names

Centre Number | Candidate Number

Edexcel GCSE

Physics

Unit P3: Applications of Physics

Higher Tier

Wednesday 5 June 2013 – Afternoon
Time: 1 hour

Paper Reference
5PH3H/01

You must have:
Calculator, ruler

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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1/1/1/1/1/1/

P 4 1 9 4 7 A 0 1 1 6

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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 $\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$

P 4 1 9 4 7 A 0 2 1 6

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Answer ALL questions

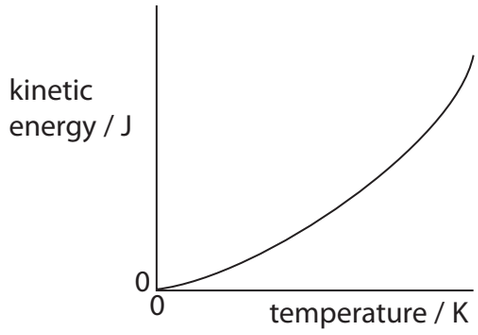
Some questions must be answered with a cross in a box ☒.
If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

Gas cylinders

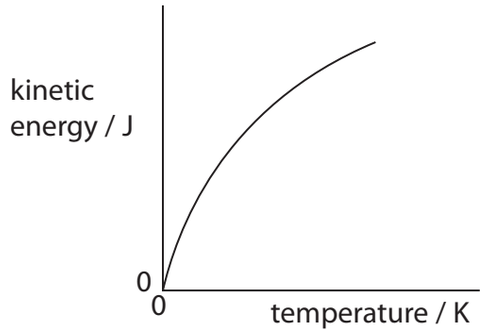
1 (a) Which graph shows the way in which the average kinetic energy of the molecules of a gas changes with temperature?

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

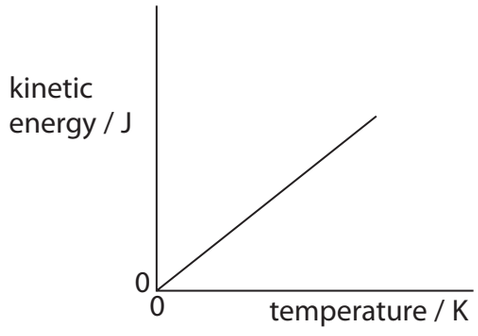
(1)



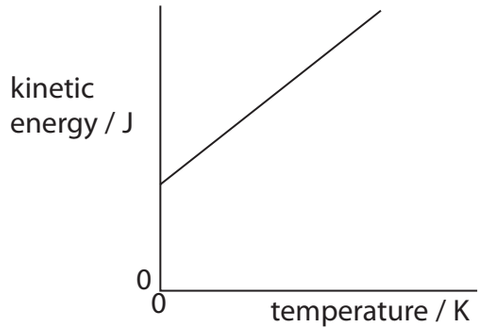
☒ **A**



☒ **B**



☒ **C**



☒ **D**

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(b) The photograph shows a scuba diver.
She can breathe under water because she carries a cylinder of air on her back.



(i) The air molecules in the cylinder move randomly.
Describe how these air molecules exert a pressure on the cylinder.

(2)

.....

.....

.....

.....

(ii) The cylinder contains air at a pressure of 21 000 kPa.

The volume of air in the cylinder is 15.0 litres.
When the valve on the cylinder is opened, the air expands until its pressure is 100 kPa.
The temperature of the air does not change.

Show that the new volume of air is about 3 200 litres.

(2)

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(iii) The cylinder is filled with air in a hot country and then taken to a cold country.

The temperature in the hot country is 305 K.
The temperature in the cold country is 278 K.
The pressure in the cylinder in the hot country is 21 000 kPa.

Calculate the pressure in the cylinder in the cold country.

(3)

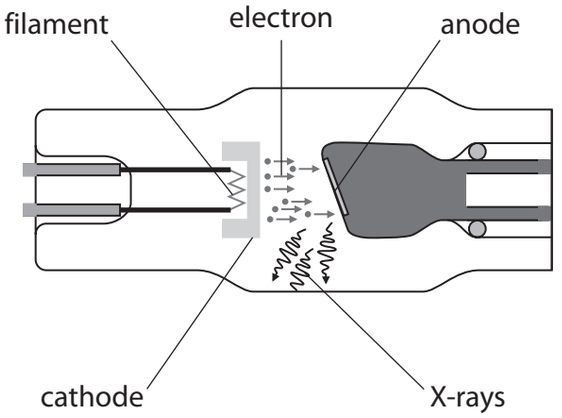
pressure in the cylinder in the cold country = ... kPa

(Total for Question 1 = 8 marks)

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X-rays

2 (a) The diagram shows X-rays being produced when fast moving electrons hit a metal target.



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

The X-rays that have most energy have the

(1)

☒ **A** greatest mass

☒ **B** highest frequency

☒ **C** highest speed

☒ **D** longest wavelength

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

Electrons travel to the target because it is

(1)

☒ **A** magnetised

☒ **B** negatively charged

☒ **C** neutral

☒ **D** positively charged

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(iii) Explain what is meant by **thermionic emission**.

(2)

.....

.....

.....

.....

(iv) Suggest why there must be a vacuum in the glass tube.

(1)

.....

.....

(b) The potential difference between the filament and metal target in an X-ray tube is 40 kV.
The charge on an electron is 1.6×10^{-19} C and its mass is 9.1×10^{-31} kg.

Calculate the speed of an electron as it reaches the target.

(3)

speed of electron = ... m/s

(Total for Question 2 = 8 marks)

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Ionising radiations

3 Ionising radiations are emitted by unstable nuclei.

(a) (i) Which particle has the same mass as but opposite charge to a β^+ particle?

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

(1)

☒ **A** electron

☒ **B** positron

☒ **C** proton

☒ **D** neutron

(ii) Suggest why a beta particle will travel further in air than an alpha particle.

(2)

.....

.....

.....

.....

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

Following the radioactive decay of a nucleus, the nucleus might undergo some rearrangement, losing energy as

(1)

☒ **A** gamma radiation

☒ **B** a proton

☒ **C** a neutron

☒ **D** an X-ray

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(c) Some unstable nuclei decay by emitting β^- radiation.

(i) Describe the process of β^- emission.

(3)

(ii) Explain what happens to the mass number and the atomic number of a nucleus when β^- emission occurs.

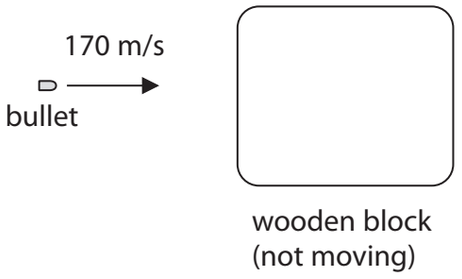
(3)

(Total for Question 3 = 10 marks)

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Collisions

4 (a) The diagram shows a bullet moving towards a wooden block.



(i) The bullet is moving with a velocity of 170 m/s.
The mass of the bullet is 0.030 kg.

Show that the momentum of the bullet is about 5.0 kg m/s.

(1)

(ii) The bullet collides with the wooden block and sticks in it.
The bullet and the wooden block move off together.
The mass of the wooden block is 0.80 kg.

Calculate the velocity of the wooden block and bullet immediately after the collision.

(3)

velocity = ... m/s

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(iii) The collision between the bullet and the wooden block is an inelastic collision.

State what is meant by an **inelastic collision**.

(2)

.....

.....

.....

.....

(b) An electron and a positron collide and annihilate each other.
Two photons are produced.

(i) Explain why two photons must be produced, rather than just one.

(2)

.....

.....

.....

.....

(ii) Calculate the minimum total energy of the photons produced when an electron and positron collide.

Use the equation

$$E = mc^2$$

mass of an electron = 9.1×10^{-31} kg
speed of light = 3.0×10^8 m/s

(2)

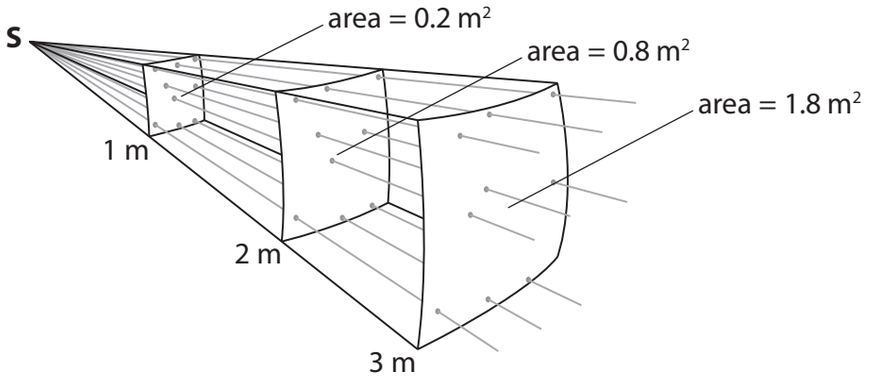
energy = ... J

(Total for Question 4 = 10 marks)

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Uses of radiation

5 The diagram shows light from a point source, **S**, spreading out as it gets further from **S**.



(a) The intensity of light passing through the surface which is 1 m from **S** is 2.5 W/m².

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

The intensity of light, in W/m², passing through the surface which is 2 m from **S** is

(1)

☒ **A** $2.5 \div 2$

☒ **B** $2.5 \div 4$

☒ **C** 2.5×2

☒ **D** 2.5×4

(ii) Calculate the power of the light passing through the surface which is 1m from **S**.

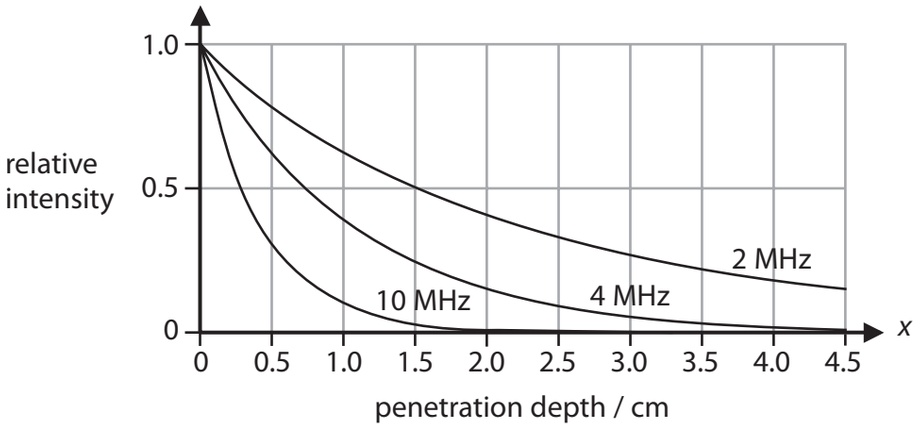
(2)

power = ... W

P 4 1 9 4 7 A 0 1 2 1 6

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(b) The graph shows how the intensity of ultrasound waves of different frequencies decreases as they penetrate soft tissue.



(i) Estimate how far a 2 MHz wave has penetrated into the soft tissue when its intensity is 25% of its original value.

(1)

penetration depth = ... cm

(ii) Explain which of these frequencies of ultrasound can be used to scan organs deep inside the body.

(2)

.....

.....

.....

.....

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*(c) Medical physicists have developed endoscopes and many other devices to help doctors diagnose medical problems.

Compare the use of electromagnetic radiation in endoscopes and in one other diagnostic device.

(6)

(Total for Question 5 = 12 marks)

P 4 1 9 4 7 A 0 1 4 1 6

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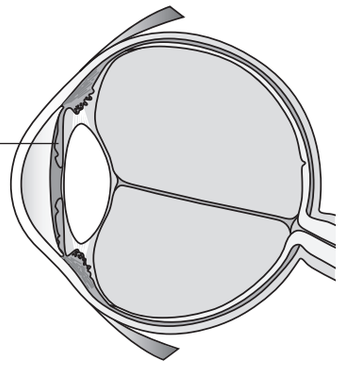
Defects of vision

6 (a) The diagram shows a human eye.

(i) Label part **X**.

(1)

X is .....



(ii) State the names of **two** parts of the eye that focus the light.

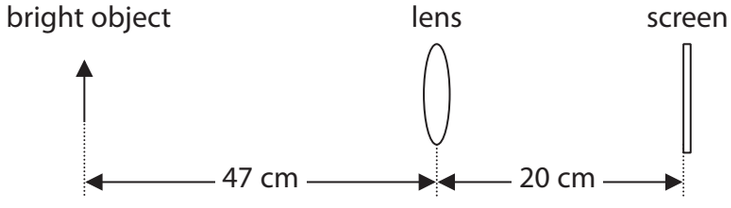
(2)

1 .....

2 .....

(b) A bright object is placed 47 cm away from a lens as shown in the diagram.

A real image of the bright object is seen on a screen which is 20 cm away from the lens as shown.



Not to scale

Calculate the focal length of the lens.

(3)

focal length = ... cm

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*(c) Long sight and short sight are two defects of vision.

Explain how long sight and short sight are different from normal sight and how one of these defects can be corrected.

(6)

(Total for Question 6 = 12 marks)

TOTAL FOR PAPER = 60 MARKS

P 4 1 9 4 7 A 0 1 6 1 6

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Mark Scheme (Results)

Summer 2013

GCSE Physics (5PH3H)
Paper 01

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General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- For questions worth more than one mark, the answer column shows how partial credit can be allocated. This has been done by the inclusion of part marks eg (1).
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

Quality of Written Communication

Questions which involve the writing of continuous prose will expect candidates to:

- Write legibly, with accurate spelling, grammar and punctuation in order to make the meaning clear
- Select and use a form and style of writing appropriate to purpose and to complex subject matter
- Organise information clearly and coherently, using specialist vocabulary when appropriate.

Question Number	Answer	Acceptable answers	Mark
1(a)	☒ **C** (graph C)		**(1)**

Question Number	Answer	Acceptable answers	Mark
1(b)(i)	A description including: • collisions (1) • with (walls of) cylinder (1)	hit / bounce off exert force	**(2)**

Question Number	Answer	Acceptable answers	Mark
1(b)(ii)	substitution (1) either $100 \times V = 15.0 \times 21\,000$ or $V = \frac{15.0 \times 21\,000}{100}$ evaluation (1) 3 150(litres)	$V_1P_1 = 15 \times 21000 = 315000$ (1 mark) $V_2P_2 =$ **100** $\times 3200 = 320000$ (1 mark) award full marks for 3150 (litres) without working	**(2)**

Question Number	Answer	Acceptable answers	Mark
1(b)(iii)	substitution (1) $\frac{21\,000 (\times V)}{305} = \frac{P (\times V)}{278}$ volume same (1) evaluation (1) 19 100 (kPa)	give full marks for correct answer, no working transposition accept 19141 (kPa) or 19000 and numbers rounding down to 191 00	**(3)**

Question Number	Answer	Acceptable answers	Mark
2(a)(i)	☒ **B** highest frequency		**(1)**

Question Number	Answer	Acceptable answers	Mark
2(a)(ii)	☒ **D** positively charged		**(1)**

Question Number	Answer	Acceptable answers	Mark
2(a)(iii)	an explanation linking: • (when) the filament is {heated/very hot} (1) with **one** of: • electrons escape (have enough energy) (1) • electrons escape from the surface (1)	cathode / metal (for filament) released accept boil off IGNORE produces / emits	**(2)**

Question Number	Answer	Acceptable answers	Mark
2(a)(iv)	a suggestion that electrons do not reach target	otherwise electrons collide with (air) particles electrons are absorbed electrons ionise air stops electrons reaching target	**(1)**

Question Number	Answer	Acceptable answers	Mark
2(b)	transposition $2 \times e \times V / m = v^2$ (1) substitution $v^2 = 2 \times 1.6 \times 10^{-19} \times 40\,000 / 9.1 \times 10^{-31}$ (1) evaluation of v 1.2×10^8 (m/s) (1)	Either order ignore powers of ten until evaluation give full marks for correct answer, no working accept 1.19×10^8	**(3)**

Question Number	Answer	Acceptable answers	Mark
3(a)(i)	☒ **A** electron		**(1)**

Question Number	Answer	Acceptable answers	Mark
3(a)(ii)	suggestion to include **two** of • the ionisation is different (1) • correct difference in ionisation (1) • the <u>masses</u> are different (1) • alpha is bigger than beta (1) • alpha hits more (air) particles (1) • alpha loses its energy in shorter distance (1)	alpha more ionising (than beta) scores 2 marks RA (heavier for bigger) RA RA IGNORE references to penetration	**(2)**

Question Number	Answer	Acceptable answers	Mark
3(b)	☒ **A** gamma radiation		**(1)**

Question Number	Answer	Acceptable answers	Mark
3(c)(i)	A description linking the following: • neutron decays / changes / becomes (1) • (neutron) into proton (1) • (plus an) electron (1)	quark changes (quark changes) from down to up / d to u e^- (do not accept β^-) accept n and p for neutron and proton $n > p + e^-$ scores 3 marks IGNORE references to atomic and mass numbers; unstable nuclei; too many neutrons; gamma emitted	**(3)**

Question Number	Answer	Acceptable answers	Mark
3(c)(ii)	An explanation linking **three** of the following: • mass number doesn't change (1) • (because) same number of nucleons / quarks (1) • atomic number goes up by one (1) • (because) there is an extra proton (1)	emitted electron mass is negligible proton and neutron have same mass a neutron has (decayed in)to a proton	**(3)**

Question Number	Answer	Acceptable answers	Mark
4(a)(i)	momentum = 0.03 × 170 (1)	Accept 5.1 seen	**(1)**

Question Number	Answer	Acceptable answers	Mark
4(a)(ii)	momentum before = momentum after (1) 5.1 = 0.83 × v (1) v = 6.1 (m/s) (1)	allow 5.0 = 0.80 x v for 1 mark max 5.0 = 0.83 x v v = 6.0 (m/s) allow ecf from (a)(i) give full marks for correct answer, no working	**(3)**

Question Number	Answer	Acceptable answers	Mark
4(a)(iii)	Statement to include any two from • kinetic energy is not conserved (1) • (lost ke) appears as heat/sound (1) • momentum is conserved (1)	ke not conserved / some ke lost no momentum lost	**(2)**

Question Number	Answer	Acceptable answers	Mark
4(b)(i)	an explanation linking • momentum (must be) conserved (1) • so must have positive and negative momentum (1)	photons move in opposite directions indication of movement in opposite directions (e.g. opposite velocities)	**(2)**

Question Number	Answer	Acceptable answers	Mark
4(b)(ii)	E = (2 ×) 9.1 × 10^{-31} × [3 × 10^{8}]^{2} (1) = 1.6 × 10^{-13} (J) (1)	8.2 × 10^{-14} (0.82 × 10^{-13}) for 1 mark give full marks for correct answer, no working	**(2)**

Question Number	Answer	Acceptable answers	Mark
5(a)(i)	☒ **B** 2.5 ÷ 4		**(1)**

Question Number	Answer	Acceptable answers	Mark
5(a)(ii)	either P = 2.5 x 0.2 or 2.5 = P / 0.2 (1) 0.5 (W) (1)	give full marks for correct answer, no working	**(2)**

Question Number	Answer	Acceptable answers	Mark
5(b)(i)	3.0 +/- 0.5 (cm)		**(1)**

Question Number	Answer	Acceptable answers	Mark
5(b)(ii)	an explanation linking • 2 MHz (1) and any **one** from: • has a higher intensity inside tissue (1) • less energy absorbed (1) • less attenuation (1) • penetrates furthest /deepest (1)	this frequency alone RA loses intensity more gradually highest penetration accept "2MHz and 4MHz" with correct reason for 1 mark	**(2)**

Question Number		Indicative Content	Mark
QWC	***5(c)**	A comparison of endoscopes with any one of the following devices: **Diagnostic devices** • CAT scanners • Fluoroscopes • Thermal imagers / IR thermometers • Pulse oximeters • PET scanners • X-ray machines • Gamma cameras **Link to electromagnetic radiation** • Endoscopes use TIR of light in optical fibres • CAT scanners X- rays and computer to generate 3D images • Fluoroscopes use X- rays and a video camera • Thermal imagers use infrared emitted by a body • IR / red LEDs used to measure oxygen levels • PET scanners detect radiation emitted by electron-positron annihilation • Gamma cameras detect gamma rays from radioactive sources **Other factors for comparison** • Safety • Ease of use • Frequency / wave length • Intensity • Penetration • Ionising / non-ionising	**(6)**
Level	**0**	No rewardable content	
1	**1 - 2**	• a limited comparison between an endoscope and one device e.g. endoscopes use light and CAT scanners detect broken bones • the answer communicates ideas using simple language and uses limited scientific terminology • spelling, punctuation and grammar are used with limited accuracy	
2	**3 - 4**	• a simple comparison between an endoscope and one device, linking them to the electromagnetic radiation used for both and a detail of use for one of them e.g. endoscopes use visible light to examine internal organs and CAT scans use X-rays • 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**	• a detailed comparison between an endoscope and one device, linking them to the electromagnetic radiation used for both and a detail of use for both of them e.g. endoscopes use visible light which is passed down optical fibres by TIR to examine internal organs. Fluoroscopes use X-rays and a video camera to show positioning of stents in arteries. • the answer communicates ideas clearly and coherently uses a range of scientific terminology accurately • spelling, punctuation and grammar are used with few errors	

Question Number	Answer	Acceptable answers	Mark
6(a)(i)	iris	allow any recognisable spelling	**(1)**

Question Number	Answer	Acceptable answers	Mark
6(a)(ii)	In either order • cornea (1) • lens (1)	aqueous humour vitreous humour allow any recognisable spelling	**(2)**

Question Number	Answer	Acceptable answers	Mark
6(b)	substitution (1) 1/f = 1/47 + 1/20 transposition **or** evaluation of 1/f (1) 0.071 evaluation of f (1) 14 (cm)	f = $\frac{1}{(1/47 + 1/20)}$ scores 2 marks numbers that round down to 14 give full marks for the correct answer, no working	**(3)**

Question Number		Indicative Content	Mark
QWC	***6(c)**	An explanation including some of the following points • normal eye image forms on retina • for all distances of objects • short sight • (clear) image of a distant object forms inside the eye / in front of retina • corrected using diverging lens • diverging the light / makes image distance longer • long sight • (clear) image of near object forms "beyond" the retina • corrected using converging lens • converging the light / makes image distance smaller Other methods of correction include • contact lenses which change the curvature of the cornea • laser correction changes curvature of cornea	**(6)**
Level	**0**	No rewardable content	
1	**1 - 2**	• a limited explanation of both long and short sight **OR** either long or short sight and how it is corrected eg long-sighted people cannot see near objects and this can be corrected by convex lenses • the answer communicates ideas using simple language and uses limited scientific terminology • spelling, punctuation and grammar are used with limited accuracy	
2	**3 - 4**	• a simple explanation of both long and short sight **AND** either how one is corrected or detail of image formation eg, long-sighted people cannot see near objects but short sighted people cannot see distant objects because the image forms in front of retina. • 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**	• a detailed explanation including both long and short sight **AND** how one is corrected **AND** detail of image formation eg long – eyeball too short so image of nearby object is beyond the retina, short-sighted people cannot see distant objects, which can be corrected by concave lenses • the answer communicates ideas clearly and coherently uses a range of scientific terminology accurately • spelling, punctuation and grammar are used with few errors	

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