Write your name here

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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P 4 4 8 0 6 A 0 1 2 0

PEARSON

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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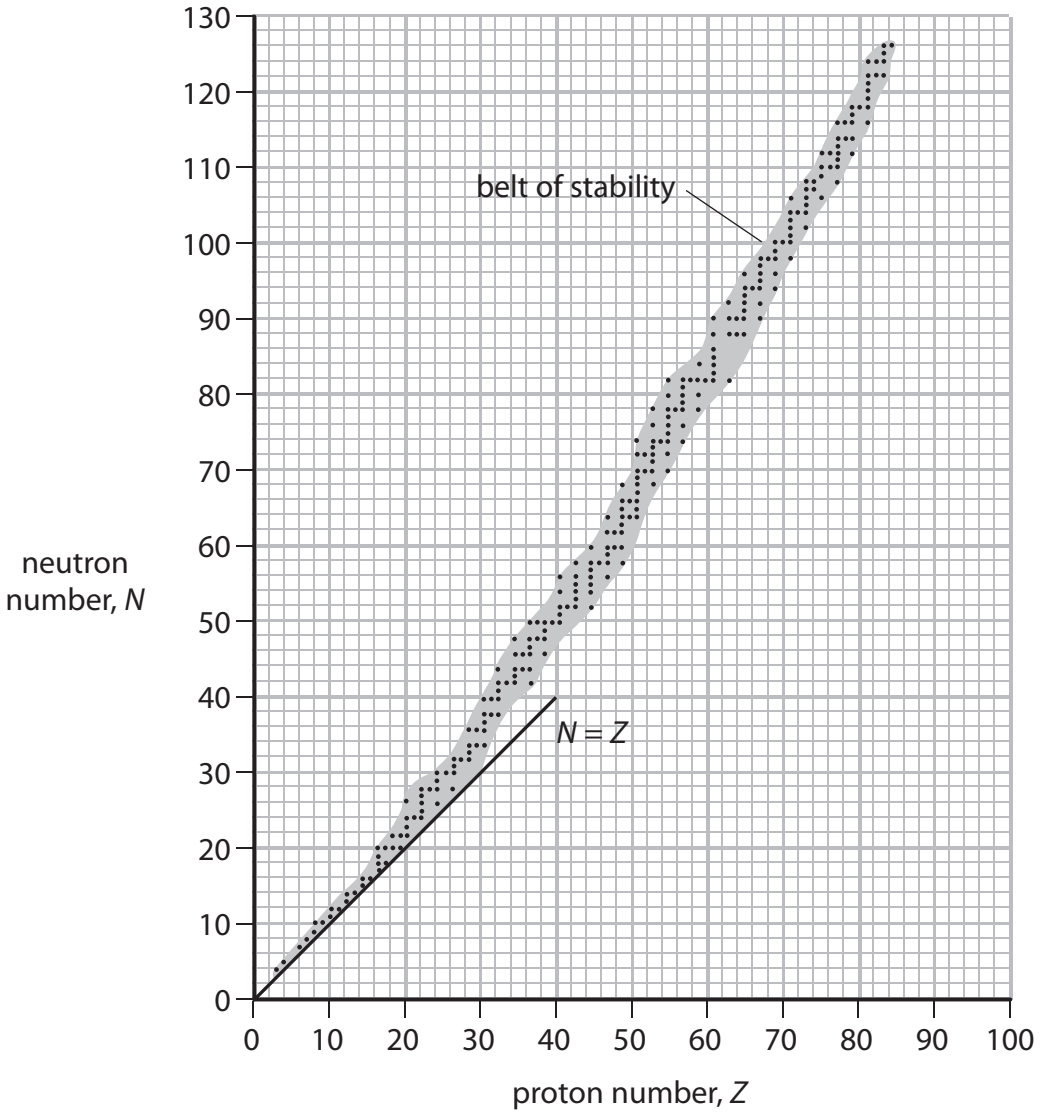
Answer ALL questions.

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

(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)

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

(d) Protons and neutrons both contain quarks.

Describe the arrangement of quarks in a proton.

(2)

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.....

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

(2)

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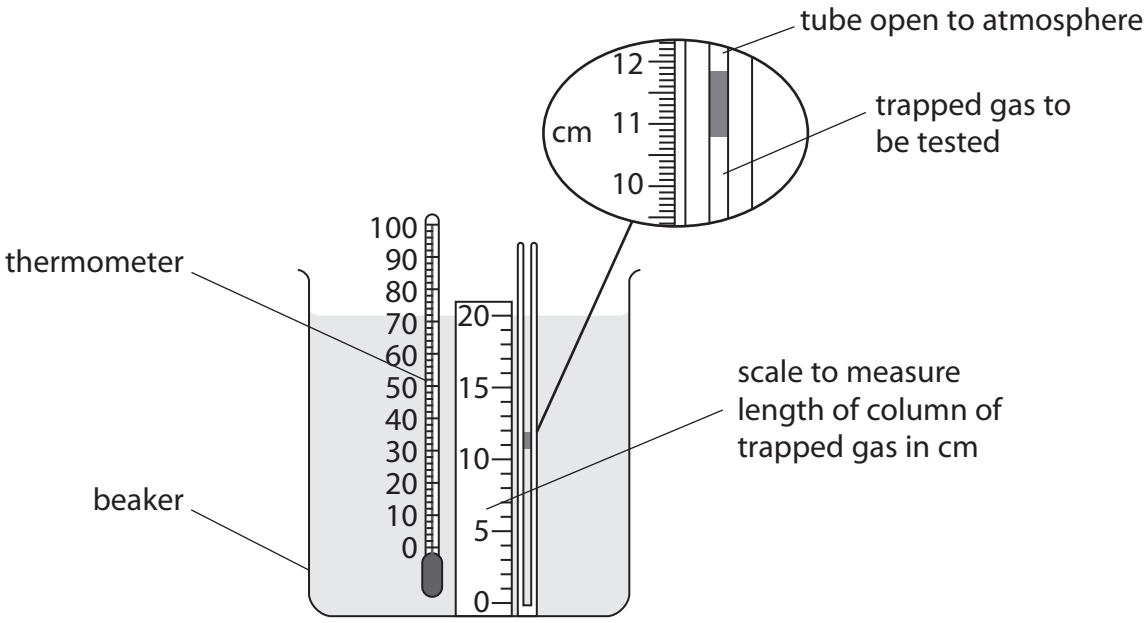
(Total for Question 1 = 8 marks)

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

(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.

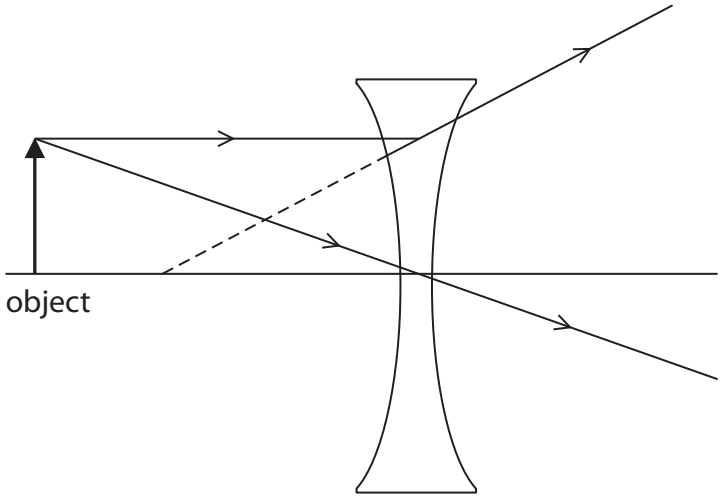
(1)

	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)

.....

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.....

.....

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

(2)

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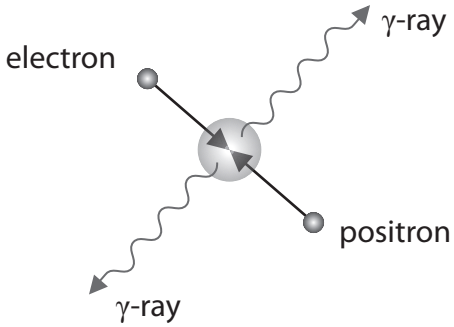
(Total for Question 4 = 10 marks)

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

(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)

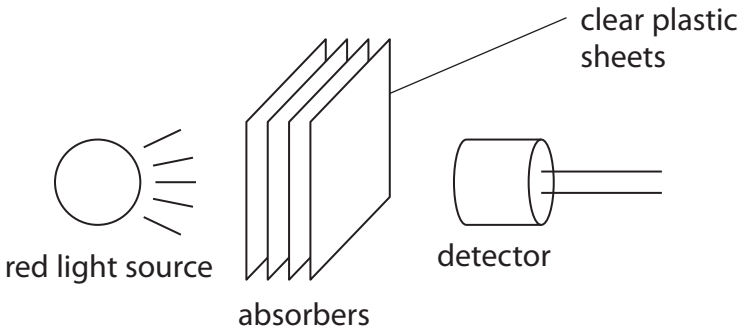
☒ **A** infrared radiation is ionising, red light is not ionising

☒ **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

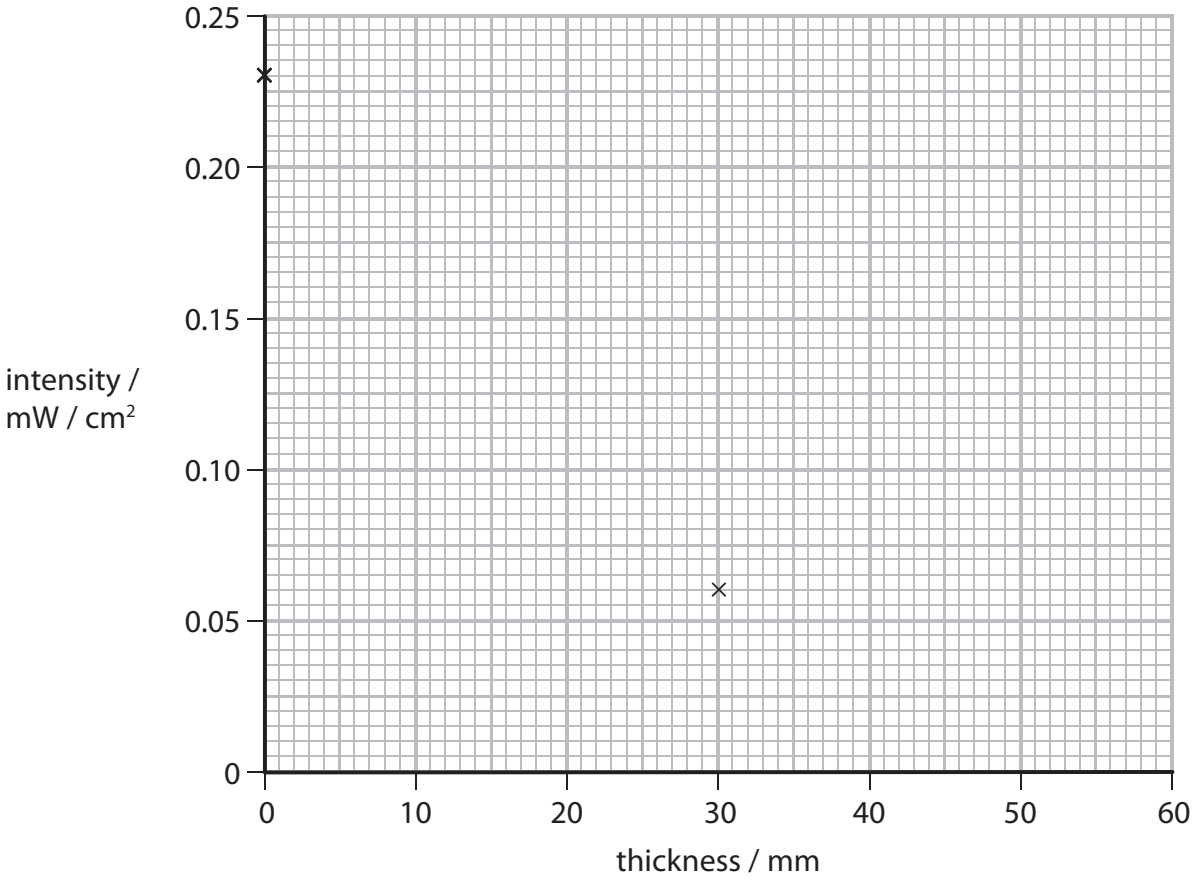
Complete the graph of intensity (*y*-axis) against thickness (*x*-axis).
Two points have been plotted.

(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)

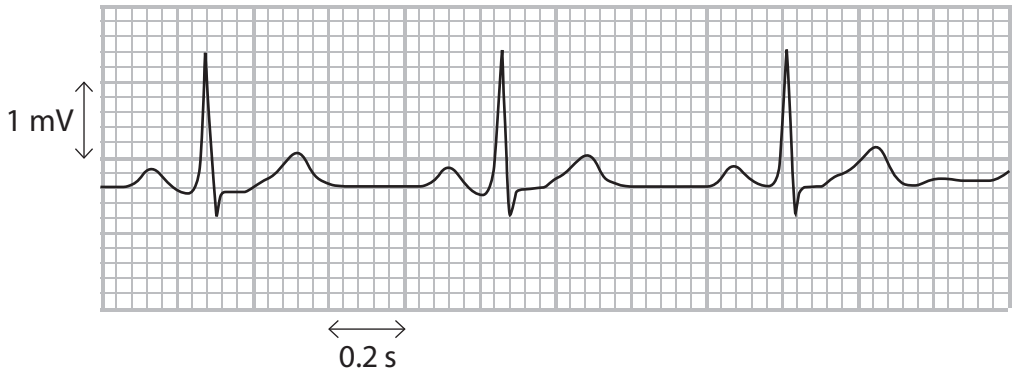
.....mW/cm²

*(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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