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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P 4 3 4 2 4 A 0 1 2 0

PEARSON

FORMULAE

You may find the following formulae useful.

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

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

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

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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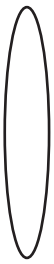
Questions begin on next page.

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 ☒.

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

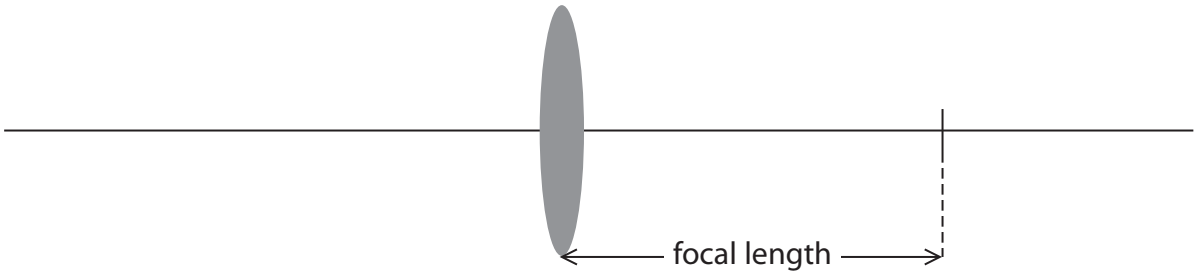
☒ **B** 8.3×10^{-1} dioptre

☒ **C** 8.3×10^{-2} dioptre

☒ **D** 8.3×10^{-3} dioptre

(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.

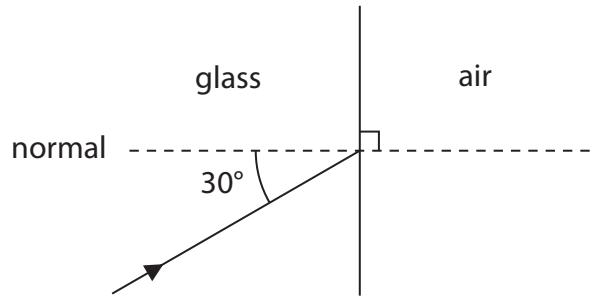
(4)

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.



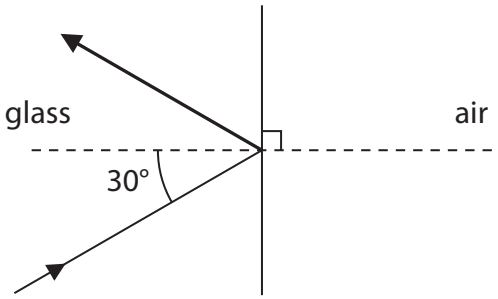
The critical angle for glass in air is 42°.

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

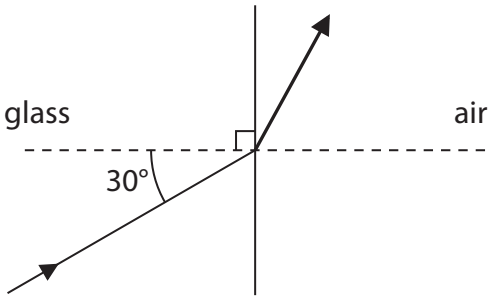
Put a cross (☒) in the box next to your answer.

(1)

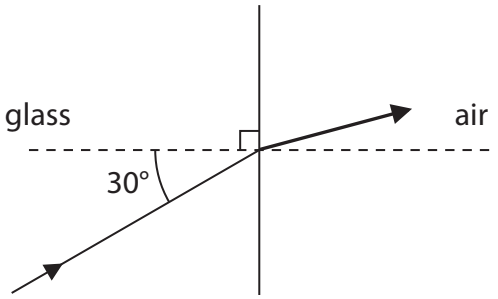
☒ **A**



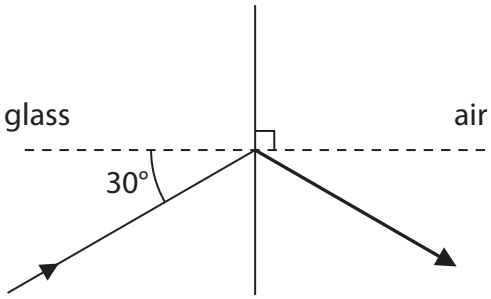
☒ **B**



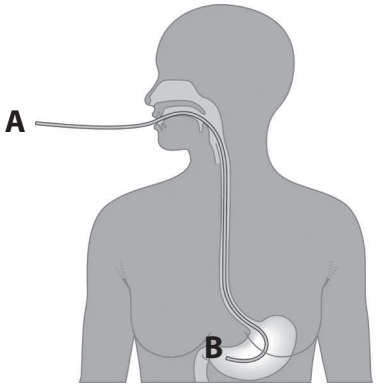
☒ **C**



☒ **D**



(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)

.....

.....

.....

.....

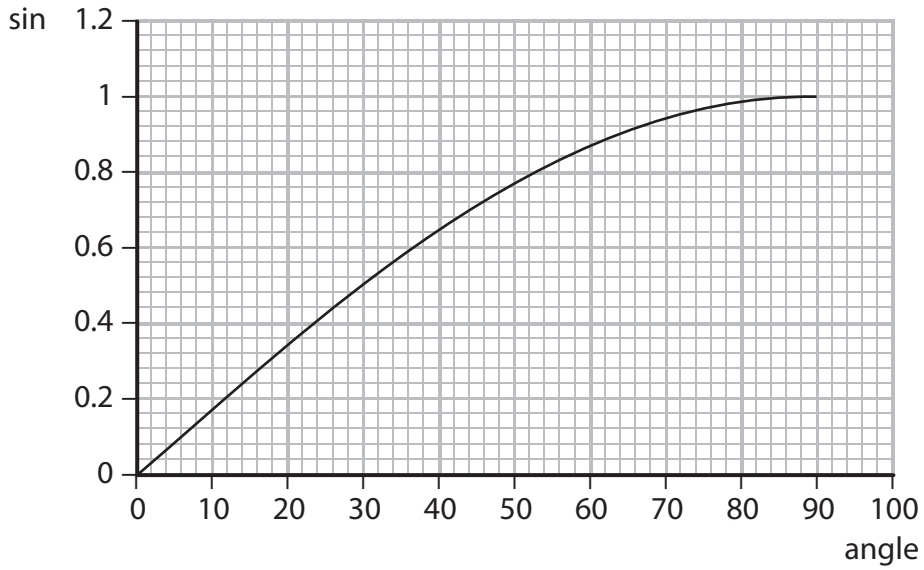
(c) The optical fibre cable in an endoscope has a refractive index of 1.70.

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)

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}

(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)

.....

.....

(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)

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

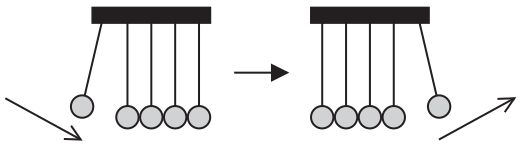
(ii) State why momentum has the unit kg.m/s.

(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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