Paper Reference(s) 8PH0/02
Pearson Edexcel Level 3 GCE

Physics

Advanced Subsidiary

Paper 2: Core Physics II

Total Marks

Friday 15 May 2020 – Morning

Time: 1 hour 30 minutes plus your additional time allowance

In the boxes below, write your name, centre number and candidate number.

Surname					
Other names					
Centre Number					
Candidate Number					

X62309A

Pearson

YOU MUST HAVE

Scientific calculator, ruler

YOU WILL BE GIVEN

Diagram Booklet

List of data, formulae and relationships Booklet

INSTRUCTIONS

Answer ALL questions in Sections A and B.

Answer the questions in the spaces provided – there may be more space than you need.

INFORMATION

The total mark for this paper is 80.

The marks for EACH question are shown in brackets – use this as a guide as to how much time to spend on each question.

In questions marked with an ASTERISK (*), marks will be awarded for your ability to structure your answer logically showing how the points that you make are related or follow on from each other where appropriate.

The list of data, formulae and relationships is provided.

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.

You are advised to show your working in calculations including units where appropriate.

SECTION A

Answer ALL questions.

All multiple choice questions must be answered with a cross in the box ☒ for the correct answer from A to D. If you change your mind about an answer, put a line through the box ~~☒~~ and then mark your new answer with a cross ☒.

1 Which of the following is a S.I. base quantity?

- ☐ **A energy**
- ☐ **B length**
- ☐ **C speed**
- ☐ **D velocity**

(TOTAL FOR QUESTION 1 = 1 MARK)

2 In a falling-ball method to investigate the viscosity of a liquid, ball bearings with two different diameters are allowed to fall through two different liquids, X and Y. The viscosity of liquid X is greater than the viscosity of liquid Y.

Look at the diagram for Question 2 in the Diagram Booklet. In which set-up, shown in this diagram, will the ball bearing have the greatest terminal velocity?

☐ A

☐ B

☐ C

☐ D

(TOTAL FOR QUESTION 2 = 1 MARK)

3 A light source radiates a power P onto a surface, covering a circular area of radius r.

Which of the following is the correct expression for the intensity I of the radiation at the surface?

☐ A $I = \frac{P}{\pi r^2}$

☐ B $I = P\pi r^2$

☐ C $I = \frac{P}{2\pi r}$

☐ D $I = 2P\pi r$

(TOTAL FOR QUESTION 3 = 1 MARK)

4 A string is held under tension. When it is plucked it vibrates with a frequency f.

Which of the following would result in a lower value for f ?

☐ **A** decreasing the cross-sectional area of the string

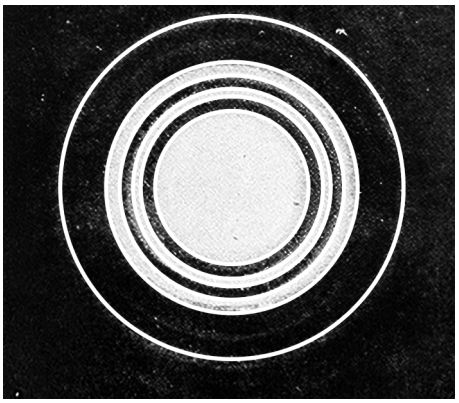
☐ **B** decreasing the density of the material of the string

☐ **C** increasing the length of the string

☐ **D** increasing the tension

(TOTAL FOR QUESTION 4 = 1 MARK)

5 The image shows a diffraction pattern observed when a beam of electrons is fired at thin gold foil.



What property of electrons does this observation demonstrate?

- ☐ **A** they exist in discrete energy levels
- ☐ **B** they have a negative charge
- ☐ **C** their small mass
- ☐ **D** their wave nature

(TOTAL FOR QUESTION 5 = 1 MARK)

6 A longitudinal wave is represented on a displacement-distance graph. A positive displacement on the graph indicates a displacement to the right.

Look at the graphs for Question 6 in the Diagram Booklet. Which shows the correct labelling of possible positions of a compression, C, and a rarefaction, R?

☐ A

☐ B

☐ C

☐ D

(TOTAL FOR QUESTION 6 = 1 MARK)

7 An electron travels at a velocity v.

Which of the following is the correct expression for the de Broglie wavelength λ of the electron?

☐ A $\lambda = \dfrac{3{\cdot}00 \times 10^{8}}{9{\cdot}11 \times 10^{-31} \times v}$

☐ B $\lambda = \dfrac{9{\cdot}11 \times 10^{-31} \times v}{3{\cdot}00 \times 10^{8}}$

☐ C $\lambda = \dfrac{6{\cdot}63 \times 10^{-34}}{9{\cdot}11 \times 10^{-31} \times v}$

☐ D $\lambda = \dfrac{9{\cdot}11 \times 10^{-31} \times v}{6{\cdot}63 \times 10^{-34}}$

(TOTAL FOR QUESTION 7 = 1 MARK)

8 In an experiment to determine the wavelength of light, three values for the wavelength are obtained and the mean value calculated.

Wavelength / nm	466	448	473
Mean wavelength / nm	462		

What is the uncertainty, in nm, in these results?

☐ A 25

☐ B 18

☐ C 14

☐ D 11

(TOTAL FOR QUESTION 8 = 1 MARK)

9 The light emitted from a laptop screen is plane polarised.

Explain how the plane of polarisation of the emitted light can be demonstrated using a polarising filter.
(3 marks)

(TOTAL FOR QUESTION 9 = 3 MARKS)

10 A student carries out an investigation to measure the Young modulus of the material of a wire. He clamps one end of the wire and passes the other end over a pulley as shown on page 5 of the diagram Booklet.

The student measures the length and diameter of the wire. He hangs masses from the free end of the wire and completes a table with values of mass and extension.

Describe how the data collected should be used to determine the Young modulus using a graphical method. Your answer should include a sketch of the expected graph. (4 marks)

(continued on the next page)

10 continued.

(TOTAL FOR QUESTION 10 = 4 MARKS)

11 Light can be modelled as a wave.

(a) Describe how light is transmitted as a transverse wave. (2 marks)

(continued on the next page)

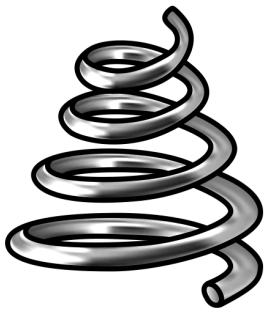
11 continued.

(b) Diffraction provides evidence for the wave nature of light.

Use Huygens' construction to describe what happens to light waves after passing through a narrow gap. (3 marks)

(TOTAL FOR QUESTION 11 = 5 MARKS)

12 **In a conical spring the diameter of the coils increases over its length. The spring can be designed so that each coil fits into the inner diameter of the next coil so they take up minimal space when fully compressed.**



A conical spring is compressed against a flat surface. Look at the graph for Question 12 in the Diagram Booklet. It shows the force-displacement graph for the spring as the compression force increases from 0 N to the point when the spring is fully compressed.

The spring obeys Hooke's law for small compression forces.

(continued on the next page)

12 continued.

(a) Determine a value for the spring constant of the spring for compression forces up to 60 N. (2 marks)

Spring constant = _____

(continued on the next page)

12 continued.

(b) The compression force is increased from 60 N to 220 N.

Determine a value for the additional energy stored in the spring due to this increase in force. (3 marks)

Additional energy = _____

(continued on the next page)

12 continued.

(c) When fully compressed all the coils lie flat inside each other.

Look at the diagram for Question 12(c) in the Diagram Booklet. It shows that the height h of the spring when unloaded is 126 mm.

Calculate the diameter d of the wire in the spring. (2 marks)

Diameter = _____

(TOTAL FOR QUESTION 12 = 7 MARKS)

13 Spacecraft in orbit will be exposed to ultraviolet radiation from the Sun. Due to the photoelectric effect they can become charged.

(a) Scientists have observed that one such spacecraft becomes charged when the frequency of the radiation is greater than $9{\cdot}9 \times 10^{14}$ Hz.

The table lists the work function of some metals.

metal	Work function eV
aluminium	4·1
caesium	2·1
nickel	5·0
platinum	3·3

Deduce the metal that covers the outside of the spacecraft. (4 marks)

(continued on the next page)

13 continued.

(continued on the next page)

13 continued.

*(b) Look at the graph for Question 13(b) in the Diagram Booklet. It shows how the intensity of ultraviolet radiation varies with height above the surface of the Earth.

An aeroplane made of the same metal as the spacecraft is flying at a height of 10 km.

Explain why the aeroplane charges at a slower rate than the spacecraft due to the photoelectric effect. (6 marks)

(continued on the next page)

13 continued.

(TOTAL FOR QUESTION 13 = 10 MARKS)

14 **In an experiment to determine the speed of sound in air, a powder is sprinkled over the base of a horizontal glass tube. One end of the tube is closed. A sound source is placed at the open end of the tube, as shown on page 9 of the Diagram Booklet.**

Soundwaves travel along the tube and reflect from the closed end.

(a) Explain why the powder forms into small piles at regular intervals along the length of the tube. (5 marks)

(continued on the next page)

14 continued.

(continued on the next page)

14 continued.

(b) When the frequency of the source is 1·8 kHz the positions of six piles and the distance they cover is 0·50 m, as shown on the diagram.

Calculate a value for the speed of sound.
(3 marks)

Speed = _____

(TOTAL FOR QUESTION 14 = 8 MARKS)

15 A magnifying glass consists of a converging lens and is used to magnify the details of an object.

A biologist is studying a flower using a magnifying glass. The anther of the flower has a width of 0·2 mm. The magnifying glass is placed 5·0 cm from the flower and an image of the anther is produced that is 3·5 mm wide.

(a) Calculate the power of the lens in the magnifying glass. (5 marks)

(continued on the next page)

15 continued.

Power of lens = _____

(continued on the next page)

15 continued.

(b) The biologist notices coloured fringes around the edges of the image. This is caused by different coloured light being refracted by different angles as it passes through the lens, as shown on page 10 of the Diagram Booklet.

The refractive index of red and blue light as the light passes from glass into air can be investigated using a 20^{o} glass prism as shown on page 10 of the Diagram Booklet.

A ray of white light is incident along the normal and passes straight into the prism. Blue and red light rays are refracted by different angles as they leave the prism. The angles of refraction are measured using a protractor, like the one shown on page 10 of the Diagram Booklet.

(continued on the next page)

15 continued.

(i) Deduce whether the measurements made using the protractor are sufficient to measure the difference in the angles of refraction between blue and red light. (3 marks)

refractive index of red light in glass = 1·509
refractive index of blue light in glass = 1·517

(continued on the next page)

15 continued.

(ii) The angle of incidence at the glass-air interface can be changed by altering the path of the light as it enters the prism. The angle of incidence of the red light at the glass-air interface is changed to 35^{o}.

Deduce whether the red light will still be refracted at the glass-air boundary. (3 marks)

(TOTAL FOR QUESTION 15 = 11 MARKS)

TOTAL FOR SECTION A = 56 MARKS

SECTION B

Answer ALL questions.

16 Read the passage and answer the questions that follow.

Atoms can be promoted into an excited state when they absorb energy. This results in the release of radiation at a random time. When several atoms are close together a quantum effect can occur. When one atom emits radiation this affects all the other nearby excited atoms. The excess energy of many of the atoms is released simultaneously and an intense flash of light is produced. This effect is called superradiance and can be used to produce lasers that emit a narrower range of frequencies than conventional lasers.

(a) When superradiance occurs the atoms all absorb the same amount of energy.

Explain how this results in all the atoms emitting radiation of a particular frequency. (5 marks)

(continued on the next page)

16 continued.

(continued on the next page)

16 continued.

(continued on the next page)

16 continued.

(b) Superradiance occurs when the distance between atoms is less than the wavelength of the emitted radiation.

An atom is in the ground state. The atom absorbs 6·2 eV of energy. The distance between neighbouring atoms is 140 nm.

Deduce whether superradiance can occur.
(3 marks)

(continued on the next page)

16 continued.

(c) Superradiant lasers are highly monochromatic.

Explain why a monochromatic light source is important in diffraction experiments. (3 marks)

(TOTAL FOR QUESTION 16 = 11 MARKS)

17 Weather stations monitor the position of storm clouds.

(a) A microwave pulse is emitted from a transducer at a weather station. The pulse reflects from a storm cloud and is detected at the same transducer 340 μs later.

Calculate the distance between the storm cloud and the weather station. (3 marks)

Distance = _____

(continued on the next page)

17 continued.

(b) The movement of a storm cloud is monitored by two weather stations. The components of the velocity of the storm cloud towards each weather station are shown on page 11 of the Diagram Booklet.

Determine the velocity of the storm cloud.
(4 marks)

(continued on the next page)

17 continued.

_____

_____

Magnitude of velocity = _____

Direction of velocity = _____

(continued on the next page)

17 continued.

(c) (i) A raindrop is falling vertically through the air.

On page 12 of the Diagram Booklet, the free-body force diagram shows the forces acting on the raindrop.

The raindrop is travelling at terminal velocity. The raindrop is spherical with a radius of $0{\cdot}10\,\text{mm}$ and a weight of $4{\cdot}1 \times 10^{-8}\,\text{N}$.

Calculate the magnitude of the terminal velocity. (4 marks)

viscosity of air = $1{\cdot}3 \times 10^{-5}\,\text{Pa s}$

density of air = $1{\cdot}2\,\text{kg m}^{-3}$

(continued on the next page)

17 continued.

Magnitude of terminal velocity = _____

(continued on the next page)

17 continued.

(ii) The value of terminal velocity calculated using the data in (c)(i) is greater than the actual terminal velocity of the raindrop.

Explain why the calculation in (c)(i) may not be valid. (2 marks)

(TOTAL FOR QUESTION 17 = 13 MARKS)

TOTAL FOR SECTION B = 24 MARKS

TOTAL FOR PAPER = 80 MARKS

END

Question 5
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Question 12
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