Please check the examination details below before entering your candidate information

Candidate surname	Other names

Pearson Edexcel Level 3 GCE

Centre Number

Candidate Number

Friday 15 May 2020

Morning (Time: 1 hour 30 minutes)

Paper Reference **8PH0/02**

Physics

Advanced Subsidiary
Paper 2: Core Physics II

You must have:
Scientific 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 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 printed at the end of this booklet.

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.

Turn over ▶

Pearson

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

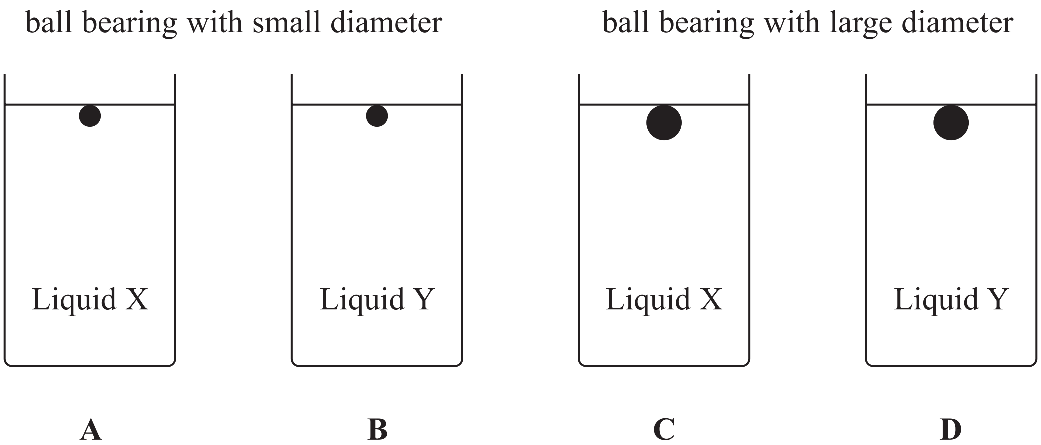
☒ **C** speed

☒ **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.

In which set-up shown below 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** $I = \dfrac{P}{\pi r^2}$

☒ **B** $I = P\pi r^2$

☒ **C** $I = \dfrac{P}{2\pi r}$

☒ **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

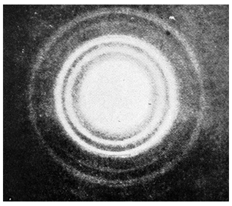
☒ **B** decreasing the density of the material of the string

☒ **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.



(Source: © The Reading Room/Alamy Stock Photo)

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

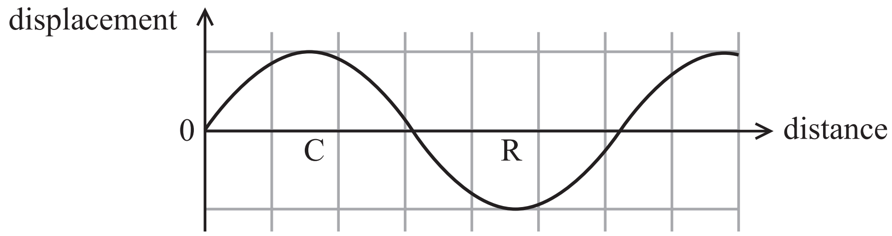
☒ **D** their wave nature

(Total for Question 5 = 1 mark)

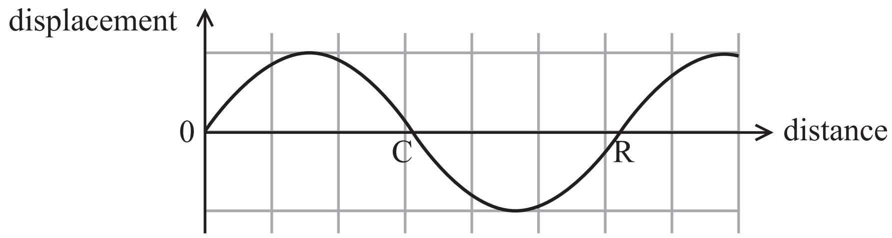
6 A longitudinal wave is represented on a displacement-distance graph. A positive displacement on the graph indicates a displacement to the right.

Which graph shows the correct labelling of possible positions of a compression, C, and a rarefaction, R?

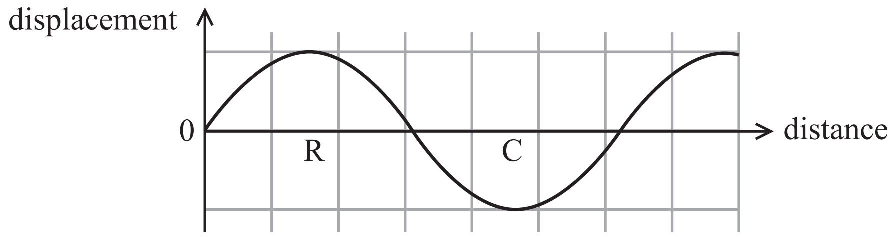
A



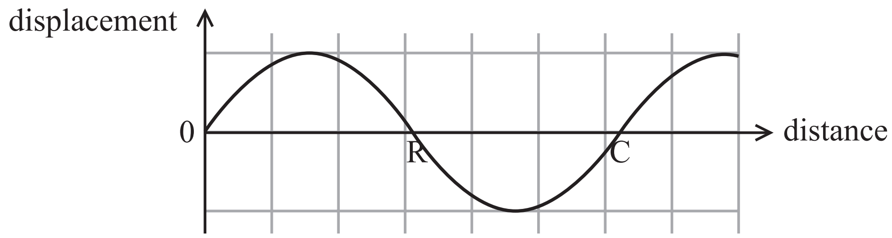
B



C



D



☒ **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** $\lambda = \dfrac{3.00 \times 10^{8}}{9.11 \times 10^{-31} \times v}$

☒ **B** $\lambda = \dfrac{9.11 \times 10^{-31} \times v}{3.00 \times 10^{8}}$

☒ **C** $\lambda = \dfrac{6.63 \times 10^{-34}}{9.11 \times 10^{-31} \times v}$

☒ **D** $\lambda = \dfrac{9.11 \times 10^{-31} \times v}{6.63 \times 10^{-34}}$

(Total for Question 7 = 1 mark)

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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)

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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.

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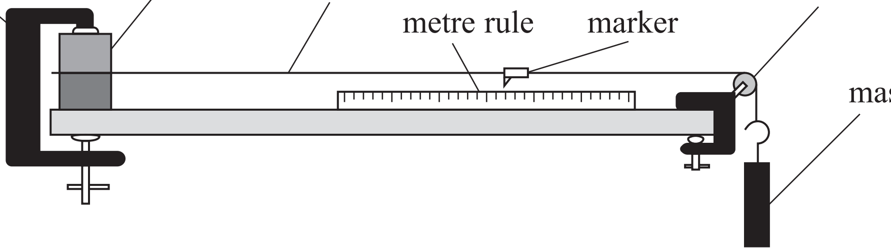
(Total for Question 9 = 3 marks)

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.



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)

(Total for Question 10 = 4 marks)

11 Light can be modelled as a wave.

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

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(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.

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(Total for Question 11 = 5 marks)

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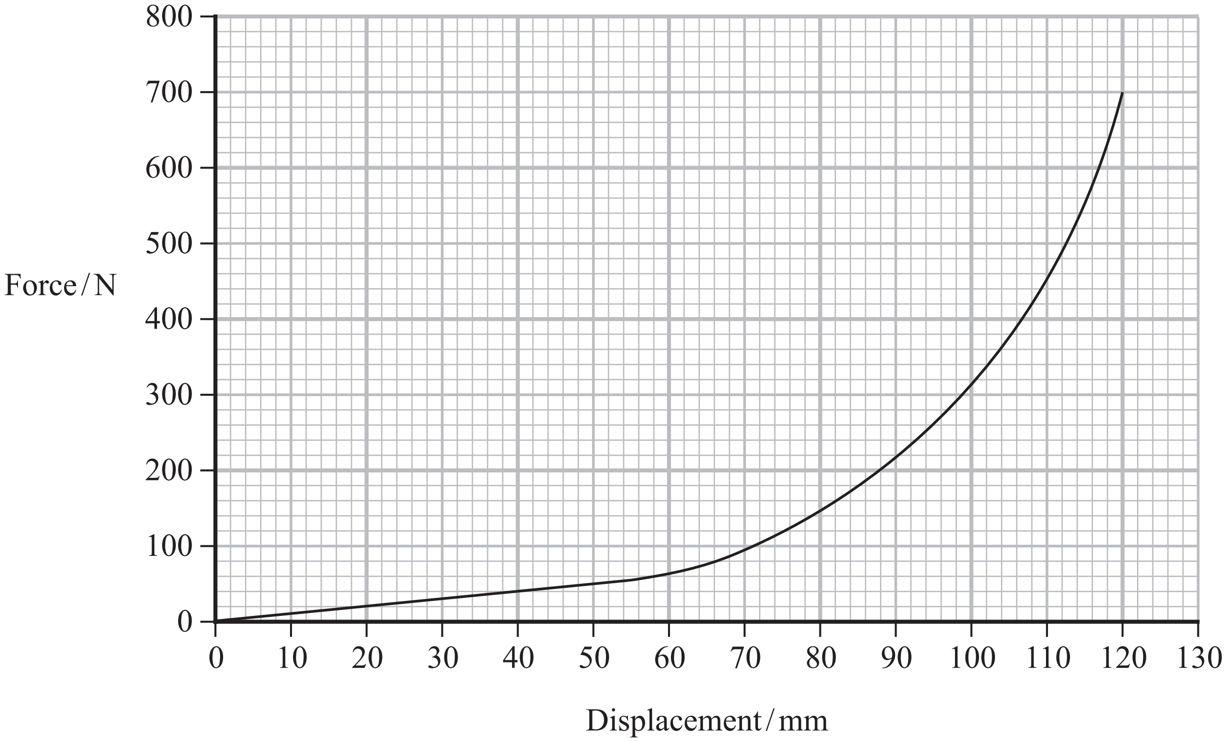
12 In a conical spring the diameter of the coils increases over its length. The spring can be designed so that each coil fits into the inner diameter of the next coil so they take up minimal space when fully compressed.

(Source: © Anatolii Riabokon/Alamy Stock Vector)

A conical spring is compressed against a flat surface. The graph 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.

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

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Spring constant = ...

(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.

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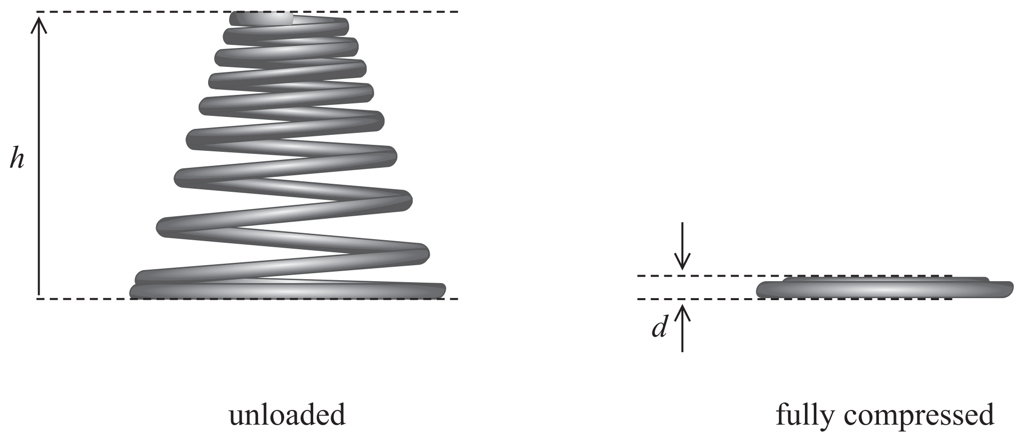
Additional energy = ...

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



The height h of the spring when unloaded is 126 mm.

Calculate the diameter d of the wire in the spring.

(2)

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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 9.9×10^{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)

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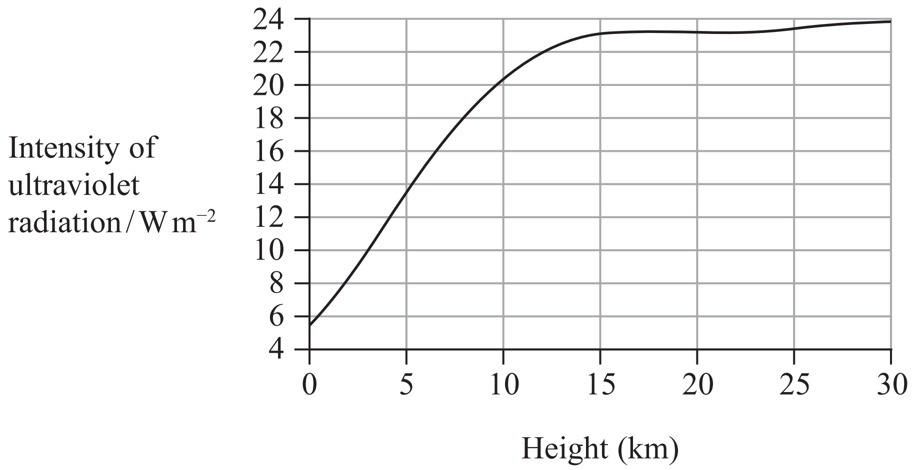
*(b) The graph shows how the intensity of ultraviolet radiation varies with height above the surface of the Earth.



(Source: semanticscholar.org)

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.

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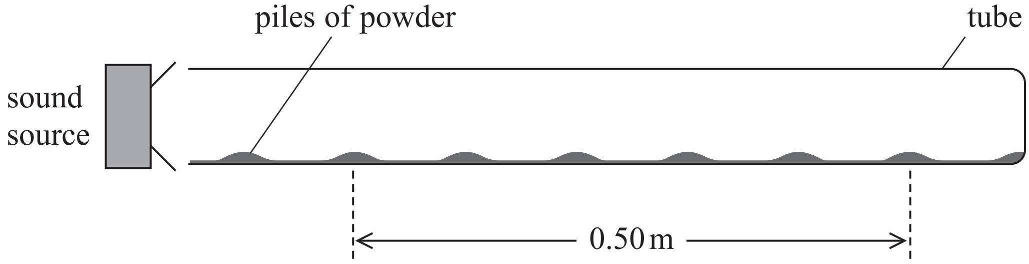
(Total for Question 13 = 10 marks)

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.



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.

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(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.

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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.

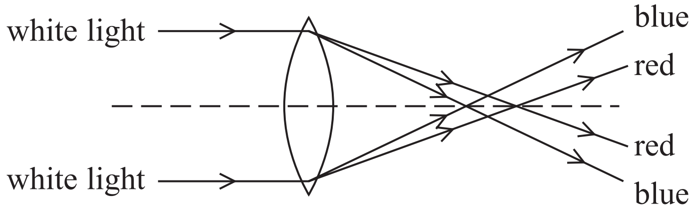
A biologist is studying a flower using a magnifying glass. The anther of the flower has a width of 0.2 mm. The magnifying glass is placed 5.0 cm from the flower and an image of the anther is produced that is 3.5 mm wide.

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

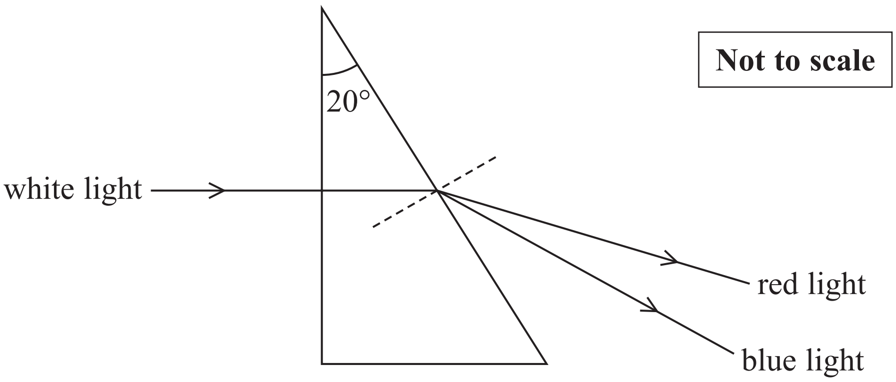
(5)

Power of lens = ...

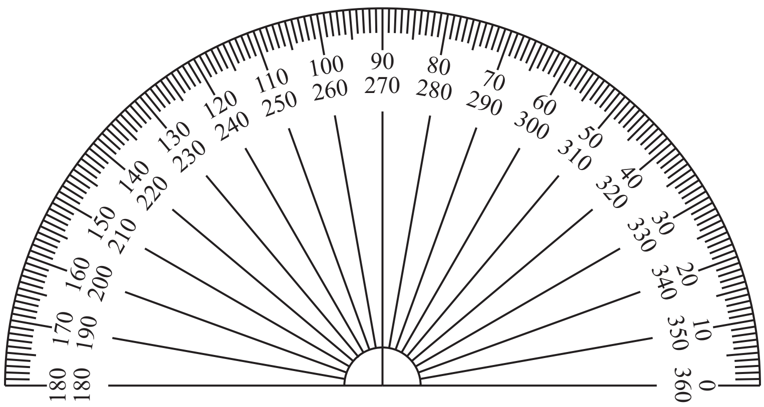
(b) The biologist notices coloured fringes around the edges of the image. This is caused by different coloured light being refracted by different angles as it passes through the lens.



The refractive index of red and blue light as the light passes from glass into air can be investigated using a 20° glass prism.



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.



(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.

refractive index of red light in glass = 1.509
refractive index of blue light in glass = 1.517

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(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°.

Deduce whether the red light will still be refracted at the glass-air boundary.

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(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)

(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)

(c) Superradiant lasers are highly monochromatic.

Explain why a monochromatic light source is important in diffraction experiments.

(3)

(Total for Question 16 = 11 marks)

17 Weather stations monitor the position of storm clouds.

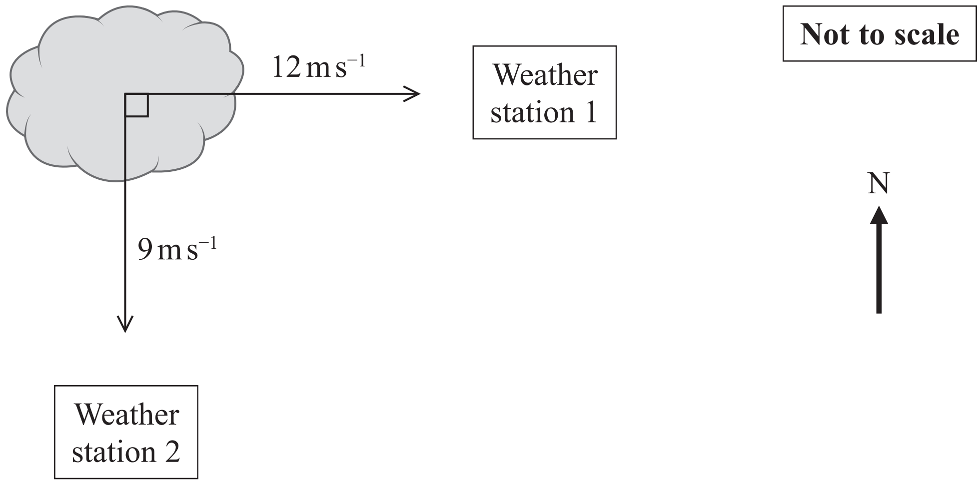
(a) A microwave pulse is emitted from a transducer at a weather station. The pulse reflects from a storm cloud and is detected at the same transducer 340 μs later.

Calculate the distance between the storm cloud and the weather station.

(3)

Distance = ...

(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 in the diagram.



Determine the velocity of the storm cloud.

(4)

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Magnitude of velocity = ...

Direction of velocity = ...

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

The free-body force diagram shows the forces acting on the raindrop.

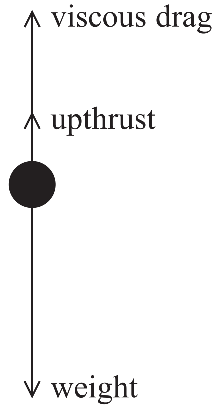

Diagram **NOT** drawn to scale

The raindrop is travelling at terminal velocity. The raindrop is spherical with a radius of 0.10 mm and a weight of 4.1×10^{-8} N.

Calculate the magnitude of the terminal velocity.

viscosity of air = 1.3×10^{-5} Pa s
density of air = $1.2\,\text{kg}\,\text{m}^{-3}$

(4)

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Magnitude of terminal velocity = ...

(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)

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(Total for Question 17 = 13 marks)

TOTAL FOR SECTION B = 24 MARKS
TOTAL FOR PAPER = 80 MARKS

List of data, formulae and relationships

Acceleration of free fall	$g = 9.81\ \text{m s}^{-2}$	(close to Earth's surface)
Electron charge	$e = -1.60 \times 10^{-19}\ \text{C}$	
Electron mass	$m_e = 9.11 \times 10^{-31}\ \text{kg}$	
Electronvolt	$1\ \text{eV} = 1.60 \times 10^{-19}\ \text{J}$	
Gravitational field strength	$g = 9.81\ \text{N kg}^{-1}$	(close to Earth's surface)
Planck constant	$h = 6.63 \times 10^{-34}\ \text{J s}$	
Speed of light in a vacuum	$c = 3.00 \times 10^{8}\ \text{m s}^{-1}$	

Mechanics

Kinematic equations of motion

$$s = \frac{(u+v)t}{2}$$

$$v = u + at$$

$$s = ut + \tfrac{1}{2}at^2$$

$$v^2 = u^2 + 2as$$

Forces

$$\Sigma F = ma$$

$$g = \frac{F}{m}$$

$$W = mg$$

$$\textit{moment of force} = Fx$$

Momentum

$$p = mv$$

Work, energy and power

$$\Delta W = F\Delta s$$

$$E_k = \tfrac{1}{2}mv^2$$

$$\Delta E_{grav} = mg\Delta h$$

$$P = \frac{E}{t}$$

$$P = \frac{W}{t}$$

$$\text{efficiency} = \frac{\text{useful energy output}}{\text{total energy input}}$$

$$\text{efficiency} = \frac{\text{useful power output}}{\text{total power input}}$$

Electricity

Potential difference

$$V = \frac{W}{Q}$$

Resistance

$$R = \frac{V}{I}$$

Electrical power and energy

$$P = VI$$

$$P = I^2R$$

$$P = \frac{V^2}{R}$$

$$W = VIt$$

Resistivity

$$R = \frac{\rho l}{A}$$

Current

$$I = \frac{\Delta Q}{\Delta t}$$

$$I = nqvA$$

Materials

Density

$\rho = \frac{m}{V}$

Stokes' law

$F = 6\pi\eta rv$

Hooke's law

$\Delta F = k\Delta x$

Young modulus

Stress $\sigma = \frac{F}{A}$

Strain $\varepsilon = \frac{\Delta x}{x}$

$E = \frac{\sigma}{\varepsilon}$

Elastic strain energy

$\Delta E_{el} = \frac{1}{2} F\Delta x$

Waves and Particle Nature of Light

Wave speed

$v = f\lambda$

Speed of a transverse wave on a string

$v = \sqrt{\frac{T}{\mu}}$

Intensity of radiation

$I = \frac{P}{A}$

Power of a lens

$P = \frac{1}{f}$

$P = P_1 + P_2 + P_3 + \ldots$

Thin lens equation

$\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$

Magnification for a lens

$m = \frac{\text{image height}}{\text{object height}} = \frac{v}{u}$

Diffraction grating

$n\lambda = d \sin \theta$

Refractive index

$n_1 \sin \theta_1 = n_2 \sin \theta_2$

$n = \frac{c}{v}$

Critical angle

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

Photon model

$E = hf$

Einstein's photoelectric equation

$hf = \phi + ½mv^2_{max}$

de Broglie wavelength

$\lambda = \frac{h}{p}$

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