Write your name here

Surname	Other names

Pearson Edexcel Level 3 GCE

Centre Number | Candidate Number

Physics

Advanced Subsidiary
Paper 2: Core Physics II

Thursday 9 June 2016 – Afternoon
Time: 1 hour 30 minutes

Paper Reference
8PH0/02

You may need a 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.*
- You may use a scientific calculator.
- 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.

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 ▶

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P 4 9 8 4 8 A 0 1 2 4

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 statement about sound is correct?

☒ **A** Sound can travel through a solid.

☒ **B** Sound can travel through a vacuum.

☒ **C** Sound waves can travel as polarised waves.

☒ **D** Sound waves travel in a direction perpendicular to the direction of the oscillations.

(Total for Question 1 = 1 mark)

2 Which of the following is a correct unit for intensity of light?

☒ **A** Jm^{-2}

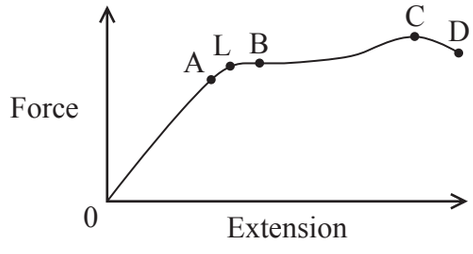
☒ **B** Ws^{-2}

☒ **C** Wm^{-2}

☒ **D** Js^{-2}

(Total for Question 2 = 1 mark)

3 The diagram shows a force-extension graph for a wire.



L is the elastic limit.

Which point represents the yield point?

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(Total for Question 3 = 1 mark)

4 A bubble of air is rising through a vertical column of water.

Which statement, about the motion of the bubble, is correct to a good approximation?

☒ **A** The bubble has a constant velocity because its weight equals the viscous drag.

☒ **B** The bubble has a constant velocity because the upthrust is equal to the viscous drag.

☒ **C** The bubble has an acceleration because its weight is greater than the upthrust.

☒ **D** The bubble has an acceleration because the viscous drag is greater than the upthrust.

(Total for Question 4 = 1 mark)

5 In an experiment a student is taking a measurement of a time interval in seconds.

He repeats the measurement and collects the following three readings:

3.2 s 3.2 s 3.3 s

Which one of the following is a correct statement?

☒ **A** The reading of 3.3 s is an error.

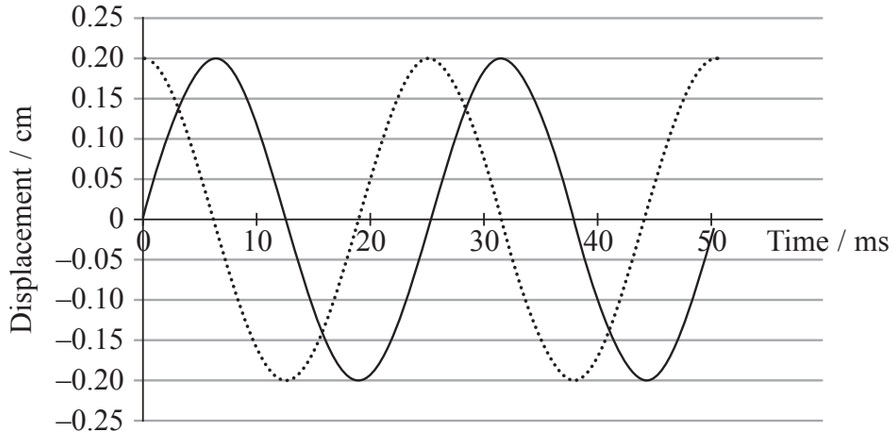
☒ **B** The average should be recorded as 3.23 s.

☒ **C** The uncertainty is 0.1 s.

☒ **D** The error is 0.1 s.

(Total for Question 5 = 1 mark)

6 The graph shows the variation of displacement with time for two waves.



What is the phase difference between these two waves?

☒ **A** 6 ms

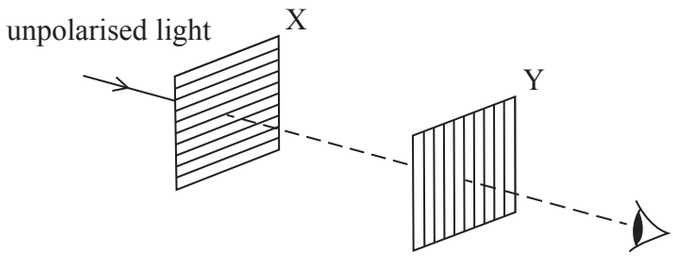
☒ **B** 0.20 cm

☒ **C** π radians

☒ **D** 90 degrees

(Total for Question 6 = 1 mark)

7 A source of unpolarised light is viewed through two crossed polarising filters X and Y.



Which row in the table correctly describes the light emerging from the two filters?

	Light emerging from filter X	Light emerging from filter Y
☒ **A**	oscillates in every direction	oscillates in one direction
☒ **B**	oscillates in every direction	no light
☒ **C**	oscillates in one direction	oscillates in one direction
☒ **D**	oscillates in one direction	no light

(Total for Question 7 = 1 mark)

8 Sound waves are produced by a vibrating guitar string.

Which row in the table correctly describes the waves produced?

	Guitar string	Sound
☒ **A**	transverse	transverse
☒ **B**	longitudinal	longitudinal
☒ **C**	longitudinal	transverse
☒ **D**	transverse	longitudinal

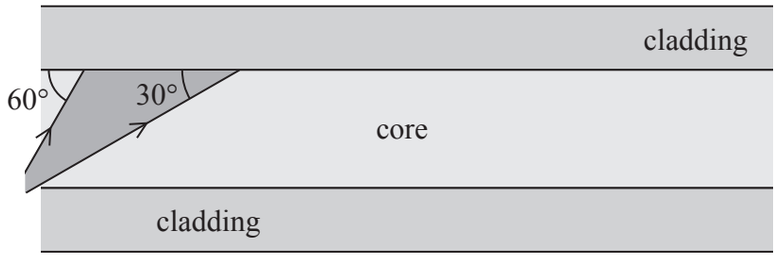
(Total for Question 8 = 1 mark)

9 A simple optical fibre consists of a core surrounded by cladding. The refractive index of the core is 1.56 and the refractive index of the cladding is 1.20.

(a) Show that the critical angle for light between these two media is about 50°.

(3)

(b) The diagram shows a diverging beam of light incident on the boundary between the core and the cladding. One side of the beam strikes the boundary at 60° and the other side at 30° as shown.



Three students each suggest a different outcome for the beam of light at the boundary.

Student A says "all the beam will totally internally reflect".

Student B says "all the beam will refract".

Student C says "some of the beam will totally internally reflect and some will refract".

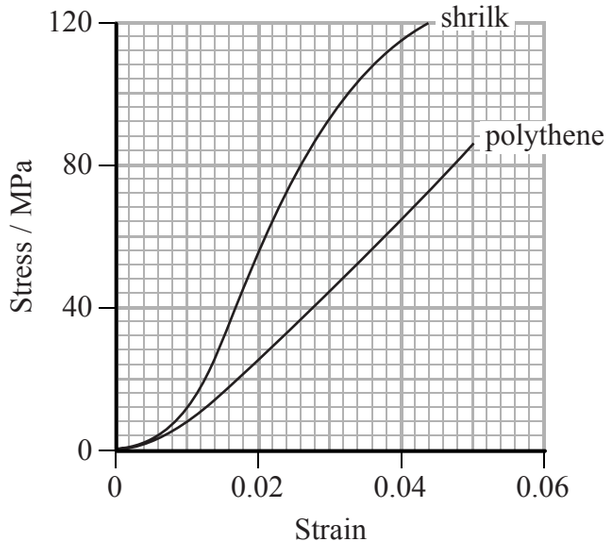
State which student is correct, adding to the diagram to illustrate your answer.

(3)

(Total for Question 9 = 6 marks)

10 Shrilk is a new material made from discarded shrimp shells. It is biodegradable and is easily moulded into different shapes. Shrilk is an alternative to polythene and could be used to make waste bags in the future.

The graph shows a stress-strain curve for a 25.0 cm length of shrilk and for a similar length of polythene, up to breaking point.



(a) (i) Calculate the force applied to the shrilk at a strain of 0.02

cross-sectional area = 1.2×10^{-6} m^2

(3)

Force = ...

(ii) Determine the extension of the shrilk at a strain of 0.04

(2)

Extension = ...

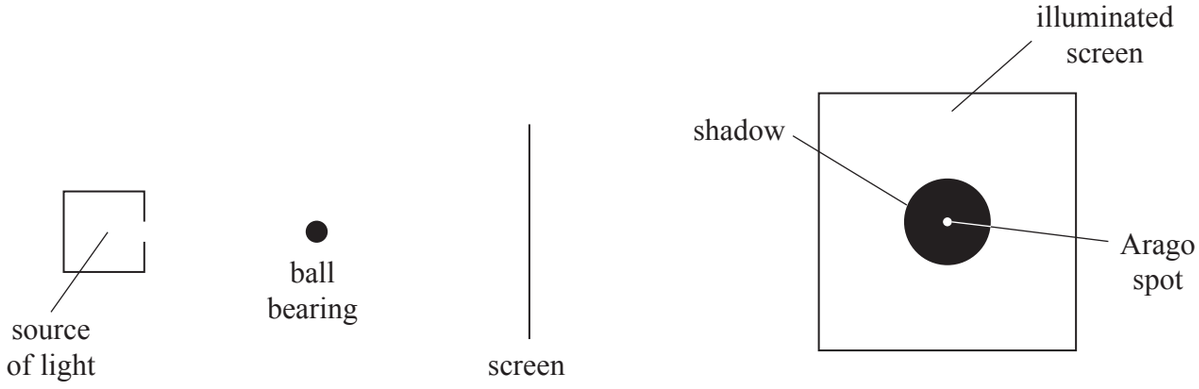
(b) Deduce whether shrilk or polythene is better for making waste bags.

(3)

(Total for Question 10 = 8 marks)

11 The diagram shows a coherent beam of light incident on a metal ball bearing.

A dark shadow is seen on a screen behind the ball bearing. There is a small spot of light in the centre of the shadow. This spot of light is known as the Arago spot.



Experimental set-up

Appearance on screen

(a) Use Huygens' construction to explain the behaviour of light as it travels past the edge of the ball bearing.

(2)

(b) Explain why a spot of light is produced at the centre of the shadow.

(3)

(c) François Arago first demonstrated this experiment in 1818 for a group of eminent scientists, to show the behaviour of light.

State the model for the behaviour of light that this experiment demonstrated and explain why the scientific community accepted this model.

(3)

(d) The ball bearing shown in the experimental set-up has a diameter of about 1 cm.

Describe how the diameter could be measured accurately.

(2)

(Total for Question 11 = 10 marks)

12 A student carries out an experiment using a guitar string. She investigates the effect of varying the tension in the guitar string on the frequency of sound produced when the string is plucked.

(a) Describe a method of varying and measuring the tension in the string.

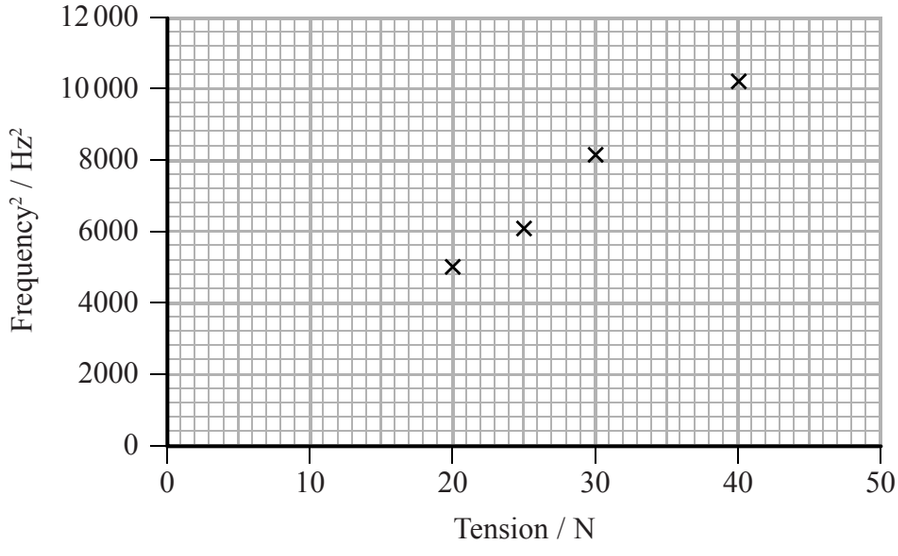
(2)

(b) The student records the following data and plots a graph.

Tension / N	20	25	30	35	40
Frequency / Hz	70	78	90	95	101
Frequency^2 / Hz^2	4900	6084	8100		10 201

Complete the table and graph.

(3)



(c) The student reads that guitar strings have a mass per unit length of between 0.4×10^{-3} kg m^{-1} and 7×10^{-3} kg m^{-1}.

Determine whether the guitar string used in this experiment lies within this range.

length of string vibrating = 0.40 m

(5)

(Total for Question 12 = 10 marks)

13 An electron beam is directed onto crystalline graphite. A fluorescent screen on the other side of the crystal shows the pattern in Figure 1. The brighter areas correspond to higher electron intensity.

The speed of the electrons is increased and the resulting pattern is shown in Figure 2.

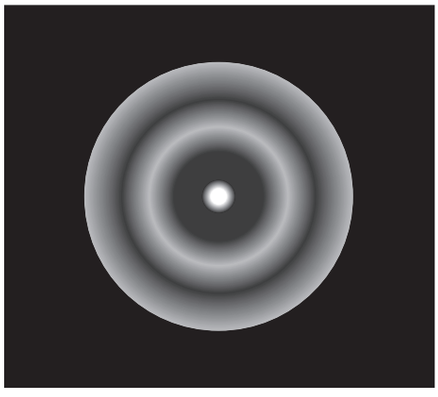


Figure 1

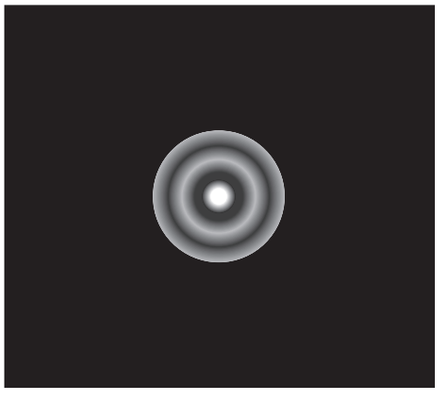
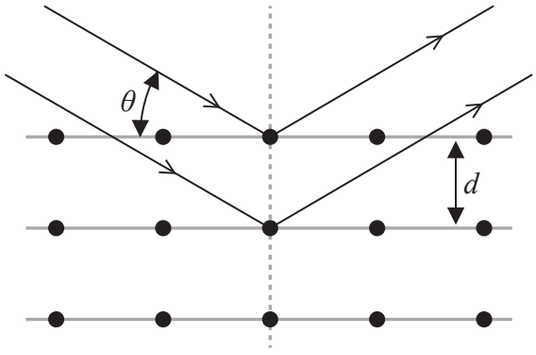


Figure 2

*(a) Discuss the conclusions that can be drawn from this information about the behaviour of electrons and the structure of graphite.

(6)

(b) An electron beam can be used to explore the structure of solid materials. The diagram shows an electron beam reflected by the top two layers of atoms within a material. The two layers are separated by a distance d.



(i) Show that the extra distance travelled by the electron beam reflecting off the second layer of atoms is given by $2d\sin\theta$.

θ is the angle between the beam and each layer of atoms.

You may add to the diagram.

(2)

.....

.....

.....

.....

(ii) Give one reason why there is more than one ring shown in both Figure 1 and Figure 2.

(1)

.....

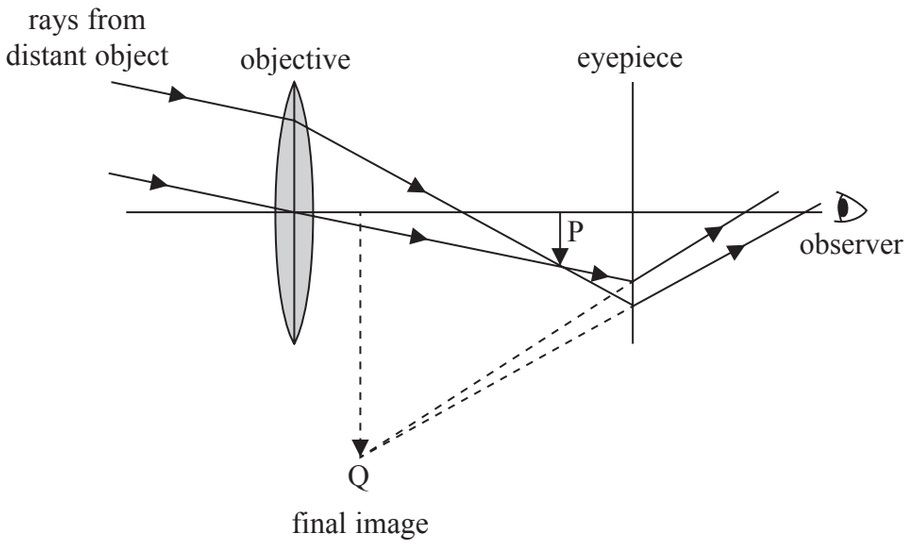
.....

.....

.....

(Total for Question 13 = 9 marks)

14 A telescope consists of a convex lens (objective) of power 0.820 D and a second lens (eyepiece) as shown.



The objective produces an image at P. This image becomes the object of the eyepiece, which produces a final image at Q.

(a) Show that the focal length of the objective lens is about 1200 mm.

(2)

(b) Telescopes can be used to observe distant objects such as the Moon.

(i) Explain why the image of the Moon produced at P by the objective lens will be at a distance of about 1200 mm from this lens.

(2)

(ii) State the properties of the image at P.

(2)

(c) The eyepiece is at a distance of 100 mm from the image at P. To give a reasonable magnification, the final image at Q should be a virtual image at a distance of 300 mm from the eyepiece.

The following lenses are available:

diverging lens focal length 150 mm,
converging lens focal length 150 mm,
diverging lens focal length 100 mm,
converging lens focal length 100 mm.

Deduce which lens should be used for the eyepiece.

(3)

(Total for Question 14 = 9 marks)

TOTAL FOR SECTION A = 60 MARKS

SECTION B

Answer ALL questions.

15 Read the following extract and then answer the questions that follow.

Powdery dust, the by-product of fearsome meteor storms that pounded the Moon, coats much of the lunar surface. A build-up of this dust could damage sensitive machinery.

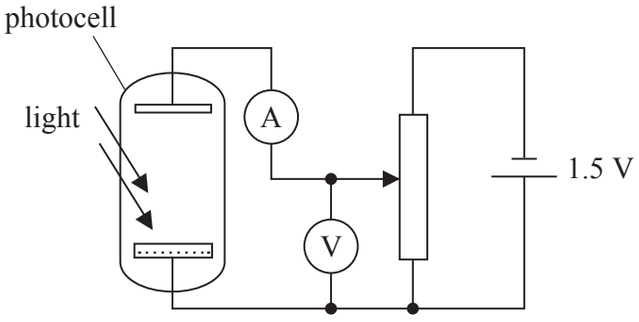
Scientists theorise that lunar dust must be electrostatically charged by ultraviolet solar radiation from the Sun. When ultraviolet radiation hits the Moon's "day side", the half that faces the Sun, it knocks electrons out of atoms in the lunar soil.

(a) Describe the particle model of ultraviolet radiation that explains how it can "knock electrons out of atoms".

(3)

(b) A teacher uses the arrangement below to demonstrate that electrons can be knocked out of a metal surface in a photocell by visible light.

The arrangement can also be used to measure the maximum kinetic energy of these electrons.



(i) Explain how the potential divider circuit can produce a range of values from 0 to 1.5 V on the voltmeter.

(3)

(ii) The potential difference on the voltmeter is increased until the ammeter reading is zero.
The voltmeter reads 0.6 V at this instant.
State the maximum kinetic energy of the electrons in eV.

(1)

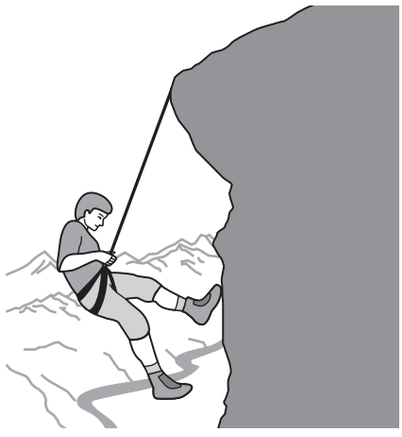
Maximum kinetic energy = ... eV

(c) Discuss whether the photocell arrangement in part (b) gives a valid demonstration of how dust particles become charged on the Moon.

(4)

(Total for Question 15 = 11 marks)

16 The diagram shows a rock climber of mass 55 kg. She is hanging on a rope with one foot in contact with a rock face. She uses this foot to push herself horizontally away from the rock face. The rope is inclined at 20° to the vertical.



(a) Complete the free-body force diagram below to represent the forces acting on the climber.

(3)

(b) (i) Show that the tension in the rope is about 600 N.

(3)

(ii) The rope extends by 2.5 cm when used as shown.

Calculate the energy stored within the rope.

(2)

.....

.....

.....

.....

Energy stored = ...

(iii) State one assumption made in this calculation.

(1)

.....

.....

(Total for Question 16 = 9 marks)

TOTAL FOR SECTION B = 20 MARKS
TOTAL FOR PAPER = 80 MARKS

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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

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

$v = u + at$

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

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

Forces

$\Sigma F = ma$

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

$W = mg$

$moment\ of\ force = Fx$

Momentum

$p = mv$

Work, energy and power

$\Delta W = F\Delta s$

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

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

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

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

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

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

Electric circuits

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

$F = 6\pi\eta r v$

Hooke's law

$F = k\Delta x$

Pressure

$$p = \frac{F}{A}$$

Young modulus

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

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

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

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

$hf = \phi + \frac{1}{2} m v_{max}^2$

de Broglie wavelength

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

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