Pearson Edexcel

Additional Assessment Materials

Summer 2021

Pearson Edexcel GCE AS Physics

Topic 5: Optics and Waves

Test 1

(Public release version)

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Additional Assessment Materials, Summer 2021

General guidance to Additional Assessment Materials for use in 2021

Context

- Additional Assessment Materials are being produced for GCSE, AS and A levels (with the exception of Art and Design).
- The Additional Assessment Materials presented in this booklet are an **optional** part of the range of evidence teachers may use when deciding on a candidate's grade.
- 2021 Additional Assessment Materials have been drawn from previous examination materials, namely past papers.
- Additional Assessment Materials have come from past papers both published (those materials available publicly) and unpublished (those currently under padlock to our centres) presented in a different format to allow teachers to adapt them for use with candidate.

Purpose

- The purpose of this resource to provide qualification-specific sets/groups of questions covering the knowledge, skills and understanding relevant to this Pearson qualification.
- This document should be used in conjunction with the mapping guidance which will map content and/or skills covered within each set of questions.
- These materials are only intended to support the summer 2021 series.

1

11 The photograph shows a guitar. The strings of the guitar are at the same tension.

When a string is plucked, a standing wave is set up on the string.

*(a) Explain how a standing wave is set up on a string.

(6)

When the string is plucked, a wave is produced. This wave travels along the string, to the top, whee the wave is then reflected so it travels in the opposite direction dawn the string. The reflected wave and incident wave then superpose. As these two waves are identical (same λ, freq, amplitude) a standing (stationary) wave is produced.
Standing waves are created when driving frequency (plucking the string) is equal to the natural frequency (of the string).

(b) A thicker string produces a note with a lower fundamental frequency than a thinner string of the same material.

Justify this statement.

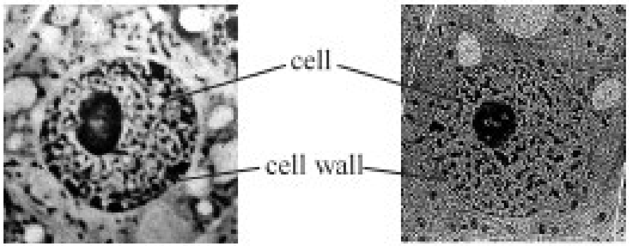
(5)

This is due to the equation $f = \frac{1}{2l}\sqrt{\frac{T}{\mu}}$.
A thicker string means it will have a larger mass, therefore μ (mass per unit length) will be larger for a thicker string. (l and T remain constant)
This means that the fundamental frequency will be lower as it is divided by a larger number.
A lower fundemental frequency ∴ means the note by the thicker string is at a lower pitch

(Total for Question 11 = 11 marks)

14 An optical microscope uses a beam of visible light. An electron microscope uses a beam of electrons.

A biologist looked at an animal cell using both microscopes. The two images are shown; both have the same magnification.



using optical microscope　　　using electron microscope

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(a) An electron in the beam of the electron microscope has a velocity of 2% of the speed of light.

Calculate the de Broglie wavelength of the electron.

(3)

Speed of light = 3×10^8 ms^{-1}

2% of speed of light = 6×10^6 ms^{-1}

$$\lambda = \frac{h}{m_e V} = \frac{6.63 \times 10^{-34}}{(9.11 \times 10^{-31}) \times (6 \times 10^6)} = 1.212952799 \times 10^{-10} \text{ m}$$

$= 1.2 \times 10^{-10}$ m (2sf)

de Broglie wavelength = 1.2×10^{-10} m

3

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°.

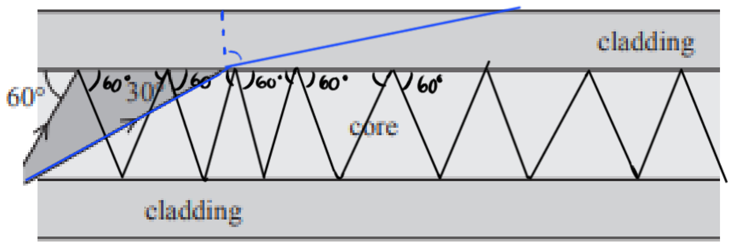
(3)

$\sin\theta = \frac{n_2}{n_1}$ $\frac{n_2}{n_1} < 1$

$\theta = \sin^{-1}\left(\frac{n_2}{n_1}\right) = \sin^{-1}\left(\frac{1.20}{1.56}\right) = 50.28486277$

$= \underline{\underline{50}}°$ (2sf)

(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)

Student C is correct.

60° > 50° ∴ TIR

30° < 50° ∴ refracts

(Total for Question 9 = 6 marks)

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

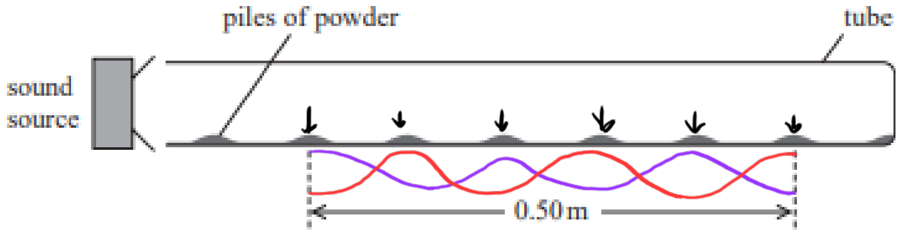
Explain how the plane of polarisation of the emitted light can be demonstrated using a polarising filter.

(3)

Place the polarising filter in front of the screen. The light should be able to pass straight through, if the filter is rotated in the same plane as the polarised light from the laptop. However, if the filter is rotated 90°, no light should go through the filter as there is no light in that plane. The only light from the laptop is blocked by the filter, as the filter blocks light 90° from the plane.

(Total for Question 9 = 3 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.

(5)

The soundwaves travel along the tube and reflected back. The incident and reflected wave superpose to form a standing/stationary wave. This causes the tube to resonanate at its natural frequency – producings vibrations with nodes and antinodes. These nodes and antinodes causes the sand to displace (causing an amplitude) at the antinodes and the sand to be stationary at the nodes.

(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)

$c = f\lambda$

2 full cycles in 0.5m

∴ 1 full cycle in 0.25m

∴ $\lambda = 0.25m$

$C = 1.8 \times 10^3 \times 0.25 = 450\ ms^{-1}$

Speed = $450\ ms^{-1}$

(Total for Question 14 = 8 marks)

TOTAL FOR PAPER IS 31 MARKS