



Additional Assessment Materials
Summer 2021

Pearson Edexcel GCE AS Physics

Topic 6: The Particle Nature of Light
Test 1

(Public release version)

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Additional Assessment Materials, Summer 2021

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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- Additional Assessment Materials have come from past papers both published (those materials available publicly) and unpublished (those currently under padlock to our centres) presented in a different format to allow teachers to adapt them for use with candidate.

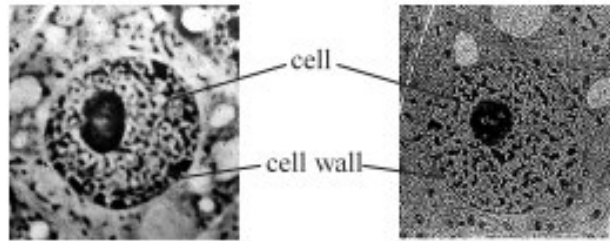
Purpose

- The purpose of this resource is 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

- 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

www.udel.edu

- (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)

$$\text{speed of light} = 3 \times 10^8$$

$$2\% \text{ speed of light} = 6 \times 10^6$$

$$\lambda = \frac{h}{m_e v} = \frac{6.63 \times 10^{-34}}{(9.11 \times 10^{-31})(6 \times 10^6)} = 1.212952799 \times 10^{-10} = 1.2 \times 10^{-10} \text{ (2sf)}$$

$$\text{de Broglie wavelength} = 1.2 \times 10^{-10} \text{ m (2sf)}$$

2

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

$$1 \text{ eV} = 1.6 \times 10^{-19} \text{ J}$$

Deduce the metal that covers the outside of the spacecraft.

$$W = hf \rightarrow \frac{W}{h} = f \rightarrow \text{Aluminium} = \frac{4.1 \times 1.6 \times 10^{-19}}{6.63 \times 10^{-34}} \quad (4)$$

$$= 9.894 \times 10^{14} = 9.9 \times 10^{14}$$

caesium & platinum (not greater than 9.9×10^{14})

will be less than 9.9×10^{14}

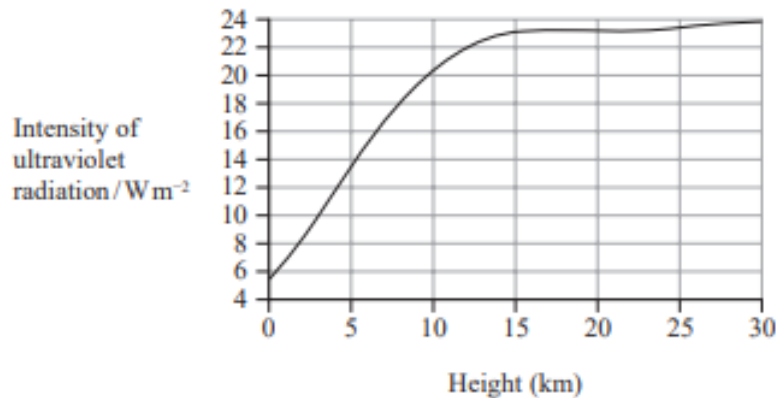
$$\therefore \text{Nickel} = \frac{5 \times 1.6 \times 10^{-19}}{6.63 \times 10^{-34}}$$

$$= 1.206 \dots \times 10^{15}$$

$$1.2 \times 10^{15} > 9.9 \times 10^{14}$$

\therefore Nickel is the metal that covers the outside of the spacecraft.

* (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. (Nickel)

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

(6)

An aeroplane flying at a height of 10 km will have an intensity of ultraviolet radiation as approximately 20 W m^{-2} . A spacecraft in orbit will have height larger than 30 km and therefore an intensity definitely larger than 20 W m^{-2} . As the aeroplane has a lower intensity it will therefore have smaller currents, therefore less electrons of the same energy (intensity does not affect kinetic energy) are emitted per second, so the aeroplane becomes charged slower due to the smaller amounts of electrons emitted per second compared to the spacecraft.

(Total for Question 13 = 10 marks)

TOTAL FOR PAPER IS 13 MARKS