GET BETTER AT PHYSICS · MARK SCHEME

Wave–Particle Duality: tiered multiple choice

AQA A-level Physics · 7407 / 7408 · Specification 3.2.2.4 · 5 questions · 5 marks

1 mark per correct letter | Worked reasoning for every question | **How students did** = from AQA examiner reports, where available

Answer key

Q1	Q2	Q3	Q4	Q5
C	B	D	D	A

Easy

Questions 1–3

1 **C**

Linking two effects to waves and particles · AQA June 2018 · AS Paper 2 · Q12

The photoelectric effect needs light to arrive as photons (a particle property). Electron diffraction needs electrons to behave as waves (a wave property): row C.

How students did: 84.2% of students got this right in June 2018.

2 **B**

Muon and electron at the same speed · AQA November 2021 · A-level Paper 1 · Q16

The muon has a much greater mass, so at the same speed it has more kinetic energy ($\frac{1}{2}mv^2$). The de Broglie wavelength $\lambda = h / (mv)$ is longer for the smaller mass, the electron: row B.

How students did: Over 70% of students got this right in November 2021.

3 **D**

Ratio of de Broglie wavelengths at equal speed · AQA June 2024 · A-level Paper 1 · Q12

$\lambda = h / (mv)$, so at the same speed $\lambda \propto 1/m$. $\lambda_{electron} / \lambda_{proton} = m_{proton} / m_{electron} = 1.67 \times 10^{-27} \div 9.11 \times 10^{-31} \approx 1800$.

> **Watch out:** The lighter particle has the longer wavelength, so the ratio is greater than 1.

How students did: Over 70% of students got this right in June 2024.

Medium

Questions 4–5

4 **D**

de Broglie wavelength from kinetic energy · AQA June 2018 · AS Paper 2 · Q11

$E = p^2 / (2m)$, so $p = \sqrt{(2Em)}$. Then $\lambda = h / p = h / \sqrt{(2Em)}$.

> **Watch out:** Check the units: $\sqrt{(2Em)}$ must give momentum (kg m s^{-1}).

How students did: Fewer than 39% of students got this right in June 2018.

5 **A**

What makes electron-diffraction rings wider? · AQA June 2023 · A-level Paper 1 · Q13

Wider rings mean larger diffraction angles, which need a longer wavelength. $\lambda = h / p$, so the momentum must fall: decrease the kinetic energy of the electrons.

> **Watch out:** Protons with the same kinetic energy have more momentum, so a shorter wavelength and smaller rings (B).

How students did: Fewer than 40% of students got this right in June 2023.

End of mark scheme. Answers from AQA's published keys; explanations written for this pack. AQA material is © AQA. More free packs and 1-to-1 tuition: **www.getbetteratphysics.co.uk**

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