

Photons, work functions and matter waves

AP Physics 2 (algebra-based) · Test

Name: _____ Date: _____ Class: _____ Mark: ____ / 20

This test covers photon energy, the photoelectric effect and matter waves with calculations and short explanations. Give every answer with its unit and show the relationship you use. Marks per part are shown in brackets.

Level: AP Physics 2 (algebra-based) · **Curriculum:** AP P2 Unit 15

Time: 40 minutes · 8 questions · Total: 20 marks · Calculator allowed

Question 1 Photon energy (2 marks)

Light of wavelength 480 nm is used in an experiment. Use $hc = 1240 \text{ eV}\cdot\text{nm}$ and $c = 3.00 \times 10^8 \text{ m/s}$.

- Calculate the photon energy in eV. (1 mark)
- Calculate the frequency of the light. (1 mark)

Question 2 Photoelectric calculation (3 marks)

Light of wavelength 450 nm falls on a metal of work function 2.10 eV.

- Calculate the maximum kinetic energy of the photoelectrons in eV. (2 marks)
- Calculate the threshold wavelength of the metal. (1 mark)

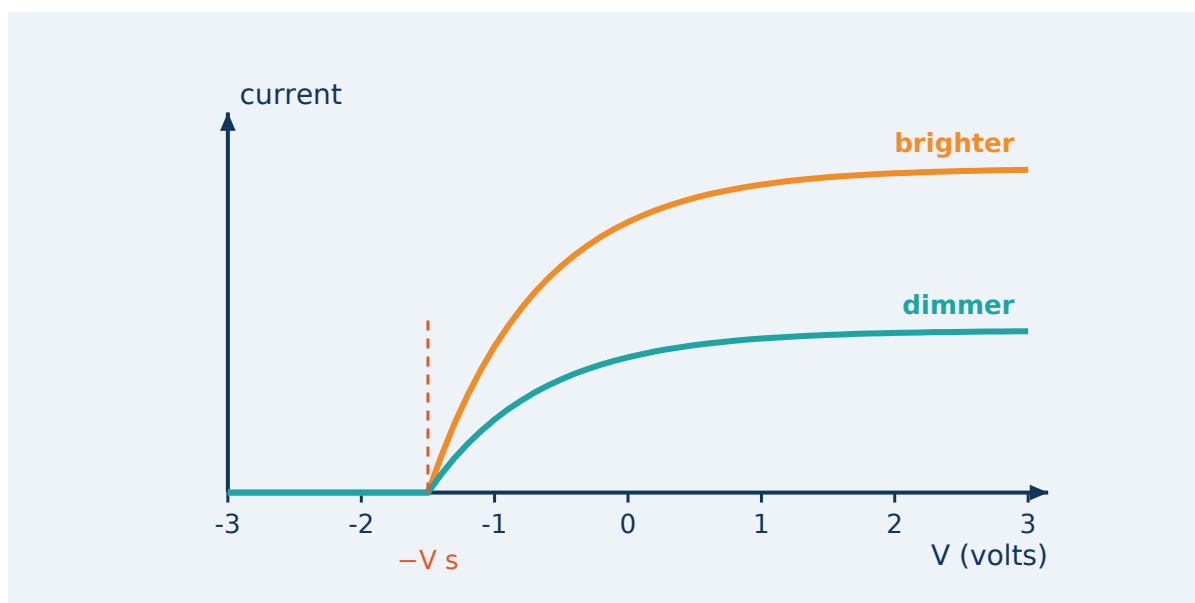
Question 3 Failure of the wave model (2 marks)

Red light of very high intensity does not eject electrons from a clean zinc plate.

- Explain why this is a problem for the wave model of light. (1 mark)
- Explain how the photon model resolves it. (1 mark)

Question 4 Reading a current graph (3 marks)

The graph shows the current in a photoelectric tube against collector potential for two intensities of light of the same frequency.



Current against potential: both curves reach zero at the same stopping potential.

- State which curve was taken with the brighter light and explain. (1 mark)
- Read the stopping potential and state the maximum kinetic energy of the electrons in eV. (1 mark)
- Explain why both curves have the same stopping potential. (1 mark)

Question 5 de Broglie wavelength of an electron (3 marks)

An electron moves at 2.0×10^6 m/s. Its mass is 9.11×10^{-31} kg.

- Calculate its momentum. (1 mark)
- Calculate its de Broglie wavelength. (1 mark)
- State why a golf ball of mass 0.045 kg at 40 m/s shows no diffraction. (1 mark)

Question 6 Evidence for the models (2 marks)

Photoelectric emission and electron diffraction are both important experiments.

- State which one supports the particle nature of light. (1 mark)
- State which one supports the wave nature of matter. (1 mark)

Question 7 Photons per second (3 marks)

A laser pointer emits 2.0 mW at a wavelength of 600 nm.

- Calculate the energy of one photon in joules. (1 mark)
- Calculate the number of photons emitted per second. (2 marks)

Question 8 LED colours (2 marks)

A blue LED needs a larger turn-on voltage than a red LED.

- a. Explain this in terms of photon energy. (2 marks)