Edexcel Physics A-Level

Topic 5.3 - Diffraction and the Nature of Light

Flashcards

What is diffraction?

What is diffraction?

Diffraction is the spreading out of a wave as it passes through a gap.

What criteria must be met for maximum diffraction to occur?

What criteria must be met for maximum diffraction to occur?

The size of the gap must be of the same magnitude as the wavelength of the wave.

What happens if the gap is much smaller than the wavelength of the wave?

What happens if the gap is much smaller than the wavelength of the wave?

The wave will be reflected.

State the diffraction grating equation.

State the diffraction grating equation.

$$n\lambda = d\sin\theta$$

What does electron diffraction provide evidence for?

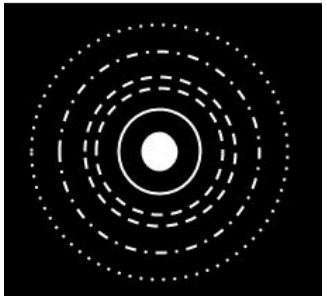
What does electron diffraction provide evidence for?

The wave nature of electrons. It suggests that particles can demonstrate wavelike properties.

Describe the diffraction pattern produced by electrons.

Describe the diffraction pattern produced by electrons.

Concentric circles of bright and dark fringes from a central bright point.



If electrons didn't have a wave nature, describe the pattern that would be produced when they pass through a slit.

If electrons didn't have a wave nature, describe the pattern that would be produced when they pass through a slit.

The electrons would be unaffected by the gap and pass straight through. A single bright region would be formed.

What is the name given to the wavelength of a particle?

What is the name given to the wavelength of a particle?

De Broglie wavelength.

What two factors does the de Broglie wavelength depend on?

What two factors does the de Broglie wavelength depend on?

1. Mass
2. Velocity

State the equation used to calculate a de Broglie wavelength.

State the equation used to calculate a de Broglie wavelength.

$$\lambda = h/mv$$

h is Planck's constant

What can ‘mv’ be replaced with in the de Broglie equation?

What can ‘mv’ be replaced with in the de Broglie equation?

p, momentum

What is the basic process of a pulse-echo technique?

What is the basic process of a pulse-echo technique?

- A wave pulse is emitted
- It is transmitted and reflected at the boundary between two media
- The returning wave (echo) is detected
- The speed and time taken are used to calculate the distance to the object

Suggest two things that may limit the amount of information that can be obtained by a pulse-echo technique.

Suggest two things that may limit the amount of information that can be obtained by a pulse-echo technique.

1. The wavelength of the radiation
2. The duration of the pulse

What are the two models that can be used to describe electromagnetic radiation?

What are the two models that can be used to describe electromagnetic radiation?

1. The wave model
2. The particle model

Which model does the photoelectric effect provide evidence for?

Which model does the photoelectric effect provide evidence for?

The particle model.

Outline the photoelectric effect.

Outline the photoelectric effect.

- Light is shone on a metal plate
- If the light has a high enough frequency, electrons are emitted from the metal surface
- If the frequency is too low, no electrons are emitted

What are the particles of light used to explain the photoelectric effect called?

What are the particles of light used to explain the photoelectric effect called?

Photons

How do you calculate the energy of a photon?

How do you calculate the energy of a photon?

$$E = hf$$

h is Planck's constant

f is the frequency of light

Explain how a photon can liberate an electron.

Explain how a photon can liberate an electron.

One photon interacts with one electron and transfers all its energy to it. If this energy is greater than the metal's work function, the electron will have sufficient energy to be released.

What is threshold frequency?

What is threshold frequency?

A metal's threshold frequency is the minimum frequency that a photon requires to liberate an electron from its surface.

If the intensity of light being shone on a metal increases, how does the energy of the photoelectrons change?

If the intensity of light being shone on a metal increases, how does the energy of the photoelectrons change?

The energy remains unaffected. An increase in intensity means more photons per area and so more photoelectrons are emitted.

Why are photoelectrons emitted with a range of kinetic energies?

Why are photoelectrons emitted with a range of kinetic energies?

The electrons are at different depths in the metal and so require different amounts of energy to be liberated. The excess energy from a photon once an electron has been liberated, is the kinetic energy of the electron.

State the equation for the maximum kinetic energy of a photoelectron.

State the equation for the maximum kinetic energy of a photoelectron.

$$\tfrac{1}{2} mv^2_{max} = hf - \phi$$

ϕ is the metal's work function

What is the conversion factor between eV and J?

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

What happens when electrons transition between energy levels?

What happens when electrons transition between energy levels?

- If electrons move to a higher energy level, radiation must be absorbed
- If electrons move to a lower energy level, radiation is emitted

Why can only certain frequencies of radiation be absorbed by an atom to cause an electron transition?

Why can only certain frequencies of radiation be absorbed by an atom to cause an electron transition?

The electrons can only exist in discrete energy levels. The energy of the photon absorbed must be the exact amount of energy required to cover the difference between two discrete energy levels.