

15.5 The Photoelectric Effect

Name: _____ Class: _____ Date: _____

Total: 10 marks

KEY WORDS work function 功函数 • photoelectric effect 光电效应 • threshold frequency 截止频率
• photons 光子

Objective

Build the skills to answer exam questions on **the photoelectric effect**.

You must be able to:

- describe the **photoelectric effect** 光电效应: light ejecting electrons from a metal
- apply the photoelectric equation $E = hf = \phi + KE_{max}$ with the **work function** 功函数 ϕ
- explain why a **threshold frequency** 截止频率 exists

1 Worked examples

Study these first. Each one shows the method for a question type used later.

■ The photoelectric effect

Light shining on a metal can eject electrons, but only if each **photon** carries enough energy.

■ The photoelectric equation

$hf = \phi + KE_{max}$, where ϕ (the work function) is the minimum energy to free an electron, and KE_{max} is the most kinetic energy an ejected electron can have.

■ Threshold frequency

Below a threshold frequency f_0 (where $hf_0 = \phi$), **no** electrons are emitted, however bright the light — direct evidence that light is quantized.

2 Practice

2.1 State what the photoelectric effect is. [1]

2.2 Define the work function of a metal. [1]

2.3 A metal has a work function of 2.0 eV. A photon of 5.0 eV strikes it. Find the maximum kinetic energy of the ejected electron. [2]

3 Exam-style questions

3.1 The photoelectric equation is [1]

- **A** $hf = \phi + KE_{max}$
 - **B** $E = mc^2$
 - **C** $E = \frac{1}{2}mv^2$
 - **D** $\lambda = h/p$
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3.2 Below the threshold frequency, the number of electrons emitted is [1]

- **A** at its maximum
 - **B** zero
 - **C** half the usual
 - **D** steadily increasing
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3.3 Light of photon energy 4.0 eV strikes a metal of work function 2.5 eV.

(a) Find the maximum kinetic energy of an ejected electron. [2]

(b) Explain why even very dim light of this frequency still ejects electrons. [2]

Solutions

2.1 light ejecting electrons from the surface of a metal.

2.2 the minimum energy needed to free an electron from the metal.

2.3 $KE_{max} = hf - \phi = 5.0 - 2.0 = 3.0$ eV.

3.1 A.

3.2 B.

3.3 (a) $KE_{max} = 4.0 - 2.5 = 1.5$ eV. (b) each photon has enough energy on its own to free an electron, so even a few photons (dim light) eject some — brightness only changes how many.