

# 15.5 The Photoelectric Effect

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Name: \_\_\_\_\_ Class: \_\_\_\_\_ Date: \_\_\_\_\_

Total: 10 marks

## Objective

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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  $\phi$
- explain why a **threshold frequency** 截止频率 exists

## 1 Worked examples

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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  $\phi$  (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

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**2.1** State what the photoelectric effect is. [1]

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

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**2.3** A metal has a work function of 2.0 eV. A photon of 5.0 eV strikes it. Find the

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maximum kinetic energy of the ejected electron. [2]

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### 3 Exam-style questions

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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]

### 4 Go further

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- work through the **15.5 The Photoelectric Effect** lesson on the **Learn** page;
- read the **Modern Physics** section of the AP Physics 2 handout on the **Know** page.

## Solutions

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**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.