22. Quantum physics

Starter Quiz ·

A-Level Physics Name: _____ Score: _____

1. Which phrases belong in the two-mark definition of a photon? Select **all** that apply.

   ☐ of energy

   ☐ that travels more slowly in glass

   ☐ of electromagnetic radiation

   ☐ a quantum, or discrete packet

   Tick every correct option.

2. Below the threshold frequency, shining a brighter light on the metal:

   ☐ emits faster electrons

   ☐ emits more electrons

   ☐ melts the metal

   ☐ still emits no electrons

3. Light shows its wave nature in interference, and its particle nature in:

   ☐ shadows

   ☐ the photoelectric effect

   ☐ reflection

   ☐ refraction

4. Electrons in an atom can only occupy certain _____ energy levels.

   _____

5. The energy of a photon is:

   ☐ $\frac{h}{f}$

   ☐ hf

   ☐ $\frac{f}{h}$

   ☐ hf^2

6. The minimum energy needed to free an electron from the surface is the _____ function.

   _____

7. The de Broglie wavelength of a particle is:

   ☐ $\frac{h}{f}$

   ☐ $\frac{p}{h}$

   ☐ hp

   ☐ $\frac{h}{p}$

8. Atomic energy levels are written as negative, with 0 for a just-free electron.

   ☐ True ☐ False

9. Higher-frequency photons carry more energy.

   ☐ True ☐ False

10. Light of 400 nm (photon energy 3.1 eV) falls on these metals. Which emit photoelectrons? Select **all** that apply.

    ☐ caesium, work function 2.1 eV

    ☐ sodium, work function 2.3 eV

    ☐ platinum, work function 5.6 eV

    ☐ zinc, work function 4.3 eV

    Tick every correct option.

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Answers ·

A-Level Physics

1. **of energy; of electromagnetic radiation; a quantum, or discrete packet**

   "A particle of light" alone scores one at best. Both the quantum idea and the electromagnetic radiation must appear.

2. **still emits no electrons**

   Each photon is below Φ, so no single photon can free an electron – brightness cannot help.

3. **the photoelectric effect**

   The photoelectric effect needs photons (particles); interference and diffraction need waves.

4. **discrete**

   The levels are discrete (quantised) – an electron cannot have an energy in between them.

5. hf

   $E = hf = \dfrac{hc}{\lambda}$ – proportional to frequency.

6. **work**

   The work function $\Phi = hf_0$ – the least energy to release a surface electron.

7. $\dfrac{h}{p}$

   $\lambda = \dfrac{h}{p}$ – wavelength is Planck's constant over momentum.

8. **True**

   The most tightly bound (ground) state is the most negative; energy rises toward 0 as the electron is freed.

9. **True**

   $E = hf$, so energy rises with frequency – a γ-ray photon carries far more than a radio one.

10. **caesium, work function 2.1 eV; sodium, work function 2.3 eV**

    Emission needs hf >= work function. Zinc and platinum emit nothing at this wavelength however intense the light; zinc needs below 290 nm, in the ultraviolet.