

Revision Sheet

A-Level Physics · Unit 22 Quantum physics

8 vocabulary items · 47 marks of exam questions (5 questions)

Part 1 · Vocabulary review (8 items). The terms this unit is examined on most. Mark it yourself from the answer key.

Section A · Chinese to English

Write the English word.

1.

[1]
2.

[1]
3.

[1]
4.

[1]
5.

[1]
6.

[1]
7.

[1]
8.

[1]

Part 2 · Exam questions (47 marks, 5 questions) begins on the next page. They are ordered easy to difficult and none of them has been set before.

- 9 (a) State an experimental phenomenon that provides evidence for:

(i) the particulate nature of electromagnetic radiation

..... [1]

(ii) the wave nature of matter.

..... [1]
- (b) A particle of matter moves with momentum p .

(i) State the equation that gives the effective wavelength λ of the particle. State the name of any other symbols used.

[2]

(ii) State the name given to the wavelength of the moving particle.

..... [1]
- (c) Electrons are accelerated from rest through a potential difference (p.d.) of 4.8 kV.

(i) Show that the final speed of the electrons is $4.1 \times 10^7 \text{ m s}^{-1}$.

[2]

(ii) Calculate the effective wavelength of a beam of electrons moving at the speed in (c)(i).
- wavelength = m [2]
- [Total: 9]

10 (a) State what is meant by:

(i) the *photoelectric effect*

.....

.....

..... [2]

(ii) *work function energy*.

.....

..... [1]

(b) A polished calcium plate in a vacuum is investigated by illuminating the surface with light.

It is found that no photoelectric current is produced when the frequency of the light is less than 6.93×10^{14} Hz.

(i) State the name of the frequency below which no photoelectric current is produced.

..... [1]

(ii) Explain how the photon model of electromagnetic radiation accounts for this phenomenon.

.....

.....

.....

..... [3]

(iii) Calculate the work function energy, in eV, of calcium.

work function energy = eV [2]

[Total: 9]

11 (a) State what is meant by a *photon*.

.....

.....

..... [2]

(b) A stationary nucleus of samarium-157 ($^{157}_{62}\text{Sm}$) emits a gamma-ray (γ -ray) photon of energy 0.57 MeV.

Determine, for one γ -ray photon:

(i) its wavelength

wavelength = m [2]

(ii) its momentum.

momentum = N s [2]

(c) (i) Using your answer to (b)(ii), determine the speed of the samarium-157 nucleus after emission of the photon.

speed = ms^{-1} [2]

(ii) By reference to your answer in (c)(i), explain quantitatively why the speed of the samarium-157 nucleus may be assumed to be negligible compared with the speed of the photon.

.....
..... [1]

[Total: 9]

12 (a) State what is meant by the work function energy of a metal.

[2]

(b) Ultraviolet radiation of frequency 1.36×10^{15} Hz is incident, in a vacuum, on a metal surface. The power of the radiation incident on the surface is 8.36 mW. Photoelectrons are emitted with a maximum kinetic energy of 3.09×10^{-19} J.

(i) Determine the number of photons incident on the surface per unit time.

number per unit time = s⁻¹ [2]

(ii) Calculate the work function energy ϕ of the metal.

$\phi =$ J [2]

(c) The frequency of the radiation incident on the surface in (b) is increased while the power remains constant.

State and explain the effect of this change on:

(i) the maximum kinetic energy of the photoelectrons

[2]

(ii) the rate of emission of photoelectrons.

[2]

13 (a) State what is meant by a photon.

.....
.....
..... [2]

(b) Electromagnetic radiation of a varying frequency f and constant intensity I is used to illuminate a metal surface. At certain frequencies, electrons are emitted from the surface of the metal. The variation with f of the maximum kinetic energy E_{MAX} of the emitted electrons is shown in Fig. 7.1.

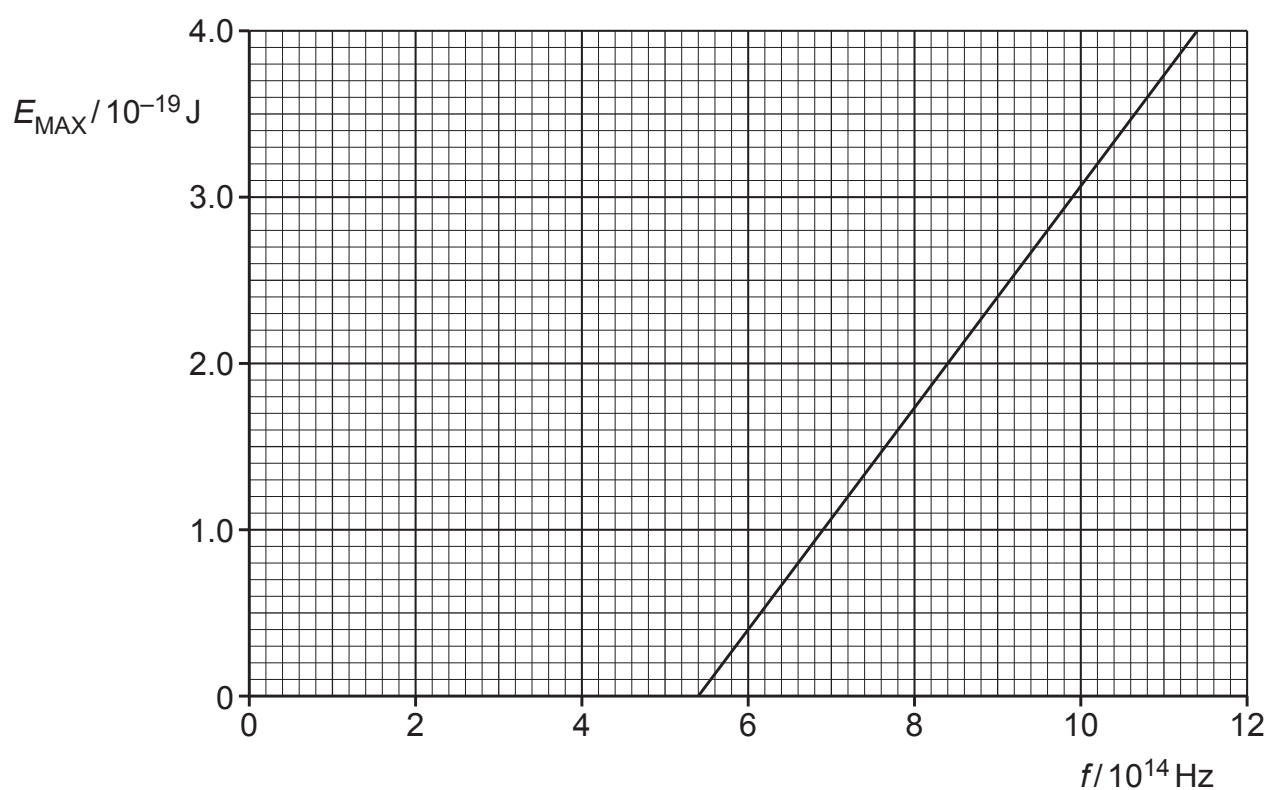


Fig. 7.1

(i) State the name of this phenomenon.

..... [1]

(ii) Describe **three** conclusions that can be drawn from the graph in Fig. 7.1. The conclusions may be qualitative or quantitative.

- 1
-
- 2
-
- 3
-
- [3]

(c) The experiment in (b) is repeated twice, each time making one change.

State, with a reason, how the graph obtained would compare with Fig. 7.1 when:

- (i) a different metal is used, but keeping the intensity I of the radiation the same
-
-
- [2]
- (ii) the same metal is used, but with electromagnetic radiation of intensity $2I$.
-
-
- [2]

[Total: 10]