

Revision Sheet

A-Level Physics · Unit 22 Quantum physics

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

Part 1 · Vocabulary review answer key. Section A wants the exact English spelling.

Question	Answer	Marks
1	particulate nature	1
2	threshold wavelength	1
3	photoelectron	1
4	photoelectric effect	1
5	threshold frequency	1
6	work function	1
7	de Broglie wavelength	1
8	energy level	1

9(a)(i)	photoelectric effect
9(a)(ii)	electron diffraction
9(b)(i)	$\lambda = h / p$ h is the Planck constant
9(b)(ii)	de Broglie (wavelength)
9(c)(i)	$\frac{1}{2}mv^2 = eV$ $\frac{1}{2} \times 9.11 \times 10^{-31} \times v^2 = 1.60 \times 10^{-19} \times 4800$ <u>so</u> $v = 4.1 \times 10^7 \text{ m s}^{-1}$
9(c)(ii)	$\lambda = h / mv$ $= 6.63 \times 10^{-34} / (9.11 \times 10^{-31} \times 4.1 \times 10^7)$ $= 1.8 \times 10^{-11} \text{ m}$

10(a)(i)	emission of electrons (from a metal surface) when electromagnetic radiation is incident (on electrons)
10a(ii)	<u>minimum</u> energy required for an electron to leave surface
10(b)(i)	threshold (frequency)
10(b)(ii)	<ul style="list-style-type: none"> photons are (discrete) packets of energy energy of photons depends on frequency (of EM radiation) electrons can only absorb a single photon (of energy) <i>Any two points, 1 mark each</i> emission only possible if photon energy is at least the work function
10(b)(iii)	work function = $hf_0 = 6.63 \times 10^{-34} \times 6.93 \times 10^{14}$ $= 4.59 \times 10^{-19} \text{ (J)}$ $= 4.59 \times 10^{-19} / 1.60 \times 10^{-19} \text{ (eV)}$ $= 2.87 \text{ eV}$

11(a)	quantum of energy of electromagnetic radiation
11(b)(i)	energy = hc / λ or energy = hf and $f = c / \lambda$ $0.57 \times 10^6 \times 1.60 \times 10^{-19} = (6.63 \times 10^{-34} \times 3.00 \times 10^8) / \lambda$ $\lambda = 2.2 \times 10^{-12} \text{ m}$

11(b)(ii)	$p = h / \lambda$
	$= (6.63 \times 10^{-34}) / (2.2 \times 10^{-12})$
	$= 3.0 \times 10^{-22} \text{ N s}$
	or
	$p = E / c$
	$= (0.57 \times 10^6 \times 1.60 \times 10^{-19}) / (3.00 \times 10^8)$
	$= 3.0 \times 10^{-22} \text{ N s}$
11(c)(i)	mass (of Sm-157 nucleus) = $157 \times 1.66 \times 10^{-27}$ or mass (of Sm-157 nucleus) = $0.157 / (6.02 \times 10^{23})$
	recoil speed = $(3.00 \times 10^{-22}) / (157 \times 1.66 \times 10^{-27})$ $= 1.2 \times 10^3 \text{ m s}^{-1}$
11(c)(ii)	$(1.2 \times) 10^3 \text{ m s}^{-1}$ is <u>much</u> less than $(3.0 \times) 10^8 \text{ m s}^{-1}$

12(a)	photon energy (to remove electron)
	minimum energy to remove electron
	or energy to remove electron from surface
	or energy to remove electron with zero kinetic energy
12(b)(i)	photon energy = hf
	number per unit time = $8.36 \times 10^{-3} / (1.36 \times 10^{15} \times 6.63 \times 10^{-34})$ $= 9.27 \times 10^{15} \text{ s}^{-1}$
12(b)(ii)	$hf = \phi + E_{\text{MAX}}$
	$\phi = (1.36 \times 10^{15} \times 6.63 \times 10^{-34}) - (3.09 \times 10^{-19})$
	$= 5.93 \times 10^{-19} \text{ J}$
12(c)(i)	greater photon energy (and same work function)
	so maximum kinetic energy is increased
12(c)(ii)	(greater photon energy and same power so) lower number of photons (per unit time)
	(each electron absorbs one photon) so lower rate of emission

13(a)	quantum of energy
	of electromagnetic radiation
13(b)(i)	photoelectric effect
13(b)(ii)	<ul style="list-style-type: none"> there is a frequency below which no electrons are emitted or threshold frequency = 5.4×10^{14} Hz work function of the metal = 3.6×10^{-19} J (or 2.2 eV) E_{MAX} increases (linearly) with (increasing) frequency gradient of the line is the Planck constant or gradient of the line is 6.7×10^{-34} J s <p><i>Any three bullet points, 1 mark each</i></p>
13(c)(i)	different threshold frequency
	(line has) same gradient but different intercept
13(c)(ii)	photons have same energy
	line unchanged