

APOLLO

Quantum physics

HL

Physics

First assessment 2025

19 questions | mark schemes

Mark-scheme answers

Physics HL | Paper 1A | May 2025 TZ1 | Q34 | 1 marks

34. A

Physics HL | Paper 1A | May 2025 TZ1 | Q35 | 1 marks

35. A

Physics HL | Paper 1A | May 2025 TZ2 | Q32 | 1 marks

32. D

Physics HL | Paper 1A | May 2025 TZ2 | Q34 | 1 marks

34. B

Physics HL | Paper 1A | May 2025 TZ2 | Q35 | 1 marks

35. B

Physics HL | Paper 1A | May 2025 TZ3 | Q32 | 1 marks

32. C

Physics HL | Paper 1A | May 2025 TZ3 | Q34 | 1 marks

34. B

5.	a		Compton scattering provides evidence for «the energy and » the momentum of the photon / refers to the collision between photon and electron ✓ The photoelectric effect provides evidence for the energy of photons ✓		[2]
	b		The photon loses energy / transfers energy to the electron ✓ $E = \frac{hc}{\lambda}$ / lower energy implies longer wavelength ✓		[2]
	c	i	$E = \frac{hc}{\lambda} = \frac{1.24 \times 10^{-6}}{7.47 \times 10^{-12}} \text{ OR } 0.166 \text{ MeV}$ ✓		[1]
	c	ii	$E = \langle 0.194 - 0.166 = \rangle 0.028 \text{ MeV}$ ✓	Accept 0.024 from the value given as show that. Allow ECF from c) i) Accept $4.5 \times 10^{-15} \text{ J}$.	[1]
	c	iii	$7.47 \times 10^{-12} - 6.40 \times 10^{-12} = 2.43 \times 10^{-12} (1 - \cos \theta)$ ✓ « $\cos \theta = 0.5597$ so » $\theta = 56.0^\circ$ ✓	Accept angle in radians (0.98 « rad »). Award [2] if 56° or 0.98 « rad » are seen as the answer without working	[2]

Question	Answers	Notes	Total
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6.	a	reads $\lambda = 5.0 \times 10^{-7}$ «m» ✓ $\Phi = \frac{hc}{\lambda} = \frac{1.24 \times 10^{-6}}{5 \times 10^{-7}}$ OR 2.48 «eV» ✓	<i>Must see full substitution or answer to 3 or more significant figures for MP2.</i>	2
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2225–6721M

6.	b	ALT 1 «hf OR $hc/\lambda = (1.24 \times 10^{-6})/(4.0 \times 10^{-7}) = 3.1$ «V» ✓ «3.1 - 2.5 =» 0.6 «V» ✓ ALT 2 $\frac{(6.63 \times 10^{-34})(3 \times 10^8)}{(4 \times 10^{-7})} - (4 \times 10^{-19}) = 9.73 \times 10^{-20}$ «J» ✓ «$(9.73 \times 10^{-20})/(1.6 \times 10^{-19})$» = 0.6 «V» ✓		2
6.	c	Particle nature suggests photons have energy related to frequency/wavelength ✓ Intensity does not change photon energy OR Intensity not related to E necessary to release electron. ✓ One photon of sufficient energy is necessary to release an electron OR photon must have sufficient energy to release electron. ✓ If light is a wave, higher intensity should provide energy with time to eject an electron. ✓		2 max

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2225–6721M

Question	Answers	Notes	Total
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Mark-scheme answers

Physics HL | Paper 1A | Nov 2025 TZ1 | Q33 | 1 marks

33. A

Physics HL | Paper 1A | Nov 2025 TZ1 | Q34 | 1 marks

34. B

Physics HL | Paper 1A | Nov 2025 TZ1 | Q35 | 1 marks

35. D

Physics HL | Paper 1A | Nov 2025 TZ1 | Q36 | 1 marks

36. C

Physics HL | Paper 1A | Nov 2025 TZ3 | Q35 | 1 marks

35. D

Physics HL | Paper 1A | Nov 2025 TZ3 | Q36 | 1 marks

36. D

1.	a		3 ✓		[1]
1.	b		Chooses 3->2 transition ✓ $\lambda = \frac{hc}{\Delta E} \quad \checkmark$ $\lambda = \frac{1.24 \times 10^{-6}}{1.89} \Rightarrow 6.56 \times 10^{-7} \text{ m}$ OR $\lambda = \frac{6.63 \times 10^{-34} \times 3.0 \times 10^8}{1.89 \times 1.6 \times 10^{-19}} \Rightarrow 6.58 \times 10^{-7} \text{ m} \quad \checkmark$	<i>Ignore sign.</i> Award [3] for CNA (correct numerical answer) Allow ECF from MP1 if they choose an incorrect transition Do not penalize 657 nm Award [1] max if they calculate a wavelength using a single energy level instead of a ΔE.	[3]

Question	Answers	Notes	Total
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10.	a		Reference to an experimental evidence e.g. Compton or photoelectric effect ✓ Brief reference to the transfer of momentum and/or energy of a photon in the example given e.g. photon scatters from an electron transferring momentum and/or energy or photon strikes «and ejects» an electron transferring momentum and/or energy. ✓	Accept any correct reference to the experiment quoted even if only about energy transfer.	[2]
10.	b	i	Energy incident per second/power is $N \frac{hc}{\lambda}$ ✓ Intensity is power per area ✓ so $I = \frac{N hc}{A \lambda}$	Allow [1] if student consistently uses energy instead of power.	[2]
10.	b	ii	Use of photon momentum $\frac{h}{\lambda}$ ✓ Force is rate of change of total momentum $N \frac{2h}{\lambda}$ ✓ Pressure is force per unit area $\frac{N 2h}{A \lambda}$ and substitution $\frac{N h}{A \lambda} = \frac{I}{c}$ to get result ✓		[3]

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Question			Answers	Notes	Total
10.	c	i	$F = \langle PA \rangle = \frac{2 \times 420}{3 \times 10^8} \times 1600$ OR $4.48 \times 10^{-3} \text{ N}$ ✓ $a = \langle \frac{F}{m} \rangle = \frac{2 \times 420 \times 1600}{3 \times 10^8 \times 1400}$ OR $3.2 \times 10^{-6} \text{ ms}^{-2}$ ✓		[2]
10.	c	ii	$s = \frac{1}{2} a t^2 \Rightarrow t = \sqrt{\frac{2s}{a}} = \sqrt{\frac{2 \times 6.1 \times 10^{11}}{3.2 \times 10^{-6}}}$ ✓ $t = 6.175 \times 10^8 \text{ s} = 19.6 \approx 20 \text{ years}$ ✓	Award full marks for a correct answer in seconds or years. Award full marks for a CNA	[2]
10.	c	iii	The intensity of light on the sail will not remain constant/the force due to the Sun/Earth/Jupiter/other planets is ignored/sail may not be flat/light may be incident at an angle/part of the radiation may be absorbed/any other reasonable statement ✓		[1]
10.	d	i	Any position along the dotted line between the spacecraft and the centre of the ellipse ✓		[1]
10.	d	ii	Jupiter is at a focus of the ellipse ✓ Speed is a maximum, potential energy is a minimum hence the spacecraft is closest to Jupiter OR The angular momentum mvr of the spacecraft is conserved and since speed is maximum the spacecraft is closest to Jupiter OR reference to Kepler' second law ✓	Accept not at the centre for MP1	[2]

Question			Answers	Notes	Total
10.	e	i	$\omega^2 r = G \frac{M}{r^2} \quad \text{OR} \quad \frac{GM}{r} = \frac{2\pi r}{T} \quad \checkmark$ $M = \rho \frac{4\pi r^3}{3} \quad \checkmark$ Manipulation to show the result e.g. $T^2 = \frac{4\pi^2}{G\rho \frac{4\pi r^3}{3}} r^3 \quad \checkmark$		[3]
10.	e	ii	$\rho = \frac{3\pi}{GT^2} = \frac{3\pi}{6.67 \times 10^{-11} \times (2.9 \times 60 \times 60)^2} \quad \checkmark$ $\rho = 1.3 \times 10^3 \text{ kg m}^{-3} \quad \checkmark$	Allow ECF from MP1	[2]

Mark-scheme answers

Physics HL | Paper 1A | Specimen 2025 | Q35 | 1 marks

35. D

Physics HL | Paper 1A | Specimen 2025 | Q39 | 1 marks

39. B