OXFORD CAMBRIDGE AND RSA EXAMINATIONS

Advanced Subsidiary GCE

PHYSICS A G482 MS

Unit G482: Electrons, Waves and Photons

Specimen Mark Scheme

The maximum mark for this paper is **100**.

This document consists of **7** printed pages and **1** blank page.

Question Number	Answer	Max Mark
1(a)(i)	Electrons in a metal	[B1]
(ii)	Ion in an electrolyte	[B1]
(b)(i)	Correctly selected and re-arranged: $\rho = RA/L$; symbols defined: A = <u>cross-sectional</u> area, R = resistance, L = length	[M1] [A1]
(ii)	ρ is independent of dimensions of the specimen of the material/AW	[B1]
(c)(i)	$R = 1.7 \times 10^{-8} \times 0.08/3.0 \times 10^{-4}$ $R = 4.5(3)\ 10^{-6}$ (Ω)	[C1] [A1]
(ii) 1	$I = Q/t$ / $I = 650/5$ $I = 130$ (A)	[C1] [A1]
(ii) 2	$n = I/e = 130/1.6 \times 10^{-19}$ $n = 8.1 \times 10^{20}$	[C1] [A1]
2(a)(i)	p.d.: energy transferred per unit charge from electrical form (into other forms, e.g. light/heat) e.m.f.: energy transferred per unit charge into electrical form (from other forms, e.g. chemical/mechanical)	[B1] [B1]
(ii)	J C^{-1}	[B1]
(b)	(Sum of) e.m.f.s = sum /total of p.d.s/sum of voltages (in a loop) energy is conserved	[B1] [B1]
(c) (i)	any straight line of best fit judged by eye	[B1]
(ii) 1	6.0 ± 0.2 (V) /consistent with the y-intercept of their graph	[B1]
(ii) 2	r = gradient / $(\varepsilon - V)/I$ / V_{lost}/I e.g. r = (6.0 – 0)/2.0 r = 3.0 Ω	[B1] [M1] [A1]
(d)(i)	I = 0.6 A and V = 4.2 V $R = V/I = 7.0$ (Ω)	[B1] [C1]
(ii)	$R = 7.0$ (Ω) $P = IV = 4.2 \times 0.6$ $P = 2.5$ W	[A1] [C1] [A1]

Question Number	Answer	Max Mark
3(a)(i)	resistance decreases/falls/drops (with increase in temperature)	[B1]
(ii)	100 ± 10 Ω	[B1]
(iii)	for low temps ΔR is large for $\Delta\theta$ and at high temps ΔR is small for same $\Delta\theta$; so sensitivity decreases (continuously)from low to high temperatures	[B1] [B1]
(b)(i)	correct circuit symbol	[B1]
(ii)	connections in parallel with fixed resistor	[B1]
(iii)	R_{th} = 100 to 105 Ω $R_{tot} = 200 + R_{th}$ $I = V/R_{tot} = 6/R_{tot}$ (= 0.02 A)	[B1] [M1] [A1]
(iv)	(V = IR = 0.02 x 200) = 4.0 (V)	[A1]
(c)(i)	basic potential divider argument detail, e.g.with R_{th} about 100 Ω at 70°C then R must be 1000 Ω to achieve 0.5 V to 5.5 V ratio/AW	[B1] [B1]
(ii)	advantage: (approx.) constant sensitivity/ linear (output) disadvantage: less sensitive (over most of range)/range of voltages is small/battery lasts for less time	[B1] [B1]
4(a)	A: gamma / γ (ray/radiation/wave) $\lambda = 10^{-16}$ to 10^{-10} (m) B: infrared / IR / i.r. $\lambda = 7 \times 10^{-7}$ to 10^{-3} (m)	[B1] [B1] [B1] [B1]
(b)	Any **two** from: travel at the speed of light/3×10^8 (m s^{-1}) (in a vacuum) can travel in a vacuum consists of oscillating E- <u>and</u> B-fields transverse waves/can be polarised can be diffracted/reflected/refracted	[B1x2]
(c)(i)	plane polarised light vibrates (travels) <u>in one plane only</u> (look for reference to one plane of oscillation)	[B1]
(ii)	only transverse waves can be polarised/AW sound waves are longitudinal/not transverse/AW	[B1] [B1]

Question Number	Answer	Max Mark
(d)(i)	evidence of knowledge of: full/max transmission when the (transmission axis of) polarising sheet is parallel to the light's plane of polarisation/vibrations no transmission when the (transmission axis of) polarising sheet is at right angles to light's plane of polarisation/vibrations	[B1] [B1]
(ii)	reflected light from surface is partially plane polarised polarising sheet is placed at right angles to reflected light's polarisation plane/AW	[B1] [B1]
(e)	any valid example: e.g. radio waves, microwaves valid method of detection: e.g. aerial (allow microwave detector)	[M1] [A1]
5(a)	possible differences in amplitude/wavelength/phase/waveform/energy: As described for progressive wave As described for standing wave	[A1] [A1]
(b)(i)	correct standing wave drawn to top of end correction	[B1]
(ii)	all A and N labelled correctly	[B1]
(iii)	clear method showing $L_1 - L_2 = \lambda/2$	[B1]
(iv)	$0.506 - 0.170 = \lambda/2$; $\lambda = 0.67(2)$ (m) v = 500 x 0.672 v = 336 (m s^{-1}) (only accept 340 m s^{-1} if working shown)	[C1] [C1] [A1]
(c)	smaller wavelength means smaller distances to measure so less accuracy <u>in the measurements</u> /AW Candidate's response shows steps in a logical order as above.	[C1] [M1] [A1] [1]
6(a)	when two waves meet/interfere (at a point) the resultant displacement is the <u>sum</u> of individual <u>displacements</u> (allow the resultant amplitude is the vector/phasor sum of the individual amplitudes)	[B1] [B1]
(b)(i)	constant phase difference (allow 1 mark for same phase difference or same frequency/wavelength)	[B2]
(ii)	path difference = $\lambda/2$	[B1]
(c)(i)	evidence shown that fringe width x = 8.0 mm $a = \lambda D/x = 6.4 \times 10^{-7} \times 1.5/8.0 \times 10^{-3} = 1.2 \times 10^{-4}$ m (give 2 marks for using x = 4.0 mm giving $a = 2.4 \times 10^{-4}$ m)	[B1] [C1] [A1]

Question Number	Answer	Max Mark
(ii)	maximum intensity when y = 0 AND minima at +4 and -4 correct repeat distance, i.e. 8.0 mm with at least 2 full cycles drawn	[B1] [B1]
7(a)	quantum of energy / radiation / packet of energy	[B1]
(b)(i)	$f = E/h = 5.60 \times 10^{-19} / 6.63 \times 10^{-34}$ $f = 8.45 \times 10^{14}$ (Hz)	[C1] [A1]
(ii) 1	minimum energy to release an electron from the surface (of the metal)	[B1]
(ii) 2	$5.60 \times 10^{-19} - 4.80 \times 10^{-19}$ (= 8.0×10^{-20} J)	[B1]
(iii)	$8.0 \times 10^{-20} = ½(9.1 \times 10^{-31})v^2$ giving $v = 4.2 \times 10^5$ (m s^{-1})	[M1] [A1]
(c)(i)	Correct selection of: $\lambda = h/p$ or $\lambda = h/mv$ where all symbols are defined	[M1] [A1]
(ii)	$\lambda = 6.6 \text{ X } 10^{-34} / (9.1 \times 10^{-31} \times 4.2 \times 10^5)$ $\lambda = 1.7 \times 10^{-9}$ (m)	[C1] [A1]
8	Any **Eleven** from: 1 kW h is the energy (transformed by) 1 kW (device) in a time of 1 hour reference to E = Pt/1 kW h = 1000 X 3600 1 kW h = 3.6×10^6 (J) 1 eV is the energy (transformed by an) electron travelling through a p.d. of 1 V reference to E = VQ 1 eV = 1.6×10^{-19} (J) kilowatt hour is useful when considering large amounts of energy/AW electronvolt is useful when considering small amounts of energy/AW eV for photons/in atomic physics/in nuclear physics kW h for domestic use/electrical bills energy of electron **or** lamp in joules (1.6×10^{-13} J and 4.3×10^6 J) (mark to be awarded only if E = Pt or E = VQ not credited) filament lamp: 1.2 kW h electron: 1.0 MeV # Candidate must make specific links to how the size of these answers compare with the Joule.	[B1] [B1] [B1] [B1] [B1] [B1] [B1] [B1] [B1] [B1] [B1] [B1] [B1] [B1] [1]
	Paper Total	**[100]**