



ASSESSMENT and
QUALIFICATIONS
ALLIANCE

Mark scheme

June 2001

GCE

Physics A

Unit PA01

Instructions to Examiners

- 1 Give due credit to alternative treatments which are correct. Give marks for what is correct; do not deduct marks because the attempt falls short of some ideal answer. Where marks are to be deducted for particular errors specific instructions are given in the marking scheme.
- 2 Do not deduct marks for poor written communication. Refer the script to the Awardsmeeting if poor presentation forbids a proper assessment. In each paper candidates may be awarded up to two marks for the Quality of Written Communication in cases of required explanation or description. However, no candidate may be awarded more than the total mark for the paper. Use the following criteria to award marks:
 - 2 marks: Candidates write with almost faultless accuracy (including grammar, spelling and appropriate punctuation); specialist terms are used confidently, accurately and with precision.
 - 1 mark: Candidates write with reasonable and generally accurate expression (including grammar, spelling and appropriate punctuation); specialist terms are used with reasonable accuracy.
 - 0 marks: Candidates fail to reach the threshold for the award of one mark.
- 3 An arithmetical error in an answer should be marked ‘AE’ thus causing the candidate to lose one mark. The candidate’s incorrect value should be carried through all subsequent calculations for the question and, if there are no subsequent errors, the candidate can score all remaining marks (indicated by ticks). These subsequent ticks should be marked ‘CE’ (consequential error).
- 4 With regard to incorrect use of significant figures, normally a penalty is imposed if the number of significant figures used by the candidate is one less, or two more, than the number of significant figures used in the data given in the question. The maximum penalty for an error in significant figures is **one mark per paper**. When the penalty is imposed, indicate the error in the script by ‘SF’ and, in addition, write ‘SF’ opposite the mark for that question on the front cover of the paper to obviate imposing the penalty more than once per paper.
- 5 No penalties should be imposed for incorrect or omitted units at intermediate stages in a calculation or which are contained in brackets in the marking scheme. Penalties for unit errors (incorrect or omitted units) are imposed only at the stage when the final answer to a calculation is considered. The maximum penalty is **one mark per question**.
- 6 All other procedures, including the entering of marks, transferring marks to the front cover and referrals of scripts (other than those mentioned above) will be clarified at the standardising meeting of examiners.

Unit 1

- 1(a) 90 (protons) ✓
(232 – 90 gives) 142 (neutrons), 90 (electrons) ✓ (2)
- (b) X = 90 ✓
Y = (any value between) 212 and 252 ✓ (3)
Z = 90 ✓ (5)
- 2(a)(i) they are annihilated
[or converted to γ rays
or converted to a pair of photons] ✓
- (ii) the rest mass energy is added ✓ (2)
- (b) more massive
more numerous any two ✓ ✓ (2)
have greater kinetic energy (4)
- 3(a) to prevent the α particles being absorbed or scattered ✓
by air molecules ✓ (2)
- (b)(i) little or no deflection ✓
by a majority of α particles ✓
- (ii) some α particles suffer large deflection
[or backscattering occurs] ✓ (3)
- (c) **first** path continues undeflected ✓
third path shows backscattering (inside the dotted circle) ✓
second path undeflected or deflected downwards and
fourth path undeflected or deflected upwards ✓ (3)
(8)

- 4(a) $s\bar{u}$ ✓ ✓ (2)
 (for any quark + antiquark combination
 or for a one s quark in a two quark combination _{max 1})

(b)(i)

	K^-	μ^-	ν_μ
charged particle	✓	✓	×
hadron	✓	×	×
meson	✓	×	×
baryon	×	×	×
lepton	×	✓	✓

✓ ✓ ✓ ✓ (one mark for each correct line)

- (ii) (conserved) lepton or baryon number or energy or momentum ✓
 (not conserved) strangeness ✓ (6)

(c)(i) time ✓

- (ii) A : proton or u quark ✓
 B : neutron or d quark ✓
 C : W^+ (boson) ✓
 D : neutrino ✓

(iii) weak (interaction) ✓

(6)
(14)

- 5(a) electrons move (or excited) from one energy level (or orbit) to another ✓
 emitting or absorbing a definite frequency/wavelength/colour ✓
 or photon energy (of electromagnetic radiation) ✓ (2)

- (b)(i) $E_i = 5.2 \text{ (eV)} \times 1.6 \times 10^{-19}$ ✓
 $= 8.3 \times 10^{-19} \text{ (J)}$ ✓
 (allow e.c.f. if incorrect value of energy in eV)

(ii) ($f = \frac{c}{\lambda}$ gives) $f = \frac{3.0 \times 10^8}{6.1 \times 10^{-7}}$ ✓
 $= 4.9 \times 10^{14} \text{ Hz}$ ✓

(iii) ($\Delta E = hf$ gives) $E = 6.63 \times 10^{-34} \times 4.9 \times 10^{14}$ ✓
 $= 3.2 \times 10^{-19} \text{ (J)}$ ✓
 (allow e.c.f from (ii))

(iv) line drawn from B to D ✓

(v) D to E ✓

(vi) B to C ✓

(9)
(11)

6(a) $(n_2 = \frac{\sin \theta_1}{\sin \theta_2} \text{ gives}) 1.5 = \frac{\sin 35^\circ}{\sin \theta} \checkmark$
 $\theta = 22^\circ \checkmark \quad (22.48^\circ) \quad (2)$

(b)(i) $(\sin \theta_c = 1/n \text{ gives}) \sin \theta_c = \frac{1}{1.5} \checkmark$
 $\theta_c = 42^\circ \checkmark \quad (41.8^\circ)$

- (ii) ray diagram to show:
 one total internal reflection \checkmark
 with one angle of reflection marked as $68^\circ \checkmark$
 correct refraction of ray on exit from top surface with 35° marked \checkmark
 angle of incidence of 22° marked at point of exit \checkmark
(6)
(8)

7(a)(i) electromagnetic radiation behaves either as a particle or as a wave \checkmark

- (ii) (electromagnetic radiation) behaves as a particle $\checkmark \quad (2)$

(b)(i) $hf = \phi + E_k \checkmark$
 $\phi = (6.63 \times 10^{-34} \times 1.67 \times 10^{15}) - (3.0 \times 10^{-19}) \checkmark$
 $= 8.1 \times 10^{-19} \checkmark \quad \text{J} \checkmark \quad (8.07 \times 10^{-19})$

- (ii) (number per second) doubled \checkmark
 (maximum kinetic energy) remains constant \checkmark
- (iii) (all) electrons have insufficient energy to leave the (new) metal \checkmark
 the work function of the (new) metal is greater than hf
 [or the work function of the (new) metal is greater than
 that of the original metal] \checkmark
(8)
(10)

The Quality of Written Communication marks are awarded primarily for the quality of answers to Q5(a) and Q7(b)(iii).