AQA

ASSESSMENT and QUALIFICATIONS ALLIANCE

Mark scheme
January 2004

GCE

Physics A

Unit PA01

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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 Awards meeting 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. Use the following criteria to award marks:

2 marks: Candidates write legibly with accurate spelling, grammar and punctuation; the answer containing information that bears some relevance to the question and being organised clearly and coherently. The vocabulary should be appropriate to the topic being examined.

1 mark: Candidates write with reasonably accurate spelling, grammar and punctuation; the answer containing some information that bears some relevance to the question and being reasonably well organised. Some of the vocabulary should be appropriate to the topic being examined.

0 marks: Candidates who 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 two, three or four significant figures will be acceptable. Exceptions to this rule occur if the data in the question is given to, for example, five significant figures as in values of wavelength or frequency in questions dealing with the Doppler effect, or in atomic data. In these cases up to two further significant figures will be acceptable. 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) 22 (nucleons) ✓
11 (electrons) ✓ (*2*)

(b) charge: $+\frac{2}{3} = -\frac{1}{3} + 1 + 0$ ✓
lepton number: $0 = 0 - 1 + 1$ ✓
baryon number: $\frac{1}{3} = \frac{1}{3} + 0 + 0$ ✓ (*3*)

(c) the electron and the positron are annihilated ✓
γ photon(s)/ γ ray(s) are produced ✓
specifying two (γ) photons/rays ✓
masses converted into energy ✓ max (*2*)
(*7*)

2

(a) baryon qqq
antibaryon $\overline{\text{qqq}}$
meson $\text{q}\bar{\text{q}}$
two names ✓
composition of each sub-group ✓✓ (*3*)

(b)(i) $n \rightarrow p$ ✓ $+ {}^{0}_{-1}\beta^{-}$ ✓ $+ \bar{\nu}_{(e)}$ ✓

(ii) a down (d) quark changes to an up (u) quark
[or udd changes to uud] ✓ (*4*)
(*7*)

3

(a)(i) diagram to show: refraction towards normal on entry ✓
total internal reflection shown along fibre ✓
refraction away from normal on leaving glass ✓

(ii) speed of light decreases on entry into glass and increases on leaving ✓ (*4*)

(b)(i) (use of $\sin\theta_c = \frac{1}{n}$ gives) $\sin\theta_c = \frac{1}{1.57}$ ✓
$\theta_c = 39.6^{o}$ ✓

(ii) ${}_1n_2 \left(= \frac{n_2}{n_1} \right) = \frac{1.57}{1.47}$ ✓ (= 1.07)

$\sin \theta_c = \frac{1}{1.07}$ ✓

$\theta_c = 69.4^o$ ✓

(iii) to protect the core surface
[or to prevent cross-over] ✓

(6)

(10)

4

(a) (use of $hf = \phi + E_k$ gives) $3.2 \times 10^{-19} = \phi + 2.1 \times 10^{-19}$ ✓
$\phi = 1.1 \times 10^{-19}$ ✓ J ✓

(3)

(b) incident energy of each photon is doubled ✓
$6.4 \times 10^{-19} = 1.1 \times 10^{-19} + E_k$ ✓
$E_k = 5.3 \times 10^{-19}$ J ✓

(3)

(6)

5

(a)(i) an electron/atom in an energy level/state or an orbiting electron ✓
is given energy ✓
to move to a higher level or orbit ✓

(ii) electromagnetic radiation is emitted when an electron falls ✓
from one fixed level to another fixed level ✓
giving the photon a discrete amount of energy ✓

max *(5)*

(b)(i) (use of $E = hf$ gives) $f = \frac{9.92 \times 10^{-19}}{6.63 \times 10^{-34}}$ ✓ ($=1.5 \times 10^{15}$ (Hz))

(use of $c = f\lambda$ gives) $\lambda = \frac{3.0 \times 10^8}{1.5 \times 10^{15}}$ ✓
$= 2.0 \times 10^{-7}$ m ✓

(ii) energy (in eV) $\left(= \frac{9.92 \times 10^{-19}}{1.60 \times 10^{-19}} \right) = 6.2$ (eV) ✓
transition from n = 2 to n = 1 ✓

(iii) line between n = 4 and n = 1 ✓
direction from 4 to 1 ✓

(7)

(12)

6

electrons diffract [or high energy electron scattering]✓
showing wave behaviour ✓

electrons are deflected in electric or magnetic fields ✓
showing particle behaviour ✓

interference of electromagnetic waves ✓
showing wave behaviour ✓

photoelectric effect ✓
showing particle behaviour ✓

max (6)
(6)

Quality of Written Communication (Q5(a) and Q6) ✓✓ (2)
(2)