ASSESSMENT and QUALIFICATIONS ALLIANCE

Mark scheme June 2003

GCE

Physics A

Unit PA01

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Unit 1

1

(a) number of protons = number of electrons (e.g.14) ✓
number of protons + number of neutrons = 28 ✓ (*2*)

(b)(i) nuclei with the same number of protons ✓
but different number of neutrons/nucleons ✓

(b)(ii) (137 – 55) = 82 ✓

(b)(iii) $\frac{Q}{m} = \frac{92 \times 1.60 \times 10^{-19}}{236 \times 1.67 \times 10^{-27}}$ ✓
$= 3.73 \times 10^{7}$ (C kg^{-1}) ✓

(b)(iv) X (= 236 – 137 – 4) = 95 ✓ (*6*)
(*8*)

2

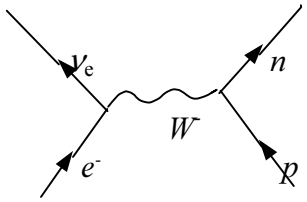
(a)(i) positron, neutron, neutrino, positive pion ✓✓(if all correct)
(lose ✓ for each error)

(a)(ii) electron, proton, negative muon ✓✓(if all correct)
(lose ✓ for each error) (*4*)

(b)(i) $(\mu^-) \rightarrow e^- + \overline{\nu_e} + \nu_\mu$ ✓

(b)(ii) difference: mass or half-life or generation of lepton ✓
similarity: both leptons or both negatively charged ✓ (*3*)

(c)



ν_e ✓
n ✓
p ✓

(*3*)
(*10*)

3

(a) there must be a large distance between collisions to allow
electrons to gain enough energy ✓
[or the vapour must not completely absorb the electrons] (*1*)

(b) the mercury vapour emits ultra violet (radiation) ✓
the coating absorbs electromagnetic radiation/light from the mercury ✓
emits longer wavelengths/lower frequencies ✓
in the visible region ✓

max (3)
(4)

4

(a) the minimum frequency (of radiation) ✓
required to eject photoelectrons ✓ (2)

(b)(i) (use of $\phi = hf_0$ gives) $\phi = 6.63 \times 10^{-34} \times 4.85 \times 10^{14}$ ✓
$= 3.22 \times 10^{-19}$ (J) ✓

(b)(ii) $\phi \left(= \dfrac{3.22 \times 10^{-19}}{1.60 \times 10^{-19}} \right) = 2.01$ (eV) ✓

(allow C.E. for value of ϕ from (i)) (3)

(c) line parallel to the given line ✓
with half the value of the x- intercept ✓ (2)

(d) statement : increase the light intensity/brightness ✓

explanation : more incident photons (per second)
one photon interacts with one electron (any two) ✓✓
more emitted electrons (per second)
greater rate of flow charge (3)
(10)

5

(a)(i) (use of $n = \dfrac{c_1}{c_2}$ gives) $c_{\text{glass}} \left(= \dfrac{3.00 \times 10^8}{1.45} \right) = 2.07 \times 10^8$ m s^{-1} ✓

(a)(ii) use of $\dfrac{\sin\theta_1}{\sin\theta_2} = \dfrac{c_1}{c_2}$ ✓

$c_{\text{liquid}} = \dfrac{2.07 \times 10^8 \times \sin 29.2^\circ}{\sin 26.6^\circ} = 2.26 \times 10^8$ m s^{-1} ✓ (3)

(allow C.E. for values of c_{glass} from (i))

(b) use of ${}_1n_2 = \dfrac{c_1}{c_2}$ and ${}_1n_2 = \dfrac{n_2}{n_1}$ ✓

to give $n_{\text{liquid}} = \dfrac{1.45 \times 2.07 \times 10^8}{2.26 \times 10^8} = 1.33$ ✓

$$\left[\text{or } n_l = \frac{c_1}{c_{\text{liquid}}} = \frac{3\times10^8}{2.26\times10^8} = 1.33\right]$$ (allow C.E. for value of c_{liquid})

[or use $_1n_2 = \frac{\sin\theta_1}{\sin\theta_2}$ and $_1n_2 = \frac{n_2}{n_1}$ to give correct answer] (*2*)

(c) diagram to show :
total internal reflection on the vertical surface ✓
refraction at bottom surface with angle in air greater than that in the liquid (29.2°) ✓ (*2*)
(*7*)

6

(a)(i) an electron moves up from one energy level to another ✓

(a)(ii) an electron is removed from an atom ✓ (*2*)

(b) (use of $hf = E_2 - E_1$ gives) $f = (2.56 - 1.92)\times10^{-19}$ ✓$/6.63\times10^{-34}$
$= 9.65\times10^{13}$ Hz ✓
(allow C.E. for incorrect ΔE) (*2*)
(*4*)

7

(a)(i) electrons behave as both particles and waves ✓

(a)(ii) particle: deflection in an electromagnetic field or other suitable examples ✓
wave: electron diffraction ✓ (*3*)

(b) (use of $\lambda = \frac{h}{mv}$ gives) $v\left(=\frac{h}{m\lambda}\right) = \frac{6.63\times10^{-34}}{9.11\times10^{-31}\times1.7\times10^{-10}}$ ✓
$= 4.28\times10^6$ m s^{-1} ✓ (*2*)
(*5*)

Quality of Written Communication (Q3(b) and Q4(d) ✓✓ (*2*)
(*2*)