OCR

RECOGNISING ACHIEVEMENT

A2 HEALTH PHYSICS

Mark Scheme 2825/2
January 2004

1 (a) (i) $F = 2.1 \times 10^{-6}$ N m (1)

(ii) clockwise moment = anticlockwise moment (for equilibrium) (1)

$2.1 \times 10^{-6} = F_0 \times 6 \times 10^{-3}$ (1)

$F_0 = 3.5 \times 10^{-4}$ N (0)

(b) (i) $P = F / A$ (1)

$P = 2.6 \times 10^{-4} / 65 \times 10^{-6}$ (1)

$P = 4.0$ N m^{-2} (1)

(ii) $P = F / A$ (0)

$P = 3.5 \times 10^{-4} / 3.2 \times 10^{-6}$ (0)

$P = 109$ or 110 N m^{-2} / Pa (1)

(iii) = 27 (1) ecf

(c) (i) 1 Wm^{-2} (1)

(ii) 10^{-12} Wm^{-2} (1)

(iii) I.L. = 10 lg I / I_0 (0)

I.L. = 10 lg 31.6 / 10^{-12} (1)

I.L. = 135 dB (1)

[total 12]

2 relevant points e.g.

description or diagram of body with <u>vertical</u> spine / cog above feet / knees bent (1)

description or diagram of body with spine inclined towards the <u>horizontal</u> / bent at back (1)

reference to larger moment when body leans forward (1)

due to the larger load-pivot distance (1)

and larger centre of mass of body – pivot distance (1)

so back muscles pull with a greater force (1)

causing greater compression on vertebrae / greater damage to tendons / slipped disc (1)

bending knees causes smaller cog – pivot distance (1)

leg muscles do some of the lifting (1)

so less force in back muscles (1)

difficulty of keeping balance / ref. to cog over pivot/toes (1)

to a max. of 7 [total 7]

3 (a) any from the following up to a maximum of 8 marks

piezoelectric crystal deforms when a p.d. is applied across it (1)

crystal oscillates when alternating p.d. is applied (1)

if this frequency matches resonant frequency of crystal, ultrasound is generated (1)

ultrasound in turn causes crystal to resonate (1)

resonating crystal causes alternating voltage across it (1)

pulsing is needed as reflected signal needs to be compared to initial signal (1)

with a continuous a.c. signal, comparison is not possible (1)

backing material damps the crystal vibration after a.c.pulse ends (1)

so that the crystal is ready to receive the reflected signal (1)

(b) (i) $1.4 \times 5.0 \times 10^{-6}$ s $= 7.0 \times 10^{-6}$ s (1)
(tolerance = 1.4 +/- 0.1)

(ii) $s = d / t$ or $d = t \times s$ (0)
$d = 7.0 \times 10^{-6} \times 1.6 \times 10^{3}$ ecf (i) (1)
$d = 0.0112$ m (0)

(iii) $0.0112 \text{ m} / 2$ ecf (ii) (1)
$= 5.6 \times 10^{-3}$ m (1)

(iv) $0.75 \text{ div} \times 5.0 \times 10^{-6}$ s (+/- 0.1 div) (0)
$t = 3.75 \times 10^{-6}$ s (1)
$d = 4.1 \times 10^{3} \times 3.75 \times 10^{-6} / 2$ (1)
$d = 7.7 \times 10^{-3}$ m (+/- 0.5×10^{-3}) (1)

(c) use e.g. monitoring foetal growth (1)
reason e.g. ultrasound is not ionising, X-radiation is ionising (1)
[total 17]

4 (a) (i) vitreous humour and cornea correctly labelled (2)

(b) (i) ciliary muscles alter the shape of the lens (1)
changing the power of the lens (1)

(ii) optic nerve carries impulses from the retina to the brain (1)

(c) <u>distant</u> objects appear blurred (1)
far point is less than infinity (1)
near point is closer than 25 cm (1)

(d) (i) $1/u + 1/v = 1/f$ (1)
$1/0.62 + 1/0.019 = 1/f$ (1)
$f = 0.018(4)$ m (1)

(ii) $p = 1/f$ (0)
$p = 1 / 0.0184$ (1)
$p = 54.3$ D (1)

(iii) $p = 1 / 0.019 - 54.3$ (1)
$p = 52.6 - 54.3$
$p = 1.7$ D (1)

(iv) $1 / 0.25 + 1 / 0.019 = p$ (1)
$p = 56.6$ D (1) [OR $1/0.25 - 1/0.62$ for (2)]
$(56.6 - 54.3) = 2.3$ D (1)
[total 18]

5 (a) stochastic: random effect / has no threshold / severity is affected by dose (1)
e.g. cancer etc (1)
non-stochastic: effect has a threshold (1)
e.g. skin burn etc., (1)

(b) Exposure is the total charge produced per unit mass (or Q / m) (1)
of air (1)

(c) (i) $0.22 \text{ Ckg}^{-1} = 0.22 / 1.6 \times 10^{-19}$ electrons kg^{-1} (1)
or $34 \times 0.22 / 1.6 \times 10^{-19}$ eV kg^{-1}
$= 34 \times 0.22 / 1.6 \times 10^{-19}$ eV kg^{-1} (1)
or 34×0.22 J kg^{-1}
$= 7.48$ (1)
Gy or J kg^{-1} (1)

(ii) type of radiation (1)
absorbing medium (1)

(d) $H_1 = Q \times D$ (1)
$H_1 = 2 \times 7.48 / 2 = 7.48$ ecf (c)(i) (1)
$H_2 = 3 \times 7.48 / 2 = 11.22$ (0)
$H_1 + H_2 = 18.70$ (1)
Sv (1)
[total 16]

6 (a) (i) Idea of zig-zag path (1)
3-5 reflections, i = r. reflection at boundary Any 3 (1)
Refractive index of light guide > air (allow denser)
Provided $i \geq C$, TIR occurs. (1)
(ii) $\sin C = 1/n$ (1)
$C = \sin^{-1}(1/1.58) = 39.3°$. (1)

(b) (i) $E = hc/\lambda = 6.63 \times 10^{-34} \times 3 \times 10^8/413 \times 10^{-9}$ Photon energy (1)
$= 4.82 \times 10^{-19}/1.6 \times 10^{-19} = 3.01$ eV eV conversion (1)
(ii) 10^4 photons = 3.01×10^4 eV (1)
% conversion $= 3.02 \times 10^4 \times 100\%/1.5 \times 10^6 = 2\%$ (1)

(c) (i) $hc/\lambda = 2.2 \times 1.6 \times 10^{-19}$ (1)
$\lambda = 6.63 \times 10^{-34} \times 3 \times 10 / (2.2 \times 1.6 \times 10^{-19})$
$= 566$ nm 560- 570 nm (1)
(ii) the work function is greater than the photon energy / no photoelectron emission Or equivalent (1)
(iii) $hf = \phi + \frac{1}{2} m_e v_{max}^2$ Or $hf = \phi$ + KE (1)
$hf - \phi = (3.02 - 2.2) \times 1.6 \times 10^{-19} = 1.31 \times 10^{-19}$ J (1)
$v_{max} = \sqrt{(2 \times 1.31 \times 10^{-19}/9.1 \times 10^{-31})}$ [Omit eV
$= (5.0\text{-}5.4) \times 10^5$ ms^{-1} conversion: 2/3] (1)
[KE = 3eV or 2.2eV: 1/3]

(d) (i) 3^{12} (1)
$= 531000$ [Allow $3^{13} = 1590000$] (1)
(ii) $Q = ne = 531000 \times 1.6 \times 10^{-19} = 8.5 \times 10^{-14}$ C (1)
$I = Q/t = 8.5 \times 10^{-14} / 3 \times 10^{-9}$ (1)
$= 2.8 \times 10^{-5}$ A Q=e: 1/3 (1)