Mark Scheme 2825/02
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HEALTH PHYSICS

1 (a) correct position of arrow (1)

(b) lowering arm:
triceps string is pulled / in tension
+ raising arm:
biceps string is pulled / in tension (1)

or

lowering arm :
biceps string / released or muscle relaxed

raising arm:
triceps string relaxed (1)

ref. to (tension representing) <u>muscle</u> contraction (1)

(c) clockwise moments = anticlockwise moments (for equilibrium) (1)

B x 0.020m = 0.075 x 9.8 x 0.20 + 0.135 x 9.8 x 0.30 (1)

do not penalise distance in cm
2 / 3 if g = 10 m s^{-2} leading to 27.7 N

B = 27.2 N (1) allow 27 N

2 (a) the change in power / focal length of the refracting system of the eye / lens (1)

by changing the shape of the lens (1)

(ref. to diagram i.e. Fig.2.2) the lens bulges to increase the power (as more refraction is required) / or ….to bend the rays more or Fig.2.2 + statement with ref. to more power etc. (1)

(b) (i) short sight / myopia (1)

(ii) lines meet in front of the retina (1)
<u>refraction</u> shown <u>at cornea</u> + continues ray to retina + originate from object (1)

(c) (i) p = 1/ f = 1/u + 1/v (1)

64 = 1 / 0.60 + 1 / v (1)

v = 0.016(0) m (1) do not allow 0.02 m

(ii) p = 1 / 0.016 + 1 / ∞ (1)
p = 62.3 D (1) allow 62.5 D

(iii) 62.3 – 64 (1) or 62.5 – 64
-1.67 D allow –1.7 D (1) or - 1.5 D

3(a) 1 each to a maximum of 3:-

- Relates frequencies to minimum audible intensities.
- Lowest audible frequency 20 Hz -25 Hz.
- Highest audible frequency 15-20 kHz.
- The ear is most sensitive at 1-3 kHz ...
- ... where it can detect sounds of intensity 10^{-12} W m^{-2} ....
- ... due to resonance in outer ear.
- the ability to detect small changes in frequency
- from 20 – 1000 Hz small changes in frequency are detectable

(b)1 each to a maximum of 3:-

- With age, frequency response becomes less sensitive / weaker / worse / decreases.
- Any sensible reason (eg ear drum is less elastic, etc.)
- Frequency range becomes narrower / highest audible frequency is less, etc.
- Minimum intensities for detecting sounds become greater.

4 any for 1 each to a max. 7 e.g.

cause: uneven curvature of the cornea / cornea not spherical / uneven shape (1)

causing different focal lengths / powers in different planes (1) allow different directions

test: identical black lines in different orientations / diagram (1)

should appear equally black/ clear (1) allow sharp

an astigmatic eye will see some lines darker and more sharply in focus than others (1)

corrective lens:
defect may be corrected with a cylindrical (contact) lens (1)
diagram (1)

such that light in one plane is less deviated while light in the other plane is refracted (1)

description of different focal lengths / powers in different planes (1)

diagram of rays in one plane converging differently to rays in another plane

(1) or explanation

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1 each to a maximum of 7:-

- Electrons are emitted from C / (hot) cathode.
- There is a high voltage between C and A .... or stated p.d. >1000 V
- ... (so) electrons are accelerated towards A / anode.
- Electrical energy becomes KE (of electron).
- Electrons undergo a sudden deceleration at A / collide with A
- (Some of) the KE is converted to X-rays / (electromagnetic) radiation
- The X-rays are produced by the deceleration / reference to bremsstrahlung
- X-rays characteristic of target produced).
- Most of the (kinetic) energy becomes heat / thermal energy.
- The reason for the vacuum.

Other good point (eg anode rotated / inner shell electron of target atom knocked out / higher pd gives more penetrating X-rays/higher energy photons).

6 (a) Low energy X-rays are absorbed by the skin / undesirable as can cause damage / greater ionising (1)

(b) $I = I_0 e^{-\mu x}$ (1) $\ln I = \ln I_o - \mu x$

$I_o = \frac{347}{e^{-250 \times 0.025}}$ (1) $\ln Io = \ln 347 + 250 \times 0.025$

$I_o = 1.79 \times 10^5\ Wm^{-2}$ (1)

(c) $P = I \times A$ (0)

$P = 347 \times \pi \times (0.10 \times 10^{-2})^2$ (1)

$P = 1.09 \times 10^{-3}$ W (1)

(d)(i) $P = 18 \times 100 / 0.15$ (1)
$P = 12000$ W (1)

(ii) $12000 / 7.5 \times 10^{17}$ (= 1.6×10^{-14} J = energy of each electron) (1)

$0.5\ m\ v^2 = 1.6 \times 10^{-14}$ (0)

$v = 1.9 \times 10^8\ ms^{-1}$ (1)

(iii) tube current = $7.5 \times 10^{17} \times 1.6 \times 10^{-19} = 0.12$ A (1)

$V \times I = 12000$ (1)

$V = 12000 / 0.12 = 100{,}000$ V or 100 kV (1)

7 (a) density (of medium) (1)

speed of ultrasound (in the medium) (1) or any factors that affect the speed of ultrasound in the medium e.g. the Young modulus

(b)(i) blood:
$f = (1.59 \times 10^6 - 1.63 \times 10^6)^2 / (1.59 \times 10^6 + 1.63 \times 10^6)^2$ (0)
$f = 1.54 \times 10^{-4}$ (1)

muscle:
$f = (1.70 \times 10^6 - 1.63 \times 10^6)^2 / (1.70 \times 10^6 + 1.63 \times 10^6)^2$ (1)
$f = 4.4 \times 10^{-4}$ (1)

so the medium is muscle (1) bald muscle gets 0/4

(ii) ($s = u \times t$)

$s = 1.54 \times 10^3 \times 26.5 \times 10^{-6} = 0.0408$ m (1)

0408 / 2 = 0.020 m (1)

(iii) $1.54 \times 10^3 / 3.5 \times 10^6 = \lambda$ (1)

4.4×10^{-4} m (1) 4.4×10^{-7} m gets full credit if 10^3 penalised in (ii)

8 (a) no threshold dose / there is always some possibility of effect occurring / probability increases with dose / random effect (1)

(b) e.g. threshold dose (above which the effect occurs) and severity increases with dose (1)
relates skin burn to threshold or severity increase due to prolonged exposure (1)

(c)(i) dose equivalent = absorbed dose x quality factor (1) (must give words)

(ii) 14 mSv = absorbed dose x 20 (1)

absorbed dose = 0.70 (1)

mGy (1) mJ kg^{-1} (allow Gy if answer wrong or J kg^{-1})

9. (a)(i) speed $v = 2\pi r / t$

$v = 2 \times \pi \times 122/2 /(30 \times 60)$ (1)

$v = 0.21$ m s^{-1} (1) allow 0.2 m s^{-1}

(ii) F = 12.5 kN x 16 = 200 kN (1)

(iii) W = F x s or

= 200 k x 2 x π x 122 / 2 (1) ecf (ii) allow ecf for distance from (i)

= 7.7 x 10^7 J (1) allow 8 x 10^7

(iv) P = W / t energy / time or F x v or

= 7.67 x 10^7 / (30 x 60) (1) or ecf (iii) / (30 x 60)

= 42.6 kW (1) allow 43 kW only allow 40 kW if working shown

(v)

- Friction force at bearing opposes motion so not useful (1)
- Friction force of tyres on rim drives wheel, so is useful (1)
- Electrical energy supplies power to drive wheels / useful implied (1)
- Input energy (electrical or energy supplied to motor) is converted into heat (1)

Last point to do with the idea that once moving with constant speed e.g.

- All work is done against friction
- No input energy is converted into E_k
- All input energy ends up as heat
- Any other relevant point relating to energy (1)

(b)(i) X is bigger than Y (as X is under greater tension due to the weight of the bike) (1)

(ii) Q is bigger than P (due to the weight of the wheel causing compression in P) (1)

(c)(i) k = F / x

= 1.8 x 10^6 / 0.90 (1)

= 2.0 x 10^6 Nm^{-1} (1)

(ii) $f = (1/2\pi\ (k/m)^{0.5}$ (0)

$= (1/2\pi\ (2.0 \times 10^6 / 9.5 \times 10^5)^{0.5}$ (1)

= 0.23 Hz (1)

(iii) If wind energy causes this frequency in the structure, the amplitude increases / resonance occurs / or explanation of resonance / ref. to natural frequency (1)
e.g. damping is necessary / mass change to shift resonant frequency / change spring constant(1)