Mark Scheme 2825/02
January 2006

HEALTH PHYSICS

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1 (a)(i) 10^{-12} (Wm^{-2}) (1)

(ii) ...is the minimum intensity / that can be detected by the ear, (1)
at the frequency at which the ear is most sensitive / 1-3 kHz (1)

(b)(i) subjective response of an individual (1)
to sound intensity / intensity level (1)

(ii) any two from
ear is most sensitive at 1 - 3 kHz (1)
as frequency decreases and increases either side of 2 kHz, intensity level must increase in order for the sound to be heard at the same loudness (1)
any comment about points on the graph of equal loudness (1)

(c)(i) I.L. = 10 lg I/I_o (0)
= 10 lg ($4.0 \times 10^{-12} / 1 \times 10^{-12}$) (1) ecf (a)(i)
= 6.02 dB (0)

(ii) 48 dB (1)

(iii) $48 = 10 \lg I / 10^{-12}$ (1) ecf (ii)
$10^{4.8} \times 10^{-12} = I$ (0)
$I = 6.3 \times 10^{-8}$ W m^{-2} (1)

(iv) any sensible answer e.g.
ear has a logarithmic response to sound (1)
intensity range is very large / easily represented by dB scale / manageable numbers (1)
intensity level is proportional to perceived loudness (1)
it makes the threshold value zero (1)

2 (a) clockwise moments = anti-clockwise (at equilibrium) (1)
$24 \times 0.6 + 50 \times 0.3 = F \times 0.03$ (1)
F = 980 N (1)

(b) MA = load / effort (1)
= 24 / 1000 (0)
= 0.024 (1)

(c) any sensible answer to a **max. of 4** e.g.
work done for both systems is the product of F and s / W = F x s (1)
small force means large s / effort moves further than load from pivot (1)
energy change is the same for both systems (1)
MA >1 means small F (1)
and hence large s
muscles would have to move further (1)
bones would have to be larger (1)
bones would have to move further (1)
pivot further from muscles / closer to load(1)
plus a reason why this would be disadvantageous to a **max.1** e.g.
awkward / non-compact shape of body (1)
to a total of 5

3 **Formation of image to a max 3** e.g.

X-rays are detected by a film / scintillation counter etc., (1)
High 'Z' means high attenuation / low transmission
[Allow atomic mass / nucleon number] (1)
shadow on the film / reference to exposure after attenuation (1)
Reference to photoelectric effect / energy range around 1-100keV /
absorption $\propto Z^3$ (1)

Explanation of the use of a contrast medium to a max.4 e.g.

X-rays do not differentiate / show up soft tissues well ...(1)
... as similar absorption / 'Z' is similar / 'Z' is low for these tissues. (1)
Contrast medium has high 'Z' / absorbs X-rays strongly.(1)
It is usually taken orally / as an enema / can be injected.(1)

Example of type of structure that can be imaged to a max.1 ***e.g.***

digestive tract / throat / stomach.(1)

to a max. 8

4 (a)(i) depth of field (1)

(ii) before / in front of the retina (1)

(iii) the image on the retina is not in focus (0)
but it is considered to be acceptably clear (1)

(b) change the shape of the lens (1)
so that the power of the lens may be altered / reference to focusing on different objects (1)

(c)(i) convex shape (1)

(ii) long sight / hypermetropia / presbyopia (1) ecf (i)

(iii) $1/f = 1/u + 1/v$ (1)
$1/f = 1/2 + 1/1$ (1)
$f = 67$ cm (1)

(iv) $p = 1/f$ (1)
$p = 1/ 0.67$ (0) ecf (iii)
$p = 1.5$ D (1)

(d) **cornea-retina distance:**
$1/f = 1/u + 1/v$
$59 = 1/\infty + 1/v$ (1)
$v = 1.7$ cm (0.01695) (1)

power of eye and lens:
$P_e + 1.5 = 1/0.25 + 1/0.017$ (1)
$P_e = 61.5$ D (1)

near point :
61.5 = 1/u + 59 (1)
u = 40 cm (1)

5(a) 6 points plotted correctly (1)
remaining point plotted correctly (1)
sensible continuous smooth graph drawn (1)

(b)(i) 0.95 +/- 0.10 mm (1)

(ii) $I / I_o = e^{-\mu x}$ (1)
$0.50 = e^{-\mu\, 0.0009}$ (1)
$\mu = 730$ (1)
m^{-1} (1)

6(a) H = Q x D (0) terms identified (1)

(b) **either :**
alpha particles are attenuated in 2-3 cm of air (1)
so all of the ionisation occurs in this small volume (1)
:or
beta-particles are attenuated in a much greater distance (1)
so energy is dissipated over a larger volume (1)
to a max. 2

(c) (i) $20 \times 5 \times 50 \times 1.0 \times 10^{-6} = 5.0 \times 10^{-3}$ Sv (1)
$+ 6 \times 10^{-3}$ Sv $= 11 \times 10^{-3}$ Sv (1)

(ii) comment with respect to MPL (and background radiation) (1)

7 **Medical uses of an endoscope [2 marks]:-**

Any **TWO** e.g.
To view inside the body./ named area e.g. stomach (1)
To view a second named area etc., (1)
To carry out minor surgical operations / keyhole surgery / incisions (e.g ulcers, cancers) (1)
To get tissue samples (1)
To remove obstacles from the stomach, etc.(1)

How light rays pass through optic fibres to a max. 2 e.g.

reference to total internal reflection(1)
explanation: 'i' is greater than 'c' / cladding is less (optically) dense than fibre (1)

Explanation of the use of coherent / non-coherent bundles *to a max. 3* e.g.

the meaning of coherent in this context (1)
non-coherent fibres are used to take light to the area (1)
coherent fibres are used to convey / construct the image (1)

Question	Expected Answers		Marks	
8				
(a)	*either* (If in parallel) when one bulb fails, other bulbs stay on *or* (If in parallel) can identify which bulb has failed;		1	[1]
(b)(i)	$P = VI$ $0.5 = 240\,I$ $I = 2.1 \times 10^{-3}$ A 1 s.f. in answer (-1) once only		1 1	[2]
(ii)	$R = V/I$ $= 240/(2.1 \times 10^{-3})$ $= 1.14 \times 10^{5}\,\Omega$ or $1.15 \times 10^{5}\,\Omega$ accept $(1.1 \text{ to } 1.2) \times 10^{5}\,\Omega$	ans	1 1	[2]
(iii)	$A = \rho l / R$ $= 1.1 \times 10^{-6} \times 6.0 \times 10^{-3} / (1.14 \times 10^{5})$ $(= 5.79 \times 10^{-14}\,\text{m}^2)$ $A = \pi r^2$ $5.79 \times 10^{-14} = \pi r^2$ so $r = 1.4 \times 10^{-7}$ m		1 1 1	[3]
(iv)	filament too thin / fragile to be manufactured / used without damage; allow ecf from **(iii)**.		1	[1]
(c)	**P**: 0 V **Q**: 0 V; **R**: 240 V **S**: 240 V current is zero (1) p.d. across (any intact) bulb becomes zero (1) so all 240 V across Y (1)	any 2	1 1 2	[4]

d(i) *either* set B bulb(s) have less resistance (than set A bulbs)
or adding (each) set B bulb lowers circuit resistance; 1

either so current increases (when set B bulb inserted)
or p.d. across (each) bulb increases
or any valid argument using V^2/R; 1

so power dissipation (in any bulb) increases; 1 [3]

(ii) set A bulbs fail first; 1

Then
either Failure current for set A bulb $I_f = \sqrt{P/R} = \sqrt{0.75/200} = 0.0612$ A; 1
When failure occurs <u>total</u> resistance of set = 240 / 0.0612 (= 3920); 1
Let X be number of 50 Ω bulbs substituted
3920 = 50X + 200(24 - X) ; 1
so X = 5.87 bulbs , so 5 or 6 bulbs;

or Total initial resistance = 24 x 200 = 4800 Ω
After substituting X set B bulbs, resistance = 4800 - 150 X (1)
Current = 240/(4800 - 150 X) (1)
So power in a set A bulb,
$P = I^2R = [240/(4800 - 150X)]^2 \times 200 = 0.75$ for failure (1)
This gives X = 5.87 i.e. 5 or 6 bulbs [4]