OCR

RECOGNISING ACHIEVEMENT

HEALTH PHYSICS

Mark Scheme 2825/02
January 2003

1.	(a)(i)	$qV = 1.6 \times 10^{-19} \times 100000$	1	
		$= 1.6 \times 10^{-14}$ J	1	
	(ii)	$E = hc / \lambda$ or $E = hf$ and $c = f \times \lambda$	1	
		$\lambda = 6.6 \times 10^{-34} \times 3.0 \times 10^{8} / 1.6 \times 10^{-14}$	1	
		$= 1.24 \times 10^{-11}$ m	1	
	(b)	Electrons knocked out of (deep-lying) energy levels	1	
		Outer electron fills vacancy	1	
		X-ray photon is emitted with energy equal to the difference in levels.	1	
	(c)	Ba has high atomic number	1	
		so attenuates large amounts	1	
		so less X-rays reach film	1	
		soft tissue has low Z	1	
		so less absorption / larger contrast with Ba	1	[13]
2.	(a)(i)	$H = Q \times D$ or $10 \times 10^{-3} = 2 \times D$	1	
		$D = 5 \times 10^{-3}$	1	
		Gy	1	
	(ii)	$E = D \times m = 5 \times 10^{-3} \times 60$ (allow ecf from (i))	1	
		E = 0.30 J	1	
	(b)	X-ray (pulses) are sent through the body from different directions	1	
		Intensity of received pulses measured for each angle	1	
		Computer constructs image from data received at each position	1	
	(c)	stochastic effect:	1	
		any 1 from		
		no threshold	(1)	
		probability is proportional to the dose received	(1)	
		or differentiation by description of non-stochastic:		
		severity not affected by threshold level or		
		severity increases with increase in dose	(1)	
		any 5 relevant points e.g.		
		cells killed at a greater rate for cells that divide	(1)	
		cancerous cells divide at a greater rate	(1)	
		rotating beam / etc.,	(1)	
		tumour at centre of rotation	(1)	
		cancerous cells have slow rate of repair	(1)	
		X-rays given in fractions	(1)	[15]
3.	(a)	$IL = 10 \log I / I_o$	0	
		$I_o = 10^{-12}$ Wm^{-2}	1	
		$55 = 10 \log I / 10^{-12}$	1	
		$I_1 = 3.16 \times 10^{-7}$ Wm^{-2}	1	
		$I_2 = 2.5 \times 10^{-6}$ Wm^{-2}	1	
		$I_1 / I_2 = 7.9$	1	
		(allow reasoned argument leading to answer of 8 for full credit)		
	(b)(i)	shape	1	
		minimum intensity at 10^{-12} Wm^{-2}	1	
		maximum intensity at 10^{2} Wm^{-2}	1	
		frequency range 20 – 20 kHz	1	
		frequency of minimum at 2 – 3 k Hz	1	
	(ii)	line above (b)	1	
		minimum at 10^{-8} Wm^{-2}	1	[12]

4. (a) scotopic:
ref. to low intensity light 1
ref. to no colour detail 1
photopic:
ref. to high intensity light 1
ref. to perception of colour 1
allow 2 out of 4 if the wrong way around

(b) As light intensity falls, colour fades as cones become less responsive 1
peripheral vision dominates as rods become more responsive or (distinct) outline seen with no detail / don't see as well / fovea stops working 1
nothing is detected at 0 Wm^{-2} 1

(c)(i) shape and position of green 1
red and blue position 1
All lines start on and higher than 400nm 1
All lines end before and on 750nm 1

(ii) max. response of the cones and rods at about 500 nm 1
relevant comment e.g 1
high absorption at this wavelength or easily detected by eye
seen both at night and in the day [13]

5. (a) Σ clockwise moments = Σ anticlockwise moments (for equilibrium) 1
$\underline{E \times 0.020} = \underline{20 \times 0.15} + \underline{120 \times 0.33}$ 1
$E = 2130$ (N) 1

(b) MA = load / effort 1
Allow either
MA = 120 / 2130 = 0.056 or
MA = 140 / 2130 = 0.066 1

(c) (perpendicular) distances of (lines of action of) forces to fulcrum are less 1
both reduced by the same factor 1 [7]

6. (a)(i) $t = s / v$ or
$t = 0.018 / 1.5 \times 10^3$ 1
$t = 1.2 \times 10^{-5}$ s 1

(ii) $t_2 = 0.016 / 4.0 \times 10^3 = 4.0 \times 10^{-6}$ s 1
allow 2 x answer to (a)(i)

(b)(i) 2.4×10^{-5} s 1

(ii) $2.4 \times 10^{-5} / 4.0 \times 10^{-6} = 6$ 1

(iii) B at 6.0 cm from A 1
C at 2.0 cm from B 1
(ignore heights)

(iv) large reflection at the air / skin boundary 1
due to the large difference in acoustic impedance between air and skin 1
so very little ultrasound penetrates into the body 1
(or there is very little ultrasound to be reflected off subsequent boundaries.) [10]

7 (a)(i) 1015 N (accept 1010-1020)
(ii) 130 N (accept 125-135)
both correct, no unit penalty 1 [1]

(b) $F = ma$ written or implicit
$(1015-130) = 1100a$ 1
so $a = 0.80\ ms^{-2}$ (accept 0.80-0.81, accept 0.8 in place of 0.80) 1
(1015+130) can get only 1 0 0 = 1/3 max) 1 [3]

(c) $18\ ms^{-1}$ (accept 15-21) 1
find largest difference/distance between force graphs (and note speed) or clear from graph 1 [2]
'where lines cross' gets 0/1
'it is the terminal velocity' gets 0/1

(d) $49.7\ ms^{-1}$ (accept 49.5 - 50.0) 1
speed is max. when driving force equals/balanced by drag force
accept 'speed where forces are equal' if speed has been stated correctly 1 [2]

(e) 220 N (accept 220 - 225) 1

work done = force x distance
= 220 x 1000
$(= 2.2 \times 10^5\ J)$ 1
allow ecf from incorrect graph reading 1 [3]
220 x 1000 only gets 1 0 1 = 2/3
22 x (anything) loses last mark

(f) work done = $35(2)x1000 = 3.5(2)x10^5$ J accept $(3.5 - 3.6)x10^5$ 1 [1]

(g) distance travelled on 1 litre at $31\ ms^{-1} = 2.2x16/3.5(2)$ 1
= 10.0 km (9.8 - 10.1) 1 [2]
allow (total) energy (in 1 litre of fuel) = $16 \times 2.2 \times 10^5$ for 1/2
reference to $22(ms^{-1})$ or $31(m\,s^{-1})$ gets 0/2

(h) ke = $\frac{1}{2}mv^2$
= $\frac{1}{2}$ x $1100x31^2$ $(= 5.29x10^5$ J) subs. 1 [1]

(i) (ke lost =) heat gained = $mc(\theta_2 - \theta_1)$
$5.3x10^5 = 8x460\ \Delta\theta$ either of first two lines correct (1)
$\Delta\theta = 144$ K so $\theta_2 = 144 + 15 = 159\ ^\circ C$ calculation of 144 (1)
addition of 15 (1)
assumption: brakes initially at 15 °C
all heat is dissipated in brakes no heat lost from brakes
no air resistance/drag any assumption (1)
not Law of Energy
assumption without calculation can score 1/3
any 3 3 [3]

(j) $W = Fd$ or $F = ma$ and $v^2 - u^2 = 2as$ (1)

$5.3 \times 10^5 = 9300d$ $9300 = 1100\,a$ so $a = 8.45 (m\,s^{-1})$

so $d = 57$ m $31^2 (- 0^2) = 2 \times 8.45\,s$ so $s = 57$ m (1)

assumption: no work done against (other) drag forces

car is on horizontal road

air resistance negligible

any valid assumption (1)

'constant braking force' and 'constant deceleration' get 0/1

any 2 2 [2]

[Total 20]