OCR

RECOGNISING ACHIEVEMENT

HEALTH PHYSICS

Mark Scheme 2825/02
June 2003

1 (a)(i)　　the ability of the ear to just detect a sound / minimum intensity that can be
　　　　　detected (at a given frequency) / allow 'quietest sound'　　　　**(B1)**
　　　　　do not allow 'minimum frequency'

　　(ii)　　the variation of the (minimum) detectable intensity with frequency　　**(B1)**
　　　　　or the ability of the ear to detect changes in frequency
　　　　　 and any 1 from　　　　　　　　　　　　　　　　　　**(B1)**
　　　　　most sensitive at about 1 – 3 kHz
　　　　　increasingly less sensitive at frequencies < 1 kHz　and > 3 kHz
　　　　　responds in the frequency range 20 – 10 kHz

　　(iii)　　resonance (due to the length of closed ear canal) /
　　　　　length of ear canal $\lambda / 4$　　　　　　　　　　　　　　**(B1)**

　(b)(i)　　$IL = 10 \lg I/I_0$
　　　　　$I_0 = 10^{-12}\ W\,m^{-2}$　　　　　　　　　　　　　　　**(C1)**
　　　　　$23 = 10 \lg I / 10^{-12}$　　or　　$\lg(I / I_0) = 2.3$　　　　·　**(C1)**
　　　　　$I = 2.0 \times 10^{-10}\ W\,m^{-2}$　　(1.99×10^{-10})　　　**(A1)**

　(ii)(no,) as the minimum intensity required to be detected at a frequency of
　　　　　200Hz is about $10^{9}\ W\,m^{-2}$ / no because it is lower than the threshold (at
　　　　　that frequency) / ecf (b)(i)　　　　　　　　　　　　　**(B1)**

2 (a) (i) $3 \times 2.8 \times 10^3$ m $= 8.4$ mm or 8.3 mm if calculated with $\mu = 250$ m^{-1} **(A1)**

  (ii) $I/I_o = e^{-\mu x}$ **(B1)**
      ln 0.125 = $-\mu \times 3 \times 2.8 \times 10^{-3}$ or ln 0.50 (or $-$ln2) $= -\mu \times 2.8 \times 10^{-3}$ **(B1)**
      $\mu = 248$ m^{-1} **(B1)**

  (b)   less photons (or X-rays) get through   **(B1)**
      some photons are absorbed / scattered / or ref. to
      photoelectric effect *do not allow other attenuation mechanisms* or
      'reflection'   **(B1)**

  (c) (i) word equation q x V or $1.6 \times 10^{-19} \times 80 \times 10^3$ **(C1)**
          $= 1.28 \times 10^{-14}$ J   **(A1)**

    (ii) $0.020 / 1.28 \times 10^{-14}$ ecf (i)   **(C1)**
         $= 1.56 \times 10^{12}$ **(A1)**

    (iii) p = E / t
         t = 0.020 / 200   **(C1)**
         t = 1.0×10^{-4} s   *allow 1×10^{-4} s*   **(A1)**

   (iv)   D = E / m   **(C1)**
         D = $0.020 / 65 \times 10^{-3}$ **(C1)**
         D = 0.31   **(A1)**
         Gy or J kg^{-1} (allow Jg^{-1} if answer is 3.1×10^{-4})   **(B1)**

  (d)   any 5 from
      direct: ionisation of (biologically important) molecules such as DNA   **(B1)**
      which damages DNA   **(B1)**
      leading to mutation / cancer / cell death /failure of cell to divide
      /cell damage   **(B1)**

      indirect: causes ionisation of water molecules (in cells) / produces free
      radicals / hydrogen peroxide formed / oxidising agent formed   **(B1)**
      which reacts with DNA   **(B1)**

      damages cell membrane / affects permeability of cell membrane   **(B1)**

3 (a) table: any 3 correct, **(B1)**   (ignore sig.fig.)   4th correct **(B1)**
      0.25,   0.50,   1.00,   2.00
  (b) 5 points plotted correctly **(B1)** +/- ½ a small square   6th correct **(B1)**
      line of best fit   **(B1)**

  (c) measurements correctly taken from graph   **(B1)**
      gradient calculated as 1.04 +/- 0.05   *do not allow 1*   **(A1)**

  (d) y-intercept measured or calculated as 52.5 +/- 0.1   **(A1)**
      unit D   **(B1)**

  (e) 1/b is the image distance / or 'b' is the power of the eye when viewing an
      object at infinity / or power of the eye when eye is relaxed / unaccommodated
                                                                                   (B1)
      it is a constant as the distance from the retina to the cornea is fixed / ref. to
      the minimum power of the eye is fixed / power cannot get any lower   **(B1)**

4 (a) (i) *near point:* is the closest point (to the eye) that an object may be placed
and still be in focus / viewed clearly   **(B1)**

(ii) *accommodation:* the ability of the eye to change its power / focal length
ref. to changing the shape of the lens /ability of eye to focus on objects at
different distances from the eye   **(B1)**

(b) (i) $p_1 = 1/u_1 + 1/v$ *allow substitution of v as about 0.020 m*
$p_2 = 1/u_2 + 1/v$
$p_1 - p_2 = 1/u_1 - 1/u_2$ **(C1)**
change in power = $1/0.25 - 1/0.15$ **(C1)**
= (-)2.67 D   **(A1)**

(ii) concave / diverging *(do not allow ecf from (i))*   **(B1)**

5 (a)   correct position of T indicated by a line ending on the black area of the
muscle   **(B1)**
any correct position of X   **(B1)**

(b)   ligaments hold the bones together   **(B1)**

(c)   total weight supported by legs is $0.70 \times 700 = 490$ N   **(C1)**
each leg weighs $(700 - 490)/2 = 105$ N   **(A1)**

(d)   centre of mass / centre of gravity is moved   **(B1)**
over the other foot / leg   **(B1)**

(e) (i) moment = force x (perpendicular) distance to fulcrum   **(C1)**
moment = $4.0 \times 9.8 \times 0.20\cos45°$ **(C1)**
moment = 5.54Nm   **(A1)**
7.84 Nm (omit cos 45) gets 2/3   5.6 or 5.7 Nm (g = 10 ms^{-2}) gets 2/3

(ii) clockwise moment (at equilibrium) = anticlockwise moments or
$F \times 0.020\sin45° = 5.54$ **(C1)**
F = 392N   *F = 277 N (omit sin 45) gets ½*   **(A1)**

(iii) MA = load / effort   **(C1)**
MA = $4.0 \times 9.8 / 392$ ecf from (ii)   **(C1)**
MA = 0.10 *ignore units if given*   *0.1 scores 1/3 unless with working* **(A1)**

6 *Any 7 e.g.*

nuclei /atoms, (with unequal nos. of neutrons and protons) spin **(B1)**
act like tiny magnets **(B1)**
align in an external magnetic field **(B1)**
they precess / wobble **(B1)**
RF radiation pulse is applied **(B1)**
resonance occurs / nuclei flip **(B1)**
RF emitted by nuclei and detected **(B1)**
the time taken for the nuclei to return to their equilibrium state (is measured)
/ time taken to return to equilibrium state is called the relaxation time **(B1)**
hydrogen atom is (most commonly) used **(B1)**
different tissues have different hydrogen content and so can be differentiated
(B1)

any 2 e.g.
it is <u>non-ionising</u> **(B1)**
differentiates well between tissues (of similar density) **(B1)**
higher resolution **(B1)**
allow response if corresponding disadvantages given

7	(a)		Quieter Less pollution/more environmentally friendly	Or other valid point, eg petrol supplies finite, safety(batteries less of fire hazard), can utilise renewable energy	2
	(b)		$P = VI$ 750 Wh = 750/12 = 62.5 Ah	0/3 for wrong ans no working 0.75/12=0.0625 (2/3) 3/3 for correct ans.	1 1 1
	(c)	(i)	No. of batteries = 960/16 = 60 No of kWh = 0.75 x 60 = 45 kWh = 45 x 1000 x 3600 =162 MJ	-1 for each error 1.62×10^8 MJ (2/3)	1 1 1
		(ii)	Work done = Fd D = 162×10^6/300 = 540 km	Allow 1sf if working shown	1 1 1
	(d)	(i)	Mass of petrol = 162/50 kg = 3.24 kg Volume = m/ρ(stated or implied) =3.24/700 = 4.6×10^{-3} m^3	Ecf Or equivalent	1 1 1 1
		(ii)	Energy lost/not 100% efficient As heat etc.	General comment + detail	1 1

	(e)		Compare :-
			  • mass,
			  • size,
			  • likely performance of petrol vs batteries,
			  • sensible statement about range
			Concluding comment
				Any 3 from 4	3