ASSESSMENT and QUALIFICATIONS ALLIANCE

Mark scheme June 2003

GCE

Physics B

Unit PHB2

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PHB2

Section A

Question 1

(a)(i)	**L** between UV and microwaves	B1	**1**
(ii)	**U** between microwaves and medium radio waves	B1	**1**
(b)	gamma radiation	B1	**1**

Question 2

(a)	place a sheet of aluminium/metal between source and detector	M1	
	Sheet thickness stated 2 to 10 mm thick or several/a few mm thick **plus** only gamma radiation can pass through such a sheet or alpha and beta will be absorbed/stopped by the sheet	A1	**2**
(b)	count rate $\propto 1/r^2$ or evidence of $C_1/C_2 = r_2^2/r_1^2$	C1	
	25 counts per second (allow cps or s^{-1}) (Bq is a up)	A1	**2**
(c)	their value calculated in (b) plotted correctly and reasonable attempt to draw correct curvature	C1	
	Correct point (25 cps) plotted with correct curvature (mark quality: must not flatten out or rise at end of their line for large distances)	A1	**2**

Question 3

(a)(i)	diffraction/interference	B1	**1**
(ii)	sin $\theta = \lambda/b$ allow for substitution with incorrect angle (or $1.22\lambda/b$)	C1	
	angle for first minimum 0.011° (allow 0.0100 – 0.0115)	C1	
	670 nm (allow 640 – 700 nm) (allow 550 nm - 580 nm if $1.22\lambda/b$)	A1	**3**
(b)	0.35 sin 0.011 or 0.35 tan 0.011 (ecf for angle from (a)(ii))	M1	
	6.7(2) x 10^{-5} m	A1	**2**

Question 4

(a)(i)	meson (not muon)	B1	**1**
(ii)	-1 or -1.6×10^{-19} C or $-e$	B1	**1**
(iii)	0	B1	**1**
(b)	baryon number $0 \rightarrow 0 + 0$ (satisfied or ^{c}s) (allow statement that as these are all leptons baryon number is not relevant owtte)	B1	
	lepton number $-1 \rightarrow -1 + 1$ x or not satisfied	B1	
	charge $(+)1 \rightarrow (+)1 + 0$ (satisfied or ^{c}s)	B1	**3**

Question 5

(a)(i)	correct substitution in $v = Hd$ ignoring powers of 10	C1	
	4600 (allow 4610 or 4620) (Mpc)	A1	**2**
(ii)	the distance to the edge/radius of the (observable) universe or the furthest galaxy that is visible	B1	**1**
(b)	distance = $4600 \times 10^{6} \times 3.3$ (light years) (ecf from (a)(I)) (this is for conversion from Mpc to light years so allow if seen in a 'wrong method' calculation of time using distance/3×10^{8})	C1	
	time for light to travel to Earth = $1.5(2) \times 10^{10}$ years (ecf from (a)(I)) **NB not 'light years'**	A1	**2**

Section B

Question 6

(a)(i)	2(.0) x 10^{-5} m (i.e. allow 1 sf)	B1	**1**
(ii)	λ = 4(.0) x 10^{-4} (m)	B1	
	$v = f\lambda$ (condone $c = f\lambda$)	C1	
	3.0 MHz sf penalty applies allow e.c.f. for omitting 10^{-4} (300 Hz) but sf penalty applies for e.g. 0.3 kHz)	A1	**3**
(b)(i)	ultrasound/wave/pulse/energy <u>spreads out</u> from the transmitter (beam not uni-directional)	B1	
	<u>energy is absorbed</u> by(or lost to) the transmitting medium/tissue/body	B1	
	incident ultrasound/wave/pulse/energy is <u>not all reflected</u> (by the reflecting object) **or** some is transmitted /absorbed by the organ **or** is reflected at different angles (so does not return to detector)	B1	
	some ultrasound/wave/pulse/energy reflected by the skin <u>since gel was not used</u> **ANY 2**	B1	**Max 2**
(ii)	distance travelled 1200 x 95 or 114 000 or 0.114 m (i.e. mark for **use of** velocity x time ignoring powers of 10)	C1	
	0.057 m (allow answers in range 0.055 to 0.057)	A1	**2**
			Total 8

Question 7

(a)(i)	6.7 (6.67) x 10^{-3} s	B1	**1**
(ii)	At least one complete cycle shown (may be a poor attempt) **and** period 6.7 x 10^{-3} s (ecf) (may be a decaying amplitude) **or** amplitude = 3 mm clear from scale (must be constant amplitude)	C1	
	At least two complete cycles shown (must be reasonable attempt at sine wave and show constant half periods and constant amplitude) Both period and amplitude shown period 6.7 x 10^{-3} s (ecf) and amplitude = 3 mm **Condone silly scales** **up applies**	A1	**2**

(b)	third harmonic: three loops shown (condone wave 'snapshot')	B1	
	maximum amplitude 1 mm clear from scale	B1	**2**
(c)	tension in the string (condone tighter string) Increased tension increases <u>frequency</u> (not leads to faster oscillations) **or** frequency is proportional to $\sqrt{\text{tension}}$ (not $\sqrt{T}$ unless T is defined)	M0 A1	
	plus any one from: mass per unit length of the string Increases mass per unit length reduces <u>frequency</u> **or** frequency is inversely proportional to $\sqrt{\text{mass per unit length}}$ **or** frequency is proportional to $\frac{1}{\sqrt{\text{mass per unit length}}}$ (not $1/\sqrt{\mu}$ unless μ defined)	M0 A1	
	density of the material (for same thickness) condone heavier string/more weight or more mass increased density etc. reduces frequency	M0 A1	
	thickness of the string (for the same material) increased thickness reduces frequency	M0 A1	**2**
	Allow B1 for stating tension and mass per unit length as factors without correct effects	B1	
(d)	Higher harmonics/frequencies (above 1000 Hz) are missed/not transmitted or only frequencies between 100 Hz and 1000 Hz are transmitted **NOTE:** Consequence is not essential but saying that the note will sound lower is 'Talk Out' Allow quieter or poorer quality as consequences	B1	**1**
			Total 8

Question 8

(a)(i)	positron / positive electron / beta + (**not** β^+)	B1	
	(electron) neutrino	B1	**2**

	(condone as ecf 'antineutrino' if electron or beta$^-$ stated for other particle) **−1 from total for each additional particle but condone neon-21**		
(ii)	11	B1	**1**
(b)(i)	activity after 1 half life = 0.75 x 10^{10} (Bq) (half of 1.5 x 10^{10})	B1	
	number of particles after 1 half life = 2.5 x 10^{11} *N* corresponds to their *A* The above may be seen substituted in $\lambda = A/N$	B1	
	divides their activity by their number of nuclei; answer + unit (probability = 0.03 s^{-1} gets 2) (no sf penalty) **OR** Arrives at correct answer using half life = 21 to 23 s and $\lambda = 0.69/t_{1/2}$	B1	**3**
(ii)	number of particles emitted per second, activity = 4.56 (4.6) x 10^9	C1	
	time read from graph 2 consistent with their activity or their activity/(i) (i.e. numerical substitution correct) (may be by implication in answer)	C1	
	number of particles (cao) (1.5-1.6) x 10^{11}	A1	**3** **Total 9**

Question 9

(a)(i)	Doppler effect/shift	B1	**1**
(ii)	The universe is expanding (**not** The universe is moving outwards/away) or The universe is the result of a 'big bang'	B1	**1**
(b)	change in wavelength = 60 nm and use of $\Delta\lambda/\lambda = v/c$ (condone either λ for this mark)	C1	
	3.0 to 3.1 x 10^7 m s^{-1} **OR** Calculates one frequency correctly using $c = f\lambda$ (5.08 x 10^{14} Hz or 4.62 x 10^{14} Hz)	A1 C1	**2**
	Arrives at 2.7 to 2.8 x 10^7 m s^{-1} (using approximation $\Delta f/f = v/c$) or 3.0 to 3.1 x 10^7 m s^{-1} (using $\Delta f/f' = v/c$)	A1	

(c)	$d \sin \theta = n\lambda$	C1	
	correct substitution for d (2.22×10^{-6} m or $1/(4.5 \times 10^{5})$ seen and $n\lambda$ ($2 \times 590 \times 10^{-9}$) (condone incorrect power of 10 for λ)	C1	
	32(.1)° (or 32(.4) if d is rounded to 2.2×10^{-6} m)	A1	**3**
(ii)	useful diagram showing more than two slits with path differences shown (not just waves spreading out from slits)	B1	
	Max 4 for answer that refers only to two slits throughout mention of interference or superposition	B1	
	light from slits is coherent (condone sources are coherent)	B1	
	path difference (from slits) is a multiple of one wavelength	B1	
	waves arrive in phase (condone light arrives in phase)	B1	
	interference is constructive	B1	
	waves add to produce larger amplitude/intensity/bright light (may be awarded for a good diagram that shows this)	B1	
	explanation of different spectral lines for the same wavelength	B1	
	lines are bright because waves from many slits are interfering (owtte)	B1	**Max 5**
	At least 3 marks for physics + use of Physics is accurate, the answer is fluent/well argued with few errors in spelling, punctuation and grammar	2	
	At least 1 mark for physics + some incorrect work the use of Physics is accurate, but the answer lacks coherence or spelling, punctuation and grammar are poor	1	
	the use of Physics is inaccurate, the answer is disjointed, with significant errors in spelling, punctuation and grammar	0	**Max 2**
			Total 15

Question 10

(a)	40 kHz	B1	**1**
(b)	Higher frequencies will not be recognised/transmitted/lost **OR** Some peaks/troughs /variations will be missed	B1	**1**
(c)	Number of bits required per second for each station = 40 000 x 8 (ecf from (a))	C1	
	Total channels = 1.5 x 10^8/bits per second required for each station (Answer 468 gets both marks **NB** NOT 469 (e.c.f. from(a) 1.875 x 10^7/their (a), rounded down) **Allow B1 only for use of 20 kHz and arriving at 937 stations**	A1	**2**
(d)	Each signal is sampled in turn	B1	
	Use time division multiplexing	B1	
	Diagram to aid explanation	B1	
	Signals sent in sequence ABCDABCD	B1	
	Signals only use fibre for part of the time	B1	**Any 2**
	Fibre-cable energy losses are less or Transmit further without repeater/boosters/amplifiers or Less frequent repeaters/boosting	B1	
	Less noise/interference (condone no noise but not that it reduces noise)	B1	
	Higher information handling capacity or Greater number of stations can use a single fibre	B1	
	Signal more secure/cannot be tapped	B1	**Any 2**

At least 3 marks for physics + use of Physics is accurate, the answer is fluent/well argued with few errors in spelling, punctuation and grammar	2	
At least 1 mark for physics + some incorrect work the use of Physics is accurate, but the answer lacks coherence or spelling, punctuation and grammar are poor	1	
the use of Physics is inaccurate, the answer is disjointed, with significant errors in spelling, punctuation and grammar	0	**Max 2**
		Total 10