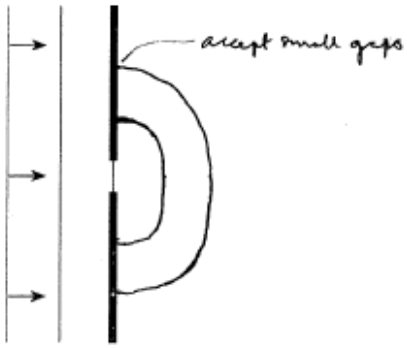
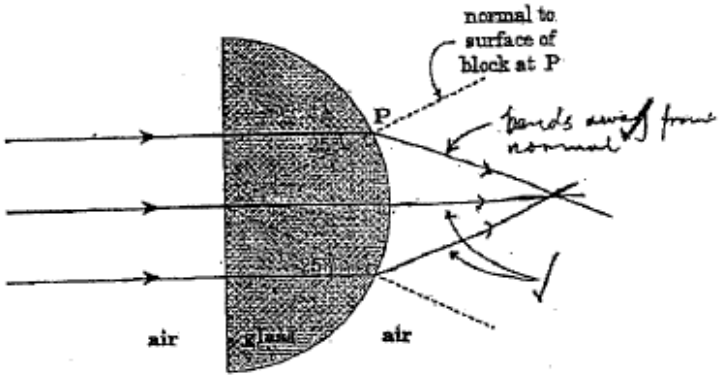
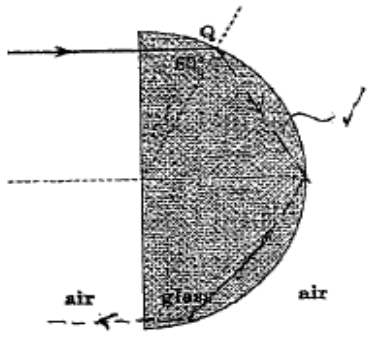
GCE Physics - PH2

Mark Scheme - January 2013

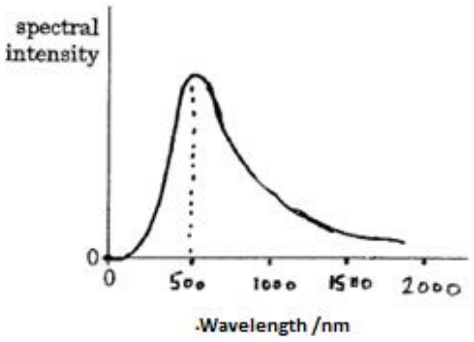
Question			Marking details	Marks Available
1	*(a)*	(i)	3.0 [cm] [accept 3 cm]	[1]
		(ii)	v = 3.0 x 5.0 (1) [cm s^{-1}] or by implication. **Full ecf on λ** $t = \frac{d}{v}$ applied (1) t = 0.70 s (**ecf** on λ) (1) OR $d = \frac{10.5}{3.0}$ (1) T = 0.20 [s] (1) [$t = 0.20x\frac{10.5}{3.0}$] t = 0.70 [s] (1)	[3]
		(iii)	B in phase, C not in phase (in antiphase not acceptable), D in phase - irrespective of explanations. (1) Correct answer and understandable explanation or 'in phase' explained, for one of B, C or D. (1) Correct answer and understandable explanation for another of B, C, or D. (1)	[3]
	(b)	(i)	Diffraction	[1]
		(ii)	Rounded and (almost) semicircular (Accept gaps of <=3 mm) (1) λ constant (1) (within about 30%)  	[2]
		(iii)	Any 2 x (1) from: • λ decreased [No penalty for (say) 'halved'] • less spreading • side beams	[2]
			Question 1 total	**[12]**

Question			Marking details	Marks Available
2	*(a)*	(i)	Constructive interference at P / waves arrive in phase at P (1) Same path length from sources / AP = BP / no path difference (1)	[2]
		(ii)	52.2 **and** 50.2 (1) λ = 2.0 [cm] (1) **ecf on slips** OR 56.8 **and** 52.8 (1) λ = 2.0 [cm] (1) **ecf on slips**	[2]
		(iii) (I)	$\lambda = \frac{10.0x10.0}{50}$ (1) = 2.0 cm (1) **UNIT** OR $\lambda = \frac{10.0x12.0}{50}$ (1) = 2.4 cm (1) **UNIT**	[2]
		(II)	AB or SP not very small compared with D OR maxima not evenly spaced	[1]
	(b)	(i)	d = 2.0 x 10^{-6} [m] (1) or by implication 3λ = d* sin72.3^o (1) [d* needs to be related to d, even 5.0 x 10^5 would do] λ = 6.35 x 10^{-7} [m] (1)	[3]
		(ii)	Up to 3rd order visible, 1 + 3x2 beams seen OR diagram (1) $\frac{d}{\lambda}$ = 3.15 (1) so only 3 orders (1) not a freestanding mark OR $\frac{4\lambda}{d}$ >1 (1) so only 3 orders (1) not a freestanding mark	[3]
			Question 2 total	**[13]**

Question			Marking details	Marks Available
3.	(a)	(i)	(I)  	[2]
			(II) 1.58 sin25^o = [1.00] sin *a* (1) or equivalent or by implication *a* = 42^o (1)	[2]
		(ii)	(I) Either *c* = 39^o (1) 60^o>39^o or equivalent (1) OR 1.58 sin 60^o gives error (1) So refraction not possible or TIR [needs *attempt* to justify] (1)	[2]
			(II) TIR at Q and at least one more instance of TIR with subsequent **ecf** (1) As drawn with reflected ray at Q going off East of South, eventually emerging through diameter face ,with at least one more TIR event.(1)  	[2]
	(b)	(i)	Thinner	[1]
		(ii)	Monomode: parallel to axis (accept straight) Multimode: zig-zag paths as well (1) or some paths involve reflections	[1]
		(iii)	Only one route for data (1) [no zig-zag routes] Each pulse [data element etc] arrives [at other end of fibre] at same time (1) No overlapping of pulses (1) [even over long distances]	[3]
			Question 3 Total	**[13]**

Question			Marking details	Marks Available
4	*(a)*		Any 4 x (1) from: • light [energy] in discrete packets • one electron ejected by one photon OR photons don't co-operate • energy not accumulated [by electron] over time or emission from instant light shines • intensity has no effect on E_{kmax} or accept intensity affects number emitted per second • wave theory doesn't predict Einstein's equation or doesn't predict threshold frequency	[4]
	(b)	(i)	$E_{kmax} = (6.63 \times 10^{-34} \times 8.7 \times 10^{14} - 3.8 \times 10^{-19})$ (1) $E_{kmax} = 1.97 \times 10^{-19}$ [J] (1)	[2]
		(ii)	These photons eject electrons with smaller E_{kmax} (1) E_{kmax} same as previously with some explanation given (1)	[2]
		(iii)	Correct use of $c = f\lambda$ (1) e.g. to give $\lambda_{thresh} = 523$ [nm] OR $f_{400\ nm} = 7.5 \times 10^{14}$ [Hz] OR $f_{700\ nm} = 4.3 \times 10^{14}$ [Hz] Comparison of 400 [nm] with λ_{thresh} (1) or 7.5×10^{14} [Hz] with f_{thresh} (5.73×10^{14} [Hz]) or substitution of 7.5×10^{14} [Hz] into Einstein's equation. Conclusion : It can (1) [if reasoned]	[3]
			Question 4 Total	**[11]**

Question			Marking details	Marks Available
5	*(a)*		$E = \frac{hc}{\lambda}$ (1) or equivalent e.g. $E = hf$ and $f = \frac{c}{\lambda}$ λ = 880 [nm] (1)	[2]
	(b)	(i)	Photon disappears and the electron gains its energy **or** electron promoted from G to U	[1]
		(ii)	1. [Passing] photon 2. Of energy 2.26 x 10^{-19} [J] or λ = 880 [nm] or equivalent 3. Causes electron to drop [from U to G] 4. Releasing additional photon 5. Identical to or in phase or polarised in the same direction or travelling in the same direction with the incident photon Award (1) mark for each of statements 1, 3 and 4 Award the 4th mark for either statement 2 or 5.	[4]
		(iii)	Electron drops [from U to G] by itself (or randomly or without stimulation...), with emission of photon	[1]
	(c)	(i)	Raising electrons to higher level or causing population inversion	[1]
		(ii)	So more electrons in higher level than lower (1). So stimulated emission more probable than absorption (1).	[2]
			Question 5 Total	**[11]**

Question			Marking details	Marks Available
6	*(a)*	(i)	$A = 4\pi(8.54 \times 10^{8}\ [m])^2$ (1) [$9.16 \times 10^{18}\ [m^2]$] $P = 5.67 \times 10^{-8}$ x area attempt x 5790^4 (1) [W] $P = 5.84 \times 10^{26}$ [W] and consistency **ecf on slips** (1) [One mark to be lost for slips e.g. powers of 10, factors of 2, 4, π] Or alternative solution using Stefan's law is acceptable.	[3]
		(ii)	$I = \dfrac{power}{4\pi(4.1x10^{16})^2}$ (1) $I = 2.76 \times 10^{-8}$ Wm^{-2} **UNIT (1)** [penalty of 1 mark for slips of 10^n, 4, π etc no penalty if same slip as in (i)]	[2]
		(iii)	$\lambda_{pmax} = \dfrac{2.9x10^{-3}}{5790}$ (1) = 5.01×10^{-7} [m] (1) GRAPH - Goes through origin and doesn't hit the axis (1) Peak at ~ 500 nm (Apply **ecf**) (1)  	[4]
	(b)		*P* goes up and *T* goes down and then *A* goes up (1) Because $A = \dfrac{P}{\sigma T^4}$ or any convincing explanation (1)	[2]
			Question 6 Total	**[11]**

Question			Marking details	Marks Available
7	*(a)*		Name (1) [e.g. antiproton, antineutron] Quarks (1) [e.g. $\bar{u}\bar{u}\bar{d}$, $\bar{u}\bar{d}\bar{d}$]	[2]
	(b)	(i)	Must be neutral or lepton number conserved (1) ν_e by considering charge and lepton number (1)	[2]
		(ii)	1st mark : π^+ (1) Either 2 x (1) from: • y can't be a lepton [violates lepton conservation] • y must be positive • y can't be a baryon OR y must have u quark number [2-1] = 1 (1) and d quark number [1-2] = -1 (1)	[3]
		(iii)	In (i) Yes – quark flavour changes or neutrino (1) In (ii) No – quark flavours conserved (1) [accept no neutrino]	[2]
			Question 7 Total	**[9]**