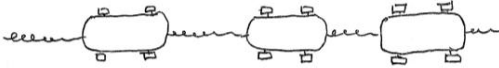
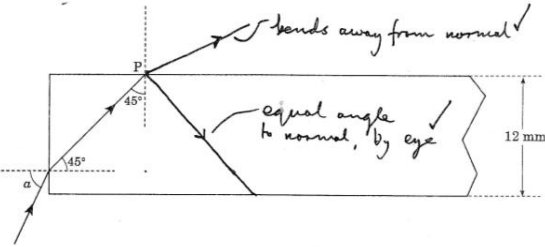
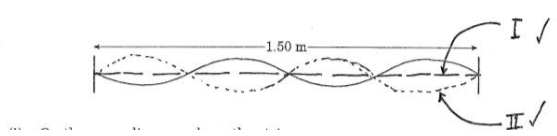
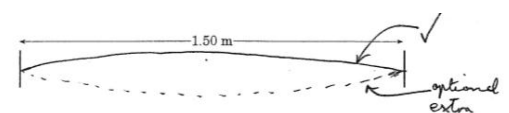


GCE Physics - PH2

Question 1			Marking details	Marks Available
1.	(a)	(i)	0.40 [m]	[1]
		(ii)	0.20 [s]	[1]
		(iii)	$f = 5.0$ [Hz] (1) or $v = \frac{\lambda}{T}$ or by implication $v = 2.0$ [m s ⁻¹] (1) ecf on T and λ F <u>and</u> J	[2]
	(b)		[1]	
	(c)	(i)	Direction of oscillations or trolley motion (accept particle vibration or wave oscillations) and direction of [wave] travel (1) are at right angles. (1)	[2]
		(ii)		[1]
			Question 1 total	[8]

Question 2			Marking details	Marks Available	
2.	(a)		Use of $v = \frac{d}{t}$ even if factor of 2 is omitted, or powers of 10 adrift (but not both these faults). (1)		
			$v = 340 \pm 10$ m s ⁻¹ UNIT (1) Answer must be seen to be derived. No marks for gradient attempt.	[2]	
	(b)	(i)	I	$\lambda = \frac{0.30 \times 0.16}{1.2}$ [m] (1) or by implication $\lambda = 0.040$ [m] (1) [0.080 m, arising from $y = 0.32$ m, loses 1 mark]	[2]
			II	$v = 332$ [m s ⁻¹] ecf	[1]
		(ii)	I	Dot nearest A should be marked 'M'.	[1]
		II	Waves [from S_1 and S_2] arrive in phase at M Accept constructive interference <u>and</u> whole number of wavelengths path difference.	[1]	
	(iii)		$\lambda = 1.1$ [m] or $\lambda > a$ or $\lambda > 0.3$ [m] or $\lambda > S_1 S_2$ (1) Maximum path difference possible [for waves from S_1 and S_2] is [the slit separation, which is only] 0.30 m or path difference can never be large enough (1) Or [Young's fringes equation gives] 'first' maximum at 4.4 m from central dot. Accept fringes too far apart.	[2]	
			Question 2 total	[9]	

Question 3		Marking details	Marks Available	
3.	(a)	<p>Award 3 x (1) of:</p> <ul style="list-style-type: none"> • Refraction is change in direction of travel as waves change medium / air to glass (or equivalent). • AB, CD are wavefronts (or peaks or crests). • AB goes to CD. • Waves travel more <u>slowly</u> in 2 than in 1. • Hence $BD < AC$ Accept wavelength less in medium 2. • Direction of travel of waves is normal to wavefronts. 	[3]	
	(b)	(i)	<p>[1.00] $\sin \alpha = 1.33 \sin 45^\circ$ (1) or equivalent or by implication $\alpha = 70^\circ$ (1)</p>	[2]
		(ii)	<p>I</p>  <p>No need for arrow heads. No penalty if reflected ray doesn't reach the bottom of the fibre.</p>	[2]
	(c)	(ii)	<p>II</p> <p>6 reflections needed [including that at P] (1) Light travels 12 mm parallel to rod axis between successive reflections. (1) or by implication Light has to travel 60 [mm] beyond P (1) Accept 72 [mm] Award 2 marks for 17 mm x 5 = 85 [mm] Award 1 mark for 17 mm x 6 = 102 [mm]</p>	[3]
		(i)	<p>$c = 49^\circ$ (1) $50^\circ > 49^\circ$ or $50^\circ > c$ AND so refraction not possible / TIR / no power loss (1)</p>	[2]
		(ii)	<p>Total internal reflection</p>	[1]
Question 3 Total			[13]	

Question 4		Marking details	Marks Available
4.	(a)	Interference between or superposition of or sum of two [progressive] waves [of equal amplitude and frequency] (1) Travelling in opposite directions or reflect (1)	[2]
	(b)	(i) 	[2]
		(ii) $\lambda = 0.75$ [m] (1) or by implication $f = 128$ Hz UNIT (1)	[2]
	(c)	(i) 	[1]
		(ii) $\lambda = 3.00$ [m] or by implication ecf provided λ consistent with diagram (1) $f = 32$ [Hz] (1) ecf	[2]
(d)	32 n [Hz] or equivalent	[1]	
Question 4 Total			[10]

Question 5		Marking details	Marks Available
5.	(a)	(i) ϕ is [minimum] energy needed to release an electron <u>from surface</u> [or from metal or from material]. (1) No marks for giving meaning of f_0 . So [minimum] <i>photon</i> energy needed is ϕ . (1) So $hf_0 = \phi$ or $E_{\text{photon}} = hf$ (1)	[3]
		(ii) Award 2 x (1) of: <ul style="list-style-type: none"> • More photons per second • Individual photon energies unchanged • $E_{k\text{max}}$ depends on energy of individual photon or $E_{k\text{max}} = hf - \phi$ does not include intensity. Accept: Photons don't co-operate [in releasing electrons].	[2]
	(b)	Increase / adjust pd until nano-ammeter shows zero current [or equiv.] (1) Read voltmeter (1) or by implication $E_{k\text{max}} = eV$ (1)	[3]
	(c)	(i) Gradient = $6.7 [\pm 0.2] \times 10^{-34}$ [J s] (1) Mention of Planck's constant and sensible comparison (1)	[2]
		(ii) $\phi = 4.1 [\pm 0.2] \times 10^{-19}$ [J] (1) barium but only award mark if some reasoning given e.g. correct reference to intercept (1)	[2]
Question 5 Total			[12]

Question 6		Marking details	Marks Available
6.	(a)	(i) $\Delta E = 1.87 \times 10^{-19}$ [J] (1) $\lambda = \frac{hc}{\Delta E}$ (1) or equivalent, including $\lambda = \frac{c}{f}$ and $f = \frac{c}{\lambda}$. $\lambda = 1.06 \times 10^{-6}$ m (1) ecf on arithmetical slip in ΔE .	[3]
		(ii) $\lambda = 7.9 \times 10^{-7}$ [m]	[1]
	(b)	(i) More electrons [accept atoms, ions] in <u>U</u> than in <u>L</u>	[1]
		(ii) PI ensures stimulated emission (1) more likely [frequent] than absorption [for photons of energy 1.87×10^{-19} J] (1) Stimulated emission needed for light amplification because in each stimulated emission event 2 photons out for 1 in or implied by “in phase”. (1)	[3]
		(iii) Electrons drop from L [to ground state] leaving L depopulated. (1) Making it easier to have more electrons in U than L or making a PI easier to establish or needing less pumping. (1)	[2]
Question 6 Total			[10]

Question 7		Marking details	Marks Available
7.	(a)	(i) Ultraviolet [or u-v]	[1]
		(ii) $\lambda_{\text{peak int}} = \underline{55 \text{ nm}}$ and $T = \frac{W}{\lambda_{\text{peak int}}}$ or by implication (1) $T = 53\,000$ K (1) ecf on 50 or 60 nm	[2]
		(iii) In tail of curve [or equivalent] greater intensity at smaller λ . Accept blue end of visible nearer peak than red end.	[1]
	(b)	(i) $I = \frac{P}{4\pi r^2}$ (1) or equivalent so $P = 2.11 \times 10^{33}$ [W] (1) or by implication So $P/P_{\text{sun}} = 5.49 \times 10^6$ or $5 \times 10^6 P_{\text{sun}} = 1.9 \times 10^{33}$ [W] (1)	[3]
		(ii) $A = \frac{P}{\sigma T^4}$ with A as subject ecf on P and T (1) or by implication $r = \sqrt{\frac{A}{4\pi}}$ (1) or $d = \sqrt{\frac{A}{\pi}}$ or by implication $d = 4.0 \times 10^{10}$ [m] (1) [one mark lost for factor of 2 or 10^n adrift.]	[3]
Question 7 Total			[10]

Question 8		Marking details	Marks Available
8.	(a)	(i) They interact by the <u>weak interaction</u> . (1) Interactions [very] infrequent compared with strong or e-m. (1) [or other correct and relevant comment e.g. no charge]	[2]
		(b)	(i) Combination of 3 quarks
		(ii) Lepton no: $1 + 0 = 0 + 0 + 1$ (1) or equivalent Charge: $0 + e = e + e + (-e)$ (1) or equiv. e.g. $0+1 = 1+1-1$	[2]
		(iii) For the 1 st mark either of these (u or d): - u: $[0 +] 1 + 2 \rightarrow 2 + 2 [+0]$ or $3 \rightarrow 4$ - d: $[0 +] 2 + 1 \rightarrow 1 + 1 [+0]$ or $3 \rightarrow 2$ For the 2 nd mark: the other (i.e. u or d) and remark that a d has changed to a u OR equivalent N.B. $uud + udd \rightarrow uud + uud$ is an alternative for the 1 st mark.	[2]
		(iv) <u>Lepton</u> number not conserved.	[1]
		Question 8 Total	[8]