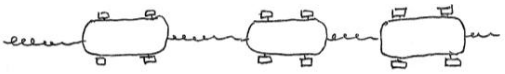
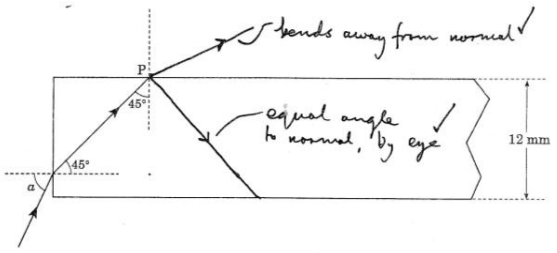
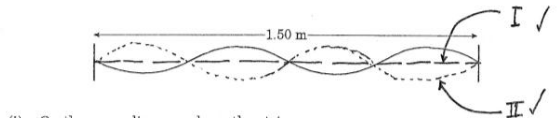
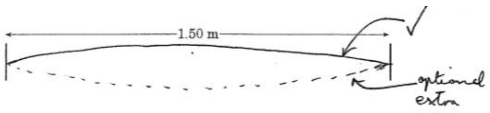
GCE Physics - PH2

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	[2]
	(b)		F <u>and</u> J	[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 = <u>340 ± 10 m s^{-1} **UNIT**</u> (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 λ = 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)		λ = 1.1 [m] **or** $\lambda > a$ **or** λ > 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)*			Award 3 x (1) of: • 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)		[1.00] sin α = 1.33 sin 45° (1) **or** equivalent **or** by implication α = 70° (1)	[2]
		(ii)	I	 No need for arrow heads. No penalty if reflected ray doesn't reach the bottom of the fibre.	[2]
		(ii)	II	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]	[3]
	(c)	(i)		c = 49° (1) 50° > 49° **or** 50° > c **AND** so refraction not possible / TIR / no power loss (1)	[2]
		(ii)		Total internal reflection	[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) I II		[2]
		(ii)	λ = 0.75 [m] (1) **or** by implication f = <u>128 Hz **UNIT**</u> (1)	[2]
	(c)	(i)		[1]
		(ii)	λ = 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** <u>from metal</u> **or** <u>from material</u>]. (1) No marks for giving meaning of f_0 . So [minimum] *photon* energy needed is ϕ. (1) So $hf_0 = \phi$ **or** $E_{photon} = hf$ (1)	[3]
		(ii)	Award 2 x (1) of: • More photons per second • Individual photon energies unchanged • E_{kmax} depends on energy of individual photon **or** $E_{kmax} = hf - \phi$ 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 $E_{kmax} = eV$ (1)	[3]
	(c)	(i)	Gradient = 6.7 [± 0.2] x 10^{-34} [J s] (1) Mention of Planck's constant and sensible comparison (1)	[2]
		(ii)	ϕ = 4.1 [± 0.2] x 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 than in 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)	$\lambda_{\text{peak int}}$ = <u>55 nm</u> **and** $T = \frac{W}{\lambda_{peak\,int}}$ 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	[1]
		(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 1st mark either of these (u or d): - u: [0 +] 1 +2 → 2 + 2 [+0] **or** 3 → 4 - d: [0 +] 2 +1 → 1 + 1 [+0] **or** 3 → 2 For the 2nd mark: the other (i.e. u or d) **and** remark that a d has changed to a u **OR** equivalent N.B. uud + udd → uud + uud is an alternative for the 1st mark.	[2]
		(iv)	<u>Lepton</u> number not conserved.	[1]
			Question 8 Total	**[8]**