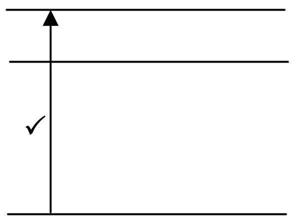
Question			Marking details	Marks Available
5.	*(a)*	(i)	Wire with rule positioned (1) and labelled moving pointer / jockey / croc clip (1) **Either c**orrectly positioned ohm-meter with no power supply **or** correctly position ammeter and voltmeter with power supply (1)	3
		(ii)	[Different] length[s] of wire (1) **Either** measure V and I **or** measure / read R (1)	2
		(iii)	Diameter of wire [not radius or csa by accept "thickness"] with micrometer / vernier calliper	1
		(iv)	cross-sectional area fro πr^2 or $\pi(d/2)^2$ (1) graph of R against l [**or** mean value of R/l] (1) ρ = gradient × [cs]a [**or** mean value of R/l × csa] (1) [NB $R = V/I$ given here can be used to credit 2nd mark of (ii)] [NB Finding R for a measured length and [cs] area and then ρ calculated → 1 only]	3
	(b)	(i)	$R \propto l$ (1) $\therefore$ R increases as strain gauge gets longer (1) $R \propto {}^1/A$ (1) $\therefore$ R increases as the strain gauge gets thinner (1) [**or** $R = \frac{\rho l}{A}$ or $\rho = \frac{RA}{l}$ (1), A increases & l decreases (1) ρ doesn't change /constant (1) so resistance increases (1)]	4
		(ii)	[csa =] $0.2 \times 10^{-3} \times 0.0012 \times 10^{-3}$ [or equiv.] (1) $\rho = 4.9 \times 10^{-7}\ \Omega$ m ((**unit**)) (1) [ecf from csa calculation] [ecf on powers of 10 in both A and l]	2
		(iii)	**Either** $1.6 = \frac{650}{650 + R} \times 6$ (1) Manipulation (1); $R = 1788\ \Omega$ (1) **Or** $I = \frac{1.6}{650}$ (=2.46×10^{-3} A) (1) $R = \frac{(6-1.6)(1)}{2.46 \times 10^{-3}} = 1788\ \Omega$ (1)	3 **[18]**

PH2 Mark Scheme – January 2010

Question			Marking details	Marks Available
1	*(a)*	(i)	I. 2 arrows drawn upwards at right angles to wave fronts	1
			II. The waves travel more slowly in the shallow water (1) as the propagation direction bends towards the normal (or equiv) (1)	2
		(ii)	I. Wavelength = 8 [±1] mm	1
			II. $f = \frac{0.33\text{ m s}^{-1}}{0.008\text{ m}}$ (1) [or by impl.] (e.c.f. on λ) = 40 or 41 Hz (1) [−1 on wrong power of 10]	2
			III. Attempt clearly based upon unchanged f <u>or</u> $\frac{v_s}{v_d} = \frac{\lambda_s}{\lambda_d}$ (1) [or by impl.] v = 0.21 [±0.02 m s^{-1}] (e.c.f. on f) (1)	2
	(b)	(i)	Total internal reflection	1
		(ii)	$1.58\sin 72^\circ = n_{clad}\sin 90^\circ$ [or by impl.] (1) $n_{clad} = 1.58\sin 72^\circ$ <u>or</u> $\sin 90^\circ = 1$ <u>or</u> by impl. (1) $n_{clad} = 1.50$ (1) [Angles transposed, leading to n = 1.64, or other transposition errors → 1 mark only]	3
		(iii)	Light takes longer by zigzag paths [accept 'multimode dispersion'] [Accept – different paths give different times] (1) A piece of data will be 'smeared out' over time on arrival <u>or</u> may overlap other pieces of data (1) [Accept 'pulse broadening' only if first mark gained by reference to zigzag paths, i.e. **not** 'multimode dispersion' + 'pulse broadening' only (2)]	2
				[14]

Question			Marking details	Marks Available
2.	*(a)*	(i)	At [centres of] bright fringes: • Path lengths from slits differ by 0, λ, 2λ... [if sources in phase] • Waves arrive in phase or sketch graphs of in-phase waves • Waves interfere constructively or displacements add to make larger displacement. • Assume slits act as coherent sources or waves diffract at slits any 4 × (1)	4
		(ii)	Separation of centres of fringes $= \frac{4.0}{3}$ mm / 1.3 mm / 1.33 mm [or equiv, or by impl.] (1) Correct data substitution into $\lambda = \frac{ay}{D}$ ignoring factors of 10 [e.c.f.] (1) $\lambda = 6.3 \times 10^{-7}$ m (1)	3
	(b)	(i)	2[.00] $\times 10^{-6}$ m	1
		(ii)	Attempt to use $n\lambda = d\sin\theta$ with $d = 2.00 \times 10^{-6}$ m [e.c.f.] (1) $\theta = 72°$ (1) $n = 3$ (1) $\lambda = 6.3 \times 10^{-7}$ m (1) [e.c.f. only on d from *(b)*(i)]	4
	(c)		More uncertainty with Young's method (1).... because..... **either** fringe separation is small and difficult to measure [whereas grating beams are well spaced] **or** fringes are not sharp compared to the beams (1) [accept: d can be measured more accurately for grating [because there are more slits]	2
				[14]

Question			Marking details	Marks Available
3	*(a)*	(i)	… in phase (1) … in antiphase [accept <u>completely</u> or 180° or π out of phase] (1)	2
		(ii)	Use stroboscope (1) and adjust flash frequency for slow motion / expect to see **A** moving up as **C** moves down etc. (1) [**Or:** Use a video camera and replay in slow motion / expect to see **A** moving up as **C** moves down etc.]	2
	(b)	(i)	**Either:**<u>Amplitude</u> constant [or falls off] for progressive wave (1) as we go through the medium; goes up and down [regularly] form stationary wave (1) **Or:** <u>Phase</u> changes steadily with distance for progressive waves (1); reverses at nodes [otherwise constant] form stationary waves (1) ["Stationary waves have nodes, progressive waves don't" → 1]	2
		(ii)	Reflections give rise to waves propagating in both directions (1); interference between these [progressive] waves gives stationary wave (1)	2
	(c)	(i)	0.6 m	1
		(ii)	30 m s^{-1} ((**unit**))	1
				[10]
4.	*(a)*	(i)	<u>Photon</u> energy	1
		(ii)	$E_{k\ max}$ is the maximum KE of emitted electron (1) ϕ is the minimum energy for an electron to escape (1). What is left over of the photon's energy after the escape is its kinetic energy. (1)	3
	(b)	(i)	Graph: Points [±0.2 divisions] (1); line [not necessarily extrapolated] (1)	2
		(ii)	I. 3.8 [± 0.2] × 10^{-19} J	1
			II. $\frac{(4.04-0.79)\times10^{-19}\text{ J}}{(11.8-6.9)\times10^{14}\text{ Hz}}\left[\text{or } \frac{\Delta y}{\Delta x} \text{ from graph}\right]$ (1) = 6.6 [± 0.4]× 10^{-34} Js (1) NB. Must be value from working.	2
		(iii)	Graph line drawn with same slope (1) and to left of / above that for sodium (1)	2
				[11]

Question			Marking details	Marks Available
5	*(a)*		$\Delta E = \frac{hc}{\lambda}$ [**or** $\Delta E = hf$ **and** $c = f\lambda$] [or by impl.] (1) $\lambda = 6.95 \times 10^{-7}$ m (1)	2
	(b)	(i)	Absorption [accept excitation]	1
		(ii)	Increases atom's [accept electron's]energy [accept 'excites atom' unless excitation credited in part (i)](1)	1
	(c)	(i)	<u>Stimulated</u> emission	1
		(ii)	Any 2 × 1 of: frequency [or wavelength or energy] / phase / propagation direction / polarisation	2
	(d)	(i)	More electrons in the higher (middle) level than the lower [or ground]	1
		(ii)	Arrow shown on Process B from lowest level to top level. 	1
		(iii)	Shorter time at top level (1) to maintain population of middle level (1)…	2
				[11]