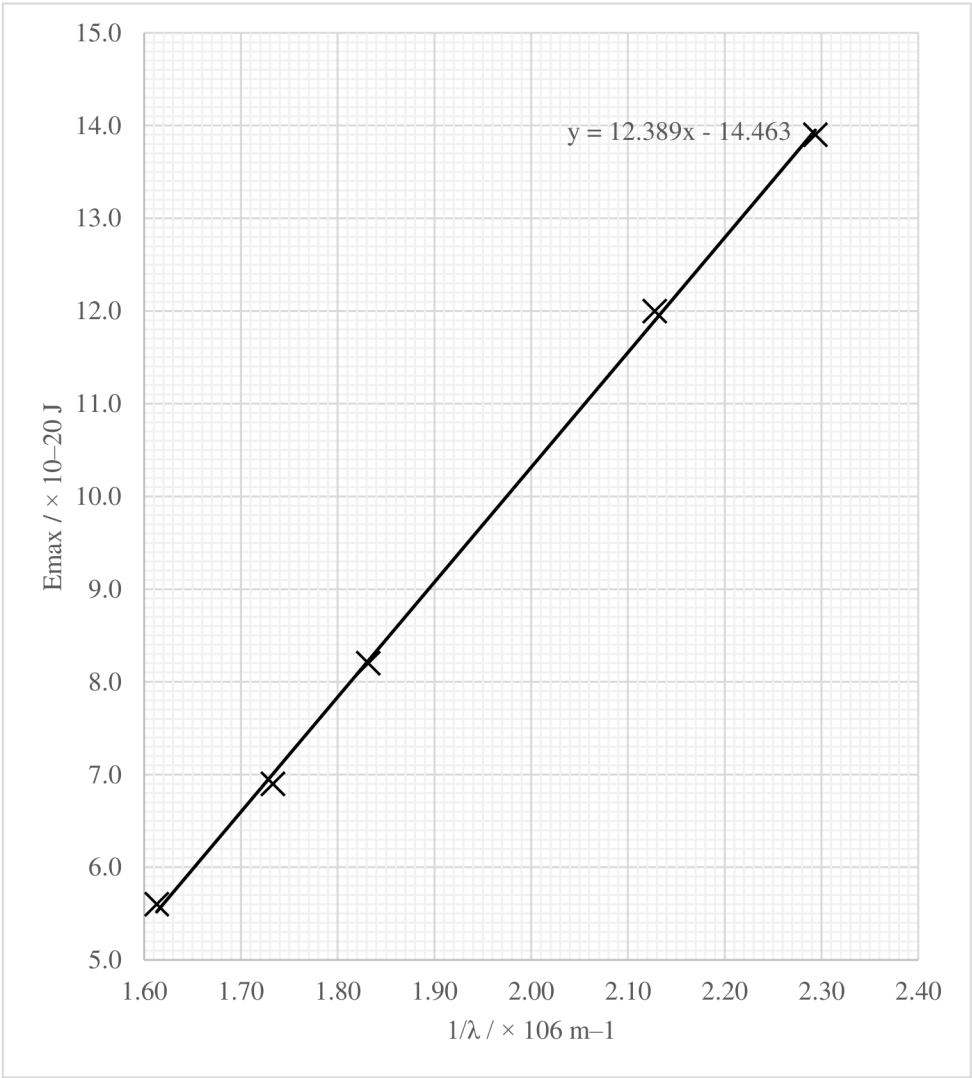
Question Number	Answer	Mark
4(a)(i)	• $1/\lambda$ values correct and rounded to 3 s.f. **(1)** • Axes labelled with quantities and units **(1)** • Sensible scales **(1)** • Plotting **(2)** • Line of best fit **(1)**	**6**

V_s / V	E_{max} / 10^{-20} J	λ / nm	$1/\lambda$ / 10^6 m^{-1}	$1/\lambda$ / nm^{-1}
0.35	5.6	620	1.61	0.00161
0.43	6.9	577	1.73	0.00173
0.51	8.2	546	1.83	0.00183
0.75	12.0	470	2.13	0.00213
0.87	13.9	436	2.29	0.00229



4(a)(ii)	• Rearranges equation to $E_{\max} = hc\frac{1}{\lambda} - \phi$ • Compares this to $y = mx + c$ **and** identifies $m = hc$ MP2 dependent on MP1	**(1)** **(1)**	**2**
4(a)(iii)	• Calculates gradient using large triangle • Use of gradient = hc • h value between 4.0×10^{-34} J s and 4.3×10^{-34} J s • ... and h value rounded to 2 or 3 sf <u>Example of calculation</u> Gradient = $(12.8 - 6.6) \times 10^{-20}$ J / $(2.2 - 1.7) \times 10^{6}$ m = 1.24×10^{-25} J m $h = 1.24 \times 10^{-25}$ J m / 3.00×10^{8} m s^{-1} = 4.13×10^{-34} J s	**(1)** **(1)** **(1)** **(1)**	**4**
4(a)(iv)	• Use of percentage difference = $((6.63 \times 10^{-34}$ J s – their $h) / 6.63 \times 10^{-34}$ J s) × 100% • Percentage difference between 35% and 40% Allow ecf for h from 4(a)(iii) for both marks MP2 dependent on MP1 For MP1, the denominator must be the published value (6.63×10^{-34} J s) <u>Example of calculation</u> Percentage difference = $((6.63 \times 10^{-34}$ J s – 4.13×10^{-34} J s) / 6.63×10^{-34} J s) × 100% Percentage difference = 38%	**(1)** **(1)**	**2**

4(b)	Random error: **EITHER** • Difficult to judge exactly when current becomes 0 (so exact stopping p.d. is difficult to identify) • Use a more sensitive ammeter (e.g. picoammeter) **OR** • Background light could affect wavelength/colour • Block background light **Or** put the colour filter directly above the photocell Systematic error: **EITHER** • Colour filters do not give monochromatic light **Or** colour filters could give a range of wavelengths/colours/frequencies **Or** colour filters might be damaged and let through other wavelengths/colours/frequencies • Use a monochromatic light source **Or** use a light source with a narrower wavelength/frequency band **Or** use a light source with a single colour (e.g. LEDs / lasers) **OR** • Zero error of the ammeter/voltmeter • Check ammeter reading is zero while no light is shining **Or** check voltmeter reading is zero while apparatus is switched off **Or** check ammeter/voltmeter reading is zero before connecting	**(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)**	**4**
	Total for question 4		**18**