Pearson Edexcel

Mark Scheme (Results)

October 2023

Pearson Edexcel International Advanced Subsidiary Level in Physics (WPH13)
Paper 01
Unit 3: Practical Skills in Physics I

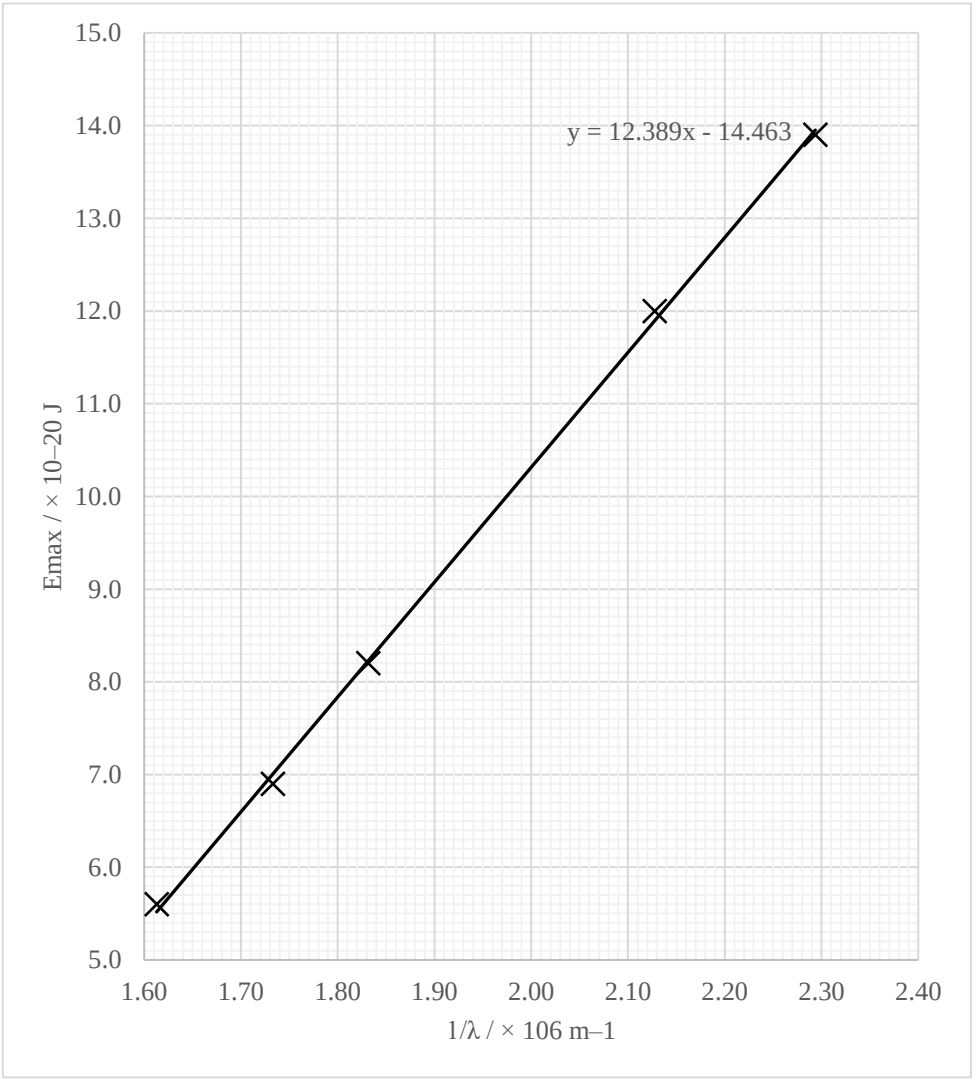
Question Number	Answer	Mark
1(a)	**Max 1 of** • Vernier calipers **(1)** • Digital calipers **(1)** • Micrometer (screw gauge) **(1)**	**1**
1(b)	**Max 1 of** • The 20.0 mm measurement is an outlier / anomaly (accept measurement 3) **(1)** • The student misread the scale for the 20.0 mm measurement **(1)** • The cube is not uniform **(1)** • The cube has been damaged **(1)**	**1**
1(c)	• Use of uncertainty = half of the range (0.1 mm) **Or** use of uncertainty = max difference from mean **(1)** • Percentage uncertainty = 0.5% rounded to 1 or 2 s.f. **(1)** Example of calculation Uncertainty = (20.3 mm – 20.1 mm) / 2 = 0.1 mm Percentage uncertainty = (0.1 mm / 20.2 mm) × 100% = 0.5%	**2**
1(d)(i)	• Converts mm to m **and** g to kg **(1)** • Use of volume = length × width × height **(1)** • Use of density = mass / volume **(1)** • Density = 8830 (kg m^{-3}) **(1)** Example of calculation Volume = length × width × height Volume = 0.0202 m × 0.0203 m × 0.0201 m = 8.24×10^{-6} m^3 Density = mass / volume Density = 0.0728 kg / 8.24×10^{-6} m^3 = 8834.95 kg m^{-3}	**4**
1(d)(ii)	**EITHER** • Calculates 2% range of uncertainty in density **(1)** • Calculates upper and lower limits of density values **(1)** • Metal is copper as it has a density within the range **(1)** MP3 dependent on MP2 **OR** • Calculates percentage difference between density from 1(d)(i) and table value • ... for all three metals • Metal is copper as it has a percentage difference < 2% **(1)** MP3 dependent on MP2 **(1)** **(1)** Allow ecf for the use of 8800 kg m^{-3} or their value from (d)(i) Example of calculation Upper limit = 8833 kg m^{-3} × 1.02 = 9010 kg m^{-3} Lower limit = 8833 kg m^{-3} × 0.98 = 8656 kg m^{-3} OR Percentage difference = ((8940 kg m^{-3} – 8830 kg m^{-3}) / 8830 kg m^{-3}) × 100% Percentage difference =1.25%	**3**
	Total for question 1	**11**

Question Number	Answer	Mark
2(a)	• Measure x with a metre rule **(1)** • Ensure the moveable rod is perpendicular to the fixed rods (e.g. use a set-square) **Or** measure x on both 30 cm rods and calculate the average **Or** measure to the centre of the moveable rod **Or** align the metre rule near to the 30 cm rod **Or** measure x while looking perpendicularly at the metre rule **(1)** • Check for zero error on ohmmeter **Or** choose appropriate range on ohmmeter **Or** repeat R readings and calculate mean R for same value of x **(1)** • Minimise contact resistance (e.g. ensure rods are clean) **(1)**	**4**
2(b)	**Max 1 of** • (When x = 0 m) the ohmmeter will measure the resistance of the (moveable) copper rod **(1)** • Zero error in ohmmeter **(1)** • The connecting leads have a resistance **(1)**	**1**
2(c)	**EITHER** • Use of $A = \pi r^2$ (accept $A = \pi d^2 / 4$) **(1)** • Use of $l = 2x + 0.05$ m **(1)** • Use of $R = \rho l/A$ (with a pair of values from the line of best fit) **(1)** • $\rho = 1.7 \times 10^{-8}\ \Omega$ m **(1)** Accept use of x = 0 (l = 0.05 m) for MP2 and correct calculated value for MP4 **OR** • Use of $A = \pi r^2$ (accept $A = \pi d^2 / 4$) **(1)** • Calculates gradient **(1)** • Use of gradient = $2\rho/A$ **(1)** • $\rho = 1.7 \times 10^{-8}\ \Omega$ m **(1)** Example of calculation $A = \pi r^2 = \pi \times (0.0015\text{ m})^2 = 7.1 \times 10^{-6}\text{ m}^2$ $l = 2x + 0.05 = (2 \times 0.25\text{ m}) + 0.05\text{ m} = 0.55\text{ m}$ $\rho = RA/l = (1.3 \times 10^{-3}\ \Omega \times 7.1 \times 10^{-6}\text{ m}^2) / 0.55\text{ m} = 1.68 \times 10^{-8}\ \Omega$ m OR $A = \pi r^2 = \pi \times (0.0015\text{ m})^2 = 7.1 \times 10^{-6}\text{ m}^2$ Gradient = $(1.55 \times 10^{-3}\ \Omega - 0.35 \times 10^{-3}\ \Omega)/(0.3\text{ m} - 0.05\text{ m}) = 4.8 \times 10^{-3}\ \Omega\text{ m}^{-1}$ ρ = gradient $\times A/2 = 1.70 \times 10^{-8}\ \Omega$ m	**4**
2(d)	• As the cross-sectional area decreases the resistance (per unit length of track) increases **(1)** • The system will estimate the position of the train is further away than it actually is **Or** the train is actually closer than the system estimates it to be **(1)** MP2 dependent on MP1	**2**
	Total for question 2	**11**

Question Number	Answer		Mark
3(a)	• Ensure metre rule is vertical • Measure *d* in multiple places **and** calculate the mean • Measure the time taken for the wave to travel at least 2 lengths of the tray **Or** measure the time taken for the wave to travel the length of the tray, repeat this **and** calculate the mean average time/speed **Or** use a video camera to film the wave to determine the time taken • Calculate *v* using the average time for the wave to travel 40 cm (accept $v = 0.40$ m/*t*) **Or** calculate v using total distance the wave travelled in the time measured	**(1)** **(1)** **(1)** **(1)**	**4**
3(b)(i)	**EITHER** • Plot a graph of v^2 on the *y*-axis against *d* on the *x*-axis **Or** compared $v^2 = kd$ with $y = mx$ • The gradient will be *k* MP2 dependent on MP1 **OR** • Plot a graph of v^2 on the *x*-axis and *d* on the *y*-axis • The gradient will be $1/k$ MP2 dependent on MP1	 **(1)** **(1)** **(1)** **(1)**	**2**
3(b)(ii)	**Max ONE from** • Values of *d* recorded to inconsistent decimal places (d.p.) • Inconsistent significant figures (s.f.) for *k* values calculated • No evidence of repeated measurement • Not enough depths tested (to plot a graph) • $k = 9.9$ incorrectly rounded (9.96)	 **(1)** **(1)** **(1)** **(1)** **(1)**	**1**
3(b)(iii)	• Mean value of $k = 9.71$ (m s^{-2}) • Calculates percentage difference from 9.81 m s^{-2} • Percentage difference small so *k* could be gravitational field strength (Allow correct conclusion from their calculated mean *k* value) MP3 depends on MP2 For MP2, the denominator must be the published value (9.81 m s^{-2}) <u>Example of calculation</u> Mean $k = (9.36 + 9.9 + 9.88) / 3 = 9.71$ Percentage difference = $[(9.81 – 9.71) / 9.81] \times 100\% = 1\%$, which is small so *k* could be *g*.	**(1)** **(1)** **(1)**	**3**
	Total for question 3		**10**

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)**	**4**
	Total for question 4		**18**