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

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October 2023
Question Paper Log Number P75623A
Publications Code WPH13_01_MS_2310

General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

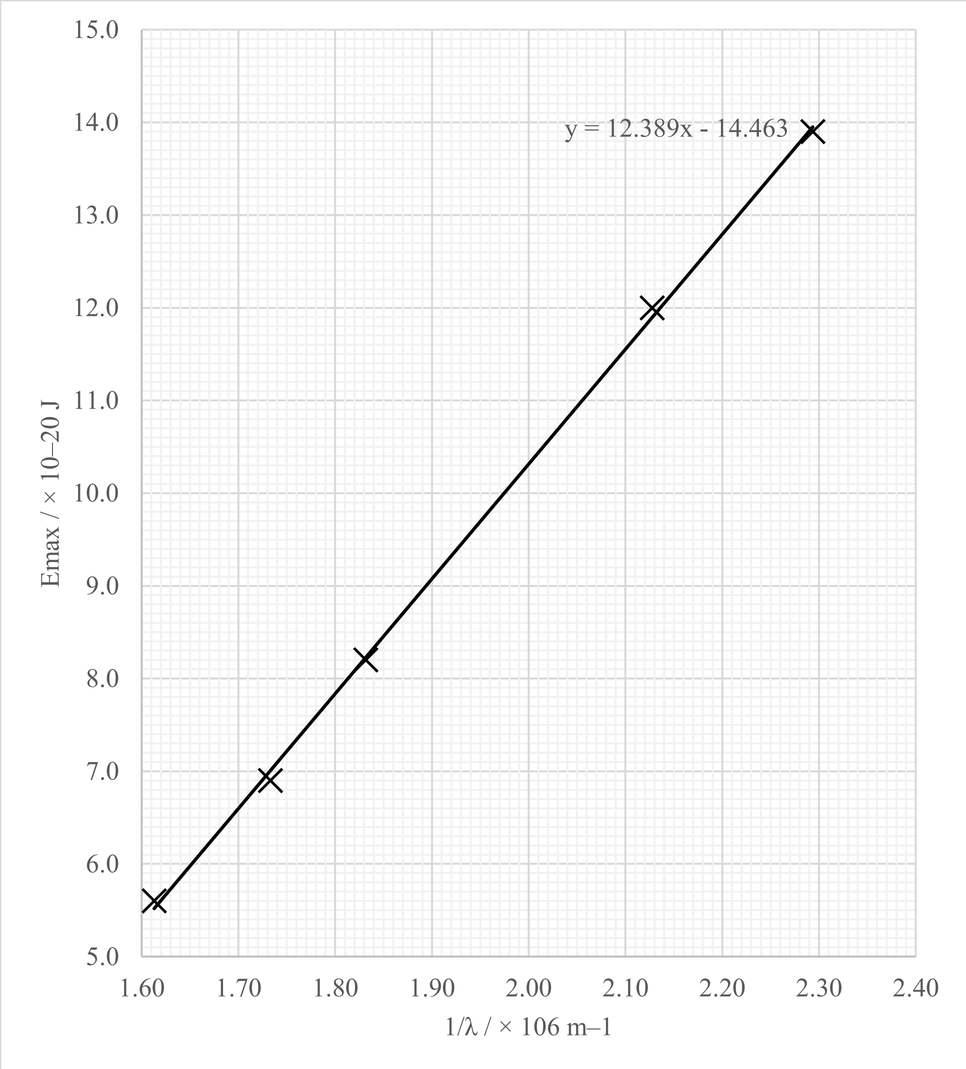
Question Number	Answer		Mark
1(a)	**Max 1 of** • Vernier calipers • Digital calipers • Micrometer (screw gauge)	(1) (1) (1)	1
1(b)	**Max 1 of** • The 20.0 mm measurement is an outlier / anomaly (accept measurement 3) • The student misread the scale for the 20.0 mm measurement • The cube is not uniform • The cube has been damaged	(1) (1) (1) (1)	1
1(c)	• Use of uncertainty = half of the range (0.1 mm) **Or** use of uncertainty = max difference from mean • Percentage uncertainty = 0.5% rounded to 1 or 2 s.f. 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%	(1) (1)	2
1(d)(i)	• Converts mm to m **and** g to kg • Use of volume = length × width × height • Use of density = mass / volume • Density = 8830 (kg m^{-3}) 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}	(1) (1) (1) (1)	4
1(d)(ii)	**EITHER** • Calculates 2% range of uncertainty in density • Calculates upper and lower limits of density values • Metal is copper as it has a density within the range 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% MP3 dependent on MP2 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%	(1) (1) (1) (1) (1) (1)	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)** <u>Example of calculation</u> $A = \pi r^2 = \pi \times (0.0015\text{ m})^2 = 7.1 \times 10^{-6}\text{ m}^2$ $l = 2x + 0.05 = (2 \times 0.25\text{ m}) + 0.05\text{ m} = 0.55\text{ m}$ $\rho = RA/l = (1.3 \times 10^{-3}\ \Omega \times 7.1 \times 10^{-6}\text{ m}^2) / 0.55\text{ m} = 1.68 \times 10^{-8}\ \Omega\text{ m}$ 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 **(1)** • Measure d in multiple places **and** calculate the mean **(1)** • 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 **(1)** • 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)**	**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 $y = mx$ **(1)** • The gradient will be k **(1)** MP2 dependent on MP1 **OR** • Plot a graph of v^2 on the x-axis and d on the y-axis **(1)** • The gradient will be $1/k$ **(1)** MP2 dependent on MP1	**2**
3(b)(ii)	**Max ONE from** • Values of d recorded to inconsistent decimal places (d.p.) **(1)** • Inconsistent significant figures (s.f.) for k values calculated **(1)** • No evidence of repeated measurement **(1)** • Not enough depths tested (to plot a graph) **(1)** • $k = 9.9$ incorrectly rounded (9.96) **(1)**	**1**
3(b)(iii)	• Mean value of $k = 9.71$ (m s^{-2}) **(1)** • Calculates percentage difference from 9.81 m s^{-2} **(1)** • Percentage difference small so k could be gravitational field strength (Allow correct conclusion from their calculated mean k value) **(1)** 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.	**3**
	Total for question 3	**10**

Question Number	Answer		Mark
4(a)(i)	• $1/\lambda$ values correct and rounded to 3 s.f. • Axes labelled with quantities and units • Sensible scales • Plotting • Line of best fit	(1) (1) (1) (2) (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 = ((6.63×10^{-34} J s – their h) / 6.63×10^{-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 = ((6.63×10^{-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) **(1)** • Use a more sensitive ammeter (e.g. picoammeter) **(1)** **OR** • Background light could affect wavelength/colour **(1)** • Block background light **Or** put the colour filter directly above the photocell **(1)** 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 **(1)** • 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) **(1)** **OR** • Zero error of the ammeter/voltmeter **(1)** • 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)**	**4**
	Total for question 4	**18**

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