Mark Scheme (Results)

Summer 2021

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

Question Number	Answer	Mark
1(a)	• Metre rule - 0.1 cm **and** Vernier calipers - 0.1 mm (1)	**1**
1(b)	• Measure length and width of sheet in multiple positions **and** obtain mean (1) • Measure thickness for at least 20 sheets (1) • Measure total mass for at least 20 sheets (1) • Calculate density = mass / (length × width × thickness) (1) MP2/3 – reference to number of sheets need only be seen once but the same number of sheets must be used for measurements of thickness and mass.	**4**
1(c)	• (Absolute) uncertainty would stay the same (1) **Or** resolution of the measuring device is the same • So, <u>percentage</u> uncertainty in thickness/mass would reduce (1) MP2 dependent on MP1	**2**
	Total for question 1	**7**

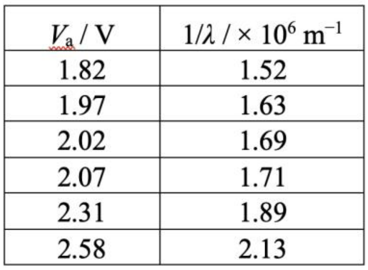
Question Number	Answer		Mark
2(a)	• Difficult to identifying when sound was loudest **Or** Difficulty hearing tuning fork due to background noise • Tube moved when marking the water level **Or** Tube not vertical when water level was marked	(1) (1)	**2**
2(b)(i)	• Calculation of the mean using 5 values • Mean l = 18.8 cm to 3 s.f. <u>Example of calculation</u> Mean $l = (18.4 + 18.0 + 19.2 + 19.4 + 19.2) / 5$ Mean l = 18.8 cm	(1) (1)	**2**
2(b)(ii)	• Use of half the range • Percentage uncertainty = 4 (%) **OR** • Use of value furthest from the mean (18.0) • Percentage uncertainty = 4 (%) Allow ecf from 2(b)(i) for use of 4 values (e.g. ignoring 18.0) for both mark points. <u>Example of calculation</u> Range = 19.4 – 18.0 = 1.4 cm Percentage uncertainty = (0.7 cm / 18.8 cm) × 100 % = 3.7 % Difference from mean = 18.8 – 18.0 = 0.8 cm Percentage uncertainty = (0.8 cm / 18.8 cm) × 100 % = 4.3 %	(1) (1)	**2**
2(c)	• Use of $v = f\lambda$ • Speed of sound = 331 m s^{-1} Allow e.c.f from 2(b)(i) <u>Example of calculation</u> $\lambda = 4 \times 0.188$ m = 0.752 m v = 440 Hz × 0.752 m = 331 m s^{-1}	(1) (1)	**2**
2(d)	• Use of percentage uncertainty from (b)(ii) to calculate relevant maximum/minimum value for speed of sound from (c) • Statement comparing this with 343 m s^{-1} MP1 – only needs to calculate one boundary – e.g. maximum if their value in (c) is below 343 m s^{-1}, minimum if (c) is above 343 m s^{-1}. **OR** • Calculates the percentage difference between 343 m s^{-1} and their speed of sound from (c) • Statement comparing this with their percentage uncertainty from (b)(ii) <u>Example of calculation</u> Percentage uncertainty = 4 % v = 331 m s^{-1} Max $v = 331 \times 1.04 = 344$ m s^{-1}	(1) (1) (1) (1)	**2**
	Total for question 2		**10**

Question Number	Answer	Mark
3(a)	• Diameter value = 17.90 mm (1) • Use of half resolution (0.005 mm) (1) • Percentage uncertainty = 0.03 (%) (1) Example of calculation Percentage uncertainty = (0.005 mm / 17.90 mm) × 100 % = 0.028 %	**3**
3(b)	• Check for zero error (1) Allow do not overtighten	**1**
3(c)(i)	• When stationary, the reading on the force meter = weight (− upthrust) (1) • When moving (at a constant speed), the reading on the force meter = weight + drag (− upthrust) (1) • Subtracting the two readings gives the value of drag (1) For MP1 and MP2 – accept descriptions given as an equation e.g. When stationary $F_1 = W - U$ When moving $F_2 = W + D - U$	**3**
3(c)(ii)	• Subtracts the two forces ($F = 0.09$ N) (1) • Use of $F = 6\pi\eta rv$ (1) • $\eta = 1.7$ (Pa s) (1) Example of calculation $F = 0.29\ \text{N} - 0.20\ \text{N}$ $F = 0.09\ \text{N}$ $F = 6\pi\eta rv$ $\eta = F/6\pi rv$ $\eta = 0.09\ \text{N} / (6 \times \pi \times 0.00895\ \text{m} \times 0.32\ \text{m s}^{-1})$ $\eta = 1.67\ \text{Pa s}$	**3**
3(d)	• A comment assessing uncertainty in force (1) • A comment assessing uncertainty in distance (1) • A comment assessing uncertainty in time (1) • Conclusion justified by their assessments (1) MP4 requires some numerical comparison Examples of assessments for MP1-3 *Force* • Resolution of the force meter is 0.01 N, so percentage uncertainty is 11% (accept 5.5% or 6%) • Force difficult to keep constant, variation likely to be larger than 0.01 N *Distance* • Meter rule resolution of 1mm, so percentage uncertainty is small • Percentage uncertainty in distance measurement is 0.2% (accept 0.4%) *Time* • Resolution of the stopwatch is 0.01 s, so percentage uncertainty is 0.6 % (accept 1.2%) • Time is short, so reaction time (0.2 s) will be a significant percentage (25%) or fraction (1/4) of the time measured • Not enough time to move eyeline, so there may be parallax error when judging when the sphere has passed the rubber band.	**4**

	Total for question 3	**14**

<table>
<tr><th>Question Number</th><th>Answer</th><th>Mark</th></tr>
<tr><td>4(a)</td><td>
• Re-arranges equation $V_a = \frac{hc}{e}\frac{1}{\lambda} + \frac{W}{e}$ and compares to $y = mx + c$ (1)
• Identifies $gradient = \frac{hc}{e}$ (1)
• States that h, c and e are all constants (1)
</td><td>3</td></tr>
<tr><td>4(b)(i)</td><td>
• Correct values calculated (1)
• Values correctly rounded to 3 sig. fig. (1)

Example
<table>
<tr><th>λ / × 10^{-7} m</th><th>$1/\lambda$ / × 10^{6} $\mathrm{m^{-1}}$</th></tr>
<tr><td>6.60</td><td>1.52</td></tr>
<tr><td>6.12</td><td>1.63</td></tr>
<tr><td>5.92</td><td>1.69</td></tr>
<tr><td>5.85</td><td>1.71</td></tr>
<tr><td>5.30</td><td>1.89</td></tr>
<tr><td>4.70</td><td>2.13</td></tr>
</table>
</td><td>2</td></tr>
<tr><td>4(b)(ii)</td><td>
• Labels axes with quantities and units (1)
• Sensible scales (1)
• Plotting – 2 points furthest from their line (1)
• Plotting – 2 points at the ends (1)
• Line of best fit (1)

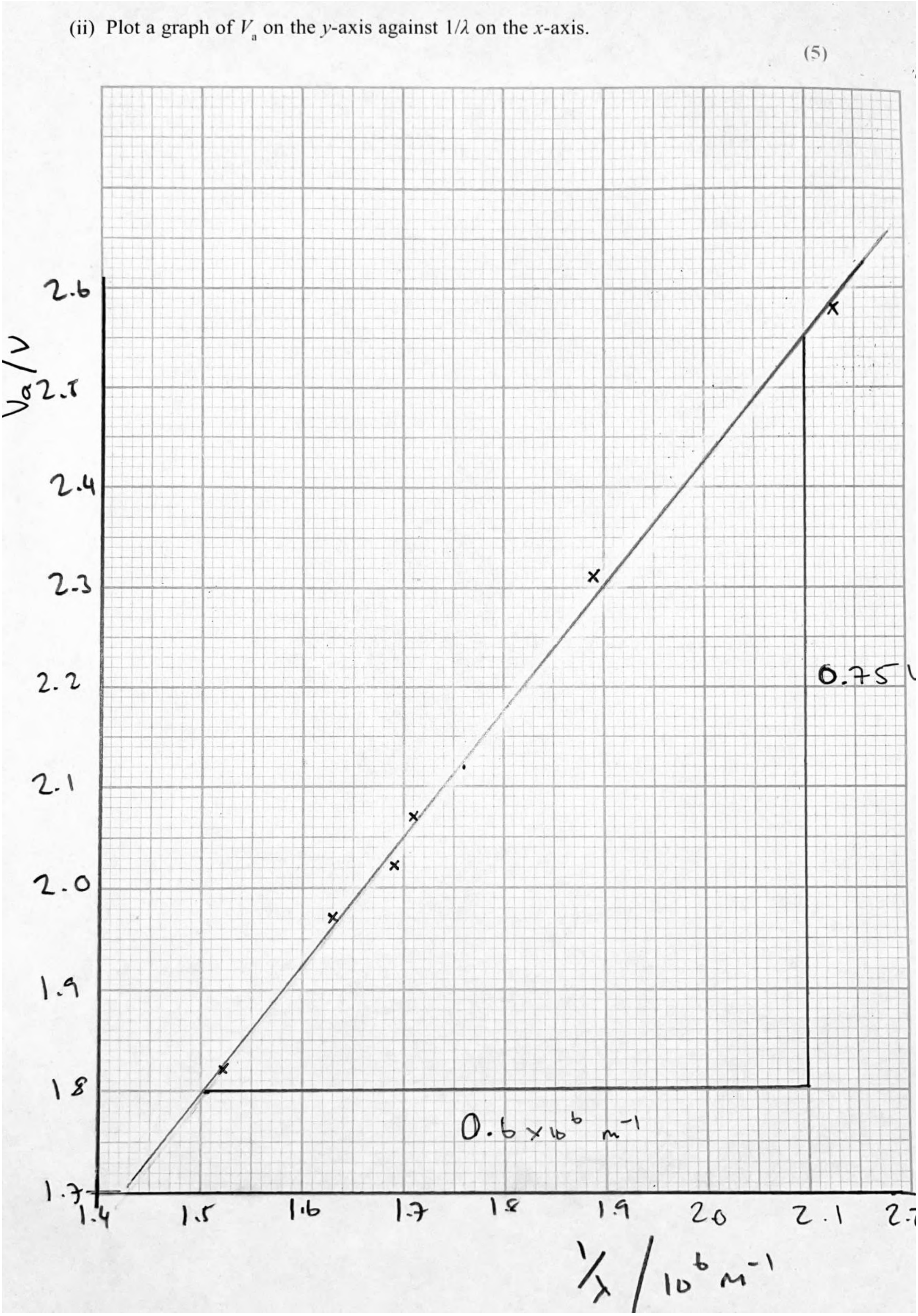
Refer to Mark Scheme Notes – Section 5 for guidance on axis labels, suitable scales & checking accuracy of plots. An example of the graph can be seen on page 11.

<table>
<tr><th>V_a / V</th><th>$1/\lambda$ / × 10^{6} $\mathrm{m^{-1}}$</th></tr>
<tr><td>1.82</td><td>1.52</td></tr>
<tr><td>1.97</td><td>1.63</td></tr>
<tr><td>2.02</td><td>1.69</td></tr>
<tr><td>2.07</td><td>1.71</td></tr>
<tr><td>2.31</td><td>1.89</td></tr>
<tr><td>2.58</td><td>2.13</td></tr>
</table>
</td><td>5</td></tr>
<tr><td>4(b)(iii)</td><td>
• Calculates gradient using large triangle - at least half their line of best fit (1)
• Use of gradient = hc/e (1)
• h = 6.65×10^{-34} to 6.85×10^{-34} J s (1)

<u>Example calculation</u>
Gradient = (2.55 – 1.80) V / (2.10 – 1.60)×10^{6} $\mathrm{m^{-1}}$ = 1.25×10^{-6} V m
h = 1.25×10^{-6} V m × 1.60×10^{-19} C / 3.00×10^{8} m $\mathrm{s^{-1}}$ = 6.67×10^{-34} J s
</td><td>3</td></tr>
<tr><td>4(b)(iv)</td><td>
• Mathematical comparison between their value from (b)(iii) and 6.63×10^{-34} J s (1)
• Comparative statement consistent with MP1 (1)

MP2 is for a statement that is justified by their value for h.
E.g.
Difference between the values is 0.04 (×10^{-34}) is very small compared to 6.63 (×10^{-34}), so method is accurate.
Or
Percentage difference is 0.6%, which is small, so method is accurate.
</td><td>2</td></tr>
</table>

4(c)	• Manufacturer’s wavelength would be shorter (than the wavelength of photons with least energy) **Or** Manufacturer’s wavelength would be shorter (than the wavelength of photons emitted at V_a) (1) • A lower λ would give a higher 1/λ **Or** the line would shift to the right, (1) **EITHER** • Difference in wavelength would be small, so negligible shift in points (Accept shift would be the same for all points, so same gradient) (1) • No change in the value of *h* obtained. (1) **OR** • Points for longer λ would shift 1/λ values less, decreasing the gradient (1) • Decreasing the value of *h* obtained. (1)	**4**
	Total for question 5	**19**

Example of a graph for 4(b)(ii)



(ii) Plot a graph of V_a on the y-axis against $1/\lambda$ on the x-axis.

(5)