Pearson Edexcel

Mark Scheme (Results)

Summer 2021

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

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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.
- Mark schemes will indicate within the table where, and which strands of QWC, are being assessed. The strands are as follows:

  i) ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear
  ii) select and use a form and style of writing appropriate to purpose and to complex subject matter
  iii) organise information clearly and coherently, using specialist vocabulary when appropriate.

Mark scheme notes

Underlying principle

The mark scheme will clearly indicate the concept that is being rewarded, backed up by examples. It is not a set of model answers.

1. Mark scheme format

1.1 You will not see 'wtte' (words to that effect). Alternative correct wording should be credited in every answer unless the MS has specified specific words that must be present. Such words will be indicated by underlining e.g. '<u>resonance</u>'

1.2 Bold lower case will be used for emphasis e.g. '**and**' when two pieces of information are needed for 1 mark.

1.3 Round brackets ( ) indicate words that are not essential e.g. "(hence) distance is increased".

1.4 Square brackets [ ] indicate advice to examiners or examples e.g. [Do not accept gravity] [ecf].

2. Unit error penalties

2.1 A separate mark is not usually given for a unit but a missing or incorrect unit will normally mean that the final calculation mark will not be awarded.

2.2 This does not apply in 'show that' questions or in any other question where the units to be used have been given, for example in a spreadsheet.

2.3 The mark will not be awarded for the same missing or incorrect unit only once within one clip in epen.

2.4 Occasionally, it may be decided not to insist on a unit e.g the candidate may be calculating the gradient of a graph, resulting in a unit that is not one that should be known and is complex.

2.5 The mark scheme will indicate if no unit error is to be applied by means of [no ue].

3. Significant figures

3.1 Use of too many significant figures in the theory questions will not be prevent a mark being awarded if the answer given rounds to the answer in the MS.

3.2 Too few significant figures will mean that the final mark cannot be awarded in 'show that' questions where one more significant figure than the value in the question is needed for the candidate to demonstrate the validity of the given answer.

3.3 The use of one significant figure might be inappropriate in the context of the question e.g. reading a value off a graph. If this is the case, there will be a clear indication in the MS.

3.4 The use of g = 10 m s^{-2} or 10 N kg^{-1} instead of 9.81 m s^{-2} or 9.81 N kg^{-1} will mean that one mark will not be awarded. (but not more than once per clip). Accept 9.8 m s^{-2} or 9.8 N kg^{-1}

3.5 In questions assessing practical skills, a specific number of significant figures will be required e.g. determining a constant from the gradient of a graph or in uncertainty calculations. The MS will clearly identify the number of significant figures required.

4. Calculations

4.1 Bald (i.e. no working shown) correct answers score full marks unless in a 'show that' question.

4.2 If a 'show that' question is worth 2 marks. then both marks will be available for a reverse working; if it is worth 3 marks then only 2 will be available.

4.3 use of the formula means that the candidate demonstrates substitution of physically correct values, although there may be conversion errors e.g. power of 10 error.

4.4 recall of the correct formula will be awarded when the formula is seen or implied by substitution.

4.5 The mark scheme will show a correctly worked answer for illustration only.

5. Graphs

5.1 A mark given for axes requires both axes to be labelled with quantities and units, and drawn the correct way round.

5.2 Sometimes a separate mark will be given for units or for each axis if the units are complex. This will be indicated on the mark scheme.

5.3 A mark given for choosing a scale requires that the chosen scale allows all points to be plotted, spreads plotted points over more than half of each axis and is not an awkward scale e.g. multiples of 3, 7 etc.

5.4 Points should be plotted to within 1 mm.

- Check the two points furthest from the best line. If both OK award mark.
- If either is 2 mm out do not award mark.
- If both are 1 mm out do not award mark.
- If either is 1 mm out then check another two and award mark if both of these OK, otherwise no mark.

5.5 For a line mark there must be a thin continuous line which is the best-fit line for the candidate's results.

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 (1) • Tube moved when marking the water level **Or** Tube not vertical when water level was marked (1)	**2**
2(b)(i)	• Calculation of the mean using 5 values (1) • Mean l = 18.8 cm to 3 s.f. (1) <u>Example of calculation</u> Mean l = (18.4 + 18.0 + 19.2 + 19.4 + 19.2) / 5 Mean l = 18.8 cm	**2**
2(b)(ii)	• Use of half the range (1) • Percentage uncertainty = 4 (%) (1) **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 %	**2**
2(c)	• Use of $v = f\lambda$ (1) • Speed of sound = 331 m s^{-1} (1) Allow e.c.f from 2(b)(i) <u>Example of calculation</u> λ = 4 × 0.188 m = 0.752 m v = 440 Hz × 0.752 m = 331 m s^{-1}	**2**
2(d)	• Use of percentage uncertainty from (b)(ii) to calculate relevant maximum/minimum value for speed of sound from (c) (1) • Statement comparing this with 343 m s^{-1} (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) (1) • Statement comparing this with their percentage uncertainty from (b)(ii) (1) <u>Example of calculation</u> Percentage uncertainty = 4 % v = 331 m s^{-1} Max v = 331 × 1.04 = 344 m s^{-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) <u>Example of calculation</u> 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) • η = 1.7 (Pa s) (1) <u>Example of calculation</u> F = 0.29 N – 0.20 N F = 0.09 N $F = 6\pi\eta rv$ $\eta = F/6\pi rv$ η = 0.09 N / (6 × π × 0.00895 m × 0.32 m s^{-1}) η = 1.67 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 <u>Examples of assessments for MP1-3</u> *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

Question Number	Answer		Mark
4(a)	• 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)	**3**
4(b)(i)	• Correct values calculated	(1)	
	• Values correctly rounded to 3 sig. fig.	(1)	**2**

Example

λ / × 10^{-7} m	$1/\lambda$ / × 10^{6} m^{-1}
6.60	1.52
6.12	1.63
5.92	1.69
5.85	1.71
5.30	1.89
4.70	2.13

Question Number	Answer		Mark
4(b)(ii)	• 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)	**5**

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.

V_a / V	$1/\lambda$ / × 10^{6} m^{-1}
1.82	1.52
1.97	1.63
2.02	1.69
2.07	1.71
2.31	1.89
2.58	2.13

Question Number	Answer		Mark
4(b)(iii)	• Calculates gradient using large triangle - at least half their line of best fit	(1)	
	• Use of gradient = *hc/e*	(1)	
	• $h = 6.65\times10^{-34}$ to 6.85×10^{-34} J s	(1)	**3**

<u>Example calculation</u>
Gradient = (2.55 – 1.80) V / (2.10 – 1.60)×10^{6} m^{-1} = 1.25×10^{-6} V m
$h = 1.25\times10^{-6}$ V m × 1.60×10^{-19} C / 3.00×10^{8} m s^{-1} = 6.67×10^{-34} J s

Question Number	Answer		Mark
4(b)(iv)	• Mathematical comparison between their value from (b)(iii) and 6.63×10^{-34} J s	(1)	
	• Comparative statement consistent with MP1	(1)	**2**

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.

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) • A lower λ would give a higher 1/λ **Or** the line would shift to the right, **EITHER** • Difference in wavelength would be small, so negligible shift in points (Accept shift would be the same for all points, so same gradient) • No change in the value of *h* obtained. **OR** • Points for longer λ would shift 1/λ values less, decreasing the gradient • Decreasing the value of *h* obtained.	(1) (1) (1) (1) (1) (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)