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Mark Scheme (Results)

June 2019

Pearson Edexcel International Advanced Subsidiary Level
In Physics (WPH13)
Paper 01 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 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.

For example:
(iii) Horizontal force of hinge on table top

66.3 (N) or 66 (N) **and** correct indication of direction [no ue] [Some examples of direction: acting from right (to left) / to the left / West / opposite direction to horizontal. May show direction by arrow. Do not accept a minus sign in front of number as direction.]	✓	**1**

This has a clear statement of the principle for awarding the mark, supported by some examples illustrating acceptable boundaries.

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. 'resonance'
   - 1.2 Bold lower case will be used for emphasis.
   - 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 Incorrect use of case e.g. 'Watt' or 'w' will **not** be penalised.
   - 2.3 There will be no unit penalty applied in 'show that' questions or in any other question where the units to be used have been given, for example in a spreadsheet.
   - 2.4 The same missing or incorrect unit will not be penalised more than once within one question (one clip in epen).
   - 2.5 Occasionally, it may be decided not to penalise a missing or incorrect 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.
   - 2.6 The mark scheme will indicate if no unit error penalty is to be applied by means of [no ue].

3. **Significant figures**
   - 3.1 Use of an inappropriate number of significant figures in the theory papers will normally only be penalised in 'show that' questions where use of too few significant figures has resulted in the candidate not demonstrating the validity of the given answer.
   - 3.2 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 be penalised by one mark (but not more than once per clip). Accept 9.8 m s^{-2} or 9.8 N kg^{-1}

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.

4.6 Example of mark scheme for a calculation:

'Show that' calculation of weight

Use of L × W × H ✓

Substitution into density equation with a volume and density ✓

Correct answer [49.4 (N)] to at least 3 sig fig. [No ue] ✓
[If 5040 g rounded to 5000 g or 5 kg, do not give 3rd mark; if conversion to kg is omitted and then answer fudged, do not give 3rd mark]
[Bald answer scores 0, reverse calculation 2/3] **3**

Example of answer:

80 cm × 50 cm × 1.8 cm = 7200 cm^3
7200 cm^3 × 0.70 g cm^{-3} = 5040 g
5040 × 10^{-3} kg × 9.81 N/kg
= 49.4 N

5. Quality of Written Communication

5.1 Indicated by QoWC in mark scheme. QWC – Work must be clear and organised in a logical manner using technical wording where appropriate.

5.2 Usually it is part of a max mark, the final mark not being awarded unless the QoWC condition has been satisfied.

6. Graphs

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

6.2 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.

6.3 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.

6.4 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.

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

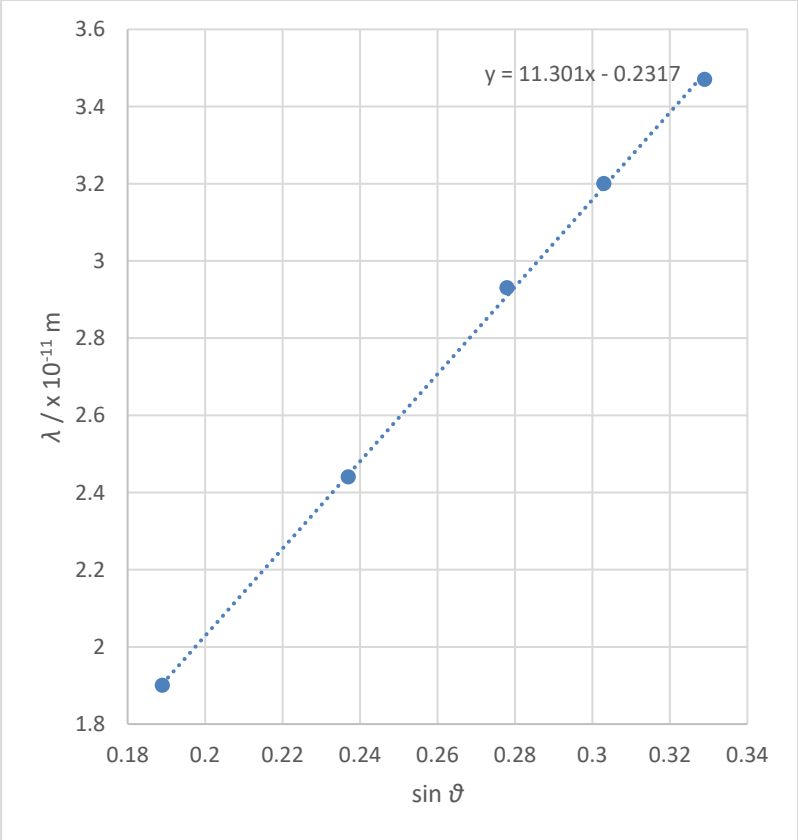
Question Number	Answer		Mark
1(a)(i)	• Resolution = 0.1 mm (accept 0.01 cm, 0.0001m, 1×10^{-4} m, etc.)	(1)	**1**
1(a)(ii)	• Percentage uncertainty is small • Because resolution much less than diameter of ball bearing MP2 requires comparison between resolution and measurements size. Accept attempted calculation of percentage uncertainty using screen value of 13.2mm for MP2	(1) (1)	**2**
1(b)	• Percentage uncertainty = 0.24 % (accept 0.2% and 0.244%) <u>Example of Calculation</u> Percentage uncertainty = (0.05 mm / 20.5 mm) × 100 % = 0.24 %	(1)	**1**
1(c)	**Max 2 from** • Take readings in different orientations/positions • Check for zero error • Ensure measurement is at widest point	 (1) (1) (1)	**2**
1(d)(i)	• Calculation of mean diameter (using 4 or 5 diameters) • Anomaly (18.3 mm) not included giving mean diameter = 19.0 mm <u>Example of Calculation</u> Mean diameter = (19.0 mm + 19.1 mm + 18.9 mm + 19.1 mm) / 4 = 19.0 mm	(1) (1)	**2**
1(d)(ii)	• Use of half range (0.1 mm) **Or** value furthest from mean • Percentage uncertainty = 0.5 % Allow full ecf for use of range of values in 1(d)(i) – e.g. use of half range of 5 values If the half range of all 5 is used, but was not use in 1(d)(i) – MP2 only If whole range (e.g. 0.2 or 0.8) is used – award only MP2 <u>Example of Calculation</u> Range = 19.1 mm – 18.9 mm = 0.2 mm Percentage uncertainty = (0.1 mm / 19.0 mm) × 100 % = 0.53 %	(1) (1)	**2**
1(e)	• Use of $V = \frac{4}{3}\pi r^3$ • Use of $\rho = \frac{m}{V}$ • Density = 7.89×10^3 kg m^{-3} (7.89 g cm^{-3}) • Value given to 3 s.f. <u>Example of Calculation</u> $V = \frac{4}{3}\pi(10.25 \times 10^{-3}\text{ m})^3 = 4.51 \times 10^{-6}$ m^3 $\rho = \frac{35.6 \times 10^{-3}\text{ kg}}{4.51 \times 10^{-6}\text{ m}^3} = 7.89 \times 10^3$ kg m^{-3}	(1) (1) (1) (1)	**4**
1(f)	• Uses percentage uncertainty to calculate the range of density values • Comparative statement consistent with their value for density from (e) <u>Example of Calculation</u> 7.75×10^3 kg m^{-3} × 1.02 = 7.91×10^3 kg m^{-3} 7.75×10^3 kg m^{-3} × 0.98 = 7.60×10^3 kg m^{-3}	(1) (1)	**2**
	Total for question 1		**16**

Question Number	Answer	Mark
2(a)	• Reference to Force = mg **Or** reference to use of a Newtonmeter to measure weight (1) • Measure initial length of spring and length with load, and subtract to give extension **Or** align zero on ruler to bottom end of spring and read opposite bottom when loaded to measure extension **Or** read scale opposite bottom of spring initially and again with load, and subtract to get extension (1) • Use of a set square to ensure the ruler is vertical **Or** use of a set square to reduce parallax error when measuring length/extension **Or** use of a pointer attached to the lower end of spring to reduce parallax error when measuring length/extension **Or** ensure ruler and spring are at eye-level to reduce parallax (1) • Uses a range of masses/forces to obtain multiple pairs of values (1)	**4**
2(b)	• k = gradient **Or** $k = \Delta F/\Delta x$ (1) • Gradient should be calculated using values from linear section of the graph (1)	**2**
	Total for question 2	**6**

Question Number	Answer	Mark
3(a)	• Use of Vernier calipers **Or** use of dividers/calipers to transfer the measurement to a ruler **Or** use of paper (tape) and marking points to be measured with a ruler **Or** use a flexible measuring tape (1) • Measure diameter of (first) ring and divide by 2 (1) • Measure in multiple orientations and calculate the mean (1) • Measure to the middle/brightest part of the ring **Or** refers to surface of the screen being curved (so diameter cannot be measured directly) (1)	**4**
3(b)	• (Diffracted) electrons experience (constructive) interference/superposition Or the pattern is evidence electrons have interfered/superposed (1) • Diffraction/interference is a wave property (1) For MP1 – it must be clear they are referring to electrons, not waves.	**2**
3(c)(i)	**Max 2 from** • Inconsistent number of significant figures (for wavelength) (1) • Only 5 sets of results (1) • Range of values of angle/wavelength is too small (1) • No evidence of repeat (1)	**2**

3(c)(ii)	• Correct sin θ values to 3 s.f. (1) • Labels axes with quantities **and** unit for λ and with no unit for sin θ (1) (Accept sin(θ/°) but not sin θ/°) • Sensible scales (1) • Plotting values (2) • Line of best fit (1)		**6**
3(c)(iii)	• Use of large triangle to determine gradient (1) • gradient = 1.10×10^{-10} to 1.20×10^{-10} (1) • Value given to 2 or 3 s.f. **and** correct unit (m) (1)		**3**
3(c)(iv)	• Comparison between $(n)\lambda = d \sin\theta$ and $y = mx$ (+ c) (1) • d is a constant given by the gradient **and** n=1 (1) MP2 is dependent on MP1 being awarded.		**2**
	Total for question 3		**19**

λ / × 10^{-11} m	θ / °	sin θ
3.47	19.2	0.329
3.2	17.7	0.304
2.93	16.1	0.277
2.44	13.7	0.237
1.9	10.9	0.189



Question Number	Answer		Mark
4(a)	• Use of $\sqrt{\frac{mg}{\mu}} = f\lambda$ • Use of $l = 1.5 \times \lambda$ • $\mu = 3.2 \times 10^{-4}$ kg m^{-1} Example of calculation $1.5 \times \lambda = 1.25$ m $\lambda = 0.833$ m $\mu = (0.25 \text{ kg} \times 9.81 \text{ m s}^{-2}) / (105^2 \text{ Hz}^2 \times 0.833^2 \text{ m}^2)$ $\mu = 3.21 \times 10^{-4}$ kg m^{-1}	(1) (1) (1)	**3**
4(b)(i)	Mark 4(b)(i) and (b)(ii) holistically **Max 2 from** *Frequency* • Uncertainty in identifying when nodes form • Uncertainty in identifying maximum amplitude *Length* • Parallax error when measuring length • Uncertainty in measuring length to top of pulley **Or** uncertainty in measuring length as string is not straight *Mass* • Zero error on mass balance	 (1) (1) (1) (1) (1)	**2**
4(b)(ii)	**Max 4 (from only 2 pairs)** **For each source from (b)(i)** Description of experimental technique Additional detail *Examples* *Frequency* • Repeat and calculate the mean frequency • Vary frequency from above and below resonance to find two values for the frequency when the standing wave forms *Length* • Use a set square to reduce parallax error in length **Or** hold ruler in contact with the wire to reduce parallax error in length **Or** ensure ruler and string are at eye-level • Switch off vibrator **Or** ensure string is straight *Mass* • Zero balance before each measurement • To remove systematic error **Or** idea that this error is not reduced by repeating	 (1) (1) (1) (1) (1) (1) (1) (1)	**4**
	Total for question 4		**9**