Mark Scheme (Results)

January 2016

Pearson Edexcel
International Advanced Level
in Physics (WPH06)

Paper 01 – Experimental Physics

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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] 3
[Bald answer scores 0, reverse calculation 2/3]

Example of answer:

$80 \text{ cm} \times 50 \text{ cm} \times 1.8 \text{ cm} = 7200 \text{ cm}^3$

$7200 \text{ cm}^3 \times 0.70 \text{ g cm}^{-3} = 5040 \text{ g}$

$5040 \times 10^{-3} \text{ kg} \times 9.81 \text{ N/kg}$

$= 49.4 \text{ N}$

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.

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)	Precision/interval/resolution of metre rule is 1 mm (1) [Allow least count/smallest division. Allow 0.5 mm] Percentage uncertainty introduced by instrument is about 1% (which is small and acceptable) (1) <u>Example of calculation</u> Uncertainty is 1 mm and measurement is about 10 cm So %U = 100 × 1/100 = 1%	**2**
1(a)(ii)	V_1 = 1.92 (cm^3) (1) Correct value to 3 SF (1) <u>Example of calculation</u> (2×10.0 cm) × 0.933 cm × 0.103 cm = 1.92 cm^3	**2**
1(b)(i)	Holds top and bottom of bung between jaws (perpendicularly) **Or** callipers are parallel to *h* (1) Repeat at different orientations for mean **Or** do not compress **Or** check for zero error (1)	**2**
1(b)(ii)	Calculates mean for *h* (1) V_2 = 29.2 (cm^3) (1) [no SF penalty] <u>Example of calculation</u> Mean *h* = 3.51 cm $(\pi \times 3.51\text{ cm}) \times (3.45^2 + 3.06^2 + 3.06\times3.45)\text{cm}^2/12 = 29.2\text{ cm}^3$	**2**
1(b)(iii)	(%U in V_2 is the same as %U in *h*) so percentage uncertainty = 0.6% or 1.1% (1) (Allow half range, as below, or whole range) <u>Example of calculation</u> 100 × (0.02/3.51) = 0.57%	**1**
1(c)	Use of $d = m/V$ (1) Density of band = 1.16 (g cm^{-3}) **and** Density of bung = 1.52 (g cm^{-3}) (1) Both values to 3 SF with correct units (1) Allow ecf from (a)(ii) and (b)(ii) <u>Example of calculation</u> Band: 2.23 g/1.92 cm^3 = 1.16 g cm^{-3} Bung: 44.48 g/29.2 cm^3 = 1.52 g cm^{-3} [Allow values reversed if calculations shown clearly]	**3**

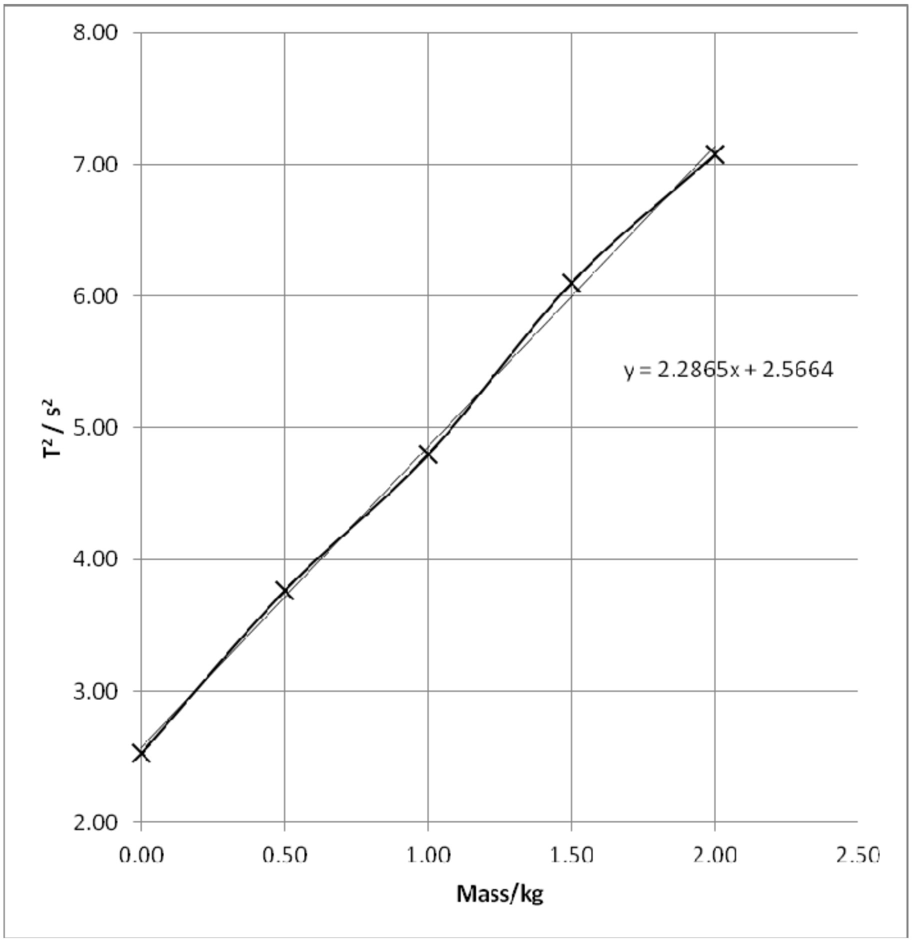
(d)	Calculates % difference in densities equal to 27% %D » %U so probably not the same rubber (ecf densities and %U in V_2) MP2 to be consistent with calculated %D) **Or** Uses uncertainty to calculate max density value of band uses uncertainty to calculate minimum density value of bung **and** concludes not the same rubber (ecf densities and %U in V_2) Example of calculation %D = 100×(1.52 – 1.16)/0.5×(1.52 + 1.16) = 100×0.36/1.34 = 27%	(1) (1) (1) (1)	**2**
	Total for Question 1		**14**

Question Number	Answer	Mark
2(a)(i)	**NB: parts (a)(i) to (a)(iii) to be marked holistically** (1) Use a stopwatch to measure *t* Record volumes at regular successive time intervals (1) **Or** record the time taken to fall to specific volumes eg 90, 80, 70 cm^3etc Any **two** from (Re-fill and) repeat for mean Maintain eye level with mark on burette – can be awarded from diagram read to bottom of meniscus (1) fully open tap each time (1) Ensure burette is vertical	**4**
2(a)(ii)	Difficulty reading 2 instruments simultaneously **Or** no account taken of liquid contained below the tap (1)	**1**
2(a)(iii)	plot ln *V* against *t* (1) where the gradient $m = -1/b$ (1) (MP2 is a dependent mark)	**2**
2(b)	Identifies an increase in the rate of flow **Or** a reduction in the time taken for a given volume **Or** for a given time the volume is greater (1) So the value of *b* decreases MP2 only awarded after an attempt at MP1) (1)	**2**
	Total for Question 2	**9**

Question Number	Answer	Mark
3(a)	Thermistor in a water bath with identified heat source (1) Means of measuring resistance (e.g. voltmeter and ammeter circuit or ohmeter) (1) Thermometer shown very close to fully submerged thermistor (1)	**3**
3(b)(i)	(At lower temperatures) the range of resistance/*R* is large (1)	**1**
3(b)(ii)	Use of ice **Or** continued heating (1)	**1**
	Total for Question 3	**5**

Question Number	Answer	Mark
4(a)(i)	Values for T^2 to 3 SF (1) Axes with labels & units (1) Scales (1) Plots (1)	**4**
4(a)(ii)	Large triangle – at least half the plotted length (1) Gradient = 2.21 – 2.31 ($s^2\,kg^{-1}$) (1) Value for k = 17.1 – 17.9 $N\,m^{-1}$ (1) <u>Example of calculation</u> $k = 4\pi^2/2.29\ s^2\,kg^{-1} = 17.2\ N\,m^{-1}$	**3**
4(a)(iii)	Intercept value correctly read off graph **Or** pair of values read correctly (1) M calculated correctly with unit (ecf candidate's values from (a)(ii)) (1) Values for k and M to 3 SF (1) <u>Example of calculation</u> M = Intercept/Gradient = 2.57/2.29 = 1.12 kg	**3**
4(b)	% Diff correctly calculated (1) Comments on accuracy e.g. %D is comparable with expected uncertainties and most plots lie very close to the line of best fit (1) [Use candidate's value from (a)(iii)] <u>Example of calculation</u> %D = 100×(1.12 – 1.05)/1.05 = 0.07/1.05 = 6.7%	**2**
	Total for Question 4	**12**

m/kg	**T/s**	**T^2/s^2**
0.00	1.59	2.53
0.50	1.94	3.76
1.00	2.19	4.80
1.50	2.47	6.10
2.00	2.66	7.08



8.00
7.00
6.00
5.00
4.00
3.00
2.00
T^2 / s^2
y = 2.2865x + 2.5664
0.00
0.50
1.00
1.50
2.00
2.50
Mass/kg

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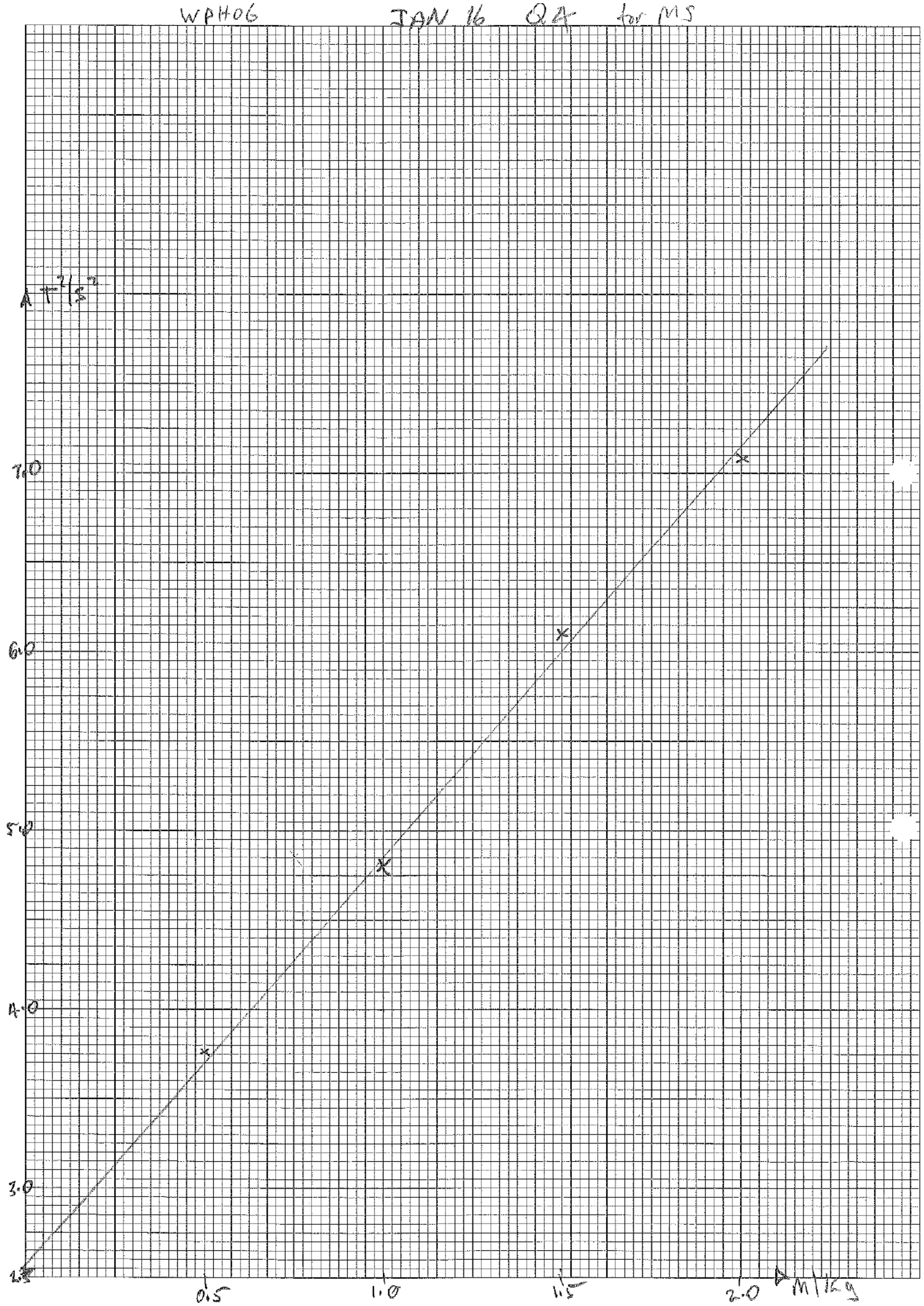

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