Mark Scheme (SAM)

Pearson Edexcel International Advanced Level in Physics

Unit 6: Experimental Physics

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.

Further notes

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.

Mark scheme format

1. You will not see 'wtte' (words to that effect). Alternative correct wording should be credited in every answer unless the mark scheme has specified specific words that must be present. Such words will be indicated by underlining, e.g. 'resonance'.
2. Bold lower case will be used for emphasis.
3. Round brackets ( ) indicate words that are not essential, e.g. '(hence) distance is increased'.
4. Square brackets [ ] indicate advice to examiners or examples, e.g. [Do not accept gravity] [ecf].

Unit error penalties

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. Incorrect use of case, e.g. 'Watt' or 'w' will **not** be penalised.
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.
4. The same missing or incorrect unit will not be penalised more than once within one question (one clip in e-pen).
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.
6. The mark scheme will indicate if no unit error penalty is to be applied by means of [no ue].

Significant figures

1. Use of an inappropriate number of significant figures (sf) 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.
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}.

Calculations

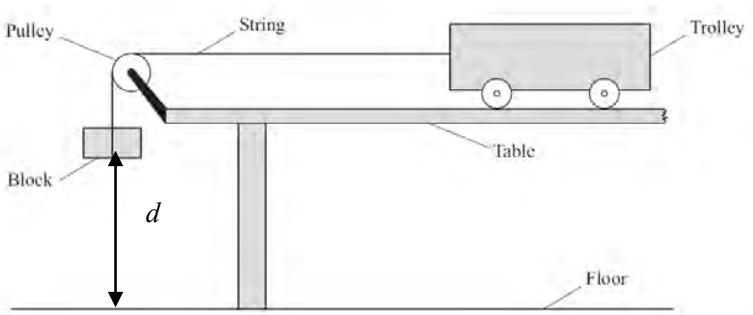
1. Bald (i.e. no working shown) correct answers score full marks unless in a 'show that' question.
2. If a 'show that' question is worth 2 marks then both marks will be available for a reverse working; if it is worth 3 marks then only 2 will be available.
3. **Use** of the formula means that the candidate demonstrates substitution of physically correct values, although there may be conversion errors, e.g. power of 10 error.
4. **Recall** of the correct formula will be awarded when the formula is seen or implied by substitution.
5. The mark scheme will show a correctly worked answer for illustration only.
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 significant figures [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] 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	✓ ✓ ✓	**(3)**

Graphs

1. A mark given for axes requires both axes to be labelled with quantities and units, and drawn the correct way round.
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.
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.
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. 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)	Divides precision by 25 mm for % uncertainty **(1)** Example of calculation Callipers precise to 0.1 mm giving %U = 100 × (0.1/25) = 0.4% less than 1%	**(1)**
1(a)(ii)	Check for zero error **(1)** **Or** Any valid method to ensure a 'maximum' diameter measured, e.g. measure diameter at several places **(1)**	**(1)**
1(a)(iii)	Thickness of coins varies **Or** Identifies anomalies **Or** Enables her to discard anomalies **(1)**	**(1)**
1(b)(i)	Use of Area × thickness **(1)** Volume = 9.59×10^{-7} m^3 to 3 SF allow any correct unit **(1)** Example of calculation $V = \pi/4 \times (25.9 \times 10^{-3}\ m)^2 \times 1.82 \times 10^{-3}\ m = 9.59 \times 10^{-7}\ m^3$	**(2)**
1(b)(ii)	Calculates %U in thickness **(1)** Calculates %U for diameter **(1)** Doubles their %U for diameter adds their %U for thickness **(1)** Example of calculation (2×(1/259) + (2/182)) × 100% = 0.8% + 1.1% = 1.9%	**(3)**
1(c)	Substitutes correctly **(1)** Density = 7380 kg m^{-3} to 3 SF with unit **(1)** Allow ecf from (b) (i) Example of calculation 7.08×10^{-3} kg / 9.59×10^{-7} m^3 = 7380 kg m^{-3} Allow corresponding answer in a correct unit, e.g. g cm^{-3}	**(2)**
1(d)	Calculates %Difference between their value and 6900 (allow as denominator either of the values or the mean) **(1)** Compares with 2 × %U to reach conclusion (Allow ecf from (b) and (c)) **(1)** **Or** Adds their %U to 6900 and subtracts their %U from 7380 **(1)** Draws a conclusion based on their answer **(1)** Example of calculation %D = (7380 – 6900)/7140 = 6.7% Total %U = 2 × 1.9% = 3.8% < 6.7%, so (probably) not the same material	**(2)**
	Total for Question 1	**(12)**

<table>
<tr><th>Question Number</th><th>Answer</th><th>Mark</th></tr>
<tr><td>2(a)</td><td>
<table>
<tr><td>Quantity to be measured</td><td>Measuring instrument</td><td>Precision of measuring instrument</td></tr>
<tr><td>Masses, M and m</td><td>Balance</td><td>At least 0.1 g</td></tr>
<tr><td>Distance, d</td><td>Metre rule</td><td>1 mm</td></tr>
<tr><td>Time, t</td><td>Stopwatch</td><td>0.01 s</td></tr>
</table>
Award 1 mark for each correct insertion, distance & time must have units (3)
</td><td>(3)</td></tr>
<tr><td>2(b)</td><td>
d from bottom of mass to floor as shown on diagram (1)


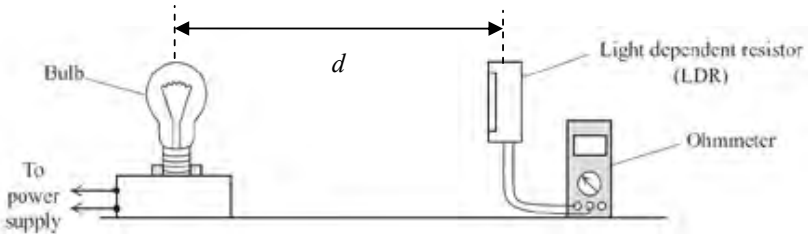
</td><td>(1)</td></tr>
<tr><td>2(c)</td><td>
Maximum 2
(Vertical) rule with use of set square (1)

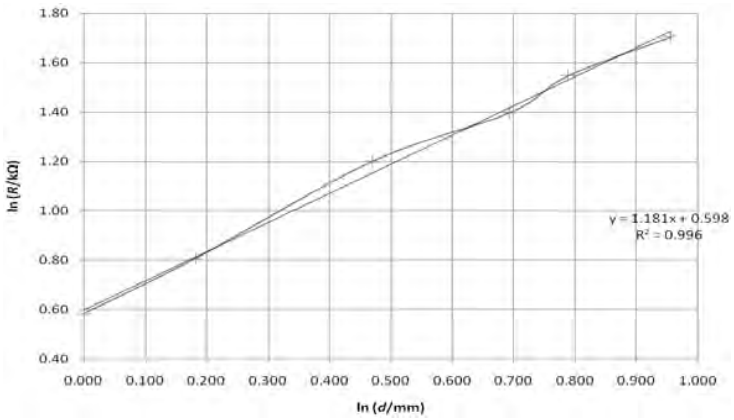
Use of set square at bottom of block
Or Eye level with bottom of block (do not credit just ‘avoid parallax’) (1)

Rule close to block
Or Marker shown (1)

Marks can be awarded from diagram
</td><td>(2)</td></tr>
<tr><td>2(d)</td><td>
Maximum 1
Start stopwatch when block/trolley released and stop when block hits floor (1)
Or Repeat several times and average (1)
</td><td>(1)</td></tr>
<tr><td>2(e)</td><td>
Identifies an appropriate risk and suitable precaution
Or explains why risk is insignificant (1)
</td><td>(1)</td></tr>
<tr><td></td><td>Total for Question 2</td><td>(8)</td></tr>
</table>

Question Number	Answer	Mark
3(a)	The amplitude of the oscillation increases **(1)**	**(1)**
3(b)(i)	Maximum correctly read to 3 SF from properly drawn curve **(1)** e.g. 1.60 Hz	**(1)**
3(b)(ii)	Take more readings **(1)** At the turning point **Or** Around the resonant frequency **(1)**	**(2)**
3(b)(iii)	More accurate **Or** Reduces random errors **Or** Reduces (percentage) uncertainty **Or** Allows many more readings to be taken in a given time **(1)**	**(1)**
	Total for Question 3	**(5)**

<table>
<tr><th>Question Number</th><th>Answer</th><th>Mark</th></tr>
<tr><td>4(a)</td><td>Distance marked from filament (allow centre of bulb) to front surface of LDR
 

(1)</td><td>(1)</td></tr>
<tr><td>4(b)</td><td>(As distance increases) light <u>intensity</u> decreases (and resistance increases with decreasing intensity) (1)</td><td>(1)</td></tr>
<tr><td>4(c)</td><td>Light from other sources (1)
Any suitable means of controlling outside light such as excluding it (darkened room) or using a tube as a shield on the LDR (1)</td><td>(2)</td></tr>
<tr><td>4(d)</td><td>Shows expansion ln R = pln$d$ + ln$k$ (1)
Compares with y = mx + c Or States that the gradient is p (1)</td><td>(2)</td></tr>
<tr><td>4(e)</td><td>
<table>
<tr><th>d/m</th><th>R/kΩ</th><th>ln (d/m)</th><th>ln (R/kΩ)</th></tr>
<tr><td>1.00</td><td>1.79</td><td>0</td><td>0.582</td></tr>
<tr><td>1.20</td><td>2.24</td><td>0.182</td><td>0.806</td></tr>
<tr><td>1.60</td><td>3.32</td><td>0.470</td><td>1.200</td></tr>
<tr><td>2.00</td><td>4.04</td><td>0.693</td><td>1.396</td></tr>
<tr><td>2.20</td><td>4.70</td><td>0.788</td><td>1.548</td></tr>
<tr><td>2.60</td><td>5.50</td><td>0.956</td><td>1.705</td></tr>
</table>


Ln & log values correct and to 3 SF consistently (allow 4SF for the values for ln R greater than one) (1)
Labels & units on table & graph (1)
Scales (1)
Plots (1)
Line of Best Fit (1)</td><td>(5)</td></tr>
<tr><td>4(f)(i)</td><td>Determines gradient with large triangle (at least half of the drawn line) (1)
1.13 < p < 1.23 3 SF and no units (1)</td><td>(2)</td></tr>
<tr><td>4(f)(ii)</td><td>Records intercept 0.56 < c < 0.62 (1)
k found from anti-log of their intercept (1)</td><td>(2)</td></tr>
<tr><td></td><td>Total for Question 4</td><td>(15)</td></tr>
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Total for Paper = 40 Marks