Mark Scheme (Results)

October 2021

Pearson Edexcel International Advanced Level in Physics (WPH16) Paper 01
Practical Skills in Physics II

Edexcel and BTEC Qualifications

Edexcel and BTEC qualifications are awarded by Pearson, the UK's largest awarding body. We provide a wide range of qualifications including academic, vocational, occupational and specific programmes for employers. For further information visit our qualifications websites at www.edexcel.com or www.btec.co.uk. Alternatively, you can get in touch with us using the details on our contact us page at www.edexcel.com/contactus.

Pearson: helping people progress, everywhere

Pearson aspires to be the world's leading learning company. Our aim is to help everyone progress in their lives through education. We believe in every kind of learning, for all kinds of people, wherever they are in the world. We've been involved in education for over 150 years, and by working across 70 countries, in 100 languages, we have built an international reputation for our commitment to high standards and raising achievement through innovation in education. Find out more about how we can help you and your students at: www.pearson.com/uk

Autumn 2021
Question Paper Log Number: P67150A
Publications Code WPH16_01_2110_MS

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] (1) **1**
[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.]

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 o**f 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.

Example of mark scheme for a calculation:

<u>'Show that' calculation of weight</u>

Use of L × W × H	(1)	
Substitution into density equation with a volume and density	(1)	
Correct answer [49.4 (N)] to at least 3 sig fig. [No ue]	(1)	**3**

[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]

<u>Example of calculation</u>
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. 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, 4, 7 etc.

5.4 Points should be plotted to within 1 mm.

- Check the two points furthest from the best line. If both are OK award the 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 are OK, otherwise no mark.

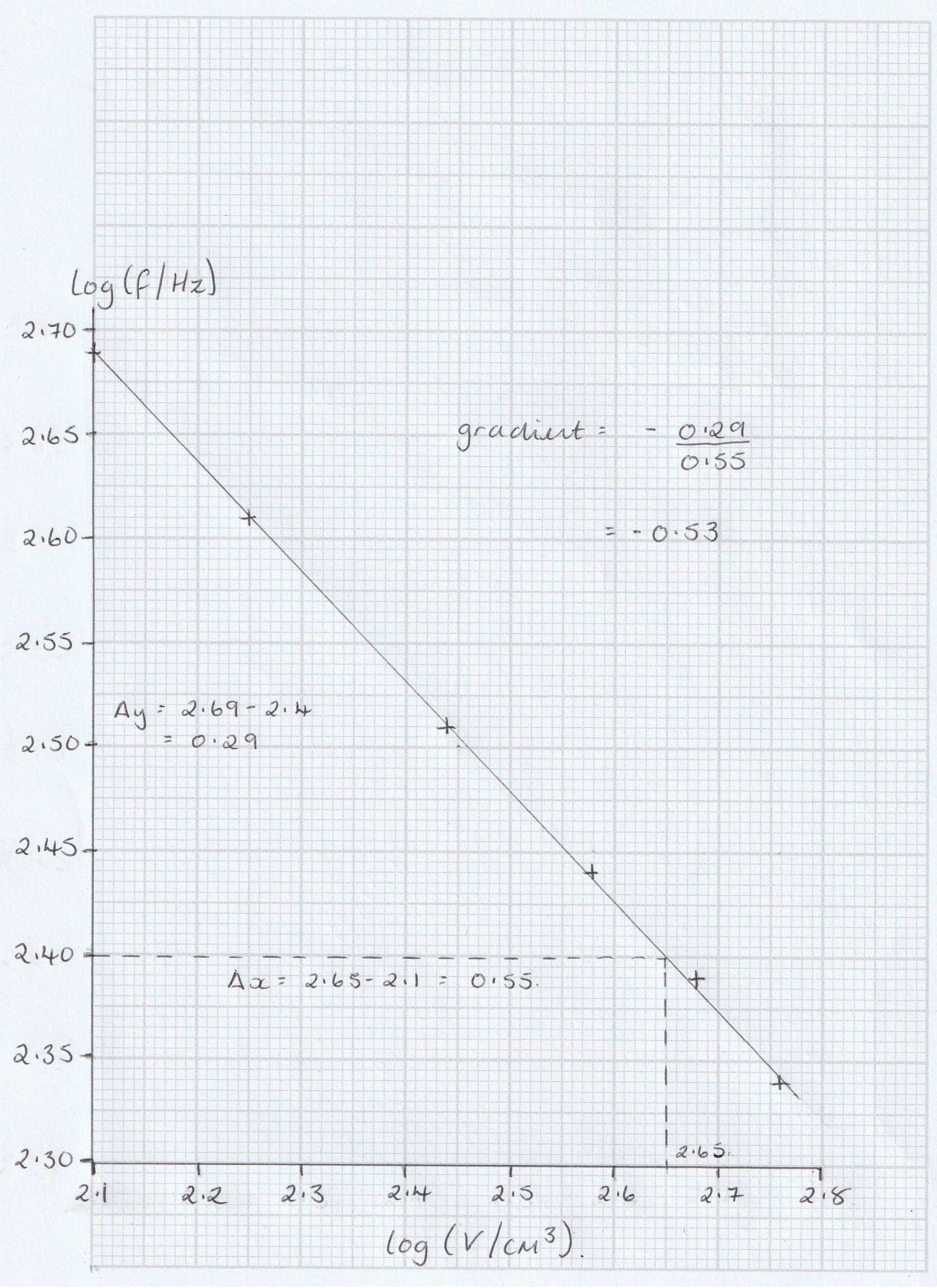
5.5 For a line mark there must be a thin continuous line which is the best-fit line for the candidate's results.

Question Number	Answer	Mark
1 (a)(i)	Mass **Or** volume (of water) (1) Time **Or** distance between resistor and thermometer (1) Ignore room temperature, temperature of the surroundings, size of the beaker or insulation, potential difference	2
1 (a)(ii)	Significant figures are inconsistent (1) Not enough sets of readings taken **Or** no repeats shown (1) No units given for $\Delta\theta$ **Or** initial and final values of θ not recorded (1)	3
1 (b)	Any **PAIR** from: Insulate the beaker **Or** cover the beaker (1) To reduce the amount of energy transfer to the environment (1) Stir the water **Or** ensure thermometer is close to the resistor (1) To ensure the water is at the same temperature as the resistor (1) MP2 dependent on MP1	2
	Total for question	**7**

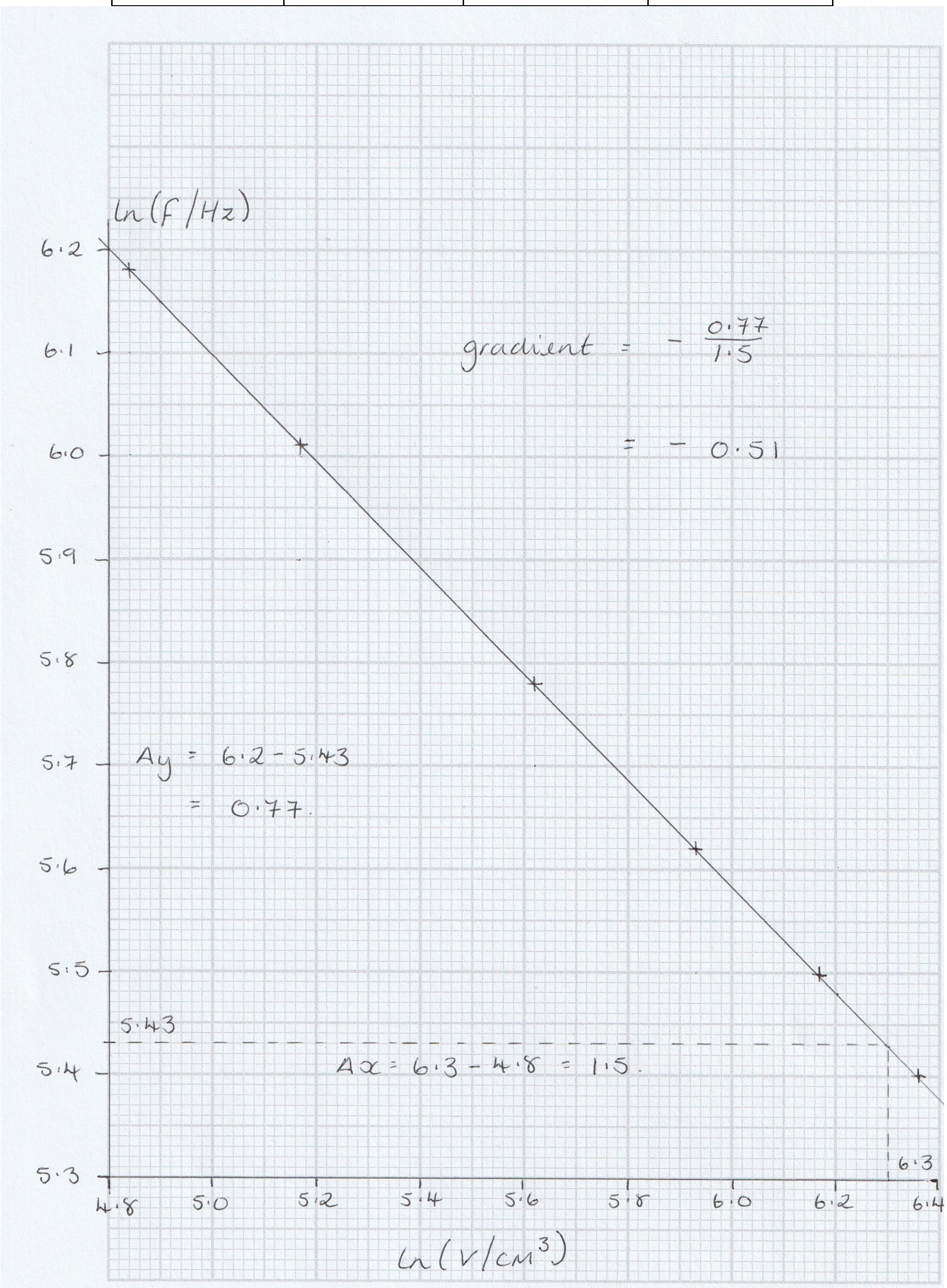
Question Number	Answer		Mark
2 (a)	Use of $T = 2\pi\sqrt{(l/g)}$ shown	(1)	
	Addition of (half) the time period for long and short pendulum shown	(1)	
	$T = 1.9$ s Accept 2 or 3 sig figs	(1)	3
	Bald answer can score MP3 only		
	<u>Example of calculation</u>		
	Long pendulum $T_l = 2\pi\sqrt{(1.00 \text{ m}/ 9.81 \text{ m s}^{-2})} = 2.01$ s		
	Short pendulum $T_s = 2\pi\sqrt{((1.00 \text{ m} - 0.25 \text{ m})/ 9.81 \text{ m s}^{-2})} = 1.74$ s		
	$T = 0.5(T_l + T_s) = 0.5(2.01 + 1.74 \text{ s}) = 1.88 \text{ s} = 1.9$ s		
2 (b)	Measure the distance h using a metre rule	(1)	
	Any THREE from:		
	Place a (timing) marker at the centre of the oscillation	(1)	
	Use a small initial angle	(1)	
	Time a number of oscillations and divide by the number	(1)	
	Repeat (measurement of time period) **and** calculate the mean	(1)	
	Start timing after several oscillations	(1)	
	Repeat the method for at least 5 values of h	(1)	
	Plot a graph of T^2 against h to check it is a straight line	(1)	6
	Accept valid alternative graph		
2 (c)	Using a light gate would eliminate reaction time	(1)	
	Either		
	Light gates remove parallax error	(1)	
	As the light gate is in fixed position	(1)	
	Or		
	There would be uncertainty in the time period from the light gate	(1)	
	As the light gate would time from edge of the bob rather than centre of mass	(1)	3
	Total for question		**12**

Question Number	Answer	Mark
3 (a)	(Adjust the signal generator to find) trace with the maximum amplitude (1) Count the number of divisions between two (adjacent) peaks (1) Multiply by the time per division (1) Calculate frequency as $1/T$ (1)	4
3 (b)(i)	All log V values correct to 2 d.p. — Accept 3 d.p. (1) All log f values correct to 2 d.p. — Accept 3 d.p. (1) Axes labelled: y as log(f / Hz) and x as log(V / cm^3) (1) Correct scales for both axes (1) Plots accurate to ± 1mm (1) Best fit line with even spread of plots (1) Accept equivalent ln-ln graph	6
3 (b)(ii)	$\log f = \log k - ½\log V$ (1) is in the form $y = c + mx$ with a gradient of –½ (1) Correct calculation of gradient using large triangle shown (1) Value of gradient in range –0.51 to –0.54 to 2 or 3 s.f., no unit (1) Valid conclusion including comparison of calculated gradient with the stated expected gradient of –½ (1) <u>Example of calculation</u> $gradient = (2.69 - 2.4)/(2.1 - 2.65) = -0.29/0.55 = -0.53$	5
	Total for question	**15**

V / cm³	f / Hz	log (V / cm³)	log (f / Hz)
576	221	2.76	2.34
476	244	2.68	2.39
376	275	2.58	2.44
276	323	2.44	2.51
176	408	2.25	2.61
126	485	2.10	2.69



V / cm^3	f / Hz	ln (V / cm^3)	ln (f / Hz)
576	221	6.36	5.40
476	244	6.17	5.50
376	275	5.93	5.62
276	323	5.62	5.78
176	408	5.17	6.01
126	485	4.84	6.18



Question Number	Answer	Mark
4 (a)(i)	Any **TWO** from: Ensure the metre rule is vertical using a set square Accept alternative valid methods (1) Ensure the end of the rod is close to the metre rule **Or** use a set square to read off the values (1) Take readings perpendicular to the scale (to avoid parallax) (1)	**2**
4 (a)(ii)	The uncertainty of a single reading is half the resolution of the metre rule, (which is 0.5 mm) (1) As the two readings are subtracted, the uncertainties are added (1)	**2**
4 (b)(i)	Micrometer screw gauge (with a resolution of 0.01mm) (Accept digital caliper) (1) As this would produce an uncertainty of 0.25% which is small (1)	**2**
4 (b)(ii)	One **PAIR** from: Repeat at different orientations **and** calculate a mean (1) To reduce the effect of <u>random errors</u> (1) Check (and correct) for zero error (1) To eliminate <u>systematic error</u> (1)	**2**
4 (b)(iii)	Mean value of d = <u>2.35</u> (mm) (1) Calculation from half range shown to give uncertainty of 0.02 (mm) (1) <u>Example of calculation</u> Mean $d = (2.35 + 2.37 + 2.34 + 2.34 + 2.33)$ mm / 5 = 11.74 mm / 5 = 2.348 mm = 2.35 mm Uncertainty = (2.37 – 2.33) mm /2 = 0.04 mm/2 = 0.02 mm	**2**
4 (c)	Use of $G = (32mglx^2) / (\pi\, yd^4)$ shown (1) Correct value of G given to 2 or 3 s.f. e.c.f. (b)(iii) (1) Bald answer scores 0 Accept value of 1.5×10^{11} (N m^{-2}) if d = 2 mm used <u>Example of calculation</u> $G = \dfrac{32 \times 0.1\text{kg} \times 9.81\text{ N kg}^{-1} \times 0.589\text{ m} \times (0.103\text{ m})^2}{3.14159 \times 0.026\text{ m} \times (2.35 \times 10^{-3}\text{ m})^4}$ $= 0.196\text{ N m}^3 / 2.49 \times 10^{-12}\text{ m}^5$ $= 7.87 \times 10^{10}$ (N m^{-2}) $= 7.9 \times 10^{10}$ (N m^{-2})	**2**

4 (d)

Use of 2× %U in x **Or** 4× %U in d shown (1)

Calculation of correct value of %U in G e.c.f. (b)(iii) (1)

Correct value of relevant limits from %U e.c.f. (c) (1)

Valid conclusion based on comparison of relevant limits with data (1)

<u>Example of calculation</u>

%U = (0.1 / 58.9) × 100 + 2 × (0.1 / 10.3) × 100 + (1 / 26) × 100 + 4 × (0.02 / 2.35) × 100

= 0.17% + 2 × 0.97% + 3.85% + 4 × 0.85%

= 0.17% + 1.94% + 3.85% + 3.40%

= 9.36% = 9.4%

Upper limit = 78.7×10^9 N m^2 × (1+0.094) = 86.1×10^9 N m^2

Lower limit = 78.7×10^9 N m^2 × (1 – 0.094) = 71.3×10^9 N m^2

As both values fall within this range, the student cannot determine which type of steel the rod is made from.

Or

Use of uncertainties to calculate maximum or minimum shown (1)

Calculation of correct value of upper limit (1)

Calculation of correct value of lower limit (1)

Valid conclusion based on comparison of relevant limit with data (1)

<u>Example of calculation</u>

$$\text{Upper limit } G = \frac{32 \times 0.1\text{kg} \times 9.81\text{Nkg}^{-1} \times (0.589+0.001)\text{m} \times ((0.103+0.001)\text{m})^2}{3.14159 \times (0.026-0.01)\text{ m} \times ((2.35-0.02) \times 10^{-3}\text{ m})^4}$$

$= 0.200$ N m^3 / 2.31×10^{-12} m^5

$= 8.68 \times 10^{10}$ (N m^{-2})

$$\text{Lower limit } G = \frac{32 \times 0.1\text{kg} \times 9.81\text{Nkg}^{-1} \times (0.589-0.001)\text{m} \times ((0.103-0.001)\text{m})^2}{3.14159 \times (0.026+0.01)\text{ m} \times ((2.35+0.02) \times 10^{-3}\text{ m})^4}$$

$= 0.192$ N m^3 / 2.68×10^{-12} m^5

$= 7.16 \times 10^{10}$ (N m^{-2})

As both values fall within this range, the student cannot determine which type of steel the rod is made from.

Or

Use of 2× %U in x **Or** 4× %U in d shown (1)

Calculation of correct value of %U in G e.c.f. (b)(iii) (1)

Correct calculation of relevant %D shown e.c.f. (c) (1)

Valid conclusion based on comparison of relevant %D with %U (1)

4

<u>Example of calculation</u>

%U = (0.1 / 58.9) × 100 + 2 × (0.1 / 10.3) × 100 + (1 / 26) × 100 + 4 × (0.02 / 2.35) × 100

	= 0.17% + 2 × 0.97% + 3.85% + 4 × 0.85% = 0.17% + 1.94% + 3.85% + 3.40% = 9.36% = 9.4% %D for structural steel = (78.7 – 79.3)/79.3 × 100 = 0.76 % %D for carbon steel = (78.7 – 77)/77 × 100 = 2.3% As % D for both structural and carbon steel are less than the %U, the student cannot determine which type of steel the rod is made from.	
	Total for question	**16**

Pearson Education Limited. Registered company number 872828
with its registered office at 80 Strand, London, WC2R 0RL, United Kingdom