Pearson Edexcel

Mark Scheme (Results)

June 2024

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

June 2024
Question Paper Log Number: P75812A
Publications Code: WPH16_01_2406_MS

General Marking Guidance

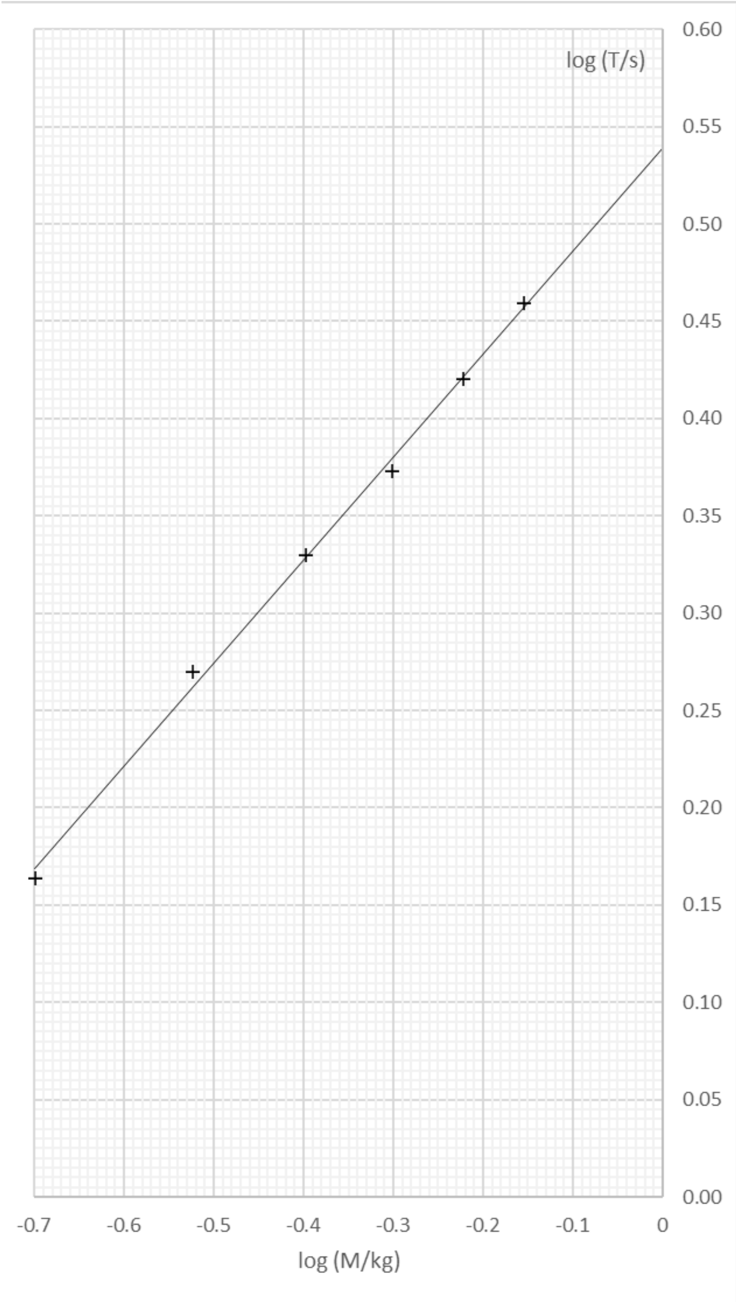
- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should 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.

Question Number	Answer	Mark
1(a)	Any **TWO** from Connect the capacitor with the correct polarity **(1)** Do not exceed the working p.d. of the capacitor **(1)** Ensure the capacitor is fully discharged when handling **(1)**	2
1(b)	Clamp metre rule in position **and** use a set square to ensure metre rule is vertical — accept spirit level **(1)** Ensure the metre rule is close to the mass **(1)** View the ruler perpendicularly **Or** Use a set square to read off the ruler **(1)**	3
1(c)(i)	Mean value of h = 0.242 m — 3 d.p. only **(1)** <u>Example of calculation</u> Mean value of $h = \frac{(0.246 + 0.239 + 0.243 + 0.241)\text{m}}{4} = 0.2423 \text{ m} = 0.242 \text{ m}$	1
1(c)(ii)	Calculation of half range shown — Accept furthest from mean **(1)** Correct percentage uncertainty given to 1 or 2 sig figs — (e.c.f. 1(c)(i)) **(1)** <u>Example of calculation</u> Half range $= \frac{(0.246 - 0.239)\text{m}}{2} = 3.5 \times 10^{-3}$ (m) Percentage uncertainty $= \frac{3.5 \times 10^{-3}\text{m}}{0.242\text{m}} \times 100 = 1.4\%$ Allow rounding or use of furthest from the mean to give half range of 4mm, so %U=1.7%	2
1(c)(iii)	Use of $E = \frac{1}{2}CV^2$ **and** $E = mgh$ **(1)** Use of efficiency $= \frac{\text{useful energy output}}{\text{total energy input}}$ **(1)** Efficiency = 0.56 — Allow 56% — e.c.f. 1(c)(i) **(1)** <u>Example of calculation</u> $E = \frac{1}{2}CV^2 = 0.5 \times (4700 \times 10^{-6})\text{C} \times (6\text{V})^2 = 0.0846 \text{ J}$ $E = mgh = (20 \times 10^{-3})\text{kg} \times 9.81\text{ms}^2 \times 0.242\text{m} = 0.0475 \text{ J}$ Efficiency $= \frac{0.0475\text{J}}{0.0846\text{J}} = 0.56$	3
	Total for question 1	**11**

Question Number	Answer		Mark
2(a)	Substitution of units for all variables into formula	**(1)**	
	Clear working leading to units of N s m^{-2}	**(1)**	**2**
	<u>Example of working</u>		
	$\eta = \frac{\pi \rho P r^4 t}{8LM} = \frac{(\text{kg m}^{-3})(\text{ N m}^{-2})(\text{m}^4)(\text{s})}{(\text{m})(\text{kg})} = \text{N s m}^{-6}\text{m}^4 = \text{N s m}^{-2}$		
2(b)	1. Measure the internal diameter of the pipe using vernier calipers	**(1)**	
	2. Repeat the measurement (of diameter) at different orientations and calculate the mean	**(1)**	
	3. Ensure pipe is horizontal using a spirit level **Or** (Turn on the tap and wait until) pressure difference is constant **Or** Keep stopwatch close to the mass balance	**(1)**	
	4. Measure *M* and corresponding value of *t*	**(1)**	
	5. Record at least 5 sets of values.	**(1)**	
	6. Plot a graph of *M* against *t* and calculate the gradient to determine η	**(1)**	**6**
	Accept valid alternative graphs with *M* and *t* as variables		
	Accept a stated gradient if correct		
2(c)	The data logger will record mass and time simultaneously	**(1)**	
	The data logger has a high sampling rate	**(1)**	**2**
	Total for question 2		**10**

Question Number	Answer	Mark
3(a)	Measure multiple oscillations and divide by the number of oscillations **(1)** Use a marker at the centre of the oscillation **Or** use a marker on the mass **(1)** Repeat the measurement of T and calculate a mean **Or** Allow the oscillations to settle before timing **(1)**	**3**
3(b)(i)	**EITHER** $\log T = \log a + b \log M$ **(1)** Compares with $y = c + mx$ where b is the gradient (which is constant) **(1)** MP2 dependent on MP1 **OR** $\log T = b \log M + \log a$ **(1)** Compares with $y = mx + c$ where b is the gradient (which is constant) **(1)** MP2 dependent on MP1	**2**
3(b)(ii)	Values of log M correct and consistent to 3 d.p. Allow consistent to 2 d.p. **(1)** Values of log T correct and consistent to 3 d.p. Allow consistent to 2 d.p. **(1)** Axes labelled: y as log (T / s) and x as log (M / kg) **(1)** Appropriate sensible scales chosen **(1)** log values plotted accurately **(1)** Best fit line drawn **(1)**	**6**

M / kg	T / s	log (M / kg)	log (T / s)
0.200	1.46	–0.699	0.164
0.300	1.86	–0.523	0.270
0.400	2.14	–0.398	0.330
0.500	2.36	–0.301	0.373
0.600	2.63	–0.222	0.420
0.700	2.88	–0.155	0.459

		
3(b)(iii)	Calculation of gradient using large triangle shown **(1)** Value of gradient in range 0.51 to 0.55 **(1)** Value of gradient given to 2 or 3 s.f., positive, no unit **(1)** <u>Example of calculation</u> $\text{gradient} = \frac{0.485 - 0.2}{-0.1 - -0.64} = \frac{0.285}{0.54} = 0.528$	**3**

3(b)(iv)	Correct y-intercept read from graph **Or** Calculation of y-intercept using calculated gradient and data point from best fit line **(1)** Conversion of log value **(1)** Calculated value of a given to 2 or 3 s.f. e.c.f. (b)(iii) **(1)** <u>Example of calculation</u> log a = y-intercept = 0.535 $a = 10^{0.535} = 3.43$ Allow unit of s, incorrect unit does not score MP3	**3**
	Total for question 3	**17**

Question Number	Answer		Mark
4(a)(i)	**EITHER**		
	Repeat (measurements of t) at different places and calculate a mean	**(1)**	
	To reduce (the effect of) random error	**(1)**	
	MP2 dependent on MP1		
	OR		
	Check and correct for zero error	**(1)**	
	To eliminate systematic error	**(1)**	**2**
	MP2 dependent on MP1		
4(a)(ii)	The micrometer screw gauge has a resolution of 0.01 mm **Or** the measurement will have an uncertainty of 0.005 mm	**(1)**	
	So the percentage uncertainty is 0.35% which is small	**(1)**	**2**
	Example of calculation $\%U = \frac{0.005\text{mm}}{1.41\text{mm}} \times 100 = 0.35\%$		
4(b)(i)	Uses V = (area of semicircle + area of rectangle) × thickness	**(1)**	
	$V = 6.24$ (cm^3)	**(1)**	**2**
	Example of calculation Volume of semicircle $= \frac{\pi D^2 t}{8} = \frac{\pi \times (10.1\text{cm})^2 \times 0.14\text{ cm}}{8} = 5.608\text{ cm}^3$ Volume of rectangle = 10.1 cm × 0.45 cm × 0.14 cm = 0.636 cm^3 $V = 5.608\text{ cm}^3 + 0.636\text{ cm}^3 = 6.24\text{ cm}^3$		

4(b)(ii)	**EITHER** Doubles %U in D Accept doubles $\frac{\Delta D}{D}$ Correct calculation of %U in $\frac{\pi D^2 t}{8}$ **Or** Correct calculation of %U in Dxt Calculation of U in $\frac{\pi D^2 t}{8}$ **and** U in Dxt U = 0.16 (cm^3) <u>Example of calculation</u> %U in D = 0.5% %U in x = 2.2% %U in t = = 1.4% %U in $\frac{\pi D^2 t}{8}$ = (2 × 0.5%) + 1.4 % = 2.4 % %U in Dxt = 0.5 % + 2.2 % + 1.4 % = 4.1 % U in V = (5.61 cm^3 × 2.4 %) + (0.64 cm^3 × 4.1%) = 0.135 cm^3 + 0.026 cm^3 = 0.16 (cm^3) **OR** Uses maximum values to calculate maximum V **Or** Uses minimum values to calculate minimum V Maximum V = 6.40 (cm^3) **Or** minimum V = 6.08 (cm^3) Correct calculation of half range U = 0.16 (cm^3) <u>Example of calculation</u> Maximum $V = \frac{\pi \times (10.15\text{cm})^2 \times 0.142\text{cm}}{8} + 10.15\text{cm} \times 0.46\text{cm} \times 0.142\text{cm}$ = 5.74 cm^3+ 0.66 cm^3= 6.40 (cm^3) Minimum $V = \frac{\pi \times (10.05\text{cm})^2 \times 0.138\text{cm}}{8} + 10.05\text{cm} \times 0.44\text{cm} \times 0.138\text{cm}$ = 5.47 cm^3 + 0.61 cm^3 = 6.08 (cm^3) U in $V = \frac{(6.40 - 6.08)\text{cm}^3}{2}$ = 0.16 (cm^3)	**(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)**	**4**

4(c)	**EITHER** Upper limit of density = 1.07 (g cm^{-3}) **(1)** Accepted value is larger than 1.07 g $cm^{-3}$the protractor may not be made of Perspex **(1)** MP2 dependent MP1 Example of calculation Upper limit of density = 1.04 g cm^{-3}× (1 + 0.03) = 1.07 (g cm^{-3}) **OR** %D = 12% **(1)** As % D is greater than 3% the protractor may not be made of Perspex **(1)** MP2 dependent MP1	2
	Total for question 4	**12**

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