edexcel

Mark Scheme (Results)

Summer 2016

Pearson Edexcel
International Advanced Level
in Physics (WPH06) Paper 01
Experimental Physics

Summer 2016
Publications Code 46655_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.

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. '<u>resonance</u>'
   - 1.2 Bold lower case will be used for emphasis e.g. '**and**' when two pieces of information are needed for 1 mark.
   - 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 This does not apply in 'show that' questions or in any other question where the units to be used have been given, for example in a spreadsheet.
   - 2.3 The mark will not be awarded for the same missing or incorrect unit only once within one clip in epen.
   - 2.4 Occasionally, it may be decided not to insist on a 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.
   - 2.5 The mark scheme will indicate if no unit error is to be applied by means of [no ue].

3. Significant figures
   - 3.1 Use of too many significant figures in the theory questions will not be prevent a mark being awarded if the answer given rounds to the answer in the MS.
   - 3.2 Too few significant figures will mean that the final mark cannot be awarded in 'show that' questions where one more significant figure than the value in the question is needed for the candidate to demonstrate the validity of the given answer.
   - 3.3 The use of one significant figure might be inappropriate in the context of the question e.g. reading a value off a graph. If this is the case, there will be a clear indication in the MS.
   - 3.4 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 mean that one mark will not be awarded. (but not more than once per clip). Accept 9.8 m s^{-2} or 9.8 N kg^{-1}
   - 3.5 In questions assessing practical skills, a specific number of significant figures will be required e.g. determining a constant from the gradient of a graph or in uncertainty calculations. The MS will clearly identify the number of significant figures required.

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.

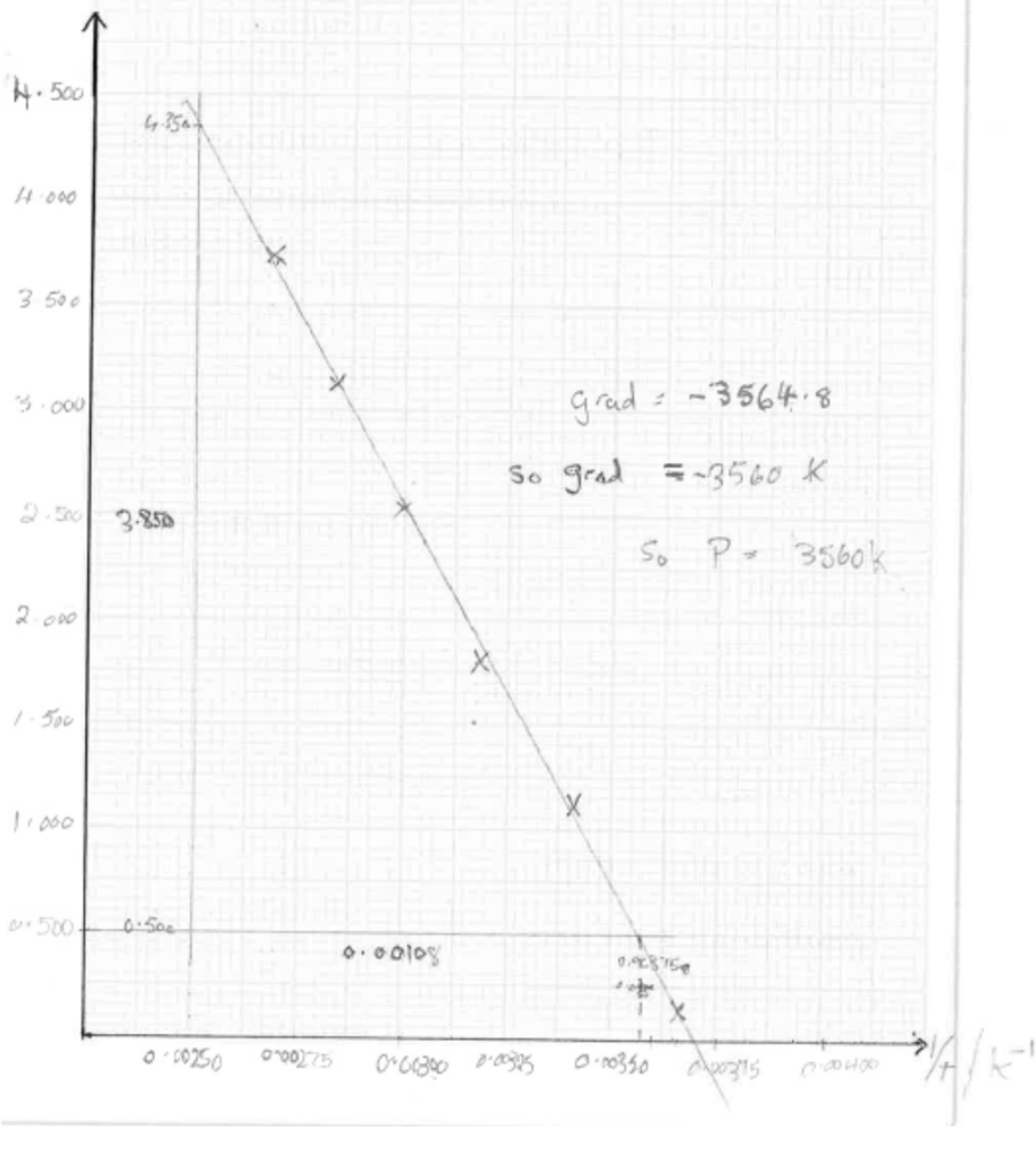
Question Number	Answer	Mark
1(a)	Precision of metre rule is 1 mm **(1)** This introduces a percentage uncertainty of 100×1/52 = 2% which is small (and acceptable) **(1)**	**2**
1(b)(i)	W_1 = 0.650 N **(1)**	**1**
1(b)(ii)	Uncertainty is 2 mm which is 1 square (2 mm) on this scale **(1)** This gives an uncertainty of about 1 square on the force axis and 1 square is 0.01 N **(1)** **Or** Uses uncertainty with gradient ($\Delta F = k\Delta x$) **(1)** Uncertainty = (0.002 × 7.14) = 0.014 N **(1)** **Or** Uses graph by reading 14.1 cm and 14.5 cm **(1)** giving (0.665 – 0.635)/2 = 0.015 N **(1)**	**2**
1(b)(iii)	%U = 100×(0.01/0.650) = 1.5 % **(1)** (ecf bii)	**1**
1(c)(i)	Three forces drawn and labelled correctly as weight/W/mg downwards and (spring) tension/T and upthrust/U upwards. U and W must touch the clay **(1)**	**1**
1(c)(ii)	W_2 = 0.280 N **(1)**	**1**
1(d)	Density of clay = 1760 (kg m^{-3}) (accept 1.76 (g cm^{-3}) (ecf their values from bi and cii) **(1)** With correct unit and 3 SF **(1)** <u>Example of calculation</u> 0.650 N /(0.650 N - 0.280 N) × 1000 kg m^{-3} = 1760 kg m^{-3}	**2**
1(e)	Uses %D = difference in values/(1680 or mean) **(1)** 2 x %U in W_1 **(1)** Suitable comment based on %U and %D using candidate's values **(1)** (MP3 is conditional on MP2) <u>Example of calculation</u> 100 × (1760 - 1680)/0.5×(1760 + 1680) = 100×(80/1720) = 4.7% %U in ratio is 2 × 1.5% = 3.0 % So %U < %D (material is not likely to be the clay)	**3**
	Total for Question 1	**13**

Question Number	Answer	Mark
2(a)(i)	Y connected correctly **(1)**	**1**
2(a)(ii)	Voltmeter connected correctly **(1)**	**1**
2(b)(i)	**2b to be marked holistically** Record V_1 and V_2 **(1)** For various values of the supply/V_1 **(1)**	**2**
2(b)(ii)	Plot a graph of V_2 (on the y-axis) against $(V_1 - V_2)$ (on the x-axis) **(1)** $C_Y = C_X$ / gradient **(1)**	**2**
2(b)(iii)	Supply p.d. does not exceed working p.d. for either capacitor/C **Or** Capacitors are connected with polarity correct (if electrolytic) **(1)**	**1**
2(b)(iv)	Ensure that capacitor Y is discharged before each reading (accept both capacitors are discharged) **Or** check for zero error on voltmeter **(1)**	**1**
	Total for Question 2	**8**

Question Number	Answer	Mark
3(a)(i)	T (= 2×1.6) = 3.2 s **(1)**	**1**
3(a)(ii)	t = 0.8 s **(1)**	**1**
3(a)(iii)	Slope/gradient (of velocity time graph) is acceleration **(1)** (At 0.80 s pendulum has) zero acceleration **(1)** (accept rate of change of velocity is zero)	**2**
3(b)(i)	Tangent centred at t = 0.4 s **(1)** a = 1.9 ms^{-2} – 2.2 m s^{-2} **(1)** <u>Example of calculation</u> Gradient = (1.6 - 0 .2)/0.70 = 2.0 a = 2.0 m s^{-2}	**2**
3(b)(ii)	t = 1.20 s **(1)**	**1**
3(c)	Any **one** from Many readings in a short time interval **(1)** (Very) low uncertainty in time measurements **(1)** Synchronous readings **(1)** (Do not accept ‘plots graph’ or reference to reaction time)	**1**
	Total for Question 3	**8**

Question Number	Answer	Mark
4(a)	See $\ln(I) = \ln(I_0) - p/T$ **(1)** where the gradient/m = $-p$ **(1)**	**2**
4(b)(i)	Values for $\ln(I)$ and $1/T$ with 3/4 sf **(1)** Axes & labels and units **(1)** Scales **(1)** Plots & Best fit line **(1)**	**4**
4(b)(ii)	Attempts gradient calculation using large triangle **(1)** p = 3560 K – 3580 K **(1)** <u>Example of calculation</u> Gradient = (3.25 – 0.50)/(2.80 – 3.57) = 2.75/–0.77 = –3.57 So p = 3570 K	**2**
4(b)(iii)	$e = 1.54 \times 10^{-19}$ C (ecf gradient from bii) **(1)** <u>Example of calculation</u> $e = 1.38 \times 10^{-23}$ J K^{-1} × 3570 K / 0.32 V = 1.54×10^{-19} C	**1**
4(b)(iv)	Calculates percentage difference = 3.8% (ecf on their value for e) **(1)** Makes sensible comment based on comparison of their %D and likely %U in experiment. **(1)** **e.g.** %D is small enough to compare favourably with expected experimental uncertainties **Or** attempts calculation for %U and compares with their %D <u>Example of calculation</u> %D = 100 × (1.60 – 1.54)/1.60 = 3.8%	**2**
	Total for Question 4	**11**

θ/°C	I/mA	$1/T$/K^{-1}	Ln(I/mA)	Ln(I/A)
0	1.2	0.00366	0.182	-6.73
20	3.0	0.00341	1.10	-5.81
40	6.0	0.00319	1.79	-5.12
60	12.5	0.00300	2.53	-4.38
80	22.6	0.00283	3.12	-3.79
100	41.7	0.00268	3.73	-3.18



4.500
4.350
4.000
3.500
3.000
2.500
3.850
2.000
1.500
1.000
0.500
0.500
0.00108
0.00250
0.00275
0.00300
0.00325
0.00350
0.00375
0.00400
1/T / K^-1
grad = -3564.8
so grad = -3560 K
so P = 3560K

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