Mark Scheme (Results)

Summer 2018

Pearson Edexcel Level 3 GCE
In Physics (8PH0)
Paper 01Core Physics I

Summer 2018
Publications Code 8PH0_01_1806_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 schemes will indicate within the table where, and which strands of QWC, are being assessed. The strands are as follows:

  i) ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear
  ii) select and use a form and style of writing appropriate to purpose and to complex subject matter
  iii) organise information clearly and coherently, using specialist vocabulary when appropriate

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.

5. Quality of Written Communication

5.1 Indicated by QoWC in mark scheme. QWC – Work must be clear and organised in a logical manner using technical wording where appropriate.

5.2 Usually it is part of a max mark, the final mark not being awarded unless the QoWC condition has been satisfied.

6. Graphs

6.1 A mark given for axes requires both axes to be labelled with quantities and units, and drawn the correct way round.

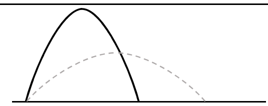
6.2 Sometimes a separate mark will be given for units or for each axis if the units are complex. This will be indicated on the mark scheme.

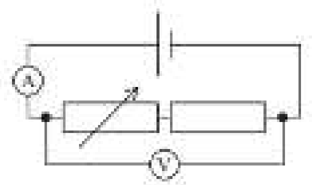
6.3 A mark given for choosing a scale requires that the chosen scale allows all points to be plotted, spreads plotted points over more than half of each axis and is not an awkward scale e.g. multiples of 3, 7 etc.

6.4 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	**D power kg m^2 s^{-3}**	**1**
	Incorrect Answers: A – Coulombs is not an SI base unit B – Incorrect, as the unit for charge in SI base units is A s C – J s^{-1} is not in SI base units	
2	**B** 	**1**
	Incorrect Answers: A – this is the trajectory for a ball kicked at an angle greater than θ, at a greater speed C – this is the trajectory for a ball kicked at an angle greater than θ, at a greater speed D – this is the trajectory for a ball kicked at an angle lower than θ, at a lower speed	
3	**A amplitude of the vibrations of the lattice ions**	**1**
	Incorrect Answers: B – the distance travelled by charge carriers between collisions will **decrease** if the temperature increases C – the drift velocity of conduction electrons will **decrease** if the temperature increases D – the number of conduction electrons per unit volume will **remain constant** if the temperature increases	
4	**B** filament bulb	**1**
	Incorrect Answers: A – this is not the graph for a diode C – this is not the graph for an ohmic resistor D – this is not the graph for a thermistor	
5	**C ± 0.1 %**	**1**
	Incorrect Answers: A – the calculation has not been multiplied by 100 to give the % uncertainty i.e. $\frac{0.1}{93} = 0.001$ B – the uncertainty in mm has not been converted to cm and the calculation has not been multiplied by 100 i.e. $\frac{1}{93} = 0.01$ D – the uncertainty in mm has not been converted to cm i.e. $\frac{1}{93} \times 100 = 1$	

6	C **190 kJ**	**1**
	Incorrect Answers: A – The velocity was not squared when using the formula $E_k = ½\, mv^2$ e.g. ½ $(1.2 \times 10^3)(18) = 11$ kJ B – The velocity was not squared and the ½ was omitted when using the formula $E_k = ½\, mv^2$ e.g. $(1.2 \times 10^3)(18) = 22$ kJ D – The ½ was omitted when using the formula $E_k = ½\, mv^2$ e.g. $(1.2 \times 10^3)(18)^2 = 390$ kJ	
7	**A** 	**1**
	Incorrect Answers: B – the ammeter would measure the current in the cell, but the voltmeter would not be measuring the p.d. across the cell C – the voltmeter would measure the p.d. across the cell but the ammeter would not be measuring the current in the cell D – the voltmeter would measure the p.d. across the cell but the ammeter would not be measuring the current in the cell	
8	**C 42 m**	**1**
	Incorrect Answers: A – 141 m is ¾ of the internal circumference of the track (¾ × 2 × π × 30 = 141 m) B – 141 m is ¼ of the internal circumference of the track (¼ × 2 × π × 30 = 47 m) D – 30 m (the radius) is the displacement travelled in one direction (downwards from the start position)	

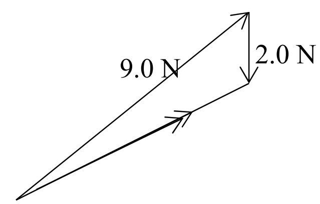
(Total for Multiple Choice Questions = 8 marks)

Question Number	Acceptable answers		Additional guidance	Mark
9(a)	• A statement applying the conservation of energy to the circuit • Use of Ohm's law for each term /individual pd leading to the cancelling of currents in the equation • $R_T = R_1 + R_2 + R_3$	(1) (1) (1)	<u>Example of calculation</u> $\mathcal{E} = V_1 + V_2 + V_3$ $\mathcal{E} = \cancel{I}R_T = \cancel{I}R_1 + \cancel{I}R_2 + \cancel{I}R_3$ $R_T = R_1 + R_2 + R_3$	3
9(b)	**Either** • Use of equation(s) to determine the total resistance of the voltmeter and 40 Ω resistor in parallel (34.3 Ω) i.e. potential divider formula or Ohm's law • Use of $\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$ • $R_v = 240$ (Ω) **Or** • Use of Ohm's law to determine the current through voltmeter (0.0075 A) i.e. current in 40 Ω resistor calculated (0.045 Ω) **and** subtracted from current in 80 Ω resistor (0.0525 Ω) • Use of Ohm's law with 1.8 V to calculate the resistance of the voltmeter • $R_v = 240$ (Ω)	 (1) (1) (1) (1) (1) (1)	<u>Example of calculation</u> $\left(\frac{R}{80\ \Omega + R}\right) 6\ \text{V} = 1.8\ \text{V}$ $R = 34.29\ \Omega$ $\frac{1}{34.29\ \Omega} = \frac{1}{40\ \Omega} + \frac{1}{R_V}$ $R_V = 240.2\ \Omega$	3

(Total for Question 9 = 6 marks)

Question Number	Acceptable answers		Additional guidance	Mark
10(a)	• Weight of the picture is equal to the vertical component of tension • $mg/2 = T\cos\theta$ where θ is the angle between the wire and the vertical • As the angle (to the vertical) is the smaller in arrangement 1, the cosine of the angle will be larger • Arrangement 1 as the tension in the wire is lower than in arrangement 2	(1) (1) (1) (1)	MP1: may be implied in an equation, accept $mg = T\cos\theta$ MP1/2: $mg/2 = T\cos\theta$ with θ defined scores 2 marks MP2/3: the angle used must be defined in words or on the diagram. Answer can be in terms of sin θ if θ defined as the angle between the wire and the horizontal e.g.MP2: $mg = 2T\sin\theta$ MP3: angle larger in 1 so sine of angle is larger MP4 conditional MP2 or MP3	4
10(b)	• The weight does not act through the nail/pivot **Or** the centre of gravity is not in line/below the nail/pivot **Or** there is a perpendicular distance between the weight and the nail/pivot • There is now a moment of the weight **Or** the anticlockwise moment is greater than the clockwise moment • The idea that the picture stops moving when the c of g is below the nail	(1) (1) (1)	Accept centre of mass for centre of gravity (Allow annotations to a diagram with additional explanation for MP1/3) MP3 Accept: the turning moment being 0 **Or** the clockwise moments equal to the anti-clockwise moments	3

(Total for Question 10 = 7 marks)

Question Number	Acceptable answers		Additional guidance	Mark
11(a)	• Use of $v = s/t$ for the horizontal motion **Or** see $u_h = 25 \text{ m s}^{-1}$ • Use of $s = ut + \frac{1}{2} at^2$ with $s = 0$ **Or** $v = u + at$ with $t = 1.0$ s **Or** see $u_v = 9.81 \text{ m s}^{-1}$ • Combining of horizontal velocity and vertical velocity expressions **Or** see $\tan\theta = \left(\frac{9.81}{25}\right)$ • $\theta = 21°$	(1) (1) (1) (1)	<u>Example of calculation</u> horizontal motion: $u_h = \frac{50 \text{ m}}{2.0 \text{ s}} = 25 \text{ m s}^{-1}$ vertical motion: $0 = (u_v)(2.0 \text{ s}) + \frac{1}{2}(-9.81 \text{ m s}^{-2})(2.0 \text{ s})^2$ $u_v = 9.81 \text{ m s}^{-1}$ $\tan\theta = \frac{u_v}{u_h} = \frac{9.81 \text{ m s}^{-1}}{25 \text{ m s}^{-1}}$ $\theta = 21.4°$	4
11(b)	• Construction of vector diagram with 2 N/weight and 9N / catapult force labelled and all three directions shown • Correct scaling of 9 N and 2 N forces • Magnitude = 7.6 N to 8.0 N • Direction = 27° to 31°	(1) (1) (1) (1)	 MP2: Award if MP3 awarded. Otherwise, the ratio of the lengths should lie between 4.3 and 4.8 (if no diagram, only MP3/4 can be awarded if answers obtained by calculation)	4

(Total for Question 11 = 8 marks

Question Number	Acceptable answers	Additional guidance	Mark
12(a)	• Use of $p = mv$ **(1)** • Use of principle of conservation of momentum **(1)** • Magnitude of velocity = 0.2 m s^{-1} with direction to the left **(1)**	MP1: see 0.3 *m*, 0.7 *m* or 2*mv* MP3: accept 'in the initial direction of glider 2' for 'to the left' <u>Example of calculation</u> (taking the initial direction of glider 1 as positive) $0.3\,m - 0.7\,m = 2mv$ $v = -0.2$ m s^{-1}	**3**
12(b)	• Glider 1 exerts this force on glider 2, so according to N3 **(1)** • Glider 2 will exert an (equal and) opposite force on glider 1 **(1)** • There is now a resultant force on glider 1 **(1)** • Glider 1 accelerates according to N1 **Or** glider 1 now moves to the left according to N1 **(1)**		**4**

(Total for Question 12 = 7 marks)

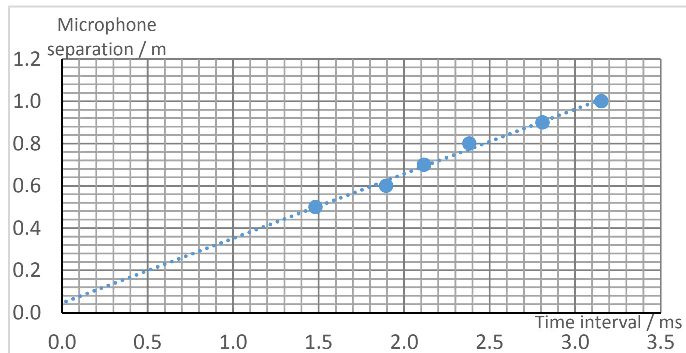
Question Number	Acceptable answers	Additional guidance	Mark
13(a)	• The (voltmeter) reading will increase **(1)** • <u>Resistance</u> increases (with length) **Or** <u>resistance</u> $\propto$ length **(1)**	MP2: accept idea of a potential divider i.e. the ratio of the of BC to the total length AD will be greater, so the proportion of the total voltage will be greater ($\frac{\text{BC}}{\text{AD}}$ V) MP2: Do not award if there is also a reference to resistivity increasing	**2**
13(b)	• Use of $V = IR$ **(1)** • Use of $R = \rho l/A$ **(1)** • (Min) resistivity = 160 (Ω m) **Or** (max) resistivity = 730 (Ω m) **(1)** • Compacted clay pathways **and** limestone are present in the soil **(1)**	<u>Example of calculation</u> $R_{\text{min}} = \frac{1.8\text{ V}}{9.5 \times 10^{-3}\text{ A}} = 189.5\ \Omega$ $R_{\text{max}} = \frac{8.0\text{ V}}{9.5 \times 10^{-3}\text{ A}} = 842.1\ \Omega$ $\rho_{\text{min}} = \frac{RA}{l} = \frac{189.5\ \Omega \times 0.650\text{ m}^2}{0.75\text{ m}} = 164.2\ \Omega\text{ m}$ $\rho_{\text{max}} = \frac{RA}{l} = \frac{842.1\ \Omega \times 0.650\text{ m}^2}{0.75\text{ m}} = 729.8\ \Omega\text{ m}$ conclusion to be consistent with calculated values	**4**

(Total for Question 13 = 6 marks)

Question Number	Acceptable answers	Additional guidance	Mark
14(a)	• Attempt to find area under the graph **(1)** • Length from 18 000 m to 20 000 m **(1)** • Comparison of calculated value to 23 km **(1)** e.g. The length is long enough	MP1: use of triangles or counting squares MP3: conclusion to be consistent with calculated value <u>Example of calculation</u> Area under the graph (counting large squares) $= 18.7 \times 100\ \mathrm{m\ s^{-1}} \times 10\ \mathrm{s} = 18\ 700\ \mathrm{m}$	**3**
14 (b)(i)	• 26 - 28 s **(1)**	Unit required	**1**
14(b)(ii)	• Use of gradient of the graph between 28 and 46 s **(1)** • Acceleration = 16 - 17 m $\mathrm{s^{-2}}$ **(1)**	<u>Example of calculation</u> Gradient of tangent = $\frac{490\ \mathrm{m\ s^{-1}} - 0\ \mathrm{m\ s^{-1}}}{52\ \mathrm{s} - 22\ \mathrm{s}}$ Acceleration = 16.3 m $\mathrm{s^{-2}}$	**2**
14(b)(iii)	• Use of $\Sigma F = ma$ using a from (ii) **(1)** • $\Sigma F = (89 + 120) \times 10^3$ N − frictional force **(1)** • Frictional force = 80 kN to 84 kN (full ecf for acceleration) **(1)**	<u>Example of calculation</u> $(89 + 120) \times 10^3$ N - F = 7790 kg × 16.3 m $\mathrm{s^{-2}}$ $F = 82.0 \times 10^3$ N	**3**

Question number	Answer	Additional guidance	Mark
*14(c)	This question assesses a student's ability to show a coherent and logically structured answer with linkages and fully-sustained reasoning. Marks are awarded for indicative content and for how the answer is structured and shows lines of reasoning. The following table shows how the marks should be awarded for indicative content. <table><tr><td>Number of indicative marking points seen in answer</td><td>Number of marks awarded for indicative marking points</td></tr><tr><td>6</td><td>4</td></tr><tr><td>5 - 4</td><td>3</td></tr><tr><td>3 - 2</td><td>2</td></tr><tr><td>1</td><td>1</td></tr><tr><td>0</td><td>0</td></tr></table> **Indicative content** • At greater speed, the drag force is greater • Resultant force decreases **Or** acceleration decreases • When the rocket is started the (resultant) force/thrust increases • The mass/weight of the car decreases as fuel is used up • Increasing the acceleration (for a given applied force) • When the brakes are applied, there is a deceleration **Or** when the brakes are applied the resultant force is in the opposite direction **Or** deceleration (due to drag forces) decreases due to smaller drag forces acting on the car at lower speeds	The following table shows how the marks should be awarded for structure and lines of reasoning <table><tr><td></td><td>Number of marks awarded for structure of answer and sustained line of reasoning</td></tr><tr><td>Answer shows a coherent and logical structure with linkages and fully sustained lines of reasoning demonstrated throughout</td><td>2</td></tr><tr><td>Answer is partially structured with some linkages and lines of reasoning</td><td>1</td></tr><tr><td>Answer has no linkages between points and is unstructured</td><td>0</td></tr></table>	6

(Total for Question 14 = 15 marks)

<table>
<tr><th>Question Number</th><th>Acceptable answers</th><th>Additional guidance</th><th>Mark</th></tr>
<tr><td>15(a)</td><td>No repeats
Or range too small
Or readings should be repeated (and mean calculated)
Or separations less than 0.50 m should be used
Or separations greater than 1.00 m should be used
Or distances should be recorded to the nearest mm
Or smaller intervals (for the separation) should be used (1)</td><td>Do not credit:
more readings should be taken
references to the number of decimal places</td><td>1</td></tr>
<tr><td>15(b)(i)</td><td>Axes labelled with quantities and units (1)
Suitable scale (1)
Correct plotting (1)
Line of best fit (1)
<table>
<tr><th>Microphone separation/ m</th><th>Time interval / ms</th></tr>
<tr><td>1.00</td><td>3.2</td></tr>
<tr><td>0.90</td><td>2.8</td></tr>
<tr><td>0.80</td><td>2.4</td></tr>
<tr><td>0.70</td><td>2.1</td></tr>
<tr><td>0.60</td><td>1.9</td></tr>
<tr><td>0.50</td><td>1.5</td></tr>
</table></td><td>

Graph may be landscape and axes either way round

MP2: Suitable scale – plotted points take up at least half the graph paper in both directions</td><td>4</td></tr>
</table>

15(b)(ii)	• Use of gradient **Or** use of 1/gradient (if axes swapped) **(1)** • Speed of sound = 280 - 310 m s^{-1} **(1)**	MP1: only award for a y/x calculation if the graph passes through the origin <u>Example of calculation</u> Speed of sound = $\frac{0.96\text{ m} - 0.04\text{ m}}{(3.0 - 0.0) \times 10^{-3}\text{ m}}$ = 307 m s^{-1}	**2**
15(c)	• Value obtained is lower than accepted value **(1)** **Max 2** • Measured times are too small **(1)** • Large percentage uncertainty for time **(1)** • Parallax when reading from the metre rule **(1)** • The distance not measured to same position on each microphone **(1)**	MP1: accept answer consistent with calculated value but do not accept different for greater/lower Ignore references to temperature	**3**

(Total for Question 15 = 10 marks)

Question Number	Acceptable answers	Additional guidance	Mark
16(a)(i)	• Oscillations/vibrations (of the light) are in one plane only **(1)** • Plane includes the direction of energy transfer **Or** Plane includes the direction of travel/propagation **(1)**	Accept: • Oscillations/vibrations (of the light) are in one direction only • perpendicular to the direction of propagation/travel **Or** perpendicular to the direction of energy transfer Allow labelled diagrams for each marking point	**2**
16(a)(ii)	• The (angle of polarisation of the) filters are 90° to one another **(1)** **Either** • If plane of polarisation of light is rotated (by 90°) when it passes through the crystal (with no p.d. across it), it can still pass through the upper filter **(1)** **Or** • If plane of polarisation of light is not rotated (by 90°) when it passes through the crystal (with a p.d. across it), it cannot pass through the upper filter **(1)**	MP2: it must be clear as to whether the candidate is describing a light screen or a dark screen	**2**
16(b)(i)	• Use of $I = P/A$ **(1)** • $P = 0.014$ W **(1)**	Example of calculation $P = 7.8\ \text{W m}^{-2} \times 1.8 \times 10^{-3}\ \text{m}^2$ $P = 0.014$ W	**2**
16(b)(ii)	• Use of $P = VI$ **(1)** • Use of efficiency = $\frac{\text{useful power output}}{\text{total power input}}$ **(1)** • Efficiency = 0.19 or 0.20 or 19 % or 20 % **(1)**	Example of calculation Power input into LED = $3.6\ \text{V} \times 20 \times 10^{-3}\ \text{A} = 0.072$ W Efficiency = $\frac{0.014\ \text{W}}{0.072\ \text{W}} = 0.194$ ecf from (b)(i) for the power output of LED	**3**

16(c)	• X is brittle at greater stresses/forces **(1)** • Y will deform plastically at greater stresses/forces **(1)** • The Young modulus for X is greater than Y **(1)** • A screen made from material Y would be more suitable as it is more flexible **(1)**	Accept converse for MP3 and MP4 MP4: accept less stiff for flexible.	**4**

(Total for Question 16 = 13 marks)

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