



Mark Scheme (Results)

Summer 2018

Pearson Edexcel Level 3 GCE
In Physics (8PH0)
Paper 02 Core Physics II

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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. 'resonance'
- 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 open.
- 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 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 $g = 10 \text{ m s}^{-2}$ 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	C $\frac{F/A}{\Delta x/x}$ (stress/strain)	1
	Incorrect Answers: A incorrect arrangement B incorrect arrangement D incorrect arrangement for strain	
2	C $t = \frac{90 \times 2}{1500}$	1
	Incorrect Answers: A -no factor of 2 B - no factor of 2 and incorrect equation D - incorrect equation	
3	D – Two points $\frac{\lambda}{2}$ apart oscillate with the same amplitude	1
	Incorrect Answers: A – Points on a wave do not all oscillate in phase B – A node is formed from destructive interference C – Stationary waves may also be formed from longitudinal waves	
4	A – amount of energy of a photon needed to release an electron	1
	Incorrect Answers: B- an electron does not release a photon C – reference to frequency incorrect D - reference to frequency incorrect and electron does not release a photon	

5	<p>B – decreasing the speed of the electrons in the beam</p> <p>Incorrect Answers: A – the number of electrons does not affect the angle C - the number of electrons does not affect the angle D – increasing the speed would decrease the distance between the rings</p>	1
6	<p>C - $\frac{\pi}{5}$ ($\frac{1}{10} \times 2\pi$)</p> <p>Incorrect Answers: A – the waves would be in antiphase B – the waves would be a quarter of a wave out of phase D – the waves would be a 20th of a wave out of phase</p>	1
7	<p>B - $v = 2fl$</p> <p>Incorrect Answers: A – wavelength is $2l$ C - wavelength is $2l$ D - wavelength is $2l$</p>	1
8	<p>C - $\mu = \frac{1}{\text{gradient}}$</p> <p>Incorrect Answers: A – incorrect use of $v = \sqrt{\frac{T}{\mu}}$ B – incorrect use of $v = \sqrt{\frac{T}{\mu}}$ D - incorrect use of $v = \sqrt{\frac{T}{\mu}}$</p>	1

(Total for Multiple Choice Questions = 8 marks)

Question Number	Acceptable Answers	Additional guidance	Mark								
9	<p>This question assesses a student’s ability to show a coherent and logically structured answer with linkages and fully-sustained reasoning.</p> <p>Marks are awarded for indicative content and for how the answer is structured and shows lines of reasoning.</p> <p>Indicative Content</p> <ul style="list-style-type: none"> • Band does not obey Hooke’s law Or there is a non-linear relationship between force and extension (1) • (The band is elastic so) the extension returns to zero when the force is removed or size/shape is unchanged (1) • For a given force the extension when loading is less than when unloading or for the same extension more force required when loading (1) • Area under the loading curve is greater than the unloading curve Or Loading increases the elastic strain energy (of the band) (1) • The band absorbs more energy when being loaded than it releases when unloaded Or Unloading: some strain energy transferred by heating (1) • Energy released by heating represented by the area between the lines (1) 	<p>The following table shows how the marks should be awarded for structure and lines of reasoning</p> <table border="1" data-bbox="1087 456 1787 906"> <thead> <tr> <th data-bbox="1087 456 1444 553"></th> <th data-bbox="1444 456 1787 553">Number of marks awarded for structure of answer and sustained line of reasoning</th> </tr> </thead> <tbody> <tr> <td data-bbox="1087 553 1444 711">Answer shows a coherent and logical structure with linkages and fully sustained lines of reasoning demonstrated throughout</td> <td data-bbox="1444 553 1787 711">2</td> </tr> <tr> <td data-bbox="1087 711 1444 808">Answer is partially structured with some linkages and lines of reasoning</td> <td data-bbox="1444 711 1787 808">1</td> </tr> <tr> <td data-bbox="1087 808 1444 906">Answer has no linkages between points and is unstructured</td> <td data-bbox="1444 808 1787 906">0</td> </tr> </tbody> </table>		Number of marks awarded for structure of answer and sustained line of reasoning	Answer shows a coherent and logical structure with linkages and fully sustained lines of reasoning demonstrated throughout	2	Answer is partially structured with some linkages and lines of reasoning	1	Answer has no linkages between points and is unstructured	0	6
	Number of marks awarded for structure of answer and sustained line of reasoning										
Answer shows a coherent and logical structure with linkages and fully sustained lines of reasoning demonstrated throughout	2										
Answer is partially structured with some linkages and lines of reasoning	1										
Answer has no linkages between points and is unstructured	0										
	Total for question 9		6								

Question Number	Acceptable Answers	Additional guidance	Mark
10(a)	<ul style="list-style-type: none"> • Use of $\Delta E_{el} = \frac{1}{2} F \Delta x$ (1) • 4.6 J (1) 	<u>Example of Calculation</u> $\Delta E_{el} = \frac{1}{2} \times 29 \text{ N} \times 0.32 \text{ m} = 4.6 \text{ J}$	2
10(b)	<ul style="list-style-type: none"> • Use of $F = k \Delta x$ (1) • 0.30 m (1) 	<u>Example of Calculation</u> $\frac{29 \text{ N}}{0.32 \text{ m}} = \frac{27 \text{ N}}{\Delta x}$ $\Delta x = 0.30 \text{ m}$	2
Total for question 10			4

Question Number	Acceptable Answers	Additional Guidance	Mark
11(a)	<p>Max 2</p> <ul style="list-style-type: none"> • Use large angles of incidence or use a wide range of angles • Use narrowest possible ray • Repeat and calculate mean • Work in a dark room. • Use monochromatic light <p style="text-align: right;">(2)</p>		2
11(b)(i)	<p>Either</p> <ul style="list-style-type: none"> • <u>Resolution</u> of protractor 1° (1) • Recognises that the results are recorded to the same precision as the resolution of the protractor (1) <p>Or</p> <ul style="list-style-type: none"> • <u>Resolution</u> of protractor 0.5° (1) • Recognises that the results are not recorded to the same precision as the resolution of the protractor (1) 	MP2 dependent on MP1	2
11(b)(ii)	<ul style="list-style-type: none"> • Use of percentage uncertainty equation with 0.5° as the resolution (1) • percentage uncertainty = 2% (1) 	<p><u>Example of calculation</u></p> $\frac{0.5}{29} \times 100\% = 1.72\%$	2
11(c)(i)	<ul style="list-style-type: none"> • Appropriate line of best fit (1) 		1
11(c)(ii)	<ul style="list-style-type: none"> • Calculates a gradient using at least half the drawn line (1) • $\eta = 1.37$ to 1.47 (1) • leading to a conclusion that glass is silica (1) <p>Or conclusion consistent with their value for η</p>	<p><u>Example of calculation</u></p> $\frac{0.9 - 0.05}{0.58} = 1.47 \text{ silica}$	3
	Total for question 11		10

Question Number	Acceptable Answers	Additional Guidance	Mark
12 (a)	<ul style="list-style-type: none"> • Electrons exist in discrete energy levels (1) • (After the mercury atom is excited) electrons move back to a lower energy level (1) • Or (After the mercury atom is excited) electrons move back down from a higher energy level (1) • <u>Photons</u> are emitted (1) • Frequency of emitted radiation / photons depends on the difference in energy between the energy levels (1) • Or reference to $\Delta E = hf$ (1) • Since there are only certain energy changes possible, only certain frequencies are possible (1) 	<p>Accept excited state for higher energy level Accept ground state for lower energy state</p>	5
12 (b)	<ul style="list-style-type: none"> • Use of $E = \frac{1}{2}mv^2$ (1) • Use of $E = hf$ and $c = f\lambda$ (1) • $\lambda = (2.4 - 2.5) \times 10^{-7}(\text{m})$ (1) • leading to a conclusion that radiation is ultraviolet Or conclusion consistent with their value for wavelength (1) 	<p>MP4 dependent on MP2</p> <p><u>Example of Calculation</u> $\Delta E_k = \frac{1}{2} \times 9.11 \times 10^{-31} \text{ kg} \times ((2.5 \times 10^6 \text{ m s}^{-1})^2 - (2.1 \times 10^6 \text{ m s}^{-1})^2)$</p> <p>$\Delta E_k = 8.4 \times 10^{-19} \text{ (J)}$</p> <p>$\lambda = \frac{6.63 \times 10^{-34} \text{ J s} \times 3 \times 10^8 \text{ m s}^{-1}}{8.4 \times 10^{-19} \text{ J}}$</p> <p>$\lambda = 2.4 \times 10^{-7}(\text{m})$</p>	4
	Total for question 12		9

Question Number	Acceptable Answers	Additional guidance	Mark
13 (a)	<ul style="list-style-type: none"> Line/surface joining points on a wave that are in phase (1) 		1
13(b)(i)	<ul style="list-style-type: none"> Do not stare into laser (1) 		1
13 (b)(ii)	<ul style="list-style-type: none"> Lack of other evidence (supporting wave theory) Or Was yet to be reproduced Or There was support / evidence for the particle model (1) 		1
13(c)(i)	<p>An explanation that makes reference to the following:</p> <ul style="list-style-type: none"> Path lengths (A-O and B-O) are equal Or Path difference is zero (1) Will arrive in phase Or phase difference is zero (1) (Bright line is position of) <u>constructive</u> interference/superposition (1) 		3
13(c)(ii)	<ul style="list-style-type: none"> 600 nm Or 600×10^{-9} m Or 6.0×10^{-7} m Or one wavelength (1) Or λ 	<p>Do not accept ($n\lambda$)</p> <p>Accept any correct equivalent value</p>	1
Total for question 13			7

			Additional guidance	Mark
14(a)(i)	<ul style="list-style-type: none"> • One ray correctly drawn (1) • Second ray correctly drawn (1) • Completes diagram with image at position 3.6 to 3.8 cm and height of 0.7 to 0.8 cm (1) 			3
14(a)(ii)	<ul style="list-style-type: none"> • Use of $m = \frac{v}{u}$ or $m = \frac{\text{image height}}{\text{object height}}$ using values from (a)(i) (1) • Magnification of 0.47 to 0.53 (1) 		<u>Example of Calculation</u> $m = \frac{v}{u} = \frac{3.7}{7.5} = 0.5$	2
14(a)(iii)	<ul style="list-style-type: none"> • Real and image on different side of converging lens to object Or rays pass through the image (1) 			1

14(b)(i)	<ul style="list-style-type: none"> • Focus image of distant/far object on to a screen (1) • Measure distance from lens to screen (1) <p>Or</p> <ul style="list-style-type: none"> • Use <u>parallel</u> rays of light (1) • Measure distance from lens to the point where the rays converge (1) 	MP2 dependent on MP1	2
14(b)(ii)	<ul style="list-style-type: none"> • Greater <u>refraction</u> (1) • To converge (parallel) rays at a point closer to the lens (1) 		2
14(b)(iii)	<ul style="list-style-type: none"> • Photograph 2 has a greater magnification (1) • so v is greater (1) • since u is constant (1) • So f is greater (1) • Hence photograph 2 taken with lens of focal length 200 mm (1) 	MP5 dependent on MP2 and MP4	5
Total for question 14			15

Question Number	Acceptable Answers	Additional guidance	Mark
15(a)	<ul style="list-style-type: none"> (High intensity of light means) <u>photons</u> strike the photocell at a greater rate (1) One to one interaction between photons and electrons (1) So Electrons released at a greater rate (1) So greater current/charge/power in external circuit (1) 		4
15(b)	<ul style="list-style-type: none"> Use of $I = \frac{P}{A}$ (1) Use of $P = \frac{E}{t}$ (1) Multiply by 23% (1) 1700 MJ (1) 	<u>Example of Calculation</u> $E = 1300 \text{ Wm}^{-2} \times 200 \text{ m}^2 \times (8 \times 60 \times 60 \text{ s} \times 0.23)$ $E = 1700 \text{ MJ}$	4
15(c)	<ul style="list-style-type: none"> Use of $E = Pt$ (1) 430 MJ (1) 	<u>Example of Calculation</u> $E = 4 \times 7500 \text{ W} \times (4 \times 60 \times 60)\text{s}$ $E = 432 \text{ MJ}$	2
15(d)	<ul style="list-style-type: none"> Use of $E = mg\Delta h$ (1) $E = 1.1 \times 10^8 \text{ J}$ (1) 	<u>Example of Calculation</u> $E = mg\Delta h = 1600 \text{ kg} \times 9.81\text{ms}^{-1} \times (8500 - 1500)\text{m}$ $E = 1.1 \times 10^8 \text{ J}$	2
15(e)	<ul style="list-style-type: none"> Drag increases as speed increases (1) Or Drag increases as <u>density</u> of air increases (1) Requiring a greater forward force (1) So motors require more energy/power so plane should fly at a reduced speed (1) 	Accept air resistance for drag	3
15(f)	Max 1 (1) <ul style="list-style-type: none"> Develops new technologies Develops alternative energy sources Raises public awareness Secures funding for other projects 		1
Total for question 15			16

Question Number	Acceptable Answers	Additional guidance	Mark
16(a)	<ul style="list-style-type: none"> • Recognises that $F=0$ Or Uses $D = U - W$ (1) • Use of $W = mg$ with $m = 5.2$ g (1) • Use of $U =$ weight of air displaced by balloon Or $U = \frac{4}{3}\rho_a\pi r^3 g$ Or $U = \rho_a V g$ and $V = \frac{4}{3}\pi r^3$ Or $U = mg$ and $\rho = \frac{m}{V}$ and $V = \frac{4}{3}\pi r^3$ (1) • 0.034 N (1) 	<p><u>Example of calculation</u></p> $D = \left(\frac{4}{3}\pi \times (0.12 \text{ m})^3 \times 1.2 \text{ kg m}^{-3} \times 9.81 \text{ m s}^{-2}\right) - ((4+1.2) \text{ kg} \times 9.81 \text{ m s}^{-2})$ $= 0.034 \text{ N}$	4
16(b)	<p><u>Viscosity</u> of air increases as temperature increases (1)</p> <p>Or</p> <p><u>Density</u> of air is lower so upthrust is smaller (1)</p>		1
Total for question 16			5

