Mark Scheme (Results)

June 2017

Pearson Edexcel
GCE Advanced Subsidiary in Physics (8PH0/02)
Paper 2 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 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.

<table>
<tr><th>Question Number</th><th>Answer</th><th>Mark</th></tr>
<tr><td>1</td><td>C $\frac{1}{2}mg\Delta x$</td><td>1</td></tr>
<tr><td></td><td>Incorrect Answers:
A – no factor of $\frac{1}{2}$
B – incorrect equation and no factor of $\frac{1}{2}$

D – incorrect equation</td><td></td></tr>
<tr><td>2</td><td>D Comparing to y=mx+c format with v as y and $\sqrt{T}$ as x</td><td>1</td></tr>
<tr><td></td><td>Incorrect Answers:
A – this assumes T is proportional to $\sqrt{v}$
B – this assumes v is proportional to T
C − this assumes $\frac{1}{T}$ is proportional to v</td><td></td></tr>
<tr><td>3</td><td>A Using nλ=dsin θ
<table><tr><th>Number of slits per mm in the diffraction grating</th><th>Wavelength of the light source</th></tr><tr><td>Increased</td><td>Increased</td></tr></table></td><td>1</td></tr>
<tr><td></td><td>Incorrect Answers:
B – wavelength decreasing would cause d to decrease
C – number of slits/mm decreasing would cause d to decrease
D –both decreasing causes d to decrease</td><td></td></tr>
<tr><td>4</td><td>A $\frac{2\pi t}{T}$</td><td>1</td></tr>
<tr><td></td><td>Incorrect Answers:
B – no factor of 2
C – incorrect substitution of f
D – incorrect substitution of f and no factor of 2</td><td></td></tr>
</table>

5	**B ground state to level 2**	**1**
	Incorrect Answers: A – incorrect change in energy C – incorrect change in energy and direction D – incorrect direction	
6	**D 4P Using $I = \frac{P}{A}$**	**1**
	Incorrect Answers: A – Incorrect arrangement of the equation B – Incorrect arrangement of the equation and incorrect use of πr^2 with $2r$ C - Incorrect use of πr^2 with $2r$	
7	**D originate from one source**	**1**
	Incorrect Answers: A – coherence requires a constant phase difference not necessarily 0 B – planes not relevant C – amplitude not relevant	
8	**C the reflected pulse can be detected before the next pulse is transmitted**	**1**
	Incorrect Answers: A – incorrect B – This is limited by the wavelength D – Diffraction is affected by wavelength	

(Total for Multiple Choice Questions = 8 marks)

Question Number	Acceptable Answers	Additional guidance	Mark
9	• Use of $p = mv$ using mass of electron (1) • Use of $\lambda = \frac{h}{p}$ (1) • $\lambda = 3.3 \times 10^{-11}$ m (1)	Example of Calculation $\lambda = \frac{6.63 \times 10^{-34}\text{ J s}}{9.11 \times 10^{-31}\text{kg} \times 2.2 \times 10^{7}\text{ m s}^{-1}}$ $\lambda = 3.3 \times 10^{-11}$ m	3

(Total for Question 9 = 3 marks)

Question Number	Acceptable Answers	Additional guidance	Mark
10(a)	• Intensity (of sound) varies **(1)** • (Intensity) is a minimum at 90° **and** a maximum at 180° **(1)**	For MP1 there must be an indication of intensity, volume, loudness or amplitude. Any reference to pitch changing means this mark cannot be awarded. MP2 can be awarded if answer only refers to audible output.	2
10(b)	• Waves (from gaps) superpose/interference **(1)** • Constructive (interference) when waves are in phase **Or** path difference is nλ **(1)** • Destructive (interference) when waves are in antiphase **Or** path difference is (n+$\frac{1}{2}$)λ **(1)** • Links constructive interference to maximum intensity **Or** links desructive interference with minimum/zero intensity **(1)**	Not superimpose MP3 Do not accept out of phase	4

(Total for Question 10 = 6 marks)

Question Number	Acceptable Answers	Additional guidance	Mark
11(a)	• **Two** straight lines drawn extrapolated from diverging rays meeting at a single point on the principal axis **(1)** • focal length = (-) 2.3 to 2.4 cm **(1)**	Accept dotted or solid lines	**2**
11(b)	• Use of $\frac{1}{u}+\frac{1}{v}=\frac{1}{f}$ **(1)** • Use of $P = \frac{1}{f}$ **(1)** • P = 46 D / Dioptre / dioptre **(1)**	Accept MP2 if you see $\frac{1}{25}$ or $\frac{1}{2.4}$ for $\frac{1}{f}$ <u>Example of Calculation</u> $\frac{1}{0.25}+\frac{1}{0.024}=46$ D	**3**
11(c)	• increases the power (of the eye) **Or** to decrease the image distance **Or** to shorten the focal length (of the eye and lens) **Or** to the eye it makes the rays appear to come from an object further away **(1)**	If a candidate states that the image is formed at the focal point or that the retina is at the focal point do not award this mark	**1**

(Total for Question 11 = 6 marks)

Question Number	Acceptable Answers		Additional guidance	Mark
12(a)	• An image formed from the apparent divergence of light rays from a single point **Or** an image that cannot be projected on to a screen	**(1)**		**1**
12(b)	• Light is refracted as it passes into medium 2 • Angle of refraction may be calculated using $n_1\sin\theta_1 = n_2\sin\theta_2$ • Angle of refraction = 89.81° • Angle of <u>incidence</u> at layer 2-3 is greater than the critical angle • So <u>total internal reflection</u> occurs (at layer 2-3 interface) • So light/ rays appear to come from surface of road (so that observer sees mirage)	**(1)** **(1)** **(1)** **(1)** **(1)** **(1)**	MP2 see use of the equation MP5 accept totally internally reflected and TIR MP6 is not just for saying there is a mirage. <u>Example of Calculation</u> $\sin^{-1}\left(\frac{1.00032 \times \sin 89.59°}{1.00030}\right) = 89.81°$	**6**

(Total for Question 12 = 7 marks)

Question Number	Acceptable Answers	Additional guidance	Mark
13(a)	• See drag = $6\pi r\eta v$ **(1)** • see Upthrust = $\rho_l V g$ **(1)** • see weight of sphere = $\rho_s V g$ **(1)**	Accept F or D for drag Do not accept $U = \rho_s V g$ for MP2 Accept ρ_f for ρ_l <u>Example of Calculation</u> At terminal velocity: Weight =Drag + Upthrust Therefore $m_s g = 6\pi r\eta v + m_l g$ $\rho_s V g = 6\pi r\eta v + \rho_l V g$ Rearranging $v = \frac{\rho_s V g - \rho_l V g}{6\pi r\eta}$ $v = \frac{Vg(\rho_s - \rho_l)}{6\pi r\eta}$	3
13(b)(i)	• Use of $v = \frac{s}{t}$ **(1)** • Use of $V = \frac{4}{3}\pi r^3$ **(1)** • Use of $v = \frac{Vg(\rho_s-\rho_l)}{6\pi r\eta}$ **(1)** • η =1.8 Pa s **(1)**	<u>Example of Calculation</u> $v = \frac{0.5}{3.9} = 0.13$ (m s^{-1}) $\eta = \frac{\frac{4}{3}\pi(4 \times 10^{-3})^3 \times 9.81 \times (7800 - 1300)}{6\pi \times 4 \times 10^{-3} \times 0.13} = 1.8$ Pa s Accept kg m^{-1}s^{-1} / N s m^{-2}	4
13(b)(ii)	5cm (no mark) • Laminar flow **Or** less/no turbulent flow **(1)** • So Stoke's law applies **Or** sphere falls at a more constant rate **(1)**	Accept wider for 5.0 cm	2

(Total for Question 13 = 9 marks)

Question Number	Acceptable Answers		Additional guidance	Mark
14(a)	• Sound travels as a longitudinal wave **Or** in a series of compressions **and** rarefactions • With oscillations/vibrations of (air) particles/molecules parallel to the direction of energy transfer	**(1)** **(1)**	Accept: Direction of energy transfer **Or** propagation of the wave **Or** direction of wave travel/motion	**2**
14(b)(i)	• the idea that there is a wide variation in the first two readings	**(1)**		**1**
14(b)(ii)	• uses $\frac{\text{half the range of values}}{\text{mean value}}$ • percentage uncertainty = 8.5%	**(1)** **(1)**	Example of Calculation $\frac{0.5 \times (0.51\text{ s} - 0.43\text{ s})}{0.47\text{ s}} \times 100\% = 8.5\%$ Accept calculations based on $\frac{\text{range of values}}{\text{mean value}}$ (17%)	**2**
14(b)(iii)	• attempt to calculate Δv • Δv = 7.4 m s^{-1} or 8.0 m s^{-1}	**(1)** **(1)**	Example of Calculation $\frac{160\text{ m}}{0.46\text{ s}} - \frac{160\text{ m}}{0.47\text{ s}} = 7.4\text{ m s}^{-1}$ Use of 80 m (Δv =3.7) scores MP1 only	**2**
14(b)(iv)	**Max 2:** • insufficient number of results • identifies one other variable to take into account • difference (in t or v) could be due to human reaction times • uncertainty in results may account for the difference	**(1)** **(1)** **(1)** **(1)**	Do not accept take readings over more days MP2 examples:wind speed/direction, humidity, air pressure MP3 do not credit human error	**2**

14(c)(i)	• Amplitude/energy/intensity of the soundwave reduces with distance travelled • Appreciate that at A **or** B two waves are interfering destructively **Or** at A **and** B there are nodes • at B the waves have travelled similar distances so have similar amplitudes	**(1)** **(1)** **(1)**	Assume they are talking about point B unless stated otherwise For MP3 Accept answers with respect to waves at point A having different amplitudes due to different distances	**3**
14(c)(ii)	• Uses graph to identify $\lambda = 0.16$ (m) • Use of $v = f\lambda$ with a valid value from the graph • v =320 m s^{-1}	**(1)** **(1)** **(1)**	using $\lambda = 0.08$ gives v= 160 m s^{-1} MP2 only <u>Example of Calculation</u> $v = 2000 \text{ Hz} \times 0.16 \text{ m} = 320 \text{ m s}^{-1}$	**3**
	Total for question 14			**15**

(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</td><td>This question assesses a student's ability to show a coherent and logical structured answer with linkage 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 points seen in answer</td><td>Number of marks awarded for indicative 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>
Particle model
One photon interacts with one electron
And each photon has energy proportional to the frequency, Or reference to $E=hf$
The electron is emitted (instantly) only if the energy of the photon is greater than the work function (of the metal)
Or The electron is emitted (instantly) only if the energy of the photon is greater than the energy needed for an electron to break free (from metal surface)
Any photon energy over and above the work function is gained by the electron as kinetic energy
Wave model
It would be expected that the energy of the electron would build up and eventually be emitted.
The (kinetic) energy of the (emitted) electrons would depend on the intensity of the wave (and not the frequency)</td><td>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 and lines of reasoning</td></tr><tr><td>Answer shows a coherent and logical structure with linkage 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 linkage between points and is unstructured</td><td>0</td></tr></table>
Linkage marks
<table><tr><th>Indicative content points</th><th>Possible linkage marks</th></tr><tr><td>0, 1</td><td>0</td></tr><tr><td>2, 3</td><td>1</td></tr><tr><td>4, 5, 6 with points from both models</td><td>2</td></tr></table></td><td>6</td></tr>
</table>

(Total for Question 15 = 6 marks)

Question Number	Acceptable Answers	Additional Guidance	Mark
16(a)	A description that makes reference to **two** of the following: • No need for further calculation **Or** gives a value for resistance without calculation **(1)** • No need for an additional power supply **(1)** • Uncertainties caused by two devices is (possibly) greater than that caused by one device **(1)**	Do not accept more precise **or** no parallax **or** quicker	2
16(b)(i)	• (As applied force increases) the length (*l*) (of wire) increases/stretches **Or** the wire is longer **(1)** • the resistance increases with reference to $R = \frac{\rho l}{A}$ **(1)**	Reference to formula may be in terms of proportionality or direct quote of equation Do not accept change in resistivity	2
16(b)(ii)	• Use of $GF = \frac{\Delta R}{\epsilon R}$ **(1)** • Substitution of $\epsilon = \frac{\Delta w}{w}$ into GF equation **(1)** • $\Delta w = 2.5 \times 10^{-5}$ m **(1)**	(*x* may seen in place of *w*) <u>Example of calculation:</u> $GF = \frac{\Delta R}{\epsilon R}$ $2 = \frac{0.001}{\Delta w / (5 \times 10^{-2})}$ $\Delta w = 2.5 \times 10^{-5}$ m Accept 2.5×10^{-3} cm / 2.5×10^{-2} mm	3
16(c)	An explanation that makes reference to the following: • As small changes (in w) are multiplied many times **Or** can use a longer wire (on a small gauge) **Or** to achieve a greater change in the length **(1)** • (So) greater sensitivity **Or** larger changes in R (for a given change in width) **(1)**		2

(Total for Question 16 = 9 marks)

Question Number	Acceptable Answers		Additional guidance	Mark
17(a)	• Use of $s = ut + \frac{1}{2}at^2$ • Acceleration = 9.61 m s^{-2} • A sensible statement based on a comparison of the magnitude of their calculated value of acceleration with 9.81 m s^{-2}	(1) (1) (1)	MP1 can be awarded if 66 m is used Accept: not weightlessness as this is less than 9.81 m s^{-2} **Or** nearly weightless as this is close to 9.81 m s^{-2} MP3 awarded following reasonable attempt at calculation <u>Example of calculation</u> $s = ut + \frac{1}{2}at^2$ ($u = 0$) 33 m = 0 + $\frac{1}{2}a(2.62\text{ s})^2$ a = 9.61 m s^{-2}	3
17(b)	• use of $a = \frac{\Delta v}{\Delta t}$ • a = 18 m s^{-2} • conclusion that compares the magnitiude of their answer to 6g	(1) (1) (1)	MP3 awarded following reasonable attempt at calculation <u>Example of calculation</u> $a = \frac{\left(\frac{130\text{ km h}^{-1} \times 1000}{(60 \times 60)\text{ s}}\right)}{2\text{ s}}$ a =18 m s^{-2} so within limit of 6g	3

17(c)	• Young modulus of steel > young modulus of wood **Or** steel is stiffer **Or** greater stress for a given strain **Or** less strain under the same stress • So there are less changes in dimensions under a given force for steel • Breaking stress of steel > breaking stress of wood **Or** steel is stronger **Or** steel withstands greater forces without breaking • steel can withstand a larger force/weight than wood of the same (cross-sectional) area **Or** Under the same force/weight steel can have a smaller (cross-sectional) area than wood • Steel coasters can be built that withstand the larger forces from faster cars **Or** (taller tracks can be built because) steel tracks can have smaller dimensions	**(1)** **(1)** **(1)** **(1)** **(1)**	Answers must a comparison between steel and wood Accept deformation for changes in dimension MP3 accept UTS steel > UTS wood	**5**

(Total for Question 17 = 11 marks)

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