Mark Scheme (RESULTS)

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Pearson Edexcel GCE
In Physics (8PH0)
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. '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 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.

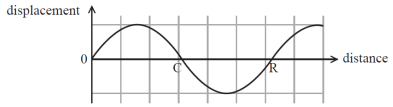
4.2 If a 'show that' question is worth 2 marks. then both marks will be available for a reverse working; if it is worth 3 marks then only 2 will be available.

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	**B** length	**1**
	Incorrect Answers: **A** energy is a derived quantity **C** speed is a derived quantity **D** velocity is a derived quantity	
2	**D** larger ball bearing in liquid with lower viscosity	**1**
	Incorrect Answers: **A** smaller ball bearing in higher viscosity will fall most slowly **B** ball bearing in higher viscosity will fall the more slowly than in lower viscosity **C** smaller ball bearing will fall more slowly than a larger ball bearing	
3	**A** $I = \frac{P}{\pi r^2}$	**1**
	Incorrect Answers: **B** incorrect arrangement **C** incorrect formula for area of a circle **D** incorrect arrangement and incorrect formula for area of a circle	
4	**C** increasing the length of the string	**1**
	Incorrect Answers: **A** results in a higher value for f **B** results in a higher value for f **D** results in a higher value for f	
5	**D** their wave nature	**1**
	Incorrect Answers: **A** not demonstrated by this observation **B** not demonstrated by this observation **C** not demonstrated by this observation	

6	**B**  	**1**
	Incorrect Answers: **A** compression and rarefaction both occur at regions of 0 displacement **C** compression and rarefaction both occur at regions of 0 displacement **D** compression and rarefaction are labelled the wrong way round with respect to the direction of the positive displacement	
7	**C** $\lambda = \frac{6.63 \times 10^{-34}}{9.11 \times 10^{-31} \times v}$	**1**
	Incorrect Answers: **A** Incorrect value for *h* **B** Incorrect arrangement and incorrect value for *h* **D** Incorrect arrangement	
8	**C** equal to the difference between the mean and 448	**1**
	Incorrect Answers: **A** this is equal to the range **B** this is equal to the difference between the values 448 and 466 **D** this is equal to the difference between the mean and 473	

(Total for Multiple Choice Questions = 8 marks)

Question Number	Acceptable Answers		Additional Guidance	Mark
9	• Rotate filter or laptop • brightness of the screen goes bright-dark every 90° • When screen goes dark plane of emitted / polarised light is perpendicular to the plane of polarisation of the filter **OR** When screen is brightest plane of emitted / polarised light is parallel to the plane of polarisation of the filter	(1) (1) (1)		**3**
	Total for question 9			**3**

Question Number	Acceptable Answers		Additional Guidance	Mark
10	• Calculate force = mg • calculate the cross-sectional area $A = \pi \frac{d^2}{4}$ • x- and y- variables to produce a suitable straight-line graph • correct use of the gradient from their graph to determine E	(1) (1) (1) (1)	Accept $A = \pi r^2$ **and** $r = \frac{d}{2}$	**4**
	Total for question 10			**4**

Question Number	Acceptable Answers		Additional Guidance	Mark
11(a)	• Light is an electromagnetic wave **Or** Light is oscillations of electric and magnetic fields	(1)		
	• Oscillations are perpendicular to the direction of energy transfer	(1)	Accept direction of wave travel	**2**
11(b)	• The wave spreads out (after passing through a gap)	(1)		
	• Each point on the wave acts as a source of (secondary) wavelets	(1)		
	• That interfere/superpose	(1)		**3**
	Total for question 11			**5**

Question Number	Acceptable Answers		Additional Guidance	Mark
12(a)	• Uses $\Delta F = k\Delta x$ with corresponding points up to F=60N **or** calculates the gradient between F=0 and 60N • 1000 -1100 N m^{-1}	(1) (1)	Example of calculation $k = \frac{\Delta F}{\Delta x} = \frac{60\text{ N}}{0.06\text{ m}} = 1000$ N m^{-1}	**2**
12(b)	• attempt to determine an area under the graph **or** use of $\Delta E_{el} = \frac{1}{2}F\Delta x$ • area between $F = 60$ and 220 used **or** average value for F used • Ans 3.75J to 4.2 J	(1) (1) (1)	For example: trapezium calculation or counting squares	**3**
12(c)	• Uses graph to find full compression of spring at F=700 (N) • ans = 6×10^{-3} m	(1) (1)	Example of calculation d =0.126 – 0.120 = 6×10^{-3} m	**2**
	Total for question 12			**7**

Question Number	Acceptable Answers		Additional Guidance	Mark
13(a)	• Use of $hf = \emptyset + \frac{1}{2}mv^2$ with $\frac{1}{2}mv^2 = 0$	(1)	<u>Example of calculation</u> $\emptyset = 6.63 \times 10^{-34}$ J s $\times 9.9 \times 10^{14}$ Hz $\emptyset = 6.6 \times 10^{-19}$ J $\emptyset = \frac{6.6 \times 10^{-19}\text{J}}{1.6 \times 10^{-19}\text{C}} = 4.1$ eV aluminium	**4**
	• Conversion between J and eV	(1)		
	• $\emptyset$ = 4.1 (eV)	(1)		
	• Compares their calculated energy with work function (J or eV) concluding aluminium	(1)		

13(b)

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.

IC points	IC mark	Max linkage mark	Max final mark
6	**4**	**2**	**6**
5	**3**	**2**	**5**
4	**3**	**1**	**4**
3	**2**	**1**	**3**
2	**2**	**0**	**2**
1	**1**	**0**	**1**
0	**0**	**0**	**0**

Indicative Content

- Intensity of UV greater at higher altitude
  or
  Intensity of UV is greater for the spacecraft
- (because UV) radiation/light is absorbed in the atmosphere
  or
  light from the sun is reflected from the atmosphere
- Higher intensity of radiation increases the number of photons(/second)
  or
  the number of photons incident (/second) on the spacecraft is greater
- E ∝ frequency so energy of photon does not depend on altitude (so photoelectric effect still occurs)
- One electron to one photon
- The rate of released electrons from the spacecraft is greater

The following table shows how the marks should be awarded for structure and lines of reasoning

	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

Accept alternative argument wrt the aeroplane

6

Total for question 13 **10**

Question Number	Acceptable Answers	Additional guidance	Mark
14(a)	• Interference of soundwaves occurs in the tube (1) • (and a) stationary wave is formed **Or** nodes **and** antinodes are formed (1) • (where) constructive interference occurs the amplitude is maximum **Or** at antinodes the amplitude is maximum (1) • (where) destructive interference occurs the amplitude is zero/minimum **Or** at nodes the amplitude is zero/minimum (1) • Powder is displaced from points of max amplitude to min amplitude points **Or** Powder is displaced from antinode to nodes (1)		**5**
14(b)	• use of $v = f\lambda$ (1) • identifies 0.5 m is 5 gaps (1) • v = 360 m s^{-1} (1)	<u>Example of calculation</u> $\frac{\lambda}{2} = \frac{0.50}{5}$ λ = 0.20 m $v = 1800$ Hz $\times$ 0.20 m = 360 m s^{-1}	**3**
	Total for question 14		**8**

Question Number	Acceptable Answers		Additional guidance	Mark
15(a)	• Use of $m = \frac{image\ height}{object\ height}$ • Use of $m = \frac{v}{u}$ • Use of $\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$ • Use of $P = \frac{1}{f}$ • 21 D	(1) (1) (1) (1)	Example of Calculation $m = \frac{3.5\times10^{-3}\text{ m}}{2.0\times10^{-4}\text{ m}} = 17.5$ $v = 17.5 \times 5.0 \times 10^{-2}\text{m} = 0.875$ (m) $\frac{1}{f} = \frac{1}{5.0\times10^{-2}\text{ m}} + \frac{1}{0.875\text{ m}}$ $f = 0.047$ m $P = \frac{1}{0.047\text{ m}} = 21.1$ D	**5**
15(b)(i)	• Use of $n_1 \sin\theta_1 = n_2 \sin\theta_2$ using angle of incidence = 20° • $r(\text{blue}) = 31.3°$ **and** $r(\text{red}) = 31.1°$ **Or** Calculates difference between $r(\text{blue})$ and $r(\text{red}) = 0.2°$ • Compares their answer to an uncertainty of protractor of 0.5° with conclusion consistent with their answer	(1) (1) (1)	Example of Calculation $\sin r(\text{blue}) = 1.517\sin20 = 0.519$ r (blue)$= \sin^{-1}(0.519) = 31.3°$ $\sin r(\text{red}) = 1.509\sin20 = 0.516$ r (red)$= \sin^{-1}(0.516) = 31.1°$ $31.3° - 31.1° = 0.2°$ $0.2° < 0.5°$ so protractor is unsuitable	**3**

15(b)(ii)	**Either** • Use of $sinC = \frac{1}{n}$ (1) • 41.5° (1) • Compares their answer to 35° and concludes that red light is not totally internally reflected **or** conclusion consistent with their answer (1) **Or** • Use of $n_1 \sin\theta_1 = n_2 \sin\theta_2$ with 35° and n=1 (1) • 60° (1) • Compares their answer to 90° with conclusion that red light is refracted **or** conclusion consistent with their answer (1)	<u>Example of Calculation</u> $\sin C = \frac{1}{1.509} = 41.5°$ $C > 35°$ so red light is not totally internally reflected	**3**
	Total for question 15		**11**

Question Number	Acceptable Answers		Additional guidance	Mark
16 (a)	• Atoms contain discrete energy levels • The atom/electron loses energy and falls back down energy levels emitting a <u>photon</u> • with energy equal to the difference in energy levels • Energy (of photon) is proportional to frequency • So emitted frequency of radiation corresponds to the difference in energy levels of a particular atom	(1) (1) (1) (1) (1)		**5**
16(b)	• Use of $E = hf$ and $v = f\lambda$ • Converts between eV to J • $\lambda = 2.0 \times 10^{-7}$ (m) **and** conclusion that superradiance can occur	(1) (1) (1)	<u>Example of calculation</u> E=6.2 eV $\times$ 1.6×10^{-19} C $E = \frac{6.63 \times 10^{-34}\ \text{Js} \times\ 3.0 \times 10^{8}\ \text{ms}^{-1}}{\lambda}$ $\lambda = 201$ nm so superradiance can occur	**3**
16(c)	• emits a very small range of frequencies/wavelengths • so smaller variation at each diffraction angle • producing a clearer/sharper interference pattern	(1) (1) (1)		**3**
	Total for question 16			**11**

Question Number	Acceptable Answers		Additional guidance	Mark
17(a)	• Use of $v = \frac{s}{t}$ with $v = 3.00 \times 10^8$ (m s^{-1}) • Correct use of factor of 2 • distance = 51000 m	(1) (1) (1)	Example of Calculation $s = \frac{3.00 \times 10^8 \text{ m s}^{-1} \times 3.4 \times 10^{-4} \text{ s}}{2}$ s = 51000 m	**3**
17(b)	• Uses Pythagoras • Speed = 15 m s^{-1} • Uses trigonometry • Angle to N-S line = 53° **Or** Angle to E-W line = 37°	(1) (1) (1) (1)	Example of Calculation $v = \sqrt{12^2 + 9^2} = 15 \text{ m s}^{-1}$ $\tan\theta = \frac{12}{9} = 53°$ to N-S line	**4**
17(c)(i)	• Recognises resultant force on raindrop = 0 **Or** Uses $W=F(+U)$ • Use of $F = 6\pi\eta rv$ • Use of U = weight of air displaced **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** $V = \frac{4}{3}\pi r^3$ **Or** states upthrust is negligible • 1.7 m s^{-1}	(1) (1) (1) (1)	Example of Calculation $W=F+U$ $F = 6\pi \times 1.3 \times 10^{-5} \text{Nm}^{-2} \times 1.0 \times 10^{-4} \times v$ $= (2.45 \times 10^{-8} v)$ (N) $U = 1.225 \text{ kg m}^{-3} \times \frac{4}{3}\pi(0.0001 \text{ m})^3 \times 9.81 \text{m s}^{-2}$ $= 4.9 \times 10^{-11}$ (N) $v = \frac{4.1\times10^{-8} \text{ N} - 4.9\times10^{-11} \text{ N}}{2.45 \times 10^{-8}} = 1.7 \text{ m s}^{-1}$	**4**
17(c)(ii)	• turbulent flow • (so) Stokes law does not apply	(1) (1)		**2**
	Total for question 17			**13**

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