Mark Scheme (final version)

October 2020

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**	**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**	**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**	**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**	**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**	**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 and brightness of the screen varies	(1)		
	Either			
	• When screen goes dark plane of polarised light is perpendicular to the plane of polarisation of the filter	(1)		
	• As polarised light from the screen is absorbed by the filter.	(1)		
	Or			
	• When screen is brightest plane of polarised light is parallel to the plane of polarisation of the filter	(1)		
	• As polarised light from the screen is transmitted by the filter.	(1)		3
	Total for question 9			3

Question Number	Acceptable Answers		Additional Guidance	Mark
10	• Calculate force $= mg$	(1)		
	• calculate the cross-sectional area $A = \pi \dfrac{d^2}{4}$	(1)	Accept $A = \pi r^2$ **and** $r = \dfrac{d}{2}$	
	• x- and y- variables to produce a suitable straight-line graph	(1)	Accept stress and strain only if definition of each is given	
	• correct use of the gradient from their graph to determine E	(1)		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)		**2**
11(b)	• The wave spreads out (after passing through a gap) • Each point on the wave acts as a source of secondary wavelets • That interfere/superpose	(1) (1) (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 $F = 60$N **Or** calculates the gradient between $F = 0$ and $F = 60$N • 1000 N m^{-1} [range to be determined from final copy of graph]	(1) (1)	Example of calculation $\Delta F = k\Delta x$ $k = \frac{\Delta F}{\Delta x} = \frac{60\ N}{0.06\ m} = 1000\ N\ m^{-1}$ [accept answers in N mm^{-1} or N cm^{-1} …]	2
12(b)	• Attempt to determine an area under the graph **Or** use of $\Delta E_{el} = \frac{1}{2}F\Delta x$ • Between $F = 60$ and $F = 220$ • Ans 4.2 [range to be decided from final copy of graph]	(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 [range to be determined from final copy of graph]	(1) (1)	Example of calculation $d = 0.126 - 0.120 = 6 \times 10^{-3}$ 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 $\frac{1}{2}mv^2 = 0$ • Conversion between J and eV • $\emptyset = 4.1$ eV • Compares their calculated energy with work function (J or eV) concluding aluminium	(1) (1) (1) (1)	Example of calculation $\emptyset = 6.63 \times 10^{-34}$ 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 [MP4 is dependent on MP3]	4

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. 	Number of indicative points seen in answer	Number of marks awarded for indicative points
6	4
5-4	3
3-2	2
1	1
0	0 | **Indicative Content** IC1 Intensity of UV radiation decreases as altitude decreases IC2 (because) UV radiation is absorbed in the atmosphere IC3 E ∝ frequency so energy of photon unchanged at lower altitude (so photoelectric effect still occurs) IC4 Links intensity of UV to number of photons/second IC5 One electron to one photon IC6 Resulting in a lower rate of electrons released at lower altitude	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 | **Linkage marks** | Number of indicative content points awarded	Possible linkage marks
0, 1	**0**
2, 3	**1**
4, 5, 6	**2**		6
	Total for question 13		10

Question Number	Acceptable Answers		Additional guidance	Mark
14(a)	• There are points along the tube where the path difference between the incident wave and reflected wave is a whole number of wavelengths	(1)	Accept: the length of tube is equal to an odd number of a quarter wavelengths	
	• The waves meet in phase and constructive interference occurs	(1)		
	• There are points along the tube where the path difference between the incident wave and reflected wave is an odd number of half wavelengths	(1)		
	• the waves meet in antiphase and destructive interference occurs	(1)		
	• the piles of powder form at the points of destructive interference	(1)		5
14(b)	• use of $v = f\lambda$	(1)	Example of calculation	
	• correct calculation of λ	(1)	$\frac{\lambda}{2} = \frac{0.50}{5}$	
	• $v = 360$ m s^{-1}	(1)	$\lambda = 0.20$ m	3
			$v = 1800$ Hz $\times 0.20$ m	
			$v = 360$ m s^{-1}	
	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 $P = \frac{1}{f}$ • 19 D	(1) (1) (1) (1) (1)	Example of Calculation $m = \frac{3.5\times10^{-3}\ m}{2.0\times10^{-4}\ m} = 17.5$ $v = -17.5 \times 5.0 \times 10^{-2} m = -0.875$ (m) $\frac{1}{f} = \frac{1}{5.0\times10^{-2}\ m} - \frac{1}{0.875\ m}$ $f = 0.053$ m $P = \frac{1}{0.053\ m} = 18.9$ 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 $\sin r(\text{blue}) = 1.517\sin20 = 0.519$ $r(\text{blue}) = \sin^{-1}(0.519) = 31.3°$ $\sin r(\text{red}) = 1.509\sin20 = 0.516$ $r(\text{red}) = \sin^{-1}(0.516) = 31.1°$ $31.3° - 31.1° = 0.2°$ $0.2° < 0.5°$ so protractor unsuitable	3
15(b)(ii)	• Use of $\sin C = \frac{1}{n}$ • $41.5°$ • Compares their answer to $35°$ and concludes that red light is not totally internally reflected **or** conclusion consistent with their answer	(1) (1) (1)	$\sin C = \frac{1}{1.509} = 41.5°$ $C > 35°$ so red light is not totally internally reflected [Accept light is refracted linked to an appropriate comparison]	3
	Total for question 15			11

Question Number	Acceptable Answers		Additional guidance	Mark
16 (a)	• Atoms contain discrete energy levels • The atom loses energy and falls back down energy levels emitting a photon • 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)	MP2 Accept it is deexcited **and** emits a photon	5
16(b)	• Use of $E = hf$ and $v = f\lambda$ • Converts between eV to J • $\lambda = 201$ nm **and** conclusion that superradiance can occur	(1) (1) (1)	Example of calculation E=6.2 eV $\times$ 1.6 $\times 10^{-19}$ C $E = \dfrac{6.63 \times 10^{-34} \text{ Js} \times\ 3.0 \times 10^8 \text{ ms}^{-1}}{\lambda}$ $\lambda = 201$ 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)	Accept short bandwidth / linewidth	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 = 27°	(1) (1) (1) (1)	Example of Calculation $v = \sqrt{12^2 + 9^2} = 15$ m s⁻¹ $\tan\theta = \frac{12}{9} = 53°$ to N-S line accept vertical and horizontal for N-S and E-W respectively or labelled on diagram/sketch	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 • $v = 1.7$ 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) $U = 1.225$ kg m⁻³ $\times \frac{4}{3}\pi(0.0001$ m$)^3 \times 9.81$m s⁻² $= 4.9 \times 10^{-11}$ (N) $v = \frac{4.1\times10^{-8} \text{ N} - 4.9\times10^{-11} \text{ N}}{2.45 \times10^{-8}} = 1.7$ m s⁻¹	4
17(c)(ii)	• turbulent flow • (so) Stokes law does not apply	(1) (1)	Accept not laminar flow Do not accept a counter-statement to that in question eg drop not spherical	2
	Total for question 17			13