Mark Scheme (Results)

Summer 2023

Pearson Edexcel 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 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.

Section A

Question Number	Answer	Mark
1	**B** n no unit *d* mm	1
	A – *d* incorrect C – *n* and *d* incorrect D– *n* and *d* incorrect	
2	**B** metre rule and micrometer	1
	A - stopwatch incorrect C - stopwatch incorrect D- stopwatch incorrect	
3	**C** $\frac{1}{5 \times 50 \times 10^{-6}}$	1
	A – incorrect calculation B– incorrect calculation D– incorrect calculation	
4	**A** X + Y	1
	B - multiplication incorrect C – division incorrect D – subtraction incorrect	
5	**C** bright dark	1
	A - at 90° the lamp appears bright B - at 90° the lamp appears bright and at 180° the lamp appears dark D - at 180° the lamp appears dark	
6	**D** unpolarised transverse waves	1
	A – this is not a stationary wave B – this is not a longitudinal wave C – this is not a polarised wave	
7	**D** 8D (4D +4D)	1

	A – incorrect calculation B – incorrect calculation C – incorrect calculation	
8	**B** $0.5 \times 0.15 \times 2.5$ $E = \frac{1}{2} F \Delta x$	**1**
	A - incorrect calculation C – incorrect calculation D – incorrect calculation	

(Total for Multiple Choice Questions = 8 marks)

Question Number	Acceptable answers		Additional guidance	Mark
9(a)	• Use of $v = \frac{s}{t}$ with v = 340 m s^{-1}	(1)	Example of calculation s = 340 m s^{-1} $\times \frac{36 \times 10^{-3}\ \text{s}}{2}$ = 6.12 m	3
	• Use of correct factor of two	(1)		
	• 6.1 m	(1)		
9(b)	**EITHER** • (as the bat gets closer) the reflected pulses take less time to return	(1)		3
	• The bat reduces the time between emitted pulses	(1)		
	• So the bat can detect small changes in the moth's position/speed **Or** To give the bat more frequent updates	(1)		
	OR • At greater distances the reflected pulse takes a longer time to return	(1)		
	• The time between pulses needs to be longer	(1)		
	• So that the reflected pulse returns before the next pulse is emitted	(1)		

(Total for Question 9 = 6 marks)

Question Number	Acceptable answers	Additional guidance	Mark
10(a)	• SI units for v, ρ and d **(1)** • Pa = N m^{-2} **(1)** • SI units for Newton = kg m s^{-2} **(1)**		**3**
10(b)(i)	• Determines the gradient up to stress of 7.0×10^7 N m^{-2} **(1)** • $1.2 - 1.3 \times 10^9$ N m^{-2} **(1)**	Example of calculation $E = \frac{5.0 \times 10^7 \text{ N m}^2}{0.04} = 1.25 \times 10^9$ N m^{-2}	**2**
10(b)(ii)	**MAX THREE** • Stress and strain are no longer proportional **Or** Fibre no longer obeys Hooke's law **(1)** • Fibres are stretched irreversibly **(1)** • Smaller change in stress to strain **Or** Larger change in strain to stress **Or** Collagen fibres becomes less stiff **(1)** • Collagen fibres break when stress = 8.0 N m^{-2} **Or** Collagen fibres break when strain = 0.08 **(1)**		**3**

(Total for Question 10 = 8 marks)

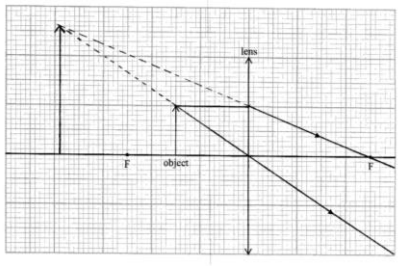
Question Number	Acceptable answers	Additional guidance	Mark
11(a)	• One electron absorbs one photon **(1)** • Photon energy is proportional to frequency **Or** Photon energy is equal to hf **(1)** • The (photon) energy is less than the work function of the metal (if frequency is below the threshold) **Or** electron gains insufficient energy to be released (if frequency is below a certain value) **(1)**		**3**
11(b)(i)	• Use of $E = \frac{1}{2}mv^2$ with $E = 2.9 - 3.0 \times 10^{-19}$ J **(1)** • $v = 8 \times 10^5$ m s^{-1} **(1)**	Example of calculation $v = \sqrt{\frac{2 \times 2.9 \times 10^{-19}\ \text{J}}{9.11 \times 10^{-31}\ \text{kg}}} = 7.98 \times 10^5$ m s^{-1}	**2**
11(b)(ii)	• Use of $hf_0 = \emptyset$ *with* $f_0 = 5.4 - 5.6 \times 10^{14}$ Hz **Or** Extrapolates graph to y axis **(1)** • Conversion between J and eV **(1)** • $\emptyset = 2.1$ to 2.4 eV **and** the metal was caesium **(1)**	Example of calculation $\emptyset = 3.6 \times 10^{-19}$ J $= (3.6 \times 10^{-19}\ \text{J}) / (1.6 \times 10^{-19}\ \text{C})$ $= 2.3$ eV	**3**

(Total for Question 11 = 8 marks)

Question Number	Acceptable answers	Additional guidance	Mark
12(a)	• (between f and 2f) there is no standing wave **Or** (between f and 2f) the amplitude (of the antinode) decreases **(1)** • At a frequency 2*f* there is a standing wave with 2 antinodes **(1)**		**2**
12(b)	• The vibrating string causes air molecules to oscillate/vibrate **Or** the vibrating string transfers energy to the air molecules **(1)** • Molecules are displaced from their (equilibrium) positions **(1)** • Where air molecules are close together the pressure is high **Or** where air molecules are far apart the pressure is low **(1)**		**3**

12(c)	**EITHER** • Equates $v = f\lambda$ and $v = \sqrt{\frac{T}{\mu}}$ **(1)** • Uses $\lambda = 2l$ **(1)** • $l = 0.27$ m **(1)** • Comparison of their value of l to 0.21 and 0.63 m **and** conclusion consistent with their answer **(1)** **OR** • Equates $v = f\lambda$ and $v = \sqrt{\frac{T}{\mu}}$ **(1)** • Uses $\lambda = 2l$ **(1)** • $f = 84$ Hz **and** 252 Hz **(1)** • Comparison of 196 Hz to their values of f **and** a conclusion consistent with their answer **(1)**	<u>Example of calculation</u> $l = \frac{1}{2\times196\ \text{Hz}}\sqrt{\frac{56\ \text{N}}{5\times10^{-3}\ \text{Kg m}^{-3}}} = 0.27$ m	**4**

(Total for Question 12 = 9 marks)

Question Number	Acceptable answers	Additional guidance	Mark
13(a)	• Two rays drawn correctly **(1)** • Image drawn, enlarged, upright and 3.7 – 3.9 large squares to the left of lens **(1)**	Extended straight line passing through the centre of the lens and top of the object **and** line parallel to the principal axes from top of the object to the lens and then an extended straight line through F on RHS Accept ray from F on left hand side passing through the top of the object to the lens and continuing parallel to principal axis on RHS and extended back to the image position 	**2**

13(b)	• Use of magnification $= \frac{\text{image height}}{\text{object height}}$ **(1)** • Use of $P = \frac{1}{f}$ **(1)** • Use of $\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$ **(1)** • Use of $m = \frac{v}{u}$ **(1)** • image height = 22×10^{-6} m with comparison to 0.1 mm and conclusion jeweller cannot see scratch **Or** m = 2.2 with comparison to their calculated value of m and conclusion jeweller cannot see scratch	<u>Example of calculation</u> Required magnification = $\frac{1 \times 10^{-4}\text{ m}}{1 \times 10^{-5}\text{ m}} = 10$ $45 = \frac{1}{0.012} + \frac{1}{v}$ v = (-)0.026 m $m = \frac{0.026}{0.012} = 2.2$ < required magnification of 10 so jeweller cannot see scratch	**5**
13(c)	**EITHER** • Use of $n = \frac{c}{v}$ **(1)** • Use of $\sin C = \frac{1}{n}$ **(1)** • $C = 25°$ **(1)** • comparison of their calculated value of C with 40° and conclusion consistent with their comparison **(1)** **OR** • Use of $n = \frac{c}{v}$ **(1)** • Use of $n_1 \sin\theta_1 = n_2 \sin\theta_2$ **(1)** • $\sin\theta_2 > 1$ **(1)** • There cannot be a refracted ray and so the ray must follow the path shown **(1)**	<u>Example of calculation</u> $n = \frac{3.0 \times 10^8\text{ m s}^{-1}}{1.25 \times 10^8\text{ m s}^{-1}} = 2.4$ $C = \sin^{-1}\frac{1}{2.4} = 24.6°$	**4**

Total for Question 13 = 11 mark

Question Number	Acceptable Answer		Additional guidance	Mark
14(a)(i)	• Use of $V = \frac{4}{3}\pi r^3$ • Use of $\rho = \frac{m}{V}$ **and** $U = mg$ • 1.73×10^{-5} (N)	**(1)** **(1)** **(1)**	Example of calculation $U = \frac{4}{3}\pi\left(\frac{1.5 \times 10^{-3}}{2}\right)^3 \times 997 \times 9.81$ $U = 1.73 \times 10^{-5}$ N	**3**
14(a)(ii)	• Use of $F = 6\pi r\eta v$ • 1.1 m s^{-1} (ecf from (a)(i))	**(1)** **(1)**	Example of calculation 1.73×10^{-5} N $= 6\pi \times 0.0011 \times (\frac{1.5 \times 10^{-3}}{2})v$ v =1.1 m s^{-1}	**2**
14(b)	• Use of $\Delta E_{el} = \frac{1}{2} F\Delta x$ **and** $\Delta F = k\Delta x$ • 2.2×10^{-14} J	**(1)** **(1)**	Example of calculation $E = 0.5 \times 1195$ N m$^{-1} \times ((18 - 12) \times 10^{-9}$ m$)^2$ $= 2.15 \times 10^{-14}$ J	**2**

(Total for Question 14 = 7 marks)

Total for Section A = 57 marks

Section B

Question Number	Acceptable answers	Additional guidance	Mark
15(a)	• (As the light from the lasers is coherent) there is a constant phase relationship for the two beams **(1)** • Waves (meet and) superpose / interfere **(1)** • Constructive interference if waves in phase **(1)** • Destructive interference if waves in antiphase **(1)** • Nodes are formed at points of destructive interference **Or** antinodes are formed at points of constructive interference **Or** waves in antiphase form nodes **Or** waves in phase form antinodes **(1)**		**5**
15(b)	• Use of $\tan\theta = \frac{o}{a}$ **(1)** • Use of $n\lambda = d\sin\theta$ with $n = 1$ **(1)** • 6.1×10^{-11} m **(1)**	<u>Example of calculation</u> $\tan\theta = \frac{5.5 \times 10^{-5}\text{ m}}{0.24\text{ m}} = 2.29 \times 10^{-4}$ $\theta = 0.013°$ $\lambda = \frac{5.32 \times 10^{-7}\text{ m}}{2}\sin 0.013° = 6.08 \times 10^{-11}$ m	**3**

15(c)	• (de Broglie) <u>wavelength</u> of electron is much less than the size/width of the gaps in diffraction grating **Or** (de Broglie) <u>wavelength</u> of electron is very much smaller than the <u>wavelength</u> of light **(1)** • So little / no diffraction **(1)** **Or** no diffraction pattern is observed		**2**

***15(d)**

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 structure and 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 Electron energy levels are discrete
Or electrons can only have certain energy states

IC2 (An excited) electron falls back down (to a lower energy level)

IC3 A photon is emitted

IC4 The photon energy is equal to the difference in the energy between the energy levels

IC5 Only certain (energy level) transitions are possible, so only discrete amounts of (photon) energy are possible

IC6 Wavelength is inversely proportional to energy (difference), (So emitted photons have a limited range of wavelengths)
Or the wavelength emitted corresponds to the change in energy (So emitted photons have a limited range of wavelengths)

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

	Number of marks awarded for structure and lines of reasoning
Answer shows a coherent and logical structure with linkage and fully sustained lines of reasoning demonstrated throughout	2
Answer is partially structured with some linkages and lines of reasoning	1
Answer has no linkage between points and is unstructured	0

Accept charge carriers for electrons and only penalise once for omission of charge carriers or lattice ions

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 15 = 16 marks)

Question Number	Acceptable answers	Additional guidance	Mark
16(a)	**MAX 4** • The current increases (non-linearly) with p.d. **(1)** • The rate of increase of current (with p.d.) decreases **(1)** • The temperature of the bulb increases so the resistance increases **(1)** • Increasing the amplitude of lattice vibration **(1)** • The frequency of collisions between electrons and ions increases **(1)**		**4**
16(b)	**MAX 3** • Use potentiometer **Or** Connect variable resistor into circuit **(1)** • Use a smaller range of p.d. **(1)** • Use smaller increment changes to p.d. **Or** Measure smaller changes in current **Or** Record more values where graph is changing most **(1)** • Replace ammeter with milliammeter		**3**

(Total for Question 16 = 7 marks)
(Total for Section B = 23 marks)
TOTAL FOR PAPER = 80 MARKS

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