Pearson Edexcel

Mark Scheme (Results)

Summer 2025

Pearson Edexcel International Advanced Subsidiary Level in Physics (WPH12)
Paper 01 Waves and Electricity

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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:

This mark scheme is published to help teachers and candidates understand the exam requirements. Please note that the mark schemes can be better understood when viewed alongside the question paper and the Principal Examiner Report for Teachers.

It's important to emphasise that a mark scheme is a work in progress that can be further refined and expanded based on students' responses to a particular paper.

It is important to avoid making assumptions about future mark schemes based on a document from one year.

Although the guiding principles of assessment remain constant, the details may vary based on the content of a particular examination paper.

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 placing brackets around the unit.

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 m s^{-2} or 10 N kg^{-1} instead of 9.81 m s^{-2} or 9.81 N kg^{-1} will be penalised by one mark (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 **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.

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

4.3 The mark scheme will show a correctly worked answer for illustration only.

5. Quality of Written Expression

5.1 Questions that asses the ability to show a coherent and logically structured answer are marked with an asterisk.

5.2 Marks are awarded for indicative content and for how the answer is structured.

5.3 Linkage between ideas, and fully-sustained reasoning is expected.

Question Number	Answer	Mark
1	**The only correct answer is B (2.04×10^8 m s^{-1})** A is not correct because this is 47% of the speed of light in a vacuum C is not correct because this is the speed of light in a vacuum D is not correct because this is greater than the speed of light in a vacuum	1
2	**The only correct answer is C (All the light is reflected)** A is not correct because none of the light will be refracted B is not correct because none of the light will be transmitted D is not correct because sll the light will be reflected and none transmitted.	1
3	**The only correct answer is B (JV^{-1})** A is not correct because a coulomb is a JV^{-1} C is not correct because a coulomb is a JV^{-1} D is not correct because a coulomb is a JV^{-1}	1
4	**The only correct answer is A (decreasing the length *l*)** B is not correct because lower tension would decrease the frequency C is not correct as strings with greater diameter vibrate with lower frequency D is not correct as strings with greater mass per unit length vibrate with lower frequency	1
5	**The only correct answer is A (A because this emits a photon with the highest frequency)** B is not correct as a photon would be absorbed C is not correct because the frequency would be smaller so wavelength larger D is not correct as a photon would be absorbed	1
6	**The only correct answer is D (increases ; decreases)** A is not correct as thermistor resistance will decrease and voltmeter reading will decrease so an ammeter reading increase B is not correct as thermistor resistance will decrease and voltmeter reading will decrease so an ammeter reading increase C is not correct as thermistor resistance will decrease and voltmeter reading will decrease so an ammeter reading increase	1
7	**The only correct answer is D (π)** A is not correct because path difference is 1 m which is half a wavelength so waves are in antiphase with phase difference π B is not correct because path difference is 1 m which is half a wavelength so waves are in antiphase with phase difference π C is not correct because path difference is 1 m which is half a wavelength so waves are in antiphase with phase difference π	1

8	**The only correct answer is C (4000 C)** A is not correct because this is 1.5 V / 6 J B is not correct because this is 6 J / 1.5V D is not correct because this is 6 KJ x 1.5 V	**1**
9	**The only correct answer is C (The maximum kinetic of the photoelectrons energy depends on the frequency of the incident light.)** A is not correct as intensity only affects the number of photoelectrons released B is not correct because the frequency affects the kinetic energy of the photoelectrons D is not correct as the number of photoelectrons emitted per second depends on intensity	**1**
10	**The only correct answer is D (4 *v*)** A because this would be 16 times less than the actual value B is not correct because this would be 8 times less than the actual value C is not correct because this would half the actual value	**1**

Question Number	Acceptable Answer	Additional Guidance	Mark
11	Use of $R = \frac{\rho l}{A}$ **(1)** calculates $A = \pi r^2$ **(1)** Diameter = 5.2×10^{-4} m **(1)**	Example of calculation $A = \frac{5.6 \times 10^{-8}\ \Omega\ \text{m} \times 0.25\ \text{m}}{65 \times 10^{-3}\ \Omega} = 2.15 \times 10^{-7}\ \text{m}^2$ $d = \sqrt{\frac{4 \times 2.15 \times 10^{-7}\ \text{m}^2}{\pi}} = 5.24 \times 10^{-4}\ \text{m}$	**3**

(Total for Question 11 = 3 marks)

Question Number	Acceptable Answer		Additional Guidance	Mark
12(a)(i)	Angle of incidence measured from the diagram in the range 53° - 55°	**(1)**		**1**
12(a)(ii)	Use of $n_1 \sin\theta_1 = n_2 \sin\theta_2$ θ_2 = 32-33° (allow ecf from (a)(i))	**(1)** **(1)**	Only penalise unit if not penalised in part ai Example of calculation $1 \times \sin 53° = 1.5 \times \sin\theta_2$ $\theta_2 = \sin^{-1}\left(\frac{1 \times \sin 53°}{1.5}\right) = 32°$	**2**
12(b)(i)	**Either** Unpolarised light has oscillations / vibrations in all / many planes polarised light has oscillations / vibrations in one plane which includes the direction of (wave) travel **Or** Unpolarised light has oscillations / vibrations in all / many directions Polarised light has oscillations / vibrations in one direction which is perpendicular to the direction of (wave) travel (MP3 dependent on MP2 being awarded)	**(1)** **(1)** **(1)** **(1)** **(1)** **(1)**	(MP3 dependent on MP2 being awarded) (MP3 dependent on MP2 being awarded)	**3**
12(b)(ii)	Intensity of light varies from a maximum to a minimum every 90 degree rotation The maximum intensity occurs when the (plane of) the polarising filter is in the same direction as the (plane of) oscillation of the light **Or** The minimum intensity occurs when the (plane of) the polarising filter is perpendicular to the (plane of) oscillation of the light	**(1)** **(1)** **(1)**	Allow amount of light / brightness for intensity	**3**

(Total for Question 12 = 9 marks)

Question Number	Acceptable Answer		Additional Guidance	Mark
13(a)	Ultrasound speed read from graph at 23°C = 4115 (m s^{-1})	**(1)**	allow range 4110 to 4120 (m s^{-1})	**4**
	Use of $v = \frac{s}{t}$	**(1)**		
	Correctly use a factor of 2 for distance or time	**(1)**		
	$t = 1.94 \times 10^{-5}$ s which is less than 200 μs so crack will **not** be detected **Or** $s = 0.41$ m which is more than 0.04m so crack will **not** be detected **Or** v = 400 ms^{-1} which is less than 4115 ms^{-1} so crack will **not** be detected	**(1)**	allow t in range 1.94×10^{-5} s to 1.95×10^{-5} s example of calculation $t = \frac{s}{v} = \frac{0.08\text{ m}}{4115\text{ m s}^{-1}}$ $t = 1.94 \times 10^{-5}$ s **Or** $s = \frac{4115\text{ m s}^{-1} \times 200 \times 10^{-6}\text{ s}}{2}$ = 0.41 m	
13(b)	(Ultrasound with a higher frequency) will have a shorter wavelength	**(1)**		**2**
	(Shorter wavelengths) will <u>diffract</u> less **Or (**Shorter wavelengths) give better <u>resolution</u>	**(1)**		

(Total for Question 13 = 6 marks)

Question Number	Acceptable Answer		Additional Guidance	Mark
14(a)	Use of $R = \frac{V}{I}$ to calculate I	**(1)**	<u>Example of calculation</u> $I = \frac{1.4\ \text{V}}{10\ \Omega} = 0.14\ A$ $r = \frac{0.1\ \text{V}}{0.14\ \text{A}} = 0.71\ \Omega$	**3**
	Use of $V = IR$ with $V = 0.1$V to calculate internal resistance	**(1)**		
	$r = 0.71\ \Omega$	**(1)**		
14(b)	When going up a hill more work is done (by the bicycle motor / battery) **Or** When going up a hill more power is required (from the bicycle motor / battery).	**(1)**	Accept energy for work done	**4**
	$P = IV$ so the current increases **Or** $P = I^2$R so the current increases	**(1)**		
	And the p.d. across the internal resistance increases	**(1)**		
	Energy transferred as thermal energy due to internal resistance increases (and battery gets hot)	**(1)**		

(Total for Question 14 = 7 marks)

Question Number	Acceptable Answer		Additional Guidance	Mark
15(a)	(Diffraction is) the spreading out of waves Passing through a gap or around an object	**(1)** **(1)**	Accept slit for gap	**2**
15(b)(i)	Use of $V = \frac{W}{Q}$ Use of $E_k = \frac{1}{2}mv^2$ Use of $\lambda = \frac{h}{\rho}$ $\lambda = 1.75 \times 10^{-11}$ (m)	**(1)** **(1)** **(1)** **(1)**	<u>Example of calculation</u> $W = 4.9 \times 10^3\ \text{V} \times 1.6 \times 10^{-19}\ \text{C} = 7.84 \times 10^{-16}\ \text{J}$ $v = \sqrt{\frac{7.84 \times 10^{-16}\ \text{J} \times 2}{9.11 \times 10^{-31}\ \text{kg}}} = 4.15 \times 10^7\ \text{m s}^{-1}$ $\lambda = \frac{6.63 \times 10^{-34}\ \text{J s}}{9.11 \times 10^{-31}\ \text{kg} \times 4.15 \times 10^7\ \text{m s}^{-1}}$ $\lambda = 1.75 \times 10^{-11}\ \text{m}$	**4**

15(b)(ii)	Converts 5000 lines per cm to slit separation (in m) Use of $n\lambda = d\sin\theta$ $\theta = 0.001°$ (this angle is very small) so not clearly visible (allow ecf from (b)(i))	**(1)** **(1)** **(1)**	Accept $\theta = (1 \times 10^{-3})°$ Example of calculation $d = \frac{1}{5000} \times 10^{-2}\ \text{m} = 2 \times 10^{-6}\ \text{m}$ $\sin\theta = \frac{2 \times 1.8 \times 10^{-11}\ \text{m}}{2 \times 10^{-6}\ \text{m}} = 0.000018$ $\theta = 0.00103°$	**3**

(Total for Question 15 = 9 marks)

Question Number	Acceptable Answer		Additional Guidance	Mark
16(a)	6 J of energy is transferred to each coulomb of charge (by the battery)	**(1)**	Accept: 6 V is the potential difference between the terminals of the battery if no current is drawn Terminal potential difference is 6 V (since internal resistance is negligible)	**1**
16(b)(i)	p.d across 200 Ω resistor = 6.00 − 1.64 (= 4.36 V) Use of $R = \frac{V}{I}$ **Or** Ratio of resistance = ratio of p.d. $I = 22$ (mA)	**(1)** **(1)** **(1)**	<u>Example of calculation</u> $200\ \Omega = \frac{4.36\ \text{V}}{I}$ $I = \frac{4.36\ \text{V}}{200\ \Omega} = 2.18 \times 10^{-2}$ (A)	**3**

16(b)(ii)	**EITHER** Use of $R = \frac{V}{I}$ for resistance of parallel section **Or** Use of $R = \frac{V}{I}$ for resistance of total circuit **and** subtract 200 Ω	**(1)**	Show that value gives 456 Ω (MP3 dependent on MP2 being awarded)	**3**
	Use of resistors in parallel equation.	**(1)**		
	$R_X = 304\ \Omega$	**(1)**		
	(Allow ecf from (b)(i))		<u>Example of calculation</u>	
	OR Use of $R = \frac{V}{I}$ for current in 100 Ω resistor Use of $I_{tot} = I_1 + I_2$ for current in resistor X $R = 304\ \Omega$ (Allow ecf from (b)(i))	**(1)** **(1)** **(1)**	$R_{parallel} = \frac{1.64\ V}{2.18\times10^{-2}\ A} = 75.23\ \Omega$ show that value = 82 Ω $\frac{1}{R_X} + \frac{1}{100\ \Omega} = \frac{1}{75.23\ \Omega}$ $R_X = 303.7\ \Omega$ OR $I = \frac{1.64\ V}{100\ \Omega} = 1.64 \times 10^{-2}\ A$ $2.18 \times 10^{-2}\ A - 1.64 \times 10^{-2}\ A = 5.4 \times 10^{-3}\ A$ $R = \frac{1.64\ V}{5.4 \times 10^{-3}\ A} = 303.7\ \Omega$	

16(b)(iii)	Use of $P = \frac{V^2}{R}$ **Or** use of $P = VI$ **Or** use of $P = I^2R$ **(1)** $P = 2.70 \times 10^{-2}$ W **(1)** (Allow ecf from (b)(i) or (b)(ii) for *I*)	<u>Example of calculation</u> $P = \frac{(1.64\text{ V})^2}{100\ \Omega}$ $P = 2.70 \times 10^{-2}$ W	**2**
16(c)	The resistance of the parallel combination would increase **(1)** So the ratio / share of parallel combination resistance to other resistance increases and so does the voltmeter reading, so student is correct **(1)**		**2**

(Total for Question 16 = 9 marks)

<table>
<tr><th>Question Number</th><th>Acceptable Answer</th><th>Additional Guidance</th><th>Mark</th></tr>
<tr><td>*17(a)</td><td>This question assesses a student's ability to show a coherent and logically structured answer with linkages and fully-sustained reasoning.

Indicative content
IC1 Vibrating tuning fork produces (sound) waves (in air)
IC2 The (sound) wave (travels down the tube and) reflects from the (closed) end
IC3 Reflected wave superposes / interferes with incident waves
IC4 Constructive interference / superposition where waves are in phase
Or
Destructive interference / superposition where waves are in antiphase
IC5 Maximum amplitudes producing antinodes
Or
Zero amplitude producing nodes
IC6 There must be an antinode at the open end
Or
There is a node at the closed end</td><td>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><th>Number of indicative points seen in answer</th><th>Number of marks awarded for indicative points</th></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><table><tr><th></th><th>Number of marks awarded for structure and lines of reasoning</th></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></td><td>6</td></tr>
<tr><td>17(b)(i)</td><td>Use of $v = f\lambda$ (1)

With $\lambda = 4 \times$ length of column (or see 0.816 m) (1)

$f =$ 417 Hz (1)</td><td><u>Example of calculation</u>
$\lambda = 4 \times 0.204\ \text{m} = 0.816\ \text{m}$

$f = \frac{v}{\lambda} = \frac{340\ \text{m s}^{-1}}{0.816\ \text{m}} = 417\ \text{Hz}$</td><td>3</td></tr>
</table>

17b(ii)	The antinode is not exactly at the open end of the tube **(1)** **Or** There is an end correction at the open end of the tube So the (actual) wavelength would be longer (than the measured / calculated wavelength) **(1)**			**2**

(Total for Question 17 = 11 marks)

Question Number	Acceptable Answer		Additional Guidance	Mark
18(a)	Electrons move to higher energy levels	**(1)**	allow atoms for electrons allow excited for moving to higher energy levels	
	They fall back to lower energy level (emitting a photon)	**(1)**	allow de-excited for fall back lower energy levels	**2**
18(b)(i)	Calculates area of screen	**(1)**		
	Use of $I = \frac{P}{A}$	**(1)**		
	Use of $P = \frac{W}{t}$	**(1)**		
	W = 131 (J)	**(1)**		**4**
			Example of calculation $A = 7.15\ \text{cm} \times 14.7\ \text{cm} = 105\ \text{cm}^2$ $P = 50 \times 10^{-3}\ \text{W cm}^{-2} \times 105\ \text{cm}^2$ P = 5.25 W $W = 5.25\ \text{W} \times 25\ \text{s}$ W = 131.3 J	

18(b)(ii)	Use of $v = f\lambda$ with $v = 3 \times 10^8$ ms^{-1}	**(1)**		
	Use of $E = hf$	**(1)**		
	divides total energy by energy of one photon	**(1)**		
	$N = 2.6 \times 10^{20}$ (photons) (Allow ecf from (b)(i))	**(1)**	<u>Example of calculation</u> $f = \frac{3 \times 10^8 \text{ m s}^{-1}}{395 \times 10^{-9} \text{ m}} = 7.59 \times 10^{14}$ Hz $E = 6.63 \times 10^{-34}$ J s $\times 7.59 \times 10^{14}$ Hz $= 5.03 \times 10^{-19}$ J $N = \frac{131.25 \text{ J}}{5.03 \times 10^{-19} \text{ J}}$ $N = 2.61 \times 10^{20}$	**4**
18(c)	**EITHER** The energy levels in mercury atoms are fixed	**(1)**		
	So frequency of the uv light would stay the same	**(1)**	(MP2 dependent on MP1 being awarded)	
	OR	**(1)**		
	Electrons could move to higher energy levels (as the pd supplies more energy)	**(1)**	(MP2 dependent on MP1 being awarded)	**2**
	So frequency of the uv light would increase.			
18(d)	Intensity (of the uv light incident on the screen) is increased	**(1)**		
	So the number of photons arriving per second is increased **Or** So energy transferred per second to the glue is increased	**(1)**	Accept power increased	**2**

(Total for Question 18 = 14 marks)
TOTAL FOR PAPER = 80 MARKS

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