Mark Scheme (Results)

October 2017

Pearson Edexcel
International Advanced Subsidiary Level
in Physics (WPH02)
Paper 01 Physics at Work

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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.

Quality of Written Communication

Questions which involve the writing of continuous prose will expect candidates to:

- write legibly, with accurate use of spelling, grammar and punctuation in order to make the meaning clear
- select and use a form and style of writing appropriate to purpose and to complex subject matter
- Organise information clearly and coherently, using specialist vocabulary when appropriate.

Full marks will be awarded if the candidate has demonstrated the above abilities.
Questions where QWC is likely to be particularly important are indicated (QWC) in the mark scheme, but this does not preclude others.

Physics Specific Marking Guidance

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.

For example:

Horizontal force of hinge on table top

66.3 (N) or 66 (N) **and** correct indication of direction [no ue]

[Some examples of direction: acting from right (to left) / to the left / West / opposite direction to horizontal. May show direction by arrow. Do not accept a minus sign in front of number as direction.]

This has a clear statement of the principle for awarding the mark, supported by some examples illustrating acceptable boundaries.

Mark scheme format

• Bold lower case will be used for emphasis.

• Round brackets ( ) indicate words that are not essential e.g. "(hence) distance is increased".

• Square brackets [ ] indicate advice to examiners or examples e.g. [Do not ccept gravity] [ecf].

Unit error penalties

• A separate mark is not usually given for a unit but a missing or incorrect unit will normally cause the final calculation mark to be lost.

• Incorrect use of case e.g. 'Watt' or 'w' will not be penalised.

• There will be no unit penalty applied in 'show that' questions or in any other question where the units to be used have been given.

• The same missing or incorrect unit will not be penalised more than once within one question but may be penalised again in another question.

• Occasionally, it may be decided not to penalise a missing or incorrect 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.

• The mark scheme will indicate if no unit error penalty is to be applied by means of [no ue].

Significant figures

• Use of an inappropriate number of significant figures in the theory papers will normally only be penalised in 'show that' questions where use of too few significant figures has resulted in the candidate not demonstrating the validity of the given answer.

• Use of an inappropriate number of significant figures will normally be penalised in the practical examinations or coursework.

• Using g = 10 m s^{-2} **will** be penalised.

Calculations

• Bald (i.e. no working shown) correct answers score full marks unless in a 'show that' question.

• Rounding errors will not be penalised.

• 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.

• 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.

• recall of the correct formula will be awarded when the formula is seen or implied by substitution.

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

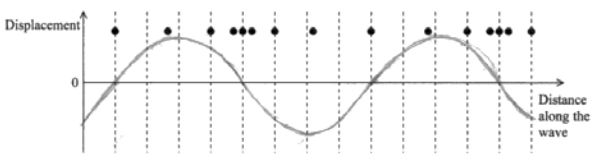
Question Number	Answer	Mark
1	**The only correct answer is A diffraction**	**1**
	B *is not correct because polarisation is not the spreading of a wave* ***C*** *is not correct because reflection occurs at an interface between two media* ***D*** *is not correct because refraction is the change in direction of a wave when incident at an interface between two media*	
2	**The only correct answer is B 4W**	**1**
	A *is not correct because only half the intensity is transmitted* ***C*** *is not correct because this is a quarter of the original intensity* ***D*** *is not correct because one polarising filter transmits half the intensity*	
3	**The only correct answer is C *n* is dependent on the material of the wire**	**1**
	A *is not correct because unit for n is* m^{-3} ***B*** *is not correct because n is the number of charge carriers per unit volume* ***D*** *is not correct because n depends only on the material of the wire*	
4	**The only correct answer is C size of gap = wavelength of wave**	**1**
	A *is not correct because size of gap is greater than the wavelength* ***B*** *is not correct because size of gap is greater than the wavelength* ***D*** *is not correct because size of gap is greater than the wavelength*	
5	**The only correct answer is B efficiency =** $\frac{\textbf{useful energy out}}{\textbf{total energy in}}$ useful energy out = E_{grav} and total energy in = $E_{grav} + E_w$	**1**
	A *is not correct because equation incorrect* ***C*** *is not correct because equation incorrect* ***D*** *is not correct because equation incorrect*	
6	**The only correct answer is C 16 Ω** using $R = \frac{\rho l}{A}$ then $R2 = \frac{2\rho \times 2l}{2A}$	**1**
	A *is not correct because incorrect use of resistivity equation* ***B*** *is not correct because incorrect use of resistivity equation* ***D*** *is not correct because incorrect use of resistivity equation*	
7	**The only correct answer is A kg m^2 s^{-1}** Unit for Planck constant = J s = kg m^2 s^{-2} × s	**1**
	B *is not correct because base units for momentum* ***C*** *is not correct because base units for J* ***D*** *is not correct because base units for N*	

8	**The only correct answer is A** $(\mathbf{20 \times 10^{-6}})\, \boldsymbol{v}$ $= \left(\frac{10\ \mu s\ \times 4}{2}\right) \times v$	**1**
	B *is not correct because incorrect reading from graph* ***C*** *is not correct because no division by 2* ***D*** *is not correct because multiplication by 2 instead of dividing*	
9	**The only correct answer is C time between consecutive pulses is too short** The next pulse would be transmitted before the previous pulse is received	**1**
	A *is not correct because it is not significant* ***B*** *is not correct because it is not significant* ***D*** *is not correct because it is not significant*	
10	**The only correct answer is A**	**1**
	B *is not correct because heater would switch on when the temperature increases* ***C*** *is not correct because p.d. across the heater will not change so it would be switched on constantly* ***D*** *is not correct because p.d. across the heater will not change so it would be switched on constantly*	
	Total for multiple choice questions	**10**

Question Number	Answer		Mark
11(a)	For light travelling from a higher refractive index medium to a lower refractive index medium **Or** For light travelling from a more dense to a less dense medium	(1)	
	Angle of incidence is greater than the <u>critical angle</u>	(1)	**2**
11(b)	Use of $\frac{v_1}{v_2}$ to determine refractive index for glass-water	(1)	
	Either		
	Use of $_1\mu_2 = \frac{\sin i}{\sin r}$ with r = 90° **Or** $_1\mu_2 = \frac{1}{\sin C}$	(1)	
	C = 63° to 64°	(1)	
	($i <$ C) so not Total Internally Reflected (conclusion must be consistent with their calculation)	(1)	
	Or		
	Use of $_1\mu_2 = \frac{\sin i}{\sin r}$ with i = 45°	(1)	
	r = 53°	(1)	
	($r < 90°$) so not Total Internally Reflected (conclusion must be consistent with their calculation)	(1)	**4**
	<u>Example of calculation:</u> Refractive index glass to water $= \frac{2.0 \times 10^8 \text{ m s}^{-1}}{2.25 \times 10^8 \text{ m s}^{-1}} = 0.89$ $C = \sin^{-1}(0.89)$ = 63°		
	Total for question 11		**6**

Question Number	Answer	Mark
12(a)	Oscillation/vibration of water molecules/particles **Or** oscillation of particles in the medium (1) (oscillations) perpendicular to direction of propagation (of the wave) **Or** (oscillations) perpendicular to direction of energy transfer **Or** (oscillations) perpendicular to direction of (wave) travel (1)	**2**
12(b)	Calculate *v* using $\frac{4 \times \text{length of tray}}{\text{time taken}}$ (1) Plot a suitable graph (1) Use gradient to calculate *g* (consistent with their graph) (1)	**3**
	Total for question 12	**5**

Question Number	Answer	Mark
13(a)(i)	400 (Hz) (1)	**1**
13(a)(ii)	The observed frequency is less than the emitted frequency **Or** observed frequency is less than 400 Hz (1)	**1**
13(b)	Greater range in frequency of audible sound centred around 400 Hz (1) Time between high/low sounds shorter (1)	**2**
	Total for question 13	**4**

Question Number	Answer	Mark
14(a)(i)	One correct position for compression labelled (1 	**1**
14(a)(ii)	Correct wavelength 54 mm / 5.4 cm / 0.054 m (1	**1**
14(b)	Sine wave drawn with one wavelength between compressions (1) Zero displacement at both compressions **and** the rarefaction inbetween (1) 	**2**
	Total for question 14	**4**

Question Number	Answer		Mark
15(a)(i)	**Either** Use of $E = hf$ Photon energy = 1.2 x 10^{-18} J Conversion between J to eV Comparison of photon energy with work function **Or** Conversion between eV and J Use of $\emptyset = hf_0$ Threshold freq = 8.9 x 10^{14} Hz Comparison of threshold frequency with radiation frequency **Or** Conversion between eV and J Use of $hf = \emptyset + E_{kmax}$ $E_{kmax} = 6.1 \times 10^{-19}$ J Comment relating $E_{kmax} > 0$ <u>Example of calculation:</u> $E = 6.63 \times 10^{-34}\text{Js} \times 1.8 \times 10^{15}\text{Hz} = 1.2\text{x}10^{-18}$ J $E = \frac{1.2 \times 10^{-18}\text{ J}}{1.6 \times 10^{-19}\text{C}} = 7.46\text{ eV}$ $7.46\text{ eV} > 3.7\text{ eV}$	(1) (1) (1) (1) (1) (1) (1) (1) (1) (1) (1) (1)	**4**
15(a)(ii)	Divide 1.8 x 10^{-9} by their value for E in (a)(i) 1.5×10^9 (electrons) <u>Example of calculation:</u> $\frac{1.8 \times 10^{-9}\text{ J}}{1.2 \times 10^{-18}\text{ J}} = 1.5 \times 10^9$	(1) (1)	**2**
15(b)	One electron absorbs one photon (instantaneously) In wave theory electrons would gradually gain enough <u>energy</u> **Or** takes time before electrons have enough <u>energy</u> to escape	(1) (1)	**2**
	Total for question 15		**8**

Question Number	Answer		Mark
***16(a)(i)**	**(QWC – work must be clear and organised in a logical manner using technical terminology where appropriate)**		
	Cold spots formed at nodes **and** hot spots formed at antinodes	(1)	
	Either		
	Nodes formed where waves meet in antiphase	(1)	
	resulting in zero/minimum <u>amplitude</u>	(1)	
	Or		
	Antinode formed where waves meet in phase	(1)	
	resulting in maximum <u>amplitude</u>	(1)	**3**
	(For MP2 and MP3 allow cold spot for nodes and hot spot for antinodes)		
16(a)(ii)	Use of $v=f\lambda$ with $v = 3.0 \times 10^8$	(1)	
	Using λ = 2.8 cm	(1)	
	$f = 1.1 \times 10^{10}$ Hz	(1)	**3**
	<u>Example of Calculation:</u> $f = \frac{3\times10^8 \text{ ms}^{-1}}{0.028 \text{ m}} = 1.07 \times 10^{10}$ Hz		
16(a)(iii)	The positions of nodes and antinodes within the food are constantly changing	(1)	
	Or		
	The standing wave is constantly changing position	(1)	
	Or		
	Points of max **or** min amplitude are constantly changing position	(1)	
	Or		
	The amplitude of the standing wave at one point in the food is constantly changing	(1)	**1**

***16(b)(i)**	**(QWC – work must be clear and organised in a logical manner using technical terminology where appropriate)** Constructive interference (1) Waves arrive in phase (1) As they have zero path difference **Or** point O is equidistant from both slits (1)	**3**
16(b)(ii)	Maxima where path difference is nλ. (1) Minima where path difference is (n + ½) λ. (1)	**2**
	Total for question 16	**12**

Question Number	Answer	Mark
17(a)	Atoms have their lowest possible energy **Or** (All) electrons are at their lowest possible energy level (1)	**1**
17(b)(i)	Use of $E = \frac{hc}{\lambda}$ (1) Conversion between eV and J (1) ΔE = 10.2 (eV) (1) Transition (−)3.39 (eV) to (−)13.6 (eV) (consistent with their calculated value) (1) Example of calculation: $\Delta E = \frac{6.63\times10^{-34}\ \text{Js}\times3\times10^{8}\ \text{ms}^{-1}}{122\times10^{-9}\ \text{m}} = 1.63 \times 10^{-18}\ \text{J}$ $\Delta E = \frac{1.63\times10^{-18}\ \text{J}}{1.6\times10^{-19}\text{C}} = 10.2\ \text{eV}$	**4**
17(b)(ii)	Ultraviolet (1)	**1**
	Total for question 17	**6**

Question Number	Answer		Mark
18(a)	Uses $\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \frac{1}{R_4}$	(1)	
	Uses the conservation of energy in dc circuits	(1)	
	$\varepsilon = I(r + \frac{R}{4})$	(1)	**3**
	Example of calculation $\frac{1}{R_T} = \frac{1}{R} + \frac{1}{R} + \frac{1}{R} + \frac{1}{R} = \frac{4}{R}$ $\varepsilon = I(r + R_T)$ $\varepsilon = I(r + \frac{R}{4})$		
18(b)	Use of $P = I^2R$	(1)	
	P = 0.074 W	(1)	**2**
	Example of calculation: $P = (4 \times 0.43\ \text{A})^2 \times 0.025\ \Omega = 0.074\ \text{W}$		
***18(c)**	**(QWC – work must be clear and organised in a logical manner using technical terminology where appropriate)**		
	There is a large/increased current through *r* **Or** current from the battery is very large	(1)	
	So there is a large p.d. across *r* **Or** more "lost volts"	(1)	
	terminal p.d. (of battery) decreases **Or** p.d. across sidelights decreases	(1)	
	Reducing the power to the sidelights	(1)	**4**
	Total for question 18		**9**

Question Number	Answer		Mark
19(a)	Measure current and (corresponding) p.d. for a range of values	(1)	
	Reverse the supply **or** the polarity of diode	(1)	
	Voltmeter and ammeter correctly connected in the circuit	(1)	
	Means of varying p.d. across LED	(1)	**4**
19(b)(i)	Use $R = \frac{V}{I}$ with I in the range of 210 to 225 (mA) R = 8.9 Ω to 9.5 Ω <u>Example of Calculation:</u> $R = \frac{2.0\ \text{V}}{0.215\ \text{A}} = 9.3\ \Omega$	(1) (1)	**2**
19(b)(ii)	Infinite **Or** very large	(1)	**1**
19(c)(i)	(in forward bias) the <u>resistance</u> (of LED or circuit) could be very/too low	(1)	**1**
19(c)(ii)	Use of $Q=It$ **and** $Q=ne$ Use of 95% Use of graph at their value for I to determine V_{LED} Use of $V=IR$ with $V_R=V- V_{LED}$ R = 14.1 Ω <u>Example of Calculation:</u> $I = \frac{1.6\times10^{18}\ \text{s}^{-1}}{0.95} \times 1.6 \times 10^{-19}\text{C} = 0.27\ \text{A}$ $R = \frac{6.0\ \text{V} - 2.2\ \text{V}}{0.27\ \text{A}} = 14.1\ \Omega$	(1) (1) (1) (1) (1)	**5**
19(c)(iii)	Use of $V = \frac{W}{Q}$ with Q = 1.6 x 10^{-19} (C) Use of 77% E =2.2 $\times 10^{-19}$ J <u>Example of Calculation:</u> $W = 1.8\ \text{V} \times 1.6 \times 10^{-19}\text{C} \times 0.77 = 2.2 \times 10^{-19}\ \text{J}$	(1) (1) (1)	**3**
	Total for question 19		**16**

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