Mark Scheme (Results)

June 2019

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 accept 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 D. A is not correct because it is the graph for a resistor. B is not correct because it is the graph for a filament lamp. C is not correct because it is the graph for a diode.	**1**
2	The only correct answer is A. B is not correct because this uses X-rays. C is not correct because this uses gamma rays. D is not correct because this uses light.	**1**
3	The only correct answer is B. A is not correct because the wavelength is too great. C is not correct because zero displacement must occur at maximum or minimum compression. D is not correct because the wavelength is too great.	**1**
4	The only correct answer is B. This is because λ is the distance between alternate nodes, which is $2l/3$.	**1**
5	The only correct answer is A. This is because the difference in rotation must be 90° or 270°. B is not correct because the difference in rotation is 180°. C is not correct because the difference in rotation is 225°. D is not correct because the difference in rotation is 225°.	**1**
6	The only correct answer is B. This is because diffraction and superposition are occurring. A is not correct because refraction is not occurring. C is not correct because neither refraction nor polarisation is occurring. D is not correct because polarisation is not occurring.	**1**
7	The only correct answer is C. This is because the potential divider gives 1.5 V, and the reverse biased diode does not conduct.	**1**
8	The only correct answer is B. This is because $I=nAve$. If I is doubled and A is doubled, then v remains the same.	**1**
9	The only correct answer is B. This is because the unit of h is J s, and J=kg m^2 s^{-2}, so h is kg m^2 s^{-1}.	**1**
10	The only correct answer is A. This is because the sound spreads around through the doorway by diffraction.	**1**

Question Number	Answer	Mark
11(a)	Use of $A = \pi r^2$ (1) Use of $R = \frac{\rho l}{A}$ (1) $R = 1.07 \times 10^3$ (Ω) (1) <u>Example of calculation</u> $A = \pi \left(\frac{0.0500 \times 10^{-3}\ \mathrm{m}}{2}\right)^2 = 1.96 \times 10^{-9}\ \mathrm{m}^2$ $R = \frac{1.50 \times 10^{-6}\ \Omega\ \mathrm{m} \times 1.40\ \mathrm{m}}{1.96 \times 10^{-9}\ \mathrm{m}^2} = 1.070 \times 10^3\ \Omega$	**3**
11(b)	increase diameter/radius **and** increase length (correspondingly) (1) lower percentage error/uncertainty (cutting/measuring) a longer length **Or** lower percentage error/uncertainty (measuring) a larger diameter (1) If neither mark is scored above, award 1 mark for: Increase the length to increase the resistance **Or** Decrease the diameter to increase the resistance (Do not award this mark if both are increased or both decreased.)	**2**
	Total for question 11	**5**

Question Number	Answer		Mark
12(a)	The emission of electrons occurs immediately/instantaneously There is a minimum frequency (of light) for the emission of electrons **Or** the (maximum) E_k/speed of the electrons depends upon the frequency (of the light) **Or** The (maximum) E_k/speed of the electrons is independent of the intensity	(1) (1)	**2**
12(b)	Use of $v=f\lambda$ with $v = 3 \times 10^8$ Converts work function to J Use of $hf = \varphi + ½\, mv^2_{max}$ with $m = 9.1 \times 10^{-31}$ Maximum velocity = 1.5×10^6 m s^{-1} <u>Example of calculation</u> $3.00 \times 10^8\ \text{m s}^{-1} = f \times 1.2 \times 10^{-7}\ \text{m}$ $f = 2.50 \times 10^{15}\ \text{Hz}$ $\varphi = 4.3\,\text{eV} \times 1.6 \times 10^{-19}\ \text{J eV}^{-1} = 6.88 \times 10^{-19}\ \text{J}$ $hf = 6.63 \times 10^{-34} \times 2.50 \times 10^{15} = 1.66 \times 10^{-18}\ \text{J}$ $1.66 \times 10^{-18} = 6.88 \times 10^{-19} + ½\, mv^2$ $½\, mv^2 = 1.66 \times 10^{-18} - 6.88 \times 10^{-19} = 9.70 \times 10^{-19}\ \text{J}$ $v_{max} = \sqrt{\dfrac{2 \times 9.70 \times 10^{-19}\ \text{J}}{9.11 \times 10^{-31}\ \text{kg}}} = 1.46 \times 10^6\ \text{m s}^{-1}$	(1) (1) (1) (1)	**4**
	Total for question 12		**6**

Question Number	Answer	Mark
13(a)	Use of power = radiation flux × area (1) Use of $P = IV$ (1) Use of efficiency $= \frac{\text{useful power output}}{\text{total power input}}$ (1) Efficiency = 0.17 or 17% (1) <u>Example of calculation</u> $P_{in} = 800\ \text{W m}^{-2} \times 1.60\ \text{m} \times 0.95\ \text{m} = 1216\ \text{W}$ $P_{out} = 29\ \text{V} \times 7.3\ \text{A} = 212\ \text{W}$ Efficiency $= \frac{212\ \text{W}}{1216\ \text{W}} = 0.174$	**4**
13(b)i	The amount of energy supplied to unit charge **Or** Work done moving unit charge around the whole circuit (1)	**1**
13(b)ii	Calculates p.d. across internal resistance (1) **Or** Use of $\varepsilon = I(R + r)$ or $\varepsilon = V + Ir$ Use of $V = IR$ (1) Internal resistance = 3.6 Ω (1) <u>Example of calculation</u> 55 V – 29 V = 7.3 A × r r = 3.56 Ω	**3**
	Total for question 13	**8**

Question Number	Answer		Mark
***14(a)**	(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate) The waves from the two loudspeakers superpose. **Or** This is an example of superposition. (Do not award if Doppler is also mentioned. Ignore ref to diffraction.) There will be a loud sound where the path difference is (0 or) a whole number of wavelengths (allow nλ). There will be a quiet sound where the path difference is equal to half a wavelength or 1.5, 2.5 etc times the wavelength (allow (n + ½)λ). Loud at the point where the waves are in phase **Or** Quiet at the point where the waves have 180°/π phase difference (allow in antiphase) At a loud point constructive interference takes place **Or** At a quiet point destructive interference takes place As one of the sound waves has travelled further than the other, the two sound waves do not completely cancel **Or** Sound reflects off walls etc so sound waves do not completely cancel	(1) (1) (1) (1) (1) (1)	**6**
14(b)	The frequencies are not identical/equal **Or** The frequencies do not stay constant The phase difference/relationship will be changing **Or** The waves are not coherent	(1) (1)	**2**
	Total for question 14		**8**

Question Number	Answer	Mark
***15(a)**	(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate) (Electrons/atoms) exist in discrete/fixed/certain energy levels/states. (1) Electron/atom gains energy and moves up energy levels/states (1) The electron/atom drops down (energy levels) emitting a photon **Or** The electron/atom gains energy by absorbing a photon. **Or** The electron/atom moves up (energy levels) by absorbing a photon. (1) The wavelength/frequency corresponds to the difference in the energy levels. **Or** The photon energy equals the difference in the energy levels. (1) Only certain/fixed/particular frequencies/wavelengths are emitted/absorbed **Or** The photons emitted/absorbed have a certain/fixed/particular frequency/wavelength. **Or** different atoms with different energy levels emit photons of different frequency/wavelength (1)	**5**
15(b)	Doppler (shift/effect) (1) The source/object/galaxy is moving (relative to the observer). (1) (At the top it is) moving away (from observer) as wavelength increased **Or** (At the bottom it is) moving towards (observer) as wavelength decreased **Or** The top of the line represents the side of the galaxy that is receding faster since its wavelength is greater. (1)	**3**
	Total for question 15	**8**

Question Number	Answer		Mark
16(a)	**Max 3** Shape/orientation/size of the object Nature/material of the surface/object **Or** the material the object is made from **Or** energy/light absorbed by object Distance to the object Absorption due to rain, fog etc	(1) (1) (1) (1)	**3**
16(b)	Use of $v = s/t$ Length (of pulse) = 1.5 m **Or** Distance (travelled by pulse in 2.5 ns) = 0.75 m **Or** Time (for pulse to return) = 6.7 ns **Or** Time (for pulse to reach object) = 3.3 ns States object can be detected with a correct comparison. <u>Example of calculation</u> $s = 3.0 \times 10^{8}\ \mathrm{m\,s^{-1}} \times 5.0 \times 10^{-9}\ \mathrm{s}$ s = 1.5 m and total distance = 2.0 m so object can be detected	(1) (1) (1)	**3**
16(c)	Ultrasound pulse takes much longer (to return from a given object) When the pulse returns the car may have moved a significant distance **Or** When the pulse returns the car may have hit the obstacle (or similar) **Or** The "map" displayed does not represent the current position **Or** The driverless car will have a slower/greater/longer response/reaction time. (If no other mark allow 1 mark max for greater diffraction with ultrasound)	(1) (1)	**2**
	Total for question 16		**8**

Question Number	Answer	Mark
17(a)	Wave must be travelling from a medium of higher refractive index (to a medium of lower refractive index) **Or** Wave must be travelling from a medium of high refractive index to a medium of low refractive index **Or** Wave must be travelling from a more dense (to a less dense) material **Or** Wave must reach a boundary at which velocity/wavelength increases (1) Angle of incidence must be larger than (or equal to) the critical angle (1)	**2**
17(b)	The angle of incidence = 45° (1) The angle (of incidence) is more than the critical angle so it reflects **Or** 45° > 42° so it reflects (1) Angle of incidence = 45° at second/each surface **Or** deviates through 90° (at either surface) **Or** reflects/repeats at second surface (1)	**3**
17(c)i	Use of $\frac{\sin i}{\sin r} = \frac{\text{velocity of light in medium 1}}{\text{velocity of light in medium 2}}$ **Or** refractive index $= \frac{\text{velocity in one medium}}{\text{velocity in other medium}}$ (1) Appreciate that $r = 90°$ and $i = c$ Or use of $\sin c = 1/ {}_{l}\mu_{p}$ (1) $c = 60°$ (1) Example of calculation $\frac{\sin c}{\sin 90°} = \frac{2.0 \times 10^8 \text{ m s}^{-1}}{2.3 \times 10^8 \text{ m s}^{-1}}$ $c = 60.4°$	**3**
17(c)ii	Ray refracts into the liquid (Ignore a ray showing partial reflection at 45° but not any other ray) (1) Ray bends away from the normal (not at 90°) and has an arrow (1)	**2**
17(d)	When water level is high light does not reach the receiver (1) Signals/informs the tank's owner **Or** Sounds an alarm **Or** Diverts/drains water away from the tank **Or** Stops water entering the tank (1)	**2**
	Total for question 17	**12**

Question Number	Answer	Mark
18(a)	(As temperature increases) the ion/atom/lattice vibrations increase (1) electrons will collide more (frequently) with the ions/atoms/lattice/particles (1) **Or** drift velocity of electrons decreases Current will be reduced (as temperature rises). (1) As $R = V/I$, R will increase (with temperature) (1)	**4**
18(b)i	As V=IR (for the resistor) and R is constant/5.1 (Ω) **Or** current is proportional to p.d. (across resistor) (1) Current is the same through the lamp and resistor (in series) **Or** Current is the same in series (1)	**2**
18(b)ii	Use of $I = V_1/R$ with V_1 = 4.80 to 4.90 V to find current (1) Calculate $V = 9.0 – V_1$ **Or** Calculate total R and subtract 5.1 Ω (1) R = 4.3 to 4.5 Ω (1) Example of calculation $4.9\,\text{V} = I \times 5.1\ \Omega$ $I = 0.961\,\text{A}$ $4.1\,\text{V} = 0.961\,\text{A} \times R$ $R = 4.27\ \Omega$	**3**
18(b)iii	Use of $P = V^2/R$ **Or** P = VI **Or** $P = I^2R$ (1) Rate of transfer of energy = 4.5 to 4.7 W (1) (Allow e.c.f for value of V or I from (b)ii) Example of calculation $P = \frac{(4.9\ \text{V})^2}{5.1\ \Omega}$ Power = 4.71 W	**2**
18(b)iv	The current/I/p.d./V becomes/is (almost) constant (at this time) (1) (So) resistance /R (and hence the temperature) becomes/is constant. (1)	**2**
18(b)v	The readings (of p.d.) can be taken at short intervals **Or** A lot of readings taken in a short time **Or** Both variables can be measured at the same time (1) The change happens (very) quickly **Or** The experiment happens in a (very) short time **Or** The time (for the experiment) is too short for people to take the readings (1)	**2**
	Total for question 18	**15**