Mark Scheme (Results)

Summer 2018

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.
- Mark schemes will indicate within the table where, and which strands of QWC, are being assessed. The strands are as follows:

  i) ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear
  ii) select and use a form and style of writing appropriate to purpose and to complex subject matter
  iii) organise information clearly and coherently, using specialist vocabulary when appropriate.

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. '<u>resonance</u>'

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.

5. Quality of Written Communication

5.1 Indicated by QoWC in mark scheme. QWC – Work must be clear and organised in a logical manner using technical wording where appropriate.

5.2 Usually it is part of a max mark, the final mark not being awarded unless the QoWC condition has been satisfied.

6. Graphs

6.1 A mark given for axes requires both axes to be labelled with quantities and units, and drawn the correct way round.

6.2 Sometimes a separate mark will be given for units or for each axis if the units are complex. This will be indicated on the mark scheme.

6.3 A mark given for choosing a scale requires that the chosen scale allows all points to be plotted, spreads plotted points over more than half of each axis and is not an awkward scale e.g. multiples of 3, 7 etc.

6.4 Points should be plotted to within 1 mm.

- Check the two points furthest from the best line. If both OK award mark.
- If either is 2 mm out do not award mark.
- If both are 1 mm out do not award mark.
- If either is 1 mm out then check another two and award mark if both of these OK, otherwise no mark.

  For a line mark there must be a thin continuous line which is the best-fit line for the candidate's results.

Question Number	Answer	Mark
1	The only correct answer is **B** A is not correct because this is the reciprocal of the correct answer C is not correct because this is the resistance of a single resistor D is not correct because this is the overall resistance of a series combination	**1**
2	The only correct answer is **D** A is not correct because amplitude can be read from the graph B is not correct because frequency is the reciprocal of time period C is not correct because time period can be read from the graph	**1**
3	The only correct answer is **A** B is not correct because this does not give the answer to the nearest 0.1cm C is not correct because this includes the anomalous reading in the calculation D is not correct because this includes the anomalous reading in the calculation and does not give the answer to the nearest 0.1cm	**1**
4	The only correct answer is **C** A is not correct because a larger number of pulses is not relevant B is not correct because the wavelength is not determined by the pulse length D is not correct because the energy is not determined by the pulse length	**1**
5	The only correct answer is **C** A is not correct because attraction would not produce an interference pattern B is not correct because scattering would not produce an interference pattern D is not correct because refraction would not produce an interference pattern	**1**
6	The only correct answer is **A** B is not correct because this is calculates power rather than intensity C is not correct because this omits efficiency from the calculation D is not correct because this uses efficiency incorrectly in the calculation	**1**
7	The only correct answer is **A** B is not correct because this would be the answer if bar N had twice the CSA C is not correct because this is the reciprocal of answer B D is not correct because this is the reciprocal of the correct answer	**1**
8	The only correct answer is **B** A is not correct because an ammeter could have a similar precision C is not correct because the experiment does not take a long time D is not correct because a graph can be plotted without using a datalogger	**1**
9	The only correct answer is **A** B is not correct because $W = VIt$ and area under graph = It C is not correct because $W = VIt$ and area under graph = It D is not correct because $W = VIt$ and area under graph = It	**1**
10	The only correct answer is **D** A is not correct because this factor on its own would not affect resistance B is not correct because this is not as significant a factor as D C is not correct because this is not as significant a factor as D	**1**

Question Number	Answer		Mark
11(a)	Use of $A = \pi r^2$ or $\frac{\pi d^2}{4}$ Use of $R = \frac{\rho l}{A}$ $R = 50\ \Omega$ <u>Example of calculation</u> $A = \pi\left(\frac{9.0 \times 10^{-3}\ \text{m}}{2}\right)^2 = 6.4 \times 10^{-5} (\text{m}^2)$ $R = \frac{4.2 \times 10^{-2}\ \Omega\ \text{m} \times 0.075\ \text{m}}{6.4 \times 10^{-5}\ \text{m}^2} = 49.5\ \Omega$	(1) (1) (1)	**3**
11(b)	Cylinder with larger (CS) area has a lower resistance V is constant Refers to $P = \frac{V^2}{R}$ so greater power (dissipated in a lower resistance) **OR** Cylinder with larger (CS) area has a lower resistance V is constant Refers to $P = VI$ with higher I so greater power (dissipated in a lower resistance) **OR** Cylinder with larger (CS) area has higher current Greater rate of collisions between electrons and ions/atoms Energy is transferred in each collision so greater power (dissipated with a higher current) [allow converse answers for cylinder with smaller CSA]	(1) (1) (1) (1) (1) (1) (1) (1) (1)	**3**
	Total for question 11		**6**

Question Number	Answer		Mark
12(a)	Conversion from eV to J Use of $E = hf$ **and** $v = f\lambda$ (accept use of $E = \frac{hc}{\lambda}$) $\lambda = 6.9 \times 10^{-7}$ m <u>Example of calculation</u> $E = \frac{hc}{\lambda}$ ((-)5.85-(-)7.65) eV × 1.6×10^{-19} C = $\frac{6.63\times10^{-34}\text{ Js}\times3.0\times10^{8}\text{ ms}^{-1}}{\lambda}$ $\lambda = 6.91 \times 10^{-7}$ m	(1) (1) (1)	**3**
12(b)	Each metal has different/unique energy levels (Allow "atom" for "metal") Only certain differences in energy levels possible (so only certain wavelengths emitted)	(1) (1)	**2**
	Total for question 12		**5**

Question Number	Answer		Mark
13(a)	(Light wave with) oscillations/vibrations only in one plane That includes the direction of wave travel **OR** (Light wave with) oscillations/vibrations in only one direction Perpendicular to the direction of wave travel (MP2 dependent on MP1 being awarded)	(1) (1) (1) (1)	**2**
***13(b)**	Maximum (intensity) when filter parallel to (polarised) light **Or** At 0°/180°/360° the filter is parallel to (polarised) light (As filter is rotated) the intensity changes as only the <u>component</u> parallel to the filter is transmitted **Or** (as filter is rotated) the intensity changes as only the <u>component</u> perpendicular to the filter is absorbed Minimum (intensity) when filter perpendicular to (polarised) light **Or** At 90°/270° the filter is perpendicular to (polarised) light Intensity never zero as light is not completely polarised	(1) (1) (1) (1)	**4**
13(c)	Light from the clouds is unpolarised **Or** light from the clouds isn't (plane) polarised **Or** less light from the clouds is (plane) polarised	(1)	**1**
	Total for question 13		**7**

Question Number	Answer		Mark
14(a)	Use of ${}_1\mu_2 = \frac{v_1}{v_2}$ $v = 2.3 \times 10^8$ m s^{-1} <u>Example of calculation</u> $1.31 = \frac{3.00 \times 10^8 \text{ m s}^{-1}}{v}$ $v = 2.29 \times 10^8$ m s^{-1}	(1) (1)	**2**
14(b)	Angle of incidence is less than the critical angle **Or** Ray refracts away from the normal (as it enters the air/bubble) **Or** angle of refraction is greater than the angle of incidence Increase in speed (from ice to air/bubble) **Or** decrease in refractive index (from ice to air/bubble) **Or** decrease in optical density (from ice to air/bubble)	(1) (1)	**2**
14(c)	Use of ${}_1\mu_2 = \frac{\sin i}{\sin r}$ with one of the angles = 90° (accept sin C = 1/n) $\theta = 50°$ <u>Example of calculation</u> $\frac{\sin\theta}{\sin 90°} = \frac{1.00}{1.31}$ $\theta = 49.8°$	(1) (1)	**2**
	Total for question 14		**6**

Question	Answer	Mark
***15(a)**	Current increases as p.d. increases (1) Causing temperature of filament/lamp to increase **Or** causing filament/lamp to get hotter (1) There is an increase in ion/atom vibrations (1) Greater rate of collisions between electrons and ions/atoms/lattice (causes an increase in resistance) (1) The rate of increase of current with p.d. decreases (1)	**5**
15(b)	Uses graph to find I at 4.2 V (500 – 520(m)A) (1) Uses sum of p.d. = sum of e.m.f. (Accept use of $\varepsilon = V + Ir$) (1) r = 3.5/3.6 Ω (1) **OR** Uses graph to find I at 4.2 V (500 – 520(m)A) (1) Uses $R = V/I$ twice with V = 6.0V and V = 4.2V (1) r = 3.5/3.6 Ω (1) <u>Example of Calculation</u> $6\text{ V} = 4.2\text{ V} + (0.51\text{ A} \times r)$ r = 3.5 Ω	**3**
	Total for question 15	**8**

Question Number	Answer		Mark
16(a)	Calculates wavelength = 0.60 (m) Recognises that path difference is equal to $3\lambda/2$ Waves in antiphase **Or** Destructive interference Minimum/zero <u>amplitude</u> (hence a quiet sound) <u>Example of calculation</u> $\lambda = \frac{340 \text{ m s}^{-1}}{567 \text{ Hz}} = 0.60$ (m)	(1) (1) (1) (1)	**4**
16(b)	Soft fabrics absorb energy Varying angles (of tiles) lead to reflection in a different direction so there is little/no superposition (between incoming wave and reflected wave) (To award MP3, there needs to be some indication that the answer is referring specifically to soft fabrics or varying angles of tiles)	(1) (1) (1)	**3**
	Total for question 16		**7**

Question Number	Answer		Mark
17(a)	Use of $v = \frac{s}{t}$ with $v = 3.00 \times 10^8$ ms^{-1}	(1)	
	Correct use of a factor of 2 (MP2 dependent upon awarding MP1)	(1)	
	s = 39 m	(1)	**3**
	<u>Example of calculation</u> $3.00 \times 10^8 \text{m s}^{-1} = \frac{2s}{2.6 \times 10^{-7}\text{s}}$ $s = \frac{3.00 \times 10^8 \text{m s}^{-1} \times 2.6 \times 10^{-7}\text{s}}{2} = 39$ m		
17(b)(i)	Any reference to a change in frequency/wavelength	(1)	
	When the truck slows down, this results in the car and truck moving closer together **Or** there is relative motion between the car and the truck	(1)	
	When the truck slows the (received) frequency is higher **Or** When the truck slows down the (received) wavelength is shorter	(1)	**3**
	(MP3 is dependent on awarding MP2)		
17(b)(ii)	The new car detects a decrease in speed more quickly (than the driver of a conventional car) **Or** the new car applies the brakes more quickly (than the driver of a conventional car)	(1)	
	The new car has negligible reaction time **Or** the conventional car (driver) has greater reaction time	(1)	
	So the new car maintains its distance from the vehicle in front **Or** the thinking/stopping distance is less	(1)	**3**
	Total for question 17		**9**

Question Number	Answer		Mark
18(a)(i)	Uses ratio of resistance to p.d.'s **Or** Use of $V=IR$ $V = 4.7$ V <u>Example of calculation</u> $V = 9\text{ V} \times \frac{120\ \Omega}{120\ \Omega + 110\ \Omega} = 4.7\text{ V}$	(1) (1)	**2**
18(a)(ii)	Uses ratio of resistances $R = 270$ (Ω) <u>Example of calculation</u> $\frac{295\ \Omega}{R} = \frac{120\ \Omega}{110\ \Omega}$ $R = \frac{295\Omega \times 110\ \Omega}{120\ \Omega} = 270\ \Omega$	(1) (1)	**2**
18(b)(i)	Uses ratio lengths : resistance using 300 Ω and two lengths $R = 150\ \Omega$ (MP2 is dependent upon awarding MP1) <u>Example of calculation</u> $\frac{33.0\text{ cm}}{67.0\text{ cm}} = \frac{R}{300\ \Omega}$ $R = 148\ \Omega$	(1) (1)	**2**
18(b)(ii)	Resistance is greater for a thinner wire **Or** resistance between X and W is greater Actual value for the resistance of the variable resistor is greater **Or** Measured value for resistance of the variable resistor is lower (MP2 is dependent on awarding MP1)	(1) (1)	**2**
18(b)(iii)	Use of micrometer **Or** Use of digital calipers Measure at different orientations/places/points/positions/lengths If values are the same/similar, then wire is uniform (Allow converse argument)	(1) (1) (1)	**3**
	Total for question 18		**11**

Question Number	Answer		Mark
19(a) (i)	Use of $E=hf$ (to find photon energy) $E = 1.3 \times 10^{-18}$ (J) The photon energy is greater than the work function So electrons (have sufficient energy to be) released (from the surface of the zinc) and the electroscope loses charge **OR** Use of $\emptyset = h f_0$ (to find threshold frequency) $f_0 = 1.0 \times 10^{15}$ (Hz) The frequency of the UV is greater than the threshold frequency So electrons (have sufficient energy to be) released (from the surface of the zinc) and the electroscope loses charge **OR** Use of KE = $hf - \emptyset$ (to find kinetic energy of electrons) KE = 6.4×10^{-19} (J) Kinetic energy value is positive So electrons (have sufficient energy to be) released (from the surface of the zinc) and the electroscope loses charge Example of Calculation $E = hf = 6.63 \times 10^{-34}$ J s $\times 2.0 \times 10^{15}$ Hz $E = 1.3 \times 10^{-18}$ J	(1) (1) (1) (1) (1) (1) (1) (1) (1) (1) (1) (1)	**4**
19(a)(ii)	One photon interacts with one electron (Same frequency so) photon/light/UV energy remains constant (At a lower intensity) there are fewer photons per second **Or** (at a lower intensity) there are fewer (photo)electrons per second So gold leaf's deflection would reduce more slowly **Or** so gold leaf takes more time to fall	(1) (1) (1) (1)	**4**

19(b)	**Max 3 from** Electrons are released instantaneously (even at low intensity) **Or** in the wave model electrons would be released after a delay (1) There is a minimum frequency for releasing electrons **Or** in the wave model electrons are released at any frequency (1) More intense light does not increase (kinetic) energy of electrons **Or** in the wave model more intense light increases (kinetic) energy of electrons (1) There is a maximum kinetic energy of electrons for a specific frequency **Or** in the wave model there is no maximum kinetic energy of electrons for a specific frequency (1)	**3**
	Total for question 19	**11**

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