Mark Scheme (Results)

January 2017

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

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January 2017
Publications Code WPH02_01_MS_1701*

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.

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.

Question Number	Answer	Mark
1	**A - correct answer** B - microwaves are not used in fibre optic telecommunications C - radio waves are not used in fibre optic telecommunications D - ultrasound waves are not used in fibre optic telecommunications	1
2	**D - correct answer** A – the wave produces is not longitudinal or progressive B - the wave produces is not longitudinal C - the wave produces is not progressive	1
3	A – increasing the duration of the pulses would not improve the level of detail **B - correct answer** C – increasing the interval between pulses would not improve the level of detail D – increasing the wavelength would not improve the level of detail	1
4	A – frequency does not apply B - frequency does not apply **C - correct answer** D - incorrect inequality	1
5	A - current would increase B - pd is unchanged as the internal resistance is 0 **C - correct answer** D - pd is unchanged as the internal resistance is 0	1
6	A - W (energy) and t (time) are SI base quantities B - I (current) is an SI base unit C - I (current) is an SI base unit **D - correct answer**	1
7	A - y and x are not the angle of incidence and angle of refraction respectively B - y and x are not the angle of incidence and angle of refraction respectively C - incorrect equation **D - correct answer**	1
8	A - wavelength is unchanged B - speed is unchanged C - both wavelength and speed are unchanged **D - correct answer**	1
9	A – not a correct description B – not a correct description **C - correct answer** D - not a correct description	1
10	A - the same pd across both wires will produce the same current and therefore the same drift velocity **B - correct answer** C - the same pd across both wires will produce the same current and therefore the same drift velocity D - the same pd across both wires will produce the same current and therefore the same drift velocity	1

Question Number	Answer		Mark
11 (a)	The p.d. (across component) can be (reduced to) zero	**(1)**	**1**
11 (b)	Use of $R = \rho l/A$ Use of $A = \pi r^2$ Diameter = 1.8×10^{-4} m <u>Example of calculation</u>	**(1)** **(1)** **(1)**	**3**

	$24\ \Omega = 1.2 \times 10^{-6}\ \Omega\ \text{m} \times 0.5\ \text{m} \div A$ $A = 2.5 \times 10^{-8}\ \text{m}^2$ $r = \sqrt{(2.5 \times 10^{-8}\ \text{m}^2 \div \pi)} = 8.9 \times 10^{-5}\ \text{m}$ $d = 1.78 \times 10^{-4}\ \text{m}$	
11 (c)	Use of ratio lengths:voltages **Or** Use of ratio lengths:resistances **Or** See $I = 0.24$ (A) **(1)** p.d. = 2.1 V **(1)** Example of calculation $V = 12.0\ \text{V} \times 7.16\ \text{cm} / 40.0\ \text{cm} = 2.15\ \text{V}$	**2**
	Total for question 11	**6**

Question Number	Answer	Mark
12(a)(i)	use of $P = \frac{E}{t}$ **and** power = flux × area **(1)** Flux = 255 W m^{-2} **(1)** <u>Example of calculation</u> Flux = 4590 J ÷ (0.005 m^2 × (60 × 60) s) Flux = 255 W m^{-2}	**2**
12(a)(ii)	Use efficiency = useful output / total input **(1)** efficiency = 0.024 = 2.4 % **(1)** <u>Example of calculation</u> Efficiency = 110 J ÷ 4590 J = 0.024 = 2.4 %	**2**
12(b)	Any **two** from: Low efficiency Need light for solar cell **Or** would not work in low light conditions Comment on required area of cell Time to charge would be long Storage of the gases	**2**
	Total for question 12	**6**

Question Number	Answer	Mark
13 (a)	**Either** Unpolarised – oscillations/vibrations in all planes **(1)** Polarised – oscillations/vibrations in single plane **(1)** Which includes the direction of the (wave) propagation **(1)** **Or** Unpolarised – oscillations/vibrations in all directions **(1)** Polarised – oscillations/vibrations in a single direction **(1)** Which is perpendicular to the direction of energy transfer **(1)** (MP3 is dependent upon awarding either MP1 or MP2)	**3**
13(b)(i)	After first filter all light (oscillating) in one plane **Or** first filter polarises the light **(1)** Second/rotated filter is perpendicular to the polarised light so light absorbed/blocked **Or** no oscillations/planes/component parallel to second filter so no light transmitted **(1)**	**2**
13 (b)(ii)	(stretched) plastic rotates/changes/alters the plane of polarisation **Or** Plane of polarisation of the (stretched) plastic is not perpendicular to the filters **(1)** So a <u>component</u> of the (polarised) light from first filter can be transmitted (through plastic and second filter) **(1)**	**2**
	Total for question 13	**7**

Question Number	Answer	Mark
14 (a)	Use of e.m.f. = sum of p.d.s **(1)** Use of $V = IR$ **(1)** r = 17 000 (Ω) **(1)** <u>Example of calculation</u> 1.79 V = 1.72 V + (4.20 μA × r) r = 16 700 (Ω)	**3**
14 (b)	Use of $P = IV$ with V=1.72 (V) **(1)** $P = 7.2 \times 10^{-6}$ W **(1)** <u>Example of calculation</u> P = 4.20 μA × 1.72 V $P = 7.2 \times 10^{-6}$ W	**2**
14 (c)	Resistance of voltmeter very large **Or** $R >> r$ **Or** internal resistance much less than resistance of voltmeter **(1)** (So) I very small [accept I = 0] **(1)** (So) Ir very small **Or** lost volts ≈ 0 **Or** $Ir << \mathcal{E}$ **(1)** (So) V (approximately) equal to e.m.f. **(1)**	**4**
	Total for question 14	**9**

Question Number	Answer		Mark
15 (a)	Idea that two (or more) waves meet (resultant) displacement is sum of individual displacements	**(1)** **(1)**	**2**
***15(b)(i)**	(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate) (When) path difference = nλ (waves are) in phase **Or** (when)path difference =$(n + \frac{1}{2})\lambda$ (waves are) in antiphase Constructive interference when path difference = nλ **Or** constructive interference when waves in phase Destructive interference when path difference =$(n + \frac{1}{2})\lambda$ **Or** destructive interference when wave in antiphase Maximum amplitude when constructive interference occurs **Or** zero amplitude when destructive interference occurs Constructive interference results in wavelengths that are observed (strongly) **Or** destructive interference results in wavelengths that are not observed	**(1)** **(1)** **(1)** **(1)** **(1)**	**5**
15(b) (ii)	Evidence of use of $2 \times d$ Wavelength for max amplitude = 460 nm (blue) Example of calculation $\lambda = 2 \times 2.3 \times 10^{-7}$m =$4.6 \times 10^{-7}$ m = 460 nm	**(1)** **(1)**	**2**
	Total for question 15		**9**

Question Number	Answer	Mark
16 (a)	A statement about the graph/diode e.g. resistance at the start of the graph is infinite, initial current remains zero as V increases, idea of threshold potential difference or resistance decreases **(1)** A statement about how a filament would behave, e.g. initial increase in current, increasing resistance, description of graph. **(1)**	**2**
16(b)(i)	The idea that the readings are not taken at regular intervals **(1)** To be able to draw a more accurate curved line of best fit **Or** Easier to draw a non-linear line of best fit **Or** to determine a (more accurate) value for the threshold voltage **(1)**	**2**
16(b)(ii)	Use of $R = V/I$ (with V = 1.88 to 1.9 (V)) **(1)** Correct use of a factor of 12 **(1)** R = 1500 Ω – 1520 Ω **(1)** <u>Example of calculation</u> 0.015 A ÷ 12 = 1.25 mA R = 1.9 V ÷ 1.25 mA R = 1500 Ω	**3**
16(c)(i)	Use of $E= QV$ **(1)** Use of $E= hf$ **(1)** $f = 5.1 \times 10^{14}$ Hz (using 2.1 V) **Or** f =(3.9 - 4.1) × 10^{14} Hz (using 1.60 V to 1.70 from graph) **(1)** <u>Example of calculation</u> $E = 2.1 \text{ V} \times 1.6 \times 10^{-19} \text{ C} = 3.36 \times 10^{-19}$ J $f = 3.36 \times 10^{-19} \text{ J} \div 6.63 \times 10^{-34} \text{ J s} = 5.07 \times 10^{14}$ Hz	**3**
16(c)(ii)	(For sodium) electrons/atoms exist in discrete energy <u>levels</u> **(1)** So only certain energy changes are possible and therefore certain frequencies **Or** frequencies emitted correspond to the difference between energy levels **(1)**	**2**
	Total for question 16	**12**

Question Number	Answer	Mark
***17(a)(i)**	(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate) Photon energy greater than the work function (of the metal) **Or** Electrons gain energy greater than the work function (of the metal) **(1)** (so that) electrons are emitted (from the surface of the metal) **(1)** **For Positive p.d**: The electrons are accelerated/attracted towards Q (creating a current) **(1)** **For negative p.d:** The idea that the (released) electrons need (kinetic) energy to reach Q **Or** The electrons decelerated/repelled by Q **(1)** At V_s no electrons have sufficient energy to reach Q (so no current) **(1)**	**5**
17(a)(ii)	Intensity related to number of photons per second **(1)** Double the electrons (per second) **(1)**	**2**
17(b)	Use of $hf = \varphi + \frac{1}{2} mv^2_{max}$ **(1)** Conversion eV to J (See 6.82×10^{-19} (J) or $4.26 \times 1.6\ 10^{-19}$) **(1)** $V_S = 0.71$ V **(1)** <u>Example of calculation</u> Max ke = $(6.63 \times 10^{-34}$ Js $\times 1.2\times 10^{15}$ Hz$) - (4.26 \times 1.6 \times 10^{-19}$ C$)$ $= 7.96 \times 10^{-19}$ J – 6.82×10^{-19} J = 1.14×10^{-19} J Max ke = 1.14×10^{-19} J ÷ 1.6×10^{-19} C $V_S = 0.71$ V	**3**
	Total for question 17	**10**

Question Number	Answer	Mark
18(a)	When car travelling towards gun, (detected) wavelength is smaller/decreased **Or** When car travelling away from gun (detected) wavelength is larger/increased **(1)** When travelling towards gun (observed) frequency is higher/increased **(1)** When travelling away from gun (observed)frequency is lower/decreased **(1)** Greater speed (of car) gives a greater change in frequency. **(1)**	**4**
18(b)	Use of $v = s / t$ **(1)** Calculates difference in times or difference in distances **(1)** Correct use of factor 2 **(1)** $v = 29.7 \text{ m s}^{-1}$ **(1)** <u>Example of calculation</u> $\Delta t = (3.333 \times 10^{-7} \text{ s}) - (3.315 \times 10^{-7} \text{ s}) = 1.8 \times 10^{-9} \text{ s}$ $1.8 \times 10^{-9} \text{ s} \div 2 = 9 \times 10^{-10} \text{ s}$ $s = (9 \times 10^{-10} \text{ s} \times 3 \times 10^{8} \text{ m s}^{-1}) = 0.27 \text{ m}$ $v = 0.27 \text{ m} \div 0.0091 \text{ s} = 29.7 \text{ m s}^{-1}$	**4**
18(c)	Infrared/lidar has shorter wavelength than microwave/radar **Or** microwave/radar has a longer wavelength than infrared/lidar **(1)** Shorter wavelength has less diffraction (accept spread out, divergent) **Or** Longer wavelength has greater diffraction (accept spread out, divergent) **(1)** Infrared/lidar can be aimed more accurately **Or** infrared/lidar will not pick up reflections from other cars **Or** microwave/radar more likely to pick up multiple reflections **(1)**	**3**
	Total for question 18	**11**

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