Mark Scheme (Results)

Summer 2017

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

Summer 2017
Publications Code WPH02_01_MS_1706*

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 $g = 10 \text{ m s}^{-2}$ **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	**A ampere is an SI base unit**	**1**
	Incorrect answers: B coulomb is an SI derived unit C joule is an SI derived unit D volt is an SI derived unit	
2	**C 5.00C** $(25 \times 10^{-3}\text{A} \times 200\text{s})$	**1**
	Incorrect answers: A 1.25×10^{-4} C is $(25 \times 10^{-3}$ A / 200s) B 1.25×10^{-1} C is (25 A / 200s) D 5.00×10^{3} C is (25 A × 200s)	
3	**A Diode has the shape of IV graph shown**	**1**
	Incorrect answers: B incorrect graph for a filament lamp C incorrect graph for a light dependent resistor D incorrect graph for a thermistor	
4	**D J s^{-1} m^{-2} (represents power per unit area, which is radiation flux)**	**1**
	Incorrect answers: A J m^{-2} (this would represent energy per unit area) B J s^{-1} (this would represent power) C J s m^{-2} (this would represent energy multiplied by time per unit area)	
5	**B higher because the wavefronts are compressed**	**1**
	Incorrect answers: A the speed of the wave would not change due to relative motion between the source and the observer C the frequency would only be lower if the source was moving away from the observer D the frequency would only be lower if the source was moving away from the observer	
6	**A (*mgh/Pt*) as useful energy gained = *mgh*. Total energy input = *Pt*, and efficiency is useful energy gained / total energy input.**	**1**
	Incorrect answers: B *Pt/mgh* would represent total energy input / useful energy output C *mghP/t* would represent a power multiplied by a power D *t/mghP* would represent the reciprocal of a power multiplied by the reciprocal of a power	
7	**C π radians is the phase difference between the two waves at A – the path difference between the two waves is (8cm – 5cm) = 3cm = 1.5λ. This results in the waves arriving in antiphase (π radians out of phase) which also occurs when the path difference is 1cm.**	**1**
	Incorrect answers: A For a phase difference of π/4 radians, the path difference would be 0.25cm B For a phase difference of π/2 radians, the path difference would be 0.5cm D For a phase difference of 3π/2 radians, the path difference would be 1.5cm.	

8	**A amplitude is the magnitude of the greatest distance of a point of a wave from the equilibrium position**	**1**
	Incorrect answers: B displacement is the distance of a point of a wave from the equilibrium point, which is not necessarily the greatest distance. C phase has nothing to do with distance D wavelength has nothing to do with distance from an equilibrium position	
9	**A 6.63×10^{-34} the gradient of an $E_{k\ max}$ vs f graph is the Planck constant (as $E_{k\ max} = hf - \varphi$)**	**1**
	Incorrect answers: B this is the mass of an electron C this is the charge of an electron D this is the speed of light in a vacuum	
10	**A 3V is the value of the potential difference across the 100 Ω resistor (as the resistor has a quarter of the total resistance of the circuit, so has a quarter of the p.d of the circuit across it).**	**1**
	Incorrect answers: B 4V would be selected by candidates assuming that 100Ω is one third of the total resistance of the circuit. C 8V would be selected by candidates assuming that the p.d. across the 100 Ω resistor is two thirds of the total p.d. of the circuit. D 9V would be selected by candidates assuming that the p.d. across the 100 Ω resistor is three quarters of the total p.d. of the circuit	

Question Number	Answer	Mark
11(a)	$\lambda = 64$ cm / 0.64m / 640mm (standard form alternatives accepted) (1)	**1**
11(b)	Antiphase / 180° / π (radians) (1)	**1**
11(c)	Transmitted wave and reflected wave (meet) **Or** two waves travelling in opposite directions (meet) (1) Superpose/Interfere (1) Constructive (superposition) creates antinodes **Or** Destructive (superposition) creates nodes (1) (For constructive, accept in phase. For destructive, accept in antiphase)	**3**
	Total for question 11	**5**

Question Number	Answer		Mark
12(a)	Enable pulse to return before next is emitted **Or** To distinguish which reflected pulse corresponds to which emitted pulse	(1)	**1**
12(b)	Use of $v = \frac{s}{t}$ Correct factor of 2 (either *s* or their *t* multiplied by 2) $t = 5.9 \times 10^{-4}$ s <u>Example of Calculation</u> $t = \frac{0.10 \text{ m} \times 2}{340 \text{ m s}^{-1}} = 5.88 \times 10^{-4}$ s	(1) (1) (1)	**3**
12(c)(i)	Ultrasound is reflected away from car/sensor **Or** Ultrasound does not reflect (straight) back (to car)	(1)	**1**
12(c)(ii)	Little/no reflection (detected) **Or** Pulse does not hit the post **Or** Post is not wide enough to reflect (enough of the ultrasound)	(1)	**1**
	Total for question 12		**6**

Question Number	Answer		Mark
13(a)	Electron(s) / atom(s) are at their lowest (possible) energy <u>level</u>	(1)	**1**
13(b)	Use of $c = f\lambda$ with c = 3.00 × 10^{8} Use of $E = hf$ Conversion between J and eV Transition (-) 1.51 (eV) to (-) 3.39 (eV) <u>Example of Calculation</u> $\Delta E = \frac{6.63\times10^{-34}\ (\text{kg s}^{-1})\times3.0\times10^{8}\ (\text{m s}^{-1})}{660\times10^{-9}\ (\text{kg s}^{-1})\times1.6\times10^{-19}} = 1.88\ (\text{eV})$ $-3.39 - (-1.51) = -1.88\ (\text{eV})$	(1) (1) (1) (1)	**4**
13(c)	Calculates photon energy Subtracts 13.6 (eV) **Or** Subtracts $(13.6 \times 1.6 \times 10^{-19})$ (J) $E_k = 1.4 \times 10^{-18}$ (J) <u>Example of Calculation</u> $E_k = (6.63 \times 10^{-34}\ (\text{kg s}^{-1}) \times 5.4 \times 10^{15}\ (\text{Hz})) - (13.6\ (\text{eV}) \times 1.6 \times 10^{-19} (\text{C}))$ $E_k = 1.4 \times 10^{-18}$ (J)	(1) (1) (1)	**3**
13(d)	Idea of only certain energy level differences/changes are possible Energy jumps are related to particular <u>photon</u> frequencies/wavelengths **and (**photons at) these frequencies/wavelengths are <u>absorbed</u>.	(1) (1)	**2**
	Total for question 13		**10**

Question Number	Answer		Mark
14(a)	Work done per unit charge For the whole circuit **Or** Converting chemical energy into electrical energy	(1) (1)	 **2**
14(b)(i)	Ammeter in series **and** Voltmeter in parallel (voltmeter may be drawn across the cell or the variable resistor) (do not accept voltmeter or ammeter drawn within dashed box)	(1)	**1**
14(b)(ii)	Large/increased current causing heating **Or** Short circuit damages battery **Or** Battery will run down more quickly	 (1)	 **1**
14(c)(i)	Draw line of best fit and extend to y-axis $\mathcal{E}$ = 5.9 – 6.1 V Attempt to determine gradient Or uses two sets of coordinates from the line with $\mathcal{E}=V+Ir$ r = 4.05 – 4.25 Ω (do not award if value is negative)	(1) (1) (1) (1)	 **4**
14(c)(ii)	Recognises $V_R = \frac{1}{2} \times \text{e.m.f.}$ **Or** Calculates $I = \frac{\varepsilon}{2r}$ Use of $P = \frac{V^2}{R}$ **Or** Use of $P = I^2R$ **Or** Use of $P = VI$ P=2.0 – 2.3 W (must be consistent with their answers from (i)) <u>Example of calculation</u> $P = \frac{3^2}{4.2}$ =2.14 W (Full ecf $\mathcal{E}$ and r from (c)(i))	 (1) (1) (1)	 **3**
	Total for question 14		**11**

Question Number	Answer		Mark
15(a)	Longitudinal waves Or (Creating a series of) compressions and rarefactions	(1)	
	Oscillations / vibrations of (air) molecules/particles/atoms	(1)	
	Oscillations / vibrations parallel to the direction of the (wave) travel	(1)	**3**
15(b)(i)	Spreading of a wave	(1)	
	When going around head / listener / obstacle **Or** When passing head / listener / obstacle (MP2 dependent on MP1)	(1)	**2**
***15(b)(ii)**	(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate)		
	The intensity reaching the left ear is the same (for all frequencies)	(1)	
	Right ear intensity is (always) less than the left ear intensity	(1)	
	When sound has travelled further the energy/intensity is reduced **Or** When sound has travelled further it covers a greater area **Or** As sound has been reflected/absorbed by head	(1)	
	Intensity reaching the right ear decreases as frequency increases	(1)	
	Because higher frequencies are diffracted less **Or** because shorter wavelengths are diffracted less	(1)	**5**
	Total for question 15		**10**

Question Number	Answer		Mark
16(a)(i)	Electrons change direction/velocity/speed **Or** electrons have a range of velocities/speeds (accept "velocity of electrons is not constant") Due to collisions with ions/atoms	(1) (1)	**2**
16(a)(ii)	Path drawn (tending) towards + Sharp changes in direction (within the filament, not just the edges)	(1) (1)	**2**
16(b)(i)	Use of $V = IR$ Use of $R = \frac{\rho l}{A}$ $\rho = 6.1 \times 10^{-8}\ \Omega$ m <u>Example of calculation</u> $\rho = \frac{\left(\frac{12(\text{V})}{1.2(\text{A})}\right) \times 7.9 \times 10^{-11}\ (\text{m}^2)}{0.013\ (\text{m})} = 6.08 \times 10^{-8}\ \Omega$ m	(1) (1) (1)	3
***16(b)(ii)**	(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate) Vibrations of the ions/atoms increase (as temp increases) (Causing) greater rate of collisions between (free) electrons and ions/atoms Refers to $I = nqvA$ in stating that current decreases as (drift) velocity decreases (Resistivity increases) as resistance increases due to $R=V/I$ with V constant	 (1) (1) (1) (1)	**4**
16 (b)(iii)	Resistance/resistivity is less (at lower temperatures) so current is larger **Or (**Large) current surge creates sudden rise in temperature	(1)	**1**
	Total for question 16		**12**

Question Number	Answer		Mark
17(a)	**Either** Polarised wave has oscillations/vibrations in one direction Perpendicular to the direction of (wave) travel **Or** Polarised wave has oscillations/vibrations in one plane Which <u>includes</u> the direction of (wave) travel (By either method, MP2 is dependent on MP1)	 (1) (1) (1) (1)	**2**
17(b)	Sunglasses block/absorb light (oscillating) perpendicularly to the (plane of polarisation of the) sunglasses **Or** sunglasses only transmit light (oscillating) in the same plane as the (plane of polarisation of the) sunglasses Reducing the <u>intensity</u> of light (reaching the eye)	(1) (1)	**2**
17(c)	Filter A as it blocks/absorbs light (polarised) in horizontal plane **Or** Filter A as it is perpendicular to the reflected light so blocks/absorbs it Light from the <u>fish</u> is unpolarised (so can still be seen) **Or** only a <u>component</u> of the light from the <u>fish</u> is absorbed **Or** a <u>component</u> of the light from the <u>fish</u> passes through	(1) (1)	**2**
	Total for question 17		**6**

Question Number	Answer		Mark
18(a)	Use of ${}_1\mu_2 = \frac{\sin i}{\sin r}$ with i =90° **or** $\sin c = \frac{1}{\mu}$	(1)	
	Critical angle = 25° (accept $c = 25°$) (no unit error)	(1)	
	Recognises that angle of incidence > critical angle (allow $i > c$)	(1)	
	<u>Total Internal Reflection</u> takes place (allow <u>TIR</u>)	(1)	**4**
	<u>Example of calculation</u> $c = \sin^{-1}\frac{1}{2.4}$ =24.6°		
18(b)(i)	Higher refractive index corresponds to a smaller critical angle **Or** see calculated value of 30° for critical angle of zircon	(1)	
	Greater range of angles of <u>incidence</u> for which reflection takes place in diamond	(1)	
	More reflection(s) for the diamond **Or** more likely for reflections in the diamond **Or** less refraction for the diamond	(1)	**3**
	(MP3 is dependent on awarding either MP1 or MP2) (Allow converse arguments in terms of zircon for MP2 and MP3)		
18(b)(ii)	Use of $\mu = \frac{\sin i}{\sin r}$ with 20° as one of the angles.	(1)	
	r(diamond) = 55° **and** r(zircon) = 43° **Or** Calculates difference between r(diamond) and r(zircon) = 12°	(1)	
	Protractor measures to $\pm 1.0°$ so can be easily distinguished (MP3 is dependent on MP2 being awarded)	(1)	**3**
	<u>Example of calculation</u> $\sin^{-1}(2.4 \times \sin 20) - \sin^{-1}(2.0 \times \sin 20) = 12°$		
	Total for question 18		**10**

Pearson Education Limited. Registered company number 872828
with its registered office at 80 Strand, London, WC2R 0RL, United Kingdom