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Mark Scheme (Results)

Summer 2015

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.

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.

For example:

(iii) 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.]	✓	**1**

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

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. 'resonance'

1.2 Bold lower case will be used for emphasis.

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

2.3 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, for example in a spreadsheet.

2.4 The same missing or incorrect unit will not be penalised more than once within one question (one clip in epen).

2.5 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.

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

3. Significant figures

3.1 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.

3.2 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 be penalised by one mark (but not more than once per clip). Accept 9.8 m s^{-2} or 9.8 N kg^{-1}

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.

4.6 Example of mark scheme for a calculation:

'Show that' calculation of weight

Use of L × W × H	✓	
Substitution into density equation with a volume and density	✓	
Correct answer [49.4 (N)] to at least 3 sig fig. [No ue] [If 5040 g rounded to 5000 g or 5 kg, do not give 3rd mark; if conversion to kg is omitted and then answer fudged, do not give 3rd mark] [Bald answer scores 0, reverse calculation 2/3]	✓	**3**

Example of answer:

80 cm × 50 cm × 1.8 cm = 7200 cm^3

7200 cm^3 × 0.70 g cm^{-3} = 5040 g

5040 × 10^{-3} kg × 9.81 N/kg

= 49.4 N

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.

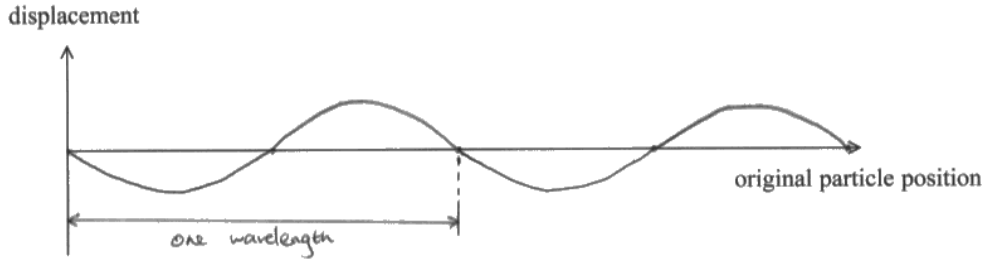
6.4 Points should be plotted to within 1 mm.

- 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.

6.5 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	A	**1**
2	D	**1**
3	D	**1**
4	A	**1**
5	C	**1**
6	B	**1**
7	C	**1**
8	B	**1**
9	B	**1**
10	A	**1**

Question Number	Answer	Mark
11	State units of n **(1)** State units of A and v **(1)** Leading to units of $C\ s^{-1}$ on both sides **(1)** (MP3 dependent on MP1 and 2) (Units should be matched explicitly, or written in the same order as equation for award of 3 marks)	**3**
	Total for Question 11	**3**

Question Number	Answer	Mark
12(a)	Correct wavelength on a sinusoidal curve **(1)** Sine curve lined up correctly with particle diagram (at least ¾ of axis, 1 ½ wavelengths) **(1)**  	**2**
12(b)	Longitudinal / compression / sound / ultrasound / infrasound / p-wave **(1)** (do not accept mechanical)	**1**
	Total for Question 12	**3**

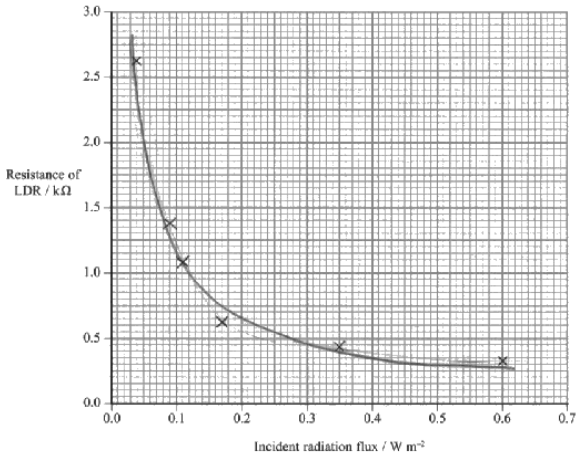
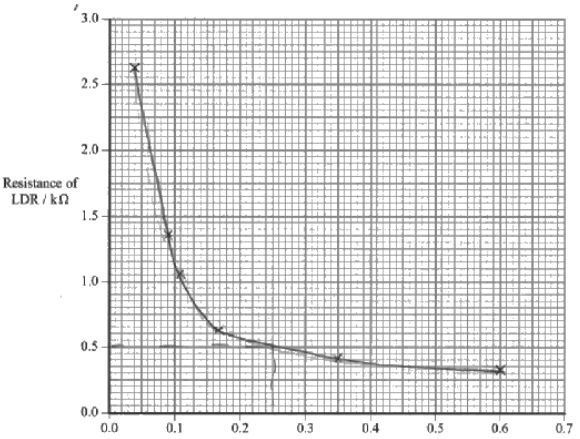
Question Number	Answer	Mark
13(a)	To be able to distinguish which reflection comes from which emission **Or** so one pulse returns before the next is emitted **(1)** (Accept reverse arguments) (Ignore references to interference/standing waves etc)	**1**
13(b)	Use of $v = s/t$ **(1)** Correct use of factor of 2 with correct distance (0.5m) (2 × time or 2 × distance) **(1)** Pulse duration = 3.3×10^{-9} s **(1)** Example of calculation Time = 2×0.5 m ÷ 3.0×10^{8} m s^{-1} Pulse duration = 3.3×10^{-9} s	**3**
13(c)	Correct reference to diffraction (e.g. Sound would spread out too much) **Or** reflected signal would have too low intensity (accept 'too weak/weaker') **Or** little sound would be reflected in correct direction **Or** sound would reflect off other objects **(1)**	**1**
	Total for Question 13	**5**

Question Number	Answer	Mark
***14**	(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate) Unpolarised light includes oscillations in all/many planes/directions **(1)** **Either** (After passing through filter) oscillations of light are in single plane **(1)** Which includes direction of energy transfer **(1)** **Or** (After passing through filter) oscillations of light are in single direction **(1)** Which is perpendicular to direction of propagation of wave **(1)** In first photo planes (of polarisation) of filters are parallel so light is transmitted **(1)** In second photo planes (of polarisation) of filters are perpendicular so light from first is absorbed/blocked by second **(1)**	**5**
	Total for Question 14	**5**

Question Number	Answer		Mark
15(a)	Electron/atom gains <u>energy</u> **Or** Electron moves to higher <u>energy</u> level	**(1)**	**1**
15(b)	Correct use of energy levels 13.6 eV and 0.9 eV	**(1)**	
	Conversion eV to J	**(1)**	
	Use of $hf = E$ **Or** $hf = E_2 - E_1$	**(1)**	
	$f = 3.1 \times 10^{15}$ Hz	**(1)**	**4**
	<u>Example of calculation</u> $E = 13.6 \text{ eV} - 0.9 \text{ eV} = 12.7 \text{ eV}$ $E = 1.6 \times 10^{-19} \text{ C} \times 12.7 \text{ eV} = 2.03 \times 10^{-18} \text{ J}$ $f = 2.03 \times 10^{-18} \text{ J} \div 6.63 \times 10^{-34} \text{ J s} = 3.06 \times 10^{15} \text{ Hz}$		
	Total for Question 15		**5**

Question Number	Answer		Mark
16(a)	Idea of two (or more) waves meeting	**(1)**	
	<u>Displacement</u> is sum of individual <u>displacements</u> (Do not accept amplitude for MP2)	**(1)**	**2**
16(b)(i)	At L_1, Path diff (= 2.4 – 1.6 = 0.8 m) = λ **Or** X to $L_1 = 2\lambda$ and Y to $L_1 = 3\lambda$	**(1)**	
	So at L_1 the waves are in phase = constructive interference/superposition (so sound is loud)	**(1)**	
	At Q_1, Path diff (= 2.1 – 1.7 = 0.4 m) = $\lambda/2$ **Or** X to $Q_1 = (2\ 1/8)\ \lambda$ and Y to $Q_1 = (2\ 5/8\ )\ \lambda$	**(1)**	
	So at Q_1 the waves are in antiphase = destructive interference/superposition (so sound is quiet)	**(1)**	**4**
16(b)(ii)	Music contains many/changing frequencies/wavelengths	**(1)**	
	so at a particular point (the music will only be in phase or in antiphase for some frequencies/wavelengths and) no overall difference in amplitude will be apparent **Or** so the points (where the sound is in phase or in antiphase) are not always in the same place **Or** the phase relationship is not constant at a particular point	**(1)**	**2**
	Total for Question 16		**8**

Question Number	Answer	Mark
***17(a)**	(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate) Fewer electrons emitted **(1)** Lower intensity of waves would provide less energy to release fewer electrons **Or** Lower intensity of waves would provide less energy to release electrons at a lower rate **Or** Lower intensity would mean a longer time for sufficient energy to be absorbed for electron release **(1)** Fewer photons would release fewer electrons **(1)** (Note that the question is about changes, so reference to max ke, instantaneous emission may be ignored. Reference to threshold frequency and work function are not required for MP3. For MP2 and 3 it must be clear which model they are referring to.)	**3**
17(b)	Use of $E = hf = \varphi + ke_{max}$ **(1)** $\varphi = 3.0 \times 10^{-19}$ (J) **(1)** <u>Example of calculation</u> 6.63×10^{-34} J s $\times$ 7.3×10^{14} Hz $= \varphi + 1.8 \times 10^{-19}$ J $\varphi = 3.04 \times 10^{-19}$ J	**2**
	Total for Question 17	**5**

Question Number	Answer	Mark
18(a)	Plot 2 points correctly **(1)** Plot 4 points correctly **(1)** Best fit curve (acceptable curves shown below) **(1)**  	**3**
18(b)	Identify required resistance for LDR from graph (0.5 kΩ) **(1)** Use of ratio of p.d.s = ratio of resistances **Or** calculation of current through LDR and use of 5.4 V **(1)** R = 4.5 kΩ (range 4.0 kΩ to 5.0 kΩ) **(1)** <u>Example of calculation</u> 0.6 V / 6 V = 0.5 k Ω / (R + R_{LDR}) (R + R_{LDR}) = 5 kΩ R = 4.5 kΩ	**3**
18(c)	Could take continuous/more readings **Or** could take many readings in a short time **(1)** Data is generated/stored digitally and can be processed by a computer **Or** A computer could plot the curve **Or** The graph curve is clearer because there are smaller increments between readings **(1)**	**2**
	Total for Question 18	**8**

Question Number	Answer	Mark
19(a)(i)	Use of $c = f\lambda$ with $c = 3.00 \times 10^8$ m s^{-1} **(1)** $\lambda = 0.024$ m = 2.4 cm **(1)** Example of calculation $\lambda = 3.00 \times 10^8$ m s^{-1}/ 1.26×10^{10} Hz $\lambda = 0.024$ m = 2.4 cm	**2**
19(a)(ii)	Microwave (accept radio) **(1)**	**1**
19(b)	Use of power = flux × area **(1)** Power = 1.3×10^{-13} W **(1)** Example of calculation Power = 4.8×10^{-13} W m^{-2} × 0.27 m^2 Power = 1.3×10^{-13} W	**2**
19(c)(i)	Diameter value from 1.8 mm to 2.0 mm **(1)**	**1**
19(c)(ii)	Diffraction greatest when wavelength is about the same as gap size **(1)** Diameter of holes much less than (microwave) wavelength, so although radiation still diffracted (through large angle), intensity is very small **(1)**	**2**
19(c)(iii)	Any reasonable physics suggestion, e.g. to reduce weight, to reduce quantity of metal used, to reduce rain fade, to reduce air resistance, to reduce wind damage, to allow drainage **(1)**	**1**
	Total for Question 19	**9**

Question Number	Answer	Mark
20(a)(i)	The length measured is about the same as the scale division **(1)** This will lead to a large percentage uncertainty **Or** on this scale a parallax error could give a result of under half the true value **(1)**	**2**
20(a)(ii)	Use of $\rho l/A = R$ **(1)** $\rho = 1.3 \times 10^{-6}$ (Ω m) **(1)** <u>Example of calculation</u> $\rho = RA / l =$ 1.8 Ω × 1.5 × 10^{-3} m × 0.24 × 10^{-3} m ÷ 0.485 m $\rho = 1.34 \times 10^{-6}$ Ω m	**2**
20(b)	Use of $P = V^2 / R$ **(1)** $R = 38$ Ω **(1)** <u>Example of calculation</u> $R = (230\text{ V})^2 \div 1400$ W $R = 38$ Ω	**2**
20(c)	Increased vibration of lattice ions so there are more (frequent) collisions of electrons with ions **(1)** So drift velocity decreases **(1)** Since $I = nAvq$, current is less (for same V), so V/I increases **(1)**	**3**
	Total for Question 20	**9**

Question Number	Answer		Mark
21(a)	Use of $\mu = c / c_{diamond}$ $\mu = 2.42$ Example of calculation $\mu = 3.00 \times 10^8 / 1.24 \times 10^8$ $\mu = 2.42$	**(1)** **(1)**	**2**
21(b)	Use of $\mu = \sin i / \sin r$ **Or** $n \sin \theta$ = constant **Or** $\sin c = 1 / \mu$ Glass: For glass angle in air = 45° **Or** Determine critical angle for glass (42˚) Glass ray shown in air refracted away from normal Diamond: Determine critical angle for diamond (24˚) **Or** attempt to determine angle of refraction for diamond (which won't work) State that total internal reflection occurs because $i > c$ **Or** State that total internal reflection occurs because r cannot be determined Diamond ray shown reflecting with angle 28˚ to normal and no other rays Example of calculation Glass: $\sin x = \sin 28° \times 1.5$ $x = 44.8$(˚) Diamond: $\sin c = 1 / \mu = 1 / 2.42$ $c = 24.4$(˚)	**(1)** **(1)** **(1)** **(1)** **(1)** **(1)**	**6**
21(c)	Diamond has a (much) lower critical angle Light from a wider range of (incident) angles is internally reflected (so it looks brighter) **Or** Light from a wider range of (incident) angles is internally reflected (so more light is reflected) **Or** light with smaller incident angles will be internally reflected (so more light is reflected)	**(1)** **(1)**	**2**
	Total for Question 21		**10**

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