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Mark Scheme (Results)

Summer 2014

Pearson Edexcel International Advanced 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 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:

<u>'Show that' calculation of weight</u>		
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.

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

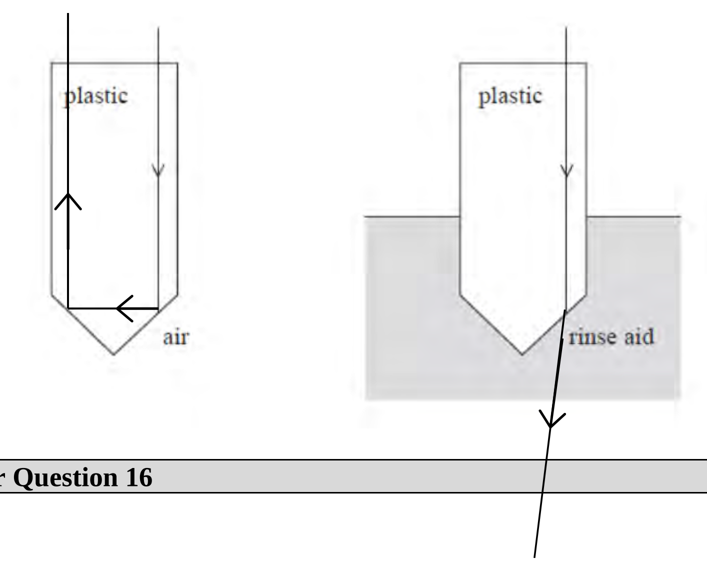
Question Number	Answer	Mark
11	(Laser) produces polarised light **(1)** The idea that light transmitted when in same plane/direction as plane/direction of polarisation of filter **(1)** The idea that light not transmitted when plane/direction at 90° to plane/direction of polarisation of filter **(1)**	**3**
	Total for Question 11	**3**

Question Number	Answer	Mark
12(a)	Oscillations/vibrations of (air) particles/molecules/atoms **(1)** Oscillations/vibrations/displacement parallel to direction of propagation **Or** Oscillations/vibrations/displacement parallel to direction of energy transfer **(1)** (Producing) compressions and rarefactions **Or** regions of high and low pressure **Or** it is a longitudinal wave **(1)**	**3**
***(12b)**	(QWC- Work must be clear and organised in a logical manner using technical wording where appropriate.) Towards → increased/higher frequency **(1)** Away → decreased/lower frequency **(1)** Towards – wave(front)s get closer together **Or** Towards – wavelength decreases **Or** Away – wave(front)s further apart **Or** Away – wavelength increases **(1)** Reference to inverse relationship between f and λ **Or** closer → more wave(front)s per second **(1)** (4^{th} mark dependent on 3^{rd} mark)	**4**
	Total for Question 12	**7**

Question Number	Answer	Mark
13	**Max 3** Cathode rays were considered to be waves **(1)** (Thomson showed them to be particles) The idea that diffraction occurs for waves (may award for description of diffraction in terms of waves) **(1)** Therefore electrons have wave nature (may award for description of electrons in terms of waves) **(1)** Electrons show wave-particle duality **(1)** (Statement that electrons have both wave and particle nature gains MP3 and MP4) **1 mark** This demonstrates how ideas changed in the light of evidence/experiments/observations **(1)**	**4**
	Total for Question 13	**4**

Question Number	Answer	Mark
14(a)	Correct use of 1.6×10^{-19} to convert eV to J **(1)** Use of $E = hf$ (with energy in eV or J) **(1)** $f = 5.8 \times 10^{14}$ Hz **(1)** <u>Example of calculation</u> $\Delta E = 2.42 \times 1.6 \times 10^{-19} = 3.87 \times 10^{-19}$ J $f = 2.42 \times 1.6 \times 10^{-19}$ J / 6.63×10^{-34} Js $f = 5.84 \times 10^{14}$ Hz	**3**
***14(b)**	(QWC- Work must be clear and organised in a logical manner using technical wording where appropriate.) Thin to give small cross-sectional area **(1)** Small area produces high resistance because $R=\rho l/A$ or $R \propto 1/A$ **Or** Thin so high resistance because $R=\rho l/A$ or $R \propto 1/A$ **(1)** Long produces high resistance because $R=\rho l/A$ or $R \propto l$ **(1)**	**3**
	Total for Question 14	**6**

Question Number	Answer		Mark
15(a)	Use of $P = IV$ Use of Power = intensity × area Use of efficiency = useful output / total input Efficiency = 0.37 or 37% <u>Example of calculation</u> P in = 0.14 A × 3.1 V = 0.43 W P out = 1.45 W m^{-2} × 0.11 m^2 = 0.16 W Efficiency = 0.16 / 0.43 = 0.37 or 37%	**(1)** **(1)** **(1)** **(1)**	**4**
15(b)	Can be logged over a longer time period than a person could do Can take different readings simultaneously **Or** Avoids timing errors **Or** Can take readings automatically Idea that data logger stores/processes the results	**(1)** **(1)** **(1)**	**3**
	Total for Question 15		**7**

Question Number	Answer		Mark
16(a)	Measurements – i = 50° to 52°, r = 34° to 36° Use of refractive index = sin i / sin r refractive index = 1.3 to 1.4 <u>Example of calculation</u> refractive index = sin 52° / sin 36° refractive index = 1.34	**(1)** **(1)** **(1)**	**3**
16(b)	Use of $\mu = v_1 / v_2$ Use of μ = 1/sin c c = 64 (°) [Reverse argument scores max 2] <u>Example of calculation</u> $\mu = 2.22 \times 10^8 \text{ m s}^{-1} / 2.00 \times 10^8 \text{ m s}^{-1}$ sin c = 1 / 1.11 c = 64.3°	**(1)** **(1)** **(1)**	**3**
16(c)	Empty – total internal reflection at first surface Empty – total internal at second surface and ray parallel to first ray Full – shows refraction Full – refraction is correct by eye 	**(1)** **(1)** **(1)** **(1)**	**4**
	Total for Question 16		**10**

Question Number	Answer		Mark
17(a)(i)	Use of $v = s/t$	**(1)**	
	Determine distance to an object when the return time is 5×10^{-4} s (0.083 m) **Or** determine time for pulse to return when distance to object is 0.01 m (6.1×10^{-4} s) **Or** Determine total distance travelled by pulse when the return time is 5×10^{-4} s (0.16 m) and compare to 20 cm **Or** determine time for pulse to return when distance travelled is 0.01 m (3.0×10^{-4} s) and compare to 2.5×10^{-4} s	**(1)**	
	Appropriate comment on suitability, e.g. detectable distance less than distance required, so suitable **Or** pulse shorter than time required to travel the distance, so suitable	**(1)**	**3**
	(Third mark is only awarded if second mark is awarded) <u>Example of calculation</u> $s = 330 \text{ m s}^{-1} \times 5 \times 10^{-4} \text{ s}$ $s = 0.165$ m One way = 0.083 m **Or** $t = 0.2 \text{ m} / 330 \text{ m s}^{-1}$ $t = 6.1 \times 10^{-4}$ s		
17(a)(ii)	Ultrasound has shorter wavelength/period **Or** Sound waves have longer wavelength/period **Or** Sound waves could have wavelength of several metres **Or** Shorter pulse possible with ultrasound	**(1)**	
	Ultrasound detects more detail than possible for sound **Or** Ultrasound detects shorter distances than possible for sound **Or** Sound would diffract (more) around obstacles	**(1)**	**2**
17(b)	(Sound) reflected away from the sensor **Or** (Sound) reflected into the ground		**1**
	Total for Question 17		**6**

Question Number	Answer		Mark
18(a)	If temperature is low the resistance of the thermistor is high The ratio of pds is the ratio of resistances So pd across the output/switch/AB will be high, switching on heater When temperature is high, pd across the output/switch/AB will be low, switching off heater **Or** If temperature is high the resistance of the thermistor is low The ratio of pds is the ratio of resistances So pd across the output/switch/AB will be low, switching off heater When temperature is low, pd across the output/switch/AB will be high, switching on heater	**(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)**	**4**
18(b)	**Max 2** heater would never switch off **Or** it could only vary the heater output because resistance of thermistor would never be zero so the output pd would never be zero **Or** it could only vary the output pd	 **(1)** **(1)** **(1)**	**2**
	Total for Question 18		**6**

Question Number	Answer		Mark
19(a)(i)	Photon – quantum/packet of something relevant e.g. light, radiation, any other named e-m radiation, energy (quantum/packet) of <u>electromagnetic</u> energy/radiation/waves (dependent mark)	**(1)** **(1)**	**2**
19(a)(ii)	Work function **-** The <u>minimum</u> energy required to remove/emit/eject an electron from the surface of the material	**(1)**	**1**
19(b)	A photon is absorbed by the dust And so an electron is emitted by the dust Negative charge is lost, so the charge of the dust becomes positive	**(1)** **(1)** **(1)**	**3**
19(c)(i)	Use of $E = hf$ Use of $c = f\lambda$ $\lambda = 3.03 \times 10^{-7}$ m <u>Example of calculation</u> $f = 6.56 \times 10^{-19}$ J / 6.63×10^{-34} Js $f = 9.89 \times 10^{14}$ Hz $\lambda = 3.00 \times 10^{8}$ m s^{-1} / 9.89×10^{14} Hz $\lambda = 3.03 \times 10^{-7}$ m	**(1)** **(1)** **(1)**	**3**
19(c)(ii)	Longer wavelength (= lower frequency) = lower photon energy **Or** photon energy is inversely proportional to wavelength **Or** identifies need to exceed/equal threshold frequency (minimum frequency required) and inverse relationship between frequency and wavelength (longer wavelength = lower frequency) So it is a maximum wavelength (dependent on first mark)	**(1)** **(1)**	**2**
	Total for Question 19		**11**

Question Number	Answer		Mark
20(a)	**Mechanism** T_1 and T_2 have a path difference They superpose **Or** superposition occurs **Or** they interfere **Remain** For some wavelengths, the path difference = n λ, in phase, so there is constructive interference **Disappear** For some wavelengths, the path difference = (n + ½) λ Antiphase (not just 'out of phase'), so there is destructive interference	 **(1)** **(1)** **(1)** **(1)** **(1)** **(1)**	**6**
20(b)	(A hydrogen atom) has discrete energy levels Light emitted when electron moves to lower energy level **Or** Light emitted when electron de-excited difference in energy levels = photon energy only certain differences (in levels) possible **Or** only certain photon energies possible	**(1)** **(1)** **(1)** **(1)**	**4**
	Total for Question 20		**10**

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