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Mark Scheme (Results)

Summer 2014

Pearson Edexcel GCE
in Physics (6PH02)
Paper 01R 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] 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	 ✓ ✓ ✓	**3**

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

Question Number	Answer		Mark
11	$I_3 = I_2 + I_1$ (possible reference to $(Q/t)_1$ etc accepted)	**(1)**	
	Charge is conserved **Or** Conservation of charge **Or** charge into point = charge out of point **Or** no charge lost	**(1)**	
	Correct reference to same time (e.g. same charge etc in same time **Or** $(Q/t)_3 = (Q/t)_1 + (Q/t)_2$ etc)	**(1)**	**3**
	Total for question 11		**3**

Question Number	Answer		Mark
12(a)	Use of distance = speed x time	**(1)**	
	Time = 1.7×10^{-8} s	**(1)**	**2**
	Example of calculation $t = s \div v$ $= 5.0 \text{ m} \div 3.0 \times 10^{8} \text{ m s}^{-1}$ Time = 1.67×10^{-8} s		
12(b)	Pulses, so the reflected signal is received before next one is sent **Or** otherwise there wouldn't be a way of telling which bit of reflected IR originated with which bit of emitted IR **Or** so that reflected pulses can be distinguished from each other	**(1)**	**1**
12(c)	Accept any sensible reason, Examples: could interfere with what is being looked at light from the background could interfere with the signal	**(1)**	**1**
	Total for question 12		**4**

Question Number	Answer	Mark
13	electron emitted by absorption of light/UV/photon **(1)** one photon absorbed by one electron **(1)** if frequency above threshold frequency then electron emitted **Or** if photon energy above work function energy then electron emitted **(1)** Use of $hf = \varphi$ (using work function to find corresponding frequency or wavelength) **Or** Use photon energy = hf (using any identified frequency or wavelength of visible light or UV to find corresponding photon energy) **(1)** Threshold frequency = 1.0×10^{15} Hz **Or** wavelength = 2.9×10^{-7} m **Or** Photon energy for light = a value between 2.9×10^{-19} J and 5.1×10^{-19} J **Or** photon energy for UV = a value between 5.1×10^{-19} J and 1.99×10^{-17} J **(1)** State visible light frequency too low / wavelength too long **Or** compare photon energy to work function **(1)** <u>Example of calculation</u> $f = 6.88 \times 10^{-19}$ J ÷ 6.33×10^{-34} J s = 1.0×10^{15} Hz	**6**
	Total for question 13	**6**

Question Number	Answer	Mark
14(a)	Use of power = intensity x area **(1)** Use of time = energy / power **(1)** Time = 19 s **(1)** <u>Example of calculation</u> P = 8000 W m^{-2} × 1.5×10^{-5} m^{2} = 0.12 J s^{-1} t = 2.3 J ÷ 0.12 J s^{-1} = 19 s	**3**
14(b)(i)	Use of $E = IVt$ **(1)** Energy = 19 000 J (2 sf)(no ue) **(1)** <u>Example of calculation</u> E = 1.4 A × 3.7 V × (60 × 60) s = 18 648 J	**2**
14(b)(ii)	Energy required = 210 x 2.3 J **(1)** Use of efficiency = output energy / input energy **(1)** Efficiency = 0.026 or 2.6% **(1)** <u>Example of calculation</u> efficiency = 210 × 2.3 J × 100 % ÷ 19 000 J = 0.026 or 2.6%	**3**
	Total for question 14	**8**

Question Number	Answer	Mark
15(a)	Credit any sensible limitation **(1)** Examples include: • blunt pencil, • protractor divisions only to one degree, • protractor of limited radius • method requires rays to be marked and then drawn on Limited precision – linked to limitation **(1)**	**2**
15(b)	Use of refractive index = ratio of speeds **(1)** Speed = 2.0×10^8 m s^{-1} **(1)** <u>Example of calculation</u> speed in plastic = 3.0×10^8 m s^{-1} ÷ 1.52 = 1.97×10^8 m s^{-1}	**2**
15(b)(ii)	Use of sin $c = 1/\mu$, sin $c = 1/n$ (or equivalent, but must allow full solution if used correctly without further equations) **(1)** critical angle = 41° **(1)** <u>Example of calculation</u> sin c = 1/1.52 c = 41°	**2**
***15(c)**	**(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate)** The light strikes the sides at an angle greater than the critical angle **(1)** It undergoes <u>total</u> internal <u>reflect</u>ion **(1)** It is reflected again **(1)** It strikes the other end at less than the critical angle **Or** It is transmitted at the final boundary **Or** the ray has zero angle of incidence at the first end and is transmitted undeviated **(1)**	**4**
	Total for question 15	**10**

Question Number	Answer		Mark
16(a)	Operable circuit with bulb and power supply variable to 12 V (ignore meters) Ammeter correctly positioned Voltmeter correctly positioned (voltmeter may be across ammeter as well, or whole circuit – but not across any additional resistive components such as a variable resistor)	**(1)** **(1)** **(1)**	**3**
16(b)(i)	The gradient of this graph is the rate of change of current with p.d. Resistance is the ratio of pd/current **Or** It is calculated using a value of pd ÷ the corresponding value of current **Or** it isn't a straight line so the gradient is not R (credit R not constant, so value at 6 V isn't applicable to other voltages)	**(1)** **(1)**	**2**
16(b)(ii)	Use of $R = V/I$ $R = 4.76\ \Omega$ <u>Example of calculation</u> $R = 6.00\ \text{V} / 1.26\ \text{A}$ $R = 4.76\ \Omega$	**(1)** **(1)**	**2**
***16(c)**	**(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate)** The resistance increases (Because) the temperature increases (accept heats up) Increasing the amplitude of the oscillation of the lattice ions Leading to more (frequent) collisions of electrons with lattice ions Allow converse marks for an explanation explicitly based on decreasing potential difference	**(1)** **(1)** **(1)** **(1)**	**4**
	Total for question 16		**11**

Question Number	Answer		Mark
17(a)	photon absorbed by electron electron moves to higher energy level **Or** electron excited where photon energy = difference in energy levels only certain changes/differences possible between discrete energy levels	**(1)** **(1)** **(1)** **(1)** **(1)**	**5**
17(b)(i)	Use of $E = hf$ Use of conversion factor to eV Energy of photon = 1.91 (eV) Identify levels 3.41 (eV) and 1.51 (eV) **Or** levels 1 and 2 <u>Example of calculation</u> $E = 6.63 \times 10^{-34}$ J s $\times 4.6 \times 10^{14}$ Hz (= 3.05×10^{-19} J) $E = 6.63 \times 10^{-34}$ J s $\times 4.6 \times 10^{14}$ Hz $\div 1.6 \times 10^{-19}$ J s = 1.91 eV = 3.41 eV − 1.51 eV (1.90 eV) as the closest match	**(1)** **(1)** **(1)** **(1)**	**4**
17(b)(ii)	Just-free electrons have zero energy state **Or** energy value of level $n = \infty$ is 0 (Bound) electrons need to gain energy to attain this state **Or** electrons need to gain energy to move to a higher level (Accept Because they must gain energy to move up for second mark) (accept answers in terms of ionisation energy)	**(1)** **(1)**	**2**
17(c)	Look for corresponding pattern of lines / frequency spacings at different place in spectrum **Or** reference to known normal positions moving away increases observed wavelength / decreases frequency (or the case for moving towards) so if shifted to red end then moving away (or blue = towards) **Or** the greater the velocity the greater the change in frequency	**(1)** **(1)** **(1)**	**3**
	Total for question 17		**14**

Question Number	Answer	Mark
*18(a)	**(QWC – Work must be clear and organised in a logical manner using technicalwording where appropriate)** a standing/stationary wave **(1)** Waves from the generator are reflected at the end **Or** waves are travelling in both directions **(1)** (When the two) waves (meet they) superpose/undergo superposition **(1)** Producing points where the waves are in phase and points where they are in antiphase **Or** producing points of zero amplitude and points of maximum amplitude OR producing nodes and antinodes **(1)**	**4**
18 b)	Wavelength = 2 × 1.8 m **(1)** Use of speed = wavelength x frequency **(1)** Speed = 1200 m s^{-1} **(1)** Example of calculation λ = 2 × 1.8 m v = 330 Hz × 3.6 m v = 1188 m s^{-1}	**3**
18(c)(i)	Point is a node, so zero amplitude OR Point is a node, so string not moving **(1)** So no energy absorbed **Or** Waves continue to move after superposition **(1)**	**2**
18(c)(ii)	(Original frequency x 2) = 660 Hz **(1)**	**1**
18(c)(iii)	Captured twice per cycle = 1320 Hz (allow ecf from (c) (iii)) **(1)** If more than 1320 Hz will be captured at points other than max amplitude **(1)**	**2**
18(d)	Scale divisions of 20 Hz **Or** Wide pointer **Or** nominal output (only) **(1)** Lack of precision (scale related) **Or** Lack of accuracy (output related) **(1)**	**2**
	Total for question 18	**14**

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