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Mark Scheme (Results)

Summer 2013

GCE Physics (6PH02)

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] ✓ **1**
[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.

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

Question Number	Answer		Mark
11(a)	Use of $c = f\lambda$ with $c = 3.00 \times 10^8$ m s^{-1} $\lambda = 1.37$ m Example of calculation $\lambda = 3.00 \times 10^8$ m s^{-1} / 2.186×10^8 Hz $\lambda = 1.37$ m	**(1)** **(1)**	**2**
11 (b)	Frequency – number of oscillations/vibrations/cycles/waves per second **Or** number of oscillations/vibrations/cycles in unit time (ignore 'complete') (do not accept 1/period, unless period is defined appropriately) [accept number of wavelengths per second] Wavelength – distance travelled during one complete oscillation/vibration/cycle **Or** shortest distance between two points at the same stage of the cycle/in phase **Or** distance between identical points on adjacent waves (Accept distance between adjacent/neighbouring peaks/crests/troughs but not just 'distance between peaks' or 'length of wave')	**(1)** **(1)**	**2**
	Total for question 11		**4**

Question Number	Answer		Mark
12 (a)	Measure angles of incidence and refraction (clear variants accepted or correct angles shown on a diagram)('*i*' and '*r*' accepted) Plots sin *i* vs sin *r* Correct gradient identified for their graph (assume sin *i* on *y* axis unless stated otherwise, assume statements using 'vs' or 'against' state *y* axis first) [If angle of reflection referred to instead of refraction, only allow 2nd mark] (Allow 3rd but not 2nd mark if *i* vs *r* and point from line used in μ = sin *i* / sin *r*)	**(1)** **(1)** **(1)**	**3**
12 (b)(i)	angle of incidence (for light travelling from denser medium) has angle of refraction of 90˚ (may refer to leaving along surface/boundary)	**(1)** **(1)**	**2**
12 (b)(ii)	Use of μ = sin *i* / sin *r* (accept stating sin *c* = 1 / μ) *c* = 49˚ (n.b. ue applies) <u>Example of calculation</u> sin *c* = 1 / μ = 1 / 1.33 *c* = 49˚	**(1)** **(1)**	**2**
	Total for question 12		**5**

Question Number	Answer		Mark
13 (a)	Use of $R = \rho l/A$ R = 17 Ω <u>Example of calculation</u> $R = 4.9 \times 10^{-7}$ Ω m × 1.0 m / 2.9×10^{-8} m^2 R = 17 Ω	**(1)** **(1)**	**2**
13 (b)	Area decreases Resistance inversely proportional to area **Or** quote $R = \rho l/A$ So this change (also) increases resistance (Accept for 2nd mark, $I = nAqv$, I decreases if A decreases, $R = V/I$) (Final mark dependent on presenting a logical explanation linking area change and resistance – not just stating increased resistance.)	**(1)** **(1)** **(1)**	**3**
	Total for question 13		**5**

Question Number	Answer		Mark
14 (a)	Reference to oscillations of electric / magnetic field (accept vibrations) Oscillations/vibrations in one plane only Plane includes direction of propagation/travel (of the light) **Or** Plane includes direction of energy transfer (third mark dependent on second mark) **Alternative mark scheme** Reference to oscillations of electric / magnetic field (accept vibrations) Oscillations/vibrations in one direction only… … perpendicular to direction of propagation/travel (of the light) **Or** … perpendicular to direction of energy transfer (third mark dependent on second mark)	**(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)**	**3**
14(b)	Identifies 90 degree difference Light aligned/intended for one filter will be blocked/absorbed/stopped by the other filter **Or** light aligned/intended for one filter will only be transmitted by that filter (2^{nd} mark dependent on 1^{st})[accept reference to lens]	**(1)** **(1)**	**2**
14 (c)	(Polarisation) absorbs/blocks/stops the unaligned part of the radiation **Or** only aligned part of radiation is transmitted So intensity / flux / amplitude (reaching each eye) reduced	 **(1)** **(1)**	**2**
14 (d)	Angle between one filter/lens/eye and plane (of polarisation) of the light (intended for the other filter) has changed The light for one eye has component in plane of polarisation of the other filter (and passes through to the other eye)	**(1)** **(1)**	**2**
	Total for question 14		**9**

Question Number	Answer		Mark
15(a)	Quantum of … **Or** (discrete) packet of … **Or** discrete quantity of …	**(1)**	
	(To score the mark must refer to something relevant e.g. light / energy) Of <u>electromagnetic</u> radiation/energy	**(1)**	**2**
***15(b)**	(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate)	**(1)**	
	describe relevant interaction between single photon and single electron		
	photon energy depends on frequency **Or** reference to $E = hf$ (must be link to photons/light)	**(1)**	
	if photon energy greater than work function, electron emitted (immediately)	**(1)**	
	whereas for waves energy could build up **Or** with waves that the electron can absorb energy continuously or over time	**(1)**	**5**
	so any frequency should work **Or** but this build up doesn't happen		
15(c)(i)	Use of $4.3 \times 1.6 \times 10^{-19}$	**(1)**	
		(1)	
	Use of $E = hf$	**(1)**	**3**
	$f = 1.0 \times 10^{15}$ Hz		
	<u>Example of calculation</u> $E = 4.3\ \text{V} \times 1.6 \times 10^{-19}\ \text{C}$ $= 6.9 \times 10^{-19}\ \text{J}$ $6.9 \times 10^{-19}\ \text{J} = 6.63 \times 10^{-34}\ \text{Js} \times f$ $f = 1.0 \times 10^{15}$ Hz		
15(c)(ii)	Ultraviolet Accept ultraviolet even if frequency in c(i) is incorrect, but allow ecf from candidate's value of frequency to appropriate part of electromagnetic spectrum	**(1)**	**1**
	Total for question 15		**11**

Question Number	Answer		Mark
16 (a)	Particles/atoms/ions/molecules (in metal) oscillate/vibrate	**(1)**	
	Along direction of propagation **Or** parallel to direction of wave travel **Or** in direction of energy transfer (along direction of motion/movement is insufficient)	**(1)**	
	Making compressions and rarefactions **Or** as a longitudinal wave	**(1)**	**3**
16 (b)	Use of $s = vt$	**(1)**	
	Correct application of factor of 2	**(1)**	
	Answer, $s = 0.015$ m **Or** total journey time for thickness 4 cm = 1.4×10^{-5} s	**(1)**	
	Comparison – Steel is corroded because thickness less than 4 cm (allow even if no division by 2) **Or** Steel is corroded because detected time less than for 4 cm (allow even if no division by 2)	**(1)**	**4**
	(For third mark, accept $s = 0.030$ m where final comparison is with total uncorroded journey distance, 8 cm **Or** time = 6.8×10^{-6} s where final comparison is with half of corroded journey time 2.6×10^{-6} s)		
	Example of calculation $s = 5900 \text{ m s}^{-1} \times 5.1 \times 10^{-6}$ s = 0.030 m Thickness = 0.030 / 2 = 0.015 m		
16 (c)	Need to measure time at which the echo arrives back **Or** need to measure time taken for echo to return	**(1)**	
	If continuous couldn't tell when this was **Or** so pulse must return before next is emitted	**(1)**	
	Shorter pulses means smaller thickness can be measured **Or** longer pulses means only larger thickness can be measured	**(1)**	**3**
	Total for question 16		**10**

Question Number	Answer		Mark
17(a)	Negative gradient (accept curve)	**(1)**	
	Straight line (dependent on first marking point)	**(1)**	
	Reference to terminal p.d. = e.m.f. – 'lost volts' **Or** $V = \varepsilon - Ir$	**(1)**	
	Intercept on V axis = ε **Or** Intercept on y axis = ε **Or** ε = value of V on graph when $I = 0$ (accept from labelled graph)(mark not awarded if line passes through origin)	**(1)**	
	Gradient = $-r$ **Or** magnitude of gradient is r (accept gradient = $-r$ marked on graph)	**(1)**	**5**
***17(b)**	(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate)		
	Ammeter explanation:		
	If ammeter has resistance, current decreased	**(1)**	
	but doesn't affect the determination because current through cell/r is measured **Or** doesn't affect the determination because the voltmeter measures the terminal p.d. for that current	**(1)**	
	OR		
	The resistance of the ammeter contributes to the load/circuit/total resistance	**(1)**	
	Values of p.d. corresponding to given values of current will be unchanged	**(1)**	
	Voltmeter explanation:		
	If voltmeter has smaller resistance it would draw current	**(1)**	
	measured current not current through cell/r	**(1)**	**4**
	Total for question 17		**9**

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Question Number	Answer		Mark
18(a)	Series sketch with two bulbs	**(1)**	
	Connected in series: because when one is removed there is a break in the circuit **Or** because when one is removed there is no current **Or** so the bulbs could have different p.d.s	**(1)**	
	Not connected in parallel because: if one removed, still complete circuit (for the other) **Or** if one removed, still current (through the other) **Or** full mains voltage would have blown small bulb	**(1)**	**3**
18(b) (i)	Use of $P = IV$ $I = 0.17$ (A) (at least 2 sf required) <u>Example of calculation</u> 40 W = $I \times 230$ V $I = 0.17$ A	**(1)** **(1)**	**2**
18(b) (ii)	Use of appropriate equation $R = 1300\ \Omega$ <u>Example of calculation</u> $P = V^2/R$ 40 W = $(230\text{ V})^2 / R$ $R = 1323\ \Omega$	**(1)** **(1)**	**2**
18(b) (iii)	Use of $R = V/I$ $R = 13\ \Omega$ <u>Example of calculation</u> $R = 2.5\text{ V} / 0.2\text{ A}$ $R = 12.5\ \Omega$	**(1)** **(1)**	**2**
18(c)	Current – both require about the same (not just both have 0.2 A) Potential difference – total (required) p.d. is very close to mains supply **Or** (operating) p.d. for mains bulb much greater than (operating) p.d. for torch bulb	**(1)** **(1)**	**2**

18(d)	Lower resistance **(1)** (smaller current, so) lower temperature (so less vibration of lattice ions) **Or** (smaller current, so) smaller drift velocity **(1)** fewer collisions of electrons with lattice ions **Or** less frequent collisions of electrons with lattice ions **(1)** Less energy dissipation (as heat) **Or** less ke lost in collisions **(1)**	**4**
	Total for question	**15**

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