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Mark Scheme (Results)
January 2011

GCE

GCE Physics (6PH02) Paper 01

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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.

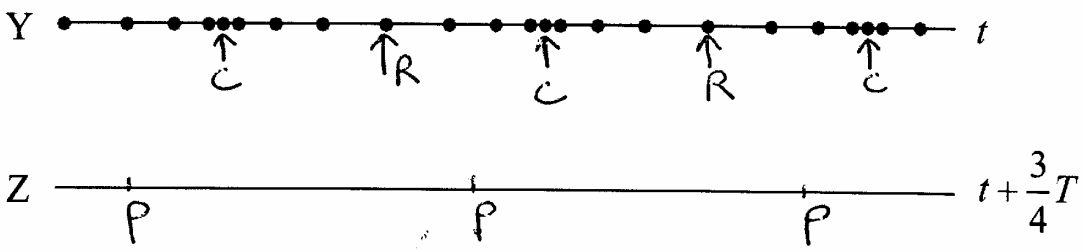
6.3 A mark given for choosing a scale requires that the chosen scale allows all points to be plotted, spreads plotted points over more than half of each axis and is not an awkward scale e.g. multiples of 3, 7 etc.

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

Question Number	Answer	Mark
11(a)	The vibrations/oscillations/movement of the molecules is parallel to /along same line as energy/ wave travels /in the same direction as the wave travels (1)	**1**
11(b)(i)	Any two compressions accurately marked (1)	**1**
11(b)(ii)	Any two rarefactions(one could be at left hand end) accurately marked (1)	**1**
11(b)(iii)	Any correct answer e.g. centre of compression to centre of adjacent compression (1)	**1**
11(c)	Two positions of compressions labelled P or C, approximately 1 or 2 correct wavelengths apart (1) Positioned half way from a true R to the next true C (1)  [Diagram for Q11 showing possible markings of C, R and P	**2**
	Total for question 11	**6**

Question Number	Answer	Mark
12(a)	Use of $v=f\lambda$ with c = 3.00×10^8 ms^{-1} (1) kHz to Hz (1) wavelength = 1520 m (1) (accept 1500 m) Example of calculation $\lambda = 3 \times 10^8$ $ms^{-1}/198000$ λ = 1515 m	**3**
12(b)*	(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate) Correct mention of diffraction (not defraction) (1) Large(r) wavelengths give large(r) diffraction or vv/ diffraction is the spreading of wave(fronts) (1) This idea applied to the context i.e.related to a building or hill, referencing size **and** lack of 'shadow'/more complete coverage (1)	**3**
	Total for question 12	**6**

Question Number	Answer	Mark
13(a)(i)	(Ultrasound because) they are above the audible range/frequency (1) ('not in the range' or 'out of the range', is not precise enough, need the clear idea that it is above the audible range. Accept greater than 20,000 Hz)	**1**
13(a)(ii)	Substitution into speed = distance/time (1) Use of $t = 0.8 \times 10^{-4}$ s **OR** halving distance found with $t = 1.6 \times 10^{-4}$ s (1) Distance = 0.12 m (1) (answer of 0.24 m scores 1) Example of calculation Distance = speed × time Distance = 1500 m $s^{-1} \times 0.8 \times 10^{-4}$ s Distance = 0.12 m	**3**
13(a)(iii)	The idea that one pulse must return before the next is sent (1) (ignore references to interference/stationary waves)	**1**
13(b)(i)	X rays cause ionisation OR can damage DNA/cells/tissue OR cause mutation (1) (do not allow 'causes cancer')	**1**
13(b)(ii)	**Max 2** X rays transverse, US longitudinal OR X rays can be polarised, US can't (1) X rays travel in vacuum, US doesn't (1) X ray Electromagnetic, US mechanical (1) X rays have (much) higher f /shorter λ / greater speed. (1)	**2**
	Total for question 13	**8**

Question Number	Answer	Mark
14(a)	Substitution into $R = \rho l/A$ (ignore powers of 10) (1) Conversion cm to m (1) R = 540 (Ω) (1) Example of calculation $R = (5.4 \times 10^{-3}\ \Omega\ \text{m} \times 0.15\ \text{m})/1.5 \times 10^{-6}\ \text{m}^2$ R = 540 Ω	**3**
14(b)(i)	Resistance/resistivity changes with temperature (allow wire gets hotter etc)(1) As temperature increases, resistance/resistivity decreases (this statement implies 1st mark so scores 2)	**2**
14(b)(ii)	Current flow causes a heating effect (1) Resistance of lead decreases/ number of charge carriers increases (1) Relates to $V = IR$ e.g. $R \propto 1/I$ or 'because V is constant, as R↓ I↑' (1)	**3**
	Total for question 14	**8**

Question Number	Answer	Mark
15(a)	Use of $P = V^2/R$ **OR** $P = IV$ and $V = IR$ (1) $R = 48.4\ \Omega$ (accept 48 Ω or 50 Ω) (1) Example of calculation $R = V^2/P$ $R = 220 \times 220 / 1000$ $R = 48.4\ \Omega$	**2**
15(b)	Use of $E = Pt$ OR $E = VIt$ OR $E = V^2t/R$ with 3 or 3×60 as the time (1) $E = 180\ 000$ J (1) (ecf values of R and/or I from (a)) (3000 J scores 1 mark)	**2**
15(c)(i)	Attempts to calculate power (1) Power = 250 W (1) Time to boil 12 mins/ 720 s (1) **OR** Calculates new current 2.27 A (1) Use of Energy=VIt with their current (1) Time = 12 mins /720 s (because of rounding, accept 700s -740 s if method correct) (1) **OR** $P \propto V^2 \propto ¼$ (1) $t \propto 1/P \propto 4$ (1) time 12 mins (1) (for any method, an answer of 6 mins scores 1 mark)	**3**
15(c)(ii)	Use of equation ,$V = IR$ or $P = V^2/R$ or $P = VI$ leading to increased current or power. (1) Cause damage/fuse to melt/ circuit breaker to trip /element to burn out/wire to melt (1) Do not credit 'short circuit' and 'explosions' Do not give 2nd mark if reference to overheating or fuses is related to resistance increasing	**2**
	Total for question 15	**9**

Question Number	Answer	Mark
16(a)	Oscillations/vibrations occur in any number of directions/every direction (1) which are perpendicular to the direction of wave travel /wave propagation/energy transfer (do not accept direction of wave) (1) **OR** Oscillations/vibrations may occur in more than one plane (2) (references to particles loses 1st mark marks can be scored from a labelled diagram)	**2**
16(b)*	(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate) Use of polarising filter /Polaroid (not just filter) (1) Rotation/turning of the filter (1) After 90º rotation (block) intensity changes (1) (Use of two filters and relative rotation 1 mark only)	**3**
16(c)	Reflected light OR light from ice is (partially) polarised (1) (Polarising) filters/lenses/glasses are at right angles to (the plane of polarisation of) the light (1) [1st mark must be about the reflected light being polarised] (Answers which say that the sunglasses are polarising the light score 0/2)	**2**
	Total for question 16	**7**

Question Number	Answer	Mark
17(a)	Use of $Q = It$ or $\Delta Q = I\Delta t$ with any relevant time (1) $t = 5 \times 3600$ (1) divide Q by 1.6×10^{-19} (1) number of electrons = 4×10^{23} (1) <u>Example of calculation</u> Number of electrons = It/e Number of electrons = $3.5\ A \times 5 \times 3600\ s / 1.6 \times 10^{-19}\ C$ Number of electrons = 3.9×10^{23}	**4**
17(b)	Use of $E=hf$ (ignore powers of 10 errors in f) (1) (gives $E = 3.6 \times 10^{-19}$ J) Divides 10 by their value of energy (1) Number of photons = 3×10^{19} (1) (likely to see 2.7 or 2.8 depending on use of calculator: both correct) <u>Example of calculation</u> Energy of 1 photon = 6.63×10^{-34} Js $\times 5.5 \times 10^{14}$ Hz = 3.6×10^{-19} J Number of photons = $10\ W/3.6 \times 10^{-19}$ J Number of photons = 2.8×10^{19}	**3**
	Total for question 17	**7**

Question Number	Answer	Mark
18(a)(i)	(The) photoelectric (effect) (1)	**1**
18(a)(ii)	3×10^{8} (ms^{-1}) **OR** speed of light **OR** speed of electromagnetic radiation (1)	**1**
18(a)(iii)	(Work function) is the (minimum) amount of energy that a surface electron needs to break free/be released (1) (There must be some reference to surface. Do not credit electrons plural or 'electron and photon')	**1**
18(b)(i)	Attempt to subtract energy values (1) Multiply by 1.6×10^{-19} (1) 1.8×10^{-19} (J) (1) (Alternative method :multiplying by e first and then subtracting Will see 8.64×10^{-19} and 6.88×10^{-19}) <u>Example of calculation</u> Energy = (5.4 eV – 4.3 eV) $\times 1.6 \times 10^{-19}$ Energy = 1.8×10^{-19} J	**3**
18(b)(ii)	Use of KE = ½ m v^2 using their energy value and $m_e = 9.11 \times 10^{-31}$ kg (1) Max speed = 6.2×10^{5} m s^{-1} or correct value using their energy (1) (allowing a full e.c.f even if speed > speed of light) <u>Example of calculation</u> 1.8×10^{-19} J = ½ (9.11×10^{-31} kg $\times v^2$) $v = \sqrt{}$ ($2 \times 1.8 \times 10^{-19}$ J / 9.11×10^{-31} kg $v = 6.2 \times 10^{5}$ m s^{-1}	**2**
18(c)	No change (1)	**1**
	Total for question 18	**9**

Question Number	Answer	Mark
19(a)(i)	Use of $n = v_1/v_2$ with λ proportional to v (1) (seeing 1.53 × 414 or 414/1.53 = 271 nm gets 1st mark) Wavelength in disc = 633 nm (1) (Alternative method finds v in plastic, then f of wave, leading to λ in air. Correct answer by this method scores 2 but incorrect answer can score the method mark) <u>Example of calculation</u> n = wavelength in air /wavelength in disc λ in air = 1.53 × 414 = 633 nm	**2**
19(a)(ii)	Division of a wavelength by 2 or 4 (414 nm or their λ from (a)(i)) (1) Vertical distance = 104 nm or ¼ their λ from (a)(i) (1)	**2**
19(a)(iii)	<u>Destructive</u> interference / superposition (1) Amplitude/intensity of wave is zero/min **OR** binary value zero **OR** there is min/no light **OR** the waves cancel/almost cancel each other **OR** cancellation (1)	**2**
19(b)(i)	Use of sin critical angle = 1/n (1) c = 40.8º (accept 41 º) (1) [bald answer of 41° scores zero] <u>example of calculation</u> sin c = 1/1.53 c = 40.8º	**2**
19(b)(ii)	Marks can only be scored for answers where the light is only in the plastic Reflection shown at point P (1) Angle of incidence = angle of reflection (judge by eye) and greater than their critical angle from (b)(i) (1) (do not penalise if arrows not drawn . Labels could override poor drawing)	**2**
	Total for question 19	**10**

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