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Mark Scheme (Results)
January 2011

GCE

GCE Physics (6PH04) 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.

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

Question Number	Answer	Mark
11(a)	Baryon (1)	**1**
11(b)	(+2/3 -1/3 + 2/3) = +1 / +1e / +e / (+)1.6×10^{-19} C (1) [Do not allow 1, 1e, e]	**1**
11(c)	($B^0 \rightarrow$) [No mark for LHS but must have an equation X = Y + Z] For RHS Λ^+ only [do not credit alternatives e.g. λ^+] (1) $\bar{p}$ only [do not credit alternatives e.g. p^-, $\bar{p}^{+/-}$] (1)	**2**
	Total for question 11	**4**

Question Number	Answer	Mark
12*	(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate) (After X) no tracks / track ceases (at X) / tracks can't be seen (after X) (1) [allow lines for tracks] (so) uncharged/neutral particles produced OR only charged particles give tracks . (1) At least one of the correct further events identified. [i.e. at the 'V' points] [in words or on diagram] (1) Both of the correct further events identified. (1)	**4**
	Total for question 12	**4**

Question Number	Answer	Mark
13(a)	Indication of vertical force(s) on sides AB or CD (1) [up or down is equivalent to vertical] Opposite vertical forces on AB and CD (1) Indication of anticlockwise rotation (1) [Allow full credit for a written description] (Commutator) switches current direction (1)	**4**
13(b)*	(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate) Flux (linkage) changes / flux is cut (1) Mention of induced e.m.f [allow induced voltage] (1) E.m.f increases with speed (1) Mention of Lenz's Law (1) (e.m.f./voltage) opposes current [not "reduces"] (1)	**Max 4**
	Total for question 13	**8**

Question Number	Answer	Mark
14(a)	Cannot be split further/has no internal structure / not made up of other particles (1)	**1**
14(b)	At least 4 radial straight lines [drawn with a ruler, need not touch particle] (1) Equispaced [very closely by eye] (1) Arrow pointing inwards (1) [ignore any words and mark the diagram only]	**3**
14(c)	Convert MeV to J [$\times 1.6 \times 10^{-13}$] (1) Divide by c^2 [$\div 9 \times 10^{16}$] (1) answer 205 - 214 (1) [Reverse calculation from 200 loses the third mark] Example of calculation 106 MeV = 106 x 1.6 x10^{-13} J = 106 x 1.6 x10^{-13} J / (3 x 10^8 m s^{-1})^2 ratio = 1.88 x 10^{-28} kg / 9.11 x 10^{-31} kg [May convert electron to 0.51 MeV]	**3**
14(d)	Use of $F = q^2/4\pi\varepsilon_0 r^2$ or $F = kq^2/r^2$ with $q = 1.6 \times 10^{-19}$ and $r = 2.7 \times 10^{-13}$ [ignore power of 10 error] (1) F = (-) 3.2 $\times 10^{-3}$ N (1) Example of calculation $F = (9 \times 10^9$ N m^2 C^{-2}) $(1.6 \times 10^{-19}$ C$)^2 / (2.7 \times 10^{-13}$ m$)^2$	**2**
14(e)	Mention of energy levels/states (1) Muon/electron jumps down / drops down /returns to original state (1) Large ΔE / large photon energy (hf) (1)	**3**
	Total for question 14	**12**

Question Number	Answer	Mark
15(a)(i)	Discharges / loses charge (1) Idea that discharge is not instantaneous (1) [e.g. over period of time, gradually, exponential]	**2**
15(a)(ii)	Decay curve starting on *y*-axis and not reaching x-axis (1) [no rise at the end] Initial current marked 2 mA (1) X-axis labelled such that $T_{½}$ = 0.02 to 0.06 s (1)	**3**
15(a)(iii)	Same graph (1) On negative side of current axis/current in the opposite direction (1)	**2**
15(b)	Use of $W = ½ CV^2$ / Use of $Q = CV$ and $W = ½ QV$ (1) $W = 5 \times 10^{-4}$ J (1) Example of calculation $W = ½ (10 \times 10^{-6}\text{ F}) (10\text{ V})^2$ $W = 5 \times 10^{-4}$ J	**2**
15(c)	Use of $\ln V/V_0 = (-) t/RC$ or $V = V_0 e^{-t/RC}$ with V and V_0 correct (1) $t = 0.13$ s (1) Example of calculation $\ln(10\text{ V}/0.7\text{ V}) = t / 0.05$ s $t = 0.13$ s	**2**
	Total for question 15	**11**

Question Number	Answer	Mark
16(a)	Observations: Most alpha went straight through / undeflected (1) [Do not credit just "alphas go through"] Some / few deflected [not "reflected] (1) Very few / < 1 in 1000 came straight back / were deflected through very large angles (>90°) / were reflected (1)	**3**
16(b)(i)	Any mention of tubes (1) Alternating p.d. / a.c. p.d. /alternating electric field (1) Length of tubes increases (1)	**3**
16(b)(ii)	Use of $p = E/c$ with $c = 3 \times 10^{8}$ (1) (Use of de Broglie) $\lambda = h/p$ with $h = 6.6 \times 10^{-34}$ (1) wavelength = 6.2×10^{-17} m (1) Example of answer $p = 20 \times 1.6 \times 10^{-10}$ J / 3×10^{8} m s^{-1} = 1.1×10^{-17} N s Correct sub of h and p i.e. $\lambda = 6.6 \times 10^{-34}$ / 1.1×10^{-17} N s	**3**
16(b)(iii)	Wavelengths need to be smaller than nuclei [allow same as / similar to – must be comparative] (1)	**1**
16(b)(iv)	Proton is not uniform / has space (1) Contains quarks (1) [ignore any reference to charge]	**2**
16(b)(v)	Kinetic energy is not conserved (1) [K.E. and momentum not conserved – do not credit]	**1**
	Total for question 16	**13**

Question Number	Answer		Mark
17(a)	Force on (charged) particles at right angles to motion Causes circular motion [not spiral / curved] OR force/acceleration is centripetal [credit first mark if clear from diagram]	(1) (1)	**2**
17(b)(i)	Momentum: $p=mv$ or $r = mv/Be$ $v = 2\pi r/T$ or $v = r\omega$ or $\omega = Be/m$ Use of $f = 1/T$ or $\omega/2\pi$ [allow q for e] Example of calculation $Ber = mv$ $Ber = m2\pi r/T$ $Be = m2\pi f$	(1) (1) (1)	**3**
17(b)(ii)	(Protons) accelerated / given energy, in the gaps / between D's/from one D to the other Every half rotation/semicircle later (polarity of D's) needs a change	 (1) (1)	**2**
17(b)(iii)	Relativistic effect / v approaching c/mass increases so frequency decreases [second mark consequent on first]	(1) (1)	**2**
17(c)	must be accelerating due to circular motion (Speed constant but) direction/velocity changing	(1) (1)	**2**
	Total for question 17		**11**

Question Number	Answer	Mark
18(a)*	(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate) Measurement of appropriate quantity e.g .height /distance /time (1) Calculate speed or inferred by an equation (1) Speed on impact (1) Statement of how method shows momentum has been conserved (1) [must include correct mention of mass and velocity] [correct description of measuring velocity directly with a sensor scores first two marks]	**4**
18(b)	Collisions inelastic / KE is transferred in collisions (1) to internal energy (of balls) [allow heat] / to KE of middle balls/to sound (1) Eventually stops because **all** energy is transferred (1)	**3**
	Total for question 18	**7**

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