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Mark Scheme (Results)
January 2012

GCE Physics (6PH04) Paper 01
Physics on the Move

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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.

Physics Specific Marking Guidance
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:
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.]
This has a clear statement of the principle for awarding the mark, supported by some examples illustrating acceptable boundaries.

Mark scheme format

• Bold lower case will be used for emphasis.
• Round brackets ( ) indicate words that are not essential e.g. "(hence) distance is increased".
• Square brackets [ ] indicate advice to examiners or examples e.g. [Do not accept gravity] [ecf].

Unit error penalties

• A separate mark is not usually given for a unit but a missing or incorrect unit will normally cause the final calculation mark to be lost.
• Incorrect use of case e.g. 'Watt' or 'w' will not be penalised.

• 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.
• The same missing or incorrect unit will not be penalised more than once within one question but may be penalised again in another question.
• 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.
• The mark scheme will indicate if no unit error penalty is to be applied by means of [no ue].

Significant figures

• 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.
• Use of an inappropriate number of significant figures will normally be penalised in the practical examinations or coursework.
• Using g = 10 m s^{-2} **will** be penalised.

Calculations

• Bald (i.e. no working shown) correct answers score full marks unless in a 'show that' question.
• Rounding errors will not be penalised.
• 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.
• 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.
• recall of the correct formula will be awarded when the formula is seen or implied by substitution.
• The mark scheme will show a correctly worked answer for illustration only.

Quality of Written Communication

- Indicated by QoWC in mark scheme. QWC – Work must be clear and organised in a logical manner using technical wording where appropriate.
- Usually it is part of a max mark, the final mark not being awarded unless the QoWC condition has been satisfied.

Question Number	Answer	Mark
1	A	**1**
2	C	**1**
3	B	**1**
4	C	**1**
5	D	**1**
6	B	**1**
7	D	**1**
8	A	**1**
9	B	**1**
10	C	**1**

Question Number	Answer	Mark
11a	Space/area/region where a force acts on a charged particle **(1)** The force is the same at all points **Or** Field strength is constant **Or** Field lines equispaced **(1)** (accept diagram with a minimum of three equispaced parallel lines, with arrows for 2nd mark)	**2**
11b	Two <u>parallel</u> plates (accept wires for plates) **(1)** Connected to a potential difference **Or** potential difference is applied **(1)** Practical method to show force Eg seeds in tray of glycerol, **(1)** Charged foil on end of rule, Charged pith ball on thread, Beam of electrons (in teltron tube) Charged oil drops (do not credit charged object) (All 3 marks can be scored from a diagram. To score the third mark the set-up must be labelled.)	**3**
	Total for question 11	**5**

Question Number	Answer	Mark
***12**	(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate) Current in a wire produces a magnetic field **(1)** Identifies direction of B field around either wire **(1)** Eg Around wire so that it is into the page at the bottom of wire **Or** clockwise when looking from left (Each) wire is in the magnetic field of the other wire **(1)** A current-carrying wire in a magnetic field experiences a force **(1)** Mention of Fleming's left hand rule (accept motor rule) **Or** identifies neutral point between wires. **(1)** (Marks 1 and 2 and a labelled neutral point could be communicated using the diagram. For neutral point accept 'fields cancel' but not 'fields in opposite directions')	**5**
	Total for question 12	**5**

Question Number	Answer	Mark
***13**	(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate) **Max 5** **Observations:** Most alpha went straight through **(1)** Some deflected **(1)** Very few came straight back **Or** very few had a deflection > 90^o **Or** 1 in 8000 came straight back **(1)** (Do not credit responses in terms of 'bounced' or 'reflected'.) **Conclusions:** <u>Atom</u> mainly <u>empty</u> (space) **(1)** Charge is concentrated in the centre/in a nucleus/nucleus is charged **(1)** Mass is concentrated (at the centre) Or dense/massive nucleus **(1)**	**Max 5**
	Total for question 13	**5**

Question Number	Answer		Mark
14(a)	To curve the tracks/paths **Or** to produce a centripetal force/acceleration **Or** to allow particles to spiral **Or** to produce an arc **Or** to produce circular motion So that momentum/energy/charge/ velocity/mass can be investigated	**(1)** **(1)**	**2**
14(b)	The <u>radius</u> of curve gets less **Or** curvature increases (Because) particle slows down **Or** loses energy **Or** loses momentum	**(1)** **(1)**	**2**
14(c)	(Magnetic field) out of page	**(1)**	**1**
14(d)(i)	Does not leave a track **Or** there is only one visible track for μ^+ Clear demonstration of charge conservation in this situation	**(1)** **(1)**	**2**
14(d)(ii)	Reference to momentum Reference to change of direction of the visible path (Hence) another particle must have an equal but opposite change of momentum **Or** another particle produced to conserve momentum	**(1)** **(1)** **(1)**	**3**
	Total for question 14		**10**

Question Number	Answer		Mark
15(a)	Reference to magnetic flux (linkage) Magnet vibrates/moves Flux/field through the coil changes <u>Induces </u>emf / pd	**(1)** **(1)** **(1)** **(1)**	**4**
15(b)(i)	Use of $T = 2\pi/\omega$ for a revolution $\omega = 3.5$ rad s^{-1} <u>Example of Calculation</u> $\omega = 33 \times 2\pi$ rad/ 60 s $\omega = 3.5$ rad s^{-1}	**(1)** **(1)**	**2**
15(b)(ii)	ω / T / f remains constant $v = r\omega$ **Or** $C = 2\pi r$ So as the stylus moves towards the centre (tangential/linear) speed/velocity **Or** path length (per rotation) gets less	**(1)** **(1)** **(1)**	**3**
	Total for question 15		**9**

Question Number	Answer	Mark
16(a)(i)	Capacitor charges up **Or** p.d. across capacitor becomes (equal to) p.d. of cell **(1)** Negative charge on one plate and positive charge on the other **Or** opposite charges on each plate **Or** movement of electrons from one plate and to the other (around the circuit) **(1)** (Reference to positive charges moving or to charge moving directly between the plates negates the second mark)	**2**
16(a)(ii)	As capacitor charges current decreases **Or** As capacitor charges current drops to zero **Or** p.d. across capacitor becomes (equal to) p.d. of cell **(1)** No current through R (means no p.d.) **Or** $V_{cell} = V_{capacitor} + V_{resistor}$ **(1)**	**2**
***16(b)**	(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate) See Q=CV **(1)** As C increased then charge flows (**Or** more charge stored) on capacitor **(1)** So p.d. across R **(1)** Charge flow / current /output signal reversed when plates move apart **(1)** **Or** See Q=CV **(1)** As C increased p.d. across capacitor decreased **(1)** So p.d. across R must increase **(1)** p.d. reverses when plates move apart **(1)**	**4**
16(c)	Use of time constant =*RC* **Or** attempt to find half life **(1)** Time constant = 0.005 (s) **Or** $t_{½}$ = 0.0035 (s) **(1)** Use of $T = 1/f$ (to give T = 0.05 s for the lowest audible frequency) **(1)** Capacitor completes discharging/charging during cycle of signal **(1)** (last mark can only be gained if supported by calculations) ($f = 1/CR$ may be used to find the 'frequency of the microphone', rather than time. In this case candidates may just calculate f =200 Hz rather than a time. Only first 3 marks are available) <u>Example of calculation</u> $RC = 10 \times 10^{6}\ \Omega \times 500 \times 10^{-12}$ F RC = 0.005 s $F = 1/T = 1/20 = 0.05$ s	**4**
	Total for question 16	**12**

Question Number	Answer		Mark
17(a)	Same mass (do not credit similar mass) Opposite charges on nucleus **Or** atom not charged/neutral (do not credit 'atoms have opposite charges'. A correct statement in terms of charges on all four particles gets 2nd mark.) (Ignore references to Baryon number, Lepton number and quarks)	**(1)** **(1)**	 **2**
17(b)	Use of $F = k\,Q_1\,Q_2\,/\,r^2$ Magnitude of both charges is 1.6×10^{-19} C Force = 8.2×10^{-8} N <u>Example of calculation</u> $F = 8.99 \times 10^9$ N m^2 C^{-2} $(1.6 \times 10^{-19}$ C$)^2$ / $(5.3 \times 10^{-11})^2$ $F = 8.19 \times 10^{-8}$ N	**(1)** **(1)** **(1)**	 **3**
17(c)	Atoms are not charged Magnetic / electric fields have no effect (Can't be contained in particle accelerators is not sufficient and ignore all comments about annihilation)	**(1)** **(1)**	 **2**
17(d)(i)	Use of $E = mc^2$ Total mass involved is 2 mg (ignore powers of 10 error) Energy = 1.8×10^{11} (J) <u>Example of calculation</u> Energy = 2×10^{-6} kg $(3 \times 10^8$ m s$^{-1})^2$ Energy = 1.8×10^{11} J	**(1)** **(1)** **(1)**	 **3**
17(d)(ii)	Need a lot of energy (to produce anti-matter)	**(1)**	**1**
	Total for question 17		**11**

Question Number	Answer		Mark
18(a)	Conversion of MeV to J Use of $E_k = ½ mv^2$ Max velocity = 4.1×10^6 (m s^{-1}) <u>Example of calculation</u> $v = \sqrt{\frac{2 \times 1.2\text{Mev} \times 1.6 \times 10^{-13}\text{J}}{14 \times 1.66 \times 10^{-27}\text{kg}}}$ velocity = 4.06×10^6 m s^{-1}	**(1)** **(1)** **(1)**	**3**
18(b)(i)	Correct momentum of any particle seen e.g. N*ux* (must contain *u*) Correct equation from conservation of momentum (allow even if *u* not shown) Rearrange for z (dependent on second mark) <u>Example of calculation</u> N*ux* = 14*uy* + N*uz* N*z* = N*x* - 14*y*	**(1)** **(1)** **(1)**	**3**
18(b)(ii)	<u>Kinetic</u> energy is conserved	**(1)**	**1**
18(b)(iii)	See $½ Nux^2$ **Or** $½ Nuz^2$ **Or** $½ 14uy^2$ Clear statement that E_k nitrogen atom = E_k neutron before – E_k neutron after **Or** E_k nitrogen atom = E_k lost by neutron	**(1)** **(1)**	**2**
18(c)(i)	Use of equation, N in the denominator must be included, given with $y = 3.0 \times 10^7$ **Or** $y = 4.1 \times 10^6$ In equation given use of: N + 1 with $y = 3.0 \times 10^7$ **Or** N + 14 with $y = 4.1 \times 10^6$ In equation given use of: N + 1 with $y = 3.0 \times 10^7$ **And** N + 14 with $y = 4.1 \times 10^6$ <u>Example of calculation</u> For hydrogen $2Nx = 3.0 \times 10^7 (N + 1)$ For nitrogen $2Nx = 4.1 \times 10^6 (N + 14)$ Equating gives $4.1 \times 10^6 (N + 14) = 3.0 \times 10^7 (N + 1)$ (so N = 1.06)	**(1)** **(1)** **(1)**	**3**
18(c)(ii)	Collision might not be elastic **Or** Speed (of particles) approaches speed of light (so mass increases)	**(1)**	**1**
	Total for question 18		**13**

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