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Mark Scheme (Results)

June 2011

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

Question Number	Answer	Mark
11(a)	Identifying the equations $E_k = p^2/2m$ and $\lambda = h/p$ **OR** $\lambda = h/p$, $p = mv$ and $E_k = \frac{1}{2} mv^2$ **(1)** Any combination or rearrangement (conditional mark) **(1)** (do not give 2nd mark just for quoting equation given in question) (Do not credit a reverse argument i.e. starting with the given equation.) <u>Example of derivation</u> $p = 2mE_k$ $\lambda = h/\sqrt{(2mE_k)}$	**2**
11(b)	Correct sub of h^2 and m **(1)** Use of $E_k = eV$ **(1)** $\lambda = 2.5 \times 10^{-11}$ m **(1)** **OR** Use of $E_k = \frac{1}{2} mv^2$ (to find $v = 3.0 \times 10^7$ (m s^{-1})) **(1)** Use of $\lambda = h/p$ with correct substitution for h and m **(1)** $\lambda = 2.5 \times 10^{-11}$ m **(1)** <u>Example of calculation</u> $\lambda = \sqrt{\frac{(6.63x10^{-34}\text{ J s})^2}{2(9.11 \times 10^{-31}\text{ kg})(2500\text{ V})(1.6\times10^{-19}\text{ C})}}$ $\lambda = 2.46 \times 10^{-11}$ m **OR** $v = \sqrt{\frac{2(2500\text{V})(1.6x10^{-19}\text{ C})}{9.1 \times 10^{-31}\text{ kg}}} = 3.0 \times 10^7$ $\lambda = 6.63 \times 10^{-34}\text{ J s} / (9.1 \times 10^{-31}\text{ kg})(3.0 \times 10^7\text{ m s}^{-1})$	**3**
	Total for question 11	**5**

Question Number	Answer		Mark
12(a)	Third column completed 4.04 and 3.50 Points plotted correctly **and** straight line drawn (ecf error in calculation for points plotted)	**(1)** **(1)**	**2**
12(b)	Any evidence of gradient (look at graph) Value between 0.061 and 0.066 (cm^{-1}) (ignore – sign) **Or** value between 6.1 and 6.6 (m^{-1})	**(1)** **(1)**	**2**
	Total for question 12		**4**

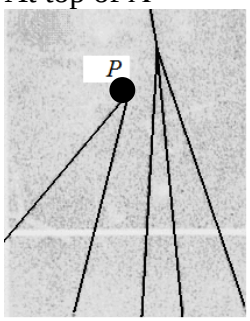
Question Number	Answer		Mark
13(a)	Method marks only Use of $Q=CV$ with V =16 V Max value of C = 12000 (μF) μF means 10^{-6} conversion of μF to F <u>Example of calculation</u> C_{max} = 1.20 × 10000 = 12000 F C_{max} = 12000 F × 16 V Q_{max} = 0.192 C	**(1)** **(1)** **(1)**	**3**
13(b)	Either use of ½ QV or ½ CV^2 Energy = 1.5 J <u>Example of calculation</u> W = ½ 0.192 C × 16 V Energy = 1.54 J	**(1)** **(1)**	**2**
	Total for question 13		**5**

Question Number	Answer		Mark
***14**	(QWC- Work must be clear and organised in a logical manner using technical wording where appropriate **Max 4** <u>Uniform</u> electric field (between plates) Force due to E **or** idea of attraction/repulsion (Ball has an) <u>acceleration</u> (**not** an increasing velocity) Which is constant/uniform (can be with reference to increasing velocity) Vertical line/ + and – values shows change in direction Inelastic collision/less energy after impact	 **(1)** **(1)** **(1)** **(1)** **(1)** **(1)**	**4**
	Total for question 14		**4**

Question Number	Answer		Mark
15(a)	Use of ½ mv^2 and mgh (do not credit use of $v^2 = 2as$ since a not constant, scores 0/2) velocity = 0.77 (m s^{-1})	**(1)** **(1)**	**2**
15(b)	Use of mv Correct momentum conservation statement Speed = 0.53 m s^{-1} (accept 0.56 m s^{-1} from use of show that value) Assumption: no external forces/ no air resistance/ no force on pivot/negligible resistance <u>Example of calculation</u> 320 g × 0.77 m s^{-1} = (320 g × v) + (55g × 1.4 m s^{-1}) Speed of bat = 0.53 m s^{-1}	**(1)** **(1)** **(1)** **(1)**	**4**
15(c)	Use of $E_k = ½ mv^2$ (allow mass in g or kg) Correct calculation of E_k before and after (95, 45, 54 to any power of ten (see below) (If 0.8 m s^{-1} and 0.56 m s^{-1}, values are 102, 50 and 54) Elastic. <u>Example of calculation</u> Before impact E_k bat = ½ 0.320 kg 0.77^2 (m s^{-1})^2 = 0.095J After impact E_k bat = ½ 0.320 kg 0.53^2 (m s^{-1})^2 = 0.045 J E_k ball = ½ 0.055 kg 1.4^2 (m s^{-1})^2 = 0.054 J	**(1)** **(1)** **(1)**	**3**
15(d)	**Max 2** x measured to nearest cm uncertainty in x gives an uncertainty in GPE / speed (of ball) difficulty of measuring a moving object some energy to sound comments on $E_{(k)}$ after › before relates uncertainty to conclusion made in (c)	**(1)** **(1)** **(1)** **(1)** **(1)** **(1)**	**2**
	Total for Question 15		**11**

Question Number	Answer		Mark
16(a)	Radial lines (at least 4) most touching nucleus but not going through it (straight by eye) Equispaced Arrow pointing away from circle	**(1)** **(1)** **(1)**	**3**
16(b)(i)	$F = Q_1 Q_2 / 4\pi\varepsilon r^2$ or $F = k Q_1 Q_2 / r^2$ Charges are $79 \times 1.6 \times 10^{-19}$ and $2 \times 1.6 \times 10^{-19}$ (values are 1.23×10^{-17} and 3.2×10^{-19})	**(1)** **(1)**	**2**
16(b)(ii)	Marks can be scored for use of symbols, cell annotation or values $F = \Delta p/(\Delta)t$ $(\Delta)v = (\Delta)p/m$ $(D5) = D4 + \frac{(-)B5 \times C5}{6.64 \times 10^{-27}}$ $(D5) = 1.24 \times 10^{7} + \frac{(-)20.2 \times 1 \times 10^{-21}}{6.64 \times 10^{-27}}$ $F/m = (-)\ 3.04 \times 10^{27}$ **OR** $a = F/m$ $v = (u) + at$ $(D5) = D4 + \frac{(-)B5 \times C5)}{6.64 \times 10^{-27}}$ $(D5) = 1.24 \times 10^{7} + \frac{(-)20.2 \times 1 \times 10^{-21}}{6.64 \times 10^{-27}}$ $F/m = (-)\ 3.04 \times 10^{27}$	**(1)** **(1)** **(1)** **(1)** **(1)** **(1)**	**3**
16(b)(iii)	$s = ½ (u+v) t$ accept $s = vt$ (with either D5 or D6) **Or** $s = ut + ½ at^2$ $(s) = ½ (D5 + D6)*C6$ or values or other correct equations	**(1)** **(1)**	**2**
16(b)(iv)	Value in range 2.00 - 2.49($\times 10^{-14}$ m)	**(1)**	**1**
***16(c)**	(QWC- Work must be clear and organised in a logical manner using technical wording where appropriate.) Atom mainly <u>empty</u> space Charge is concentrated in the centre/in a nucleus/nucleus is charged Mass is concentrated (at the centre) **Or** Dense/massive nucleus	**(1)** **(1)** **(1)**	**3**
	Total for question 16		**14**

Question Number	Answer		Mark
17(a)	(Magnetic) force acts at right angles to ion motion/current Force is the centripetal force **or** causing centripetal acceleration **or** direction of acceleration/force is to centre (of circle)	**(1)** **(1)**	**2**
17(b)	See $F = BQv$ **or** $r = p/BQ$ $F = mv^2/r$ **or** $p = mv$ $f = v/2\pi r$ **or** $f = \omega/2\pi$ **or** $T = 2\pi r/v$ **or** $T = 2\pi/\omega$	**(1)** **(1)** **(1)**	**3**
17(c)(i)	Identifies positive (field) above **and** below (the ion) which repels the ion	**(1)** **(1)**	**2**
17(c)(ii)	$3 \times 32.0645 / 10 \times (10^6)$ $= 0.0000096$(u)	**(1)** **(1)**	**2**
17(c)(iii)	Convert MeV to J Convert J to kg Convert kg to u Mass loss = 0.0024(u) (and this is more than 0.00001u) <u>Example of calculation</u> mass loss = 2.2 MeV x 1.6 x 10^{-13} J J to kg 3.52 x10^{-13} / 9 x 10^{16} kg kg to u 3.91 x 10^{-30} / 1.66 x 10^{-27} u	**(1)** **(1)** **(1)** **(1)**	**4**
	Total for question 17		**13**

Question Number	Answer		Mark
18(a)	to keep the time spent in each tube the same **Or** so that frequency of <u>alternating</u> pd/voltage constant (do not accept reference to ac currents)	**(1)**	**1**
18(b)(i)	At top of Λ  	**(1)**	**1**
18(b)(ii)	No <u>track/trail</u> to this point (as no charge) Then two tracks (as two charged particles)	**(1)** **(1)**	**2**
18(b)(iii)	$D^0 \rightarrow k^+ + \pi^-$ Correct symbols , do not accept pi as a word Correct charge symbols as above, top right of each term. Wrong position or extra ones loses this mark (any extra particles or gamma 0/2)	**(1)** **(1)**	**2**
***18(b)(iv)**	(QWC- Work must be clear and organised in a logical manner using technical wording where appropriate.) Charge: +1 -1= 0 (the positive sign must be used, 1 -1 = 0 is not enough) **Or** reference to positive and negative charges cancelling. Energy/mass/mass-energy: of D is equal to that of the new particles Momentum: Of D is equal to sum/total of momentum of new particles	 **(1)** **(1)** **(1)** **(1)** **(1)** **(1)**	**6**
18(c)(i)	$c\bar{u}$	**(1)**	**1**
18(c)(ii)	$u\bar{d}$ **or** $u\bar{s}$ **or** $c\bar{d}$ **or** $c\bar{s}$ (allow words)	**(1)**	**1**
	Total for question 18		**14**

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