Mark Scheme (Results)

Summer 2013

GCE Physics 6PH04

Paper 01R: 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.

Mark scheme notes

Underlying principles

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] [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.]	✓	**1**

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:

<u>'Show that' calculation of weight</u>

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]	✓	**3**

[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]

Example of answer:

$80 \text{ cm} \times 50 \text{ cm} \times 1.8 \text{ cm} = 7200 \text{ cm}^3$
$7200 \text{ cm}^3 \times 0.70 \text{ g cm}^{-3} = 5040 \text{ g}$
$5040 \times 10^{-3} \text{ kg} \times 9.81 \text{ N/kg}$
$= 49.4 \text{ N}$

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

Question Number	Answer		Mark
***11**	(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate)		
	Alternating p.d. max 2		
	Electric field/ p.d. accelerates particles **Or** Electric field /p.d. gives particles energy	**(1)**	
	Constant time period **Or** constant frequency	**(1)**	
	Polarity of dees switches every half cycle **Or** P.d. switches every half cycle	**(1)**	
	Magnetic field max 2		
	Magnetic field/force at right angles to particles path	**(1)**	
	Maintains circular motion (whilst in dees) **Or** Experiences centripetal force/acceleration (whilst in dees)	**(1)**	
	Radius of circle increases as particles get faster	**(1)**	**4**
	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) No external/unbalanced/resultant force so momentum of system is conserved Rocket gains momentum in backward direction Module gains equal amount of momentum in forward direction <u>Kinetic</u> energy of the system increases (Some) chemical energy converted to KE **Alternative mark scheme** if candidate presumes that the initial total momentum is zero (Max 4) No external/unbalanced/resultant force so momentum of system is conserved Rocket and module have equal amount of momentum and move in opposite directions (after separation) <u>Kinetic</u> energy of the system increases (Some) chemical energy converted to KE	**(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)**	5
	Total for question 12		**5**

Question Number	Answer		Mark
13(a)	The <u>magnetic</u> field (must be) at right angles to the current	**(1)**	**1**
13(b)	All three units for force, length and current clearly identified (The unit of force is kg m s^{-2} **, t**he unit of current is A, the unit of length is m) T = kg A^{-1} s^{-2}	**(1)** **(1)**	 **2**
13(c)	*Use* of $\rho = m/V$ Use of $mg = BIl$ B = 0.53 (T) (no u.e. as given in question for part (b)) <u>Example of calculation</u> $m = 2.7 \times 10^{3}$ kg $m^{-3} \times 10 \times 10^{-3}$ m $\times 10 \times 10^{-3}$ m $\times l$ $m = 0.27 \times l$ $B = (0.27 \times l \times 9.81$ m s^{-2})/ (5 A $\times l$) B = 0.53 T	**(1)** **(1)** **(1)**	 **3**
13(d)	(Magnetic field is) into paper/page	**(1)**	**1**
	Total for question 13		**7**

Question Number	Answer		Mark
14(a)(i)	Three quarks **Or** three antiquarks (accept the letter q to represent quarks)	**(1)**	**1**
14(a)(ii)	Quark and an antiquark (accept the letter q to represent quarks)	**(1)**	**1**
14(b)	Similarity: they have the same mass **Or** same magnitude of charge Difference: opposite charge	**(1)** **(1)**	 **2**
14(c)(i)	Up and antistrange (in words or symbols, and can be in either order)	**(1)**	**1**
14(c)(ii)	μ^{-} $+ \ _{\mu}$ $K^{-} \rightarrow \mu^{-} + \ _{\mu}$	**(1)** **(1)**	 **2**
14(c)(iii)	Energy = 2 × 494 MeV eV to J conversion Energy = 1.58×10^{-10} (J) (division by c^2 and subsequent multiplication by c^2 is not penalised) <u>Example of calculation</u>	**(1)** **(1)** **(1)**	 **3**

	Energy = $2 \times 494 \times 10^{6}$ eV $\times 1.6 \times 10^{-19}$ J eV^{-1} Energy = 1.58×10^{-10} J	
	Total for question 14	**10**

Question Number	Answer		Mark
15(a)	Use of $Q = It$ Q = 2.8 C <u>Example of calculation</u> $Q = 2.0 \times 10^{3}$ A $\times 1.4 \times 10^{-3}$ s Q = 2.8 C	**(1)** **(1)**	 **2**
15(a)(ii)	See $\tau = RC$ $\tau = 3.0 \times 10^{-4}$ (s) Relates time constant to the time for which current is required <u>Example of calculation</u> $\tau = 0.50\Omega \times (600 \times 10^{-6}$ F) $\tau = 3.0 \times 10^{-4}$ s 1.4×10^{-3}s / 3.0×10^{-4} s = 4.7RC	**(1)** **(1)** **(1)**	 **3**
15(b)(i)	Use of $Q = CV$ V = 4700 V (e.c.f from (a)(i)) <u>Example of calculation</u> V = 2.8V / (600×10^{-6} F) V = 4670 V	**(1)** **(1)**	 **2**
15(b)(ii)	Use of $W = ½\, QV$ **Or** $W = ½\, Q^2/C$ **Or** $W = ½\, CV^2$ Use of $P = W/t$ P = 4.7 MW (e.c.f. from (a)(i) and/or (b)(i)) <u>Example of calculation</u> P = (2.8 C × 2.8 C) / ($2 \times 600 \times 10^{-6}$ F $\times 1.4 \times 10^{-3}$ s) P = 4.7 MW	**(1)** **(1)** **(1)**	 **3**
	Total for question 15		**10**

Question Number	Answer		Mark
16(a)	Velocity/direction changing **Or** (object is) accelerating Force towards centre of circle	**(1)** **(1)**	 **2**
16(b)	High(er) speed means large(r) force **Or** small(er) radius means large(r) force (For sharp bends) centripetal/resultant/required <u>force</u> would need to be greater than maximum frictional force **Or** (for sharp bends) friction cannot provide the (required) centripetal/resultant force	 **(1)** **(1)**	**2**
16(c)(i)	Resolving forces vertically <u>N</u> sin θ = mg Resolving forces horizontally <u>N</u> cos θ = mv^2/r Division of vertical equation by horizontal equation to get correct answer	**(1)** **(1)** **(1)**	 **3**
16(c)(ii)	Use of tan $\theta = gr/v^2$ θ = 57º <u>Example of calculation</u> tan θ = (9.81 m s^{-2} × 18.7 m)/ (11.0 m s^{-1})^2 θ = 56.6º	**(1)** **(1)**	 **2**
	Total for question 16		**10**

Question Number	Answer		Mark
17(a)	Arrow(s) downwards	**(1)**	**1**
17(b)	Use of $E = V/d$ Use of $F = EQ$ $F = 5.1 \times 10^{-16}$ N <u>Example of calculation</u> $F = (160\text{ V} \times 1.6 \times 10^{--19}\text{ C})/ 5.0 \times 10^{--2}\text{ m}$ $F = 5.12 \times 10^{-16}$ N	**(1)** **(1)** **(1)**	 **3**
17(c)	Between the plates there is an acceleration/force which is vertical/upwards Constant horizontal velocity Outside the plates no (electric) field /force acts **Or** Outside the plates speed so large that gravitational effect negligible	**(1)** **(1)** **(1)**	 **3**
17(d)(i)	Release of (surface) electrons due to heating	**(1)**	**1**
17(d)(ii)	Use of $E_k = ½mv^2$ Use of $V = W/Q$ p.d. = 410 V <u>Example of calculation</u> $E_k = 9.11 \times 10^{-31}\text{ kg} \times (1.2 \times 10^7\text{ m s}^{-1})^2/2$ $E_k = 6.56 \times 10^{-17}$ J p.d. = $(6.56 \times 10^{-17}\text{ J})/(1.6 \times 10^{-19}\text{ C})$ p.d. = 410V	**(1)** **(1)** **(1)**	 **3**
	Total for question 17		**11**

Question Number	Answer		Mark
18(a)	Use of $N\Phi = NBA$ $\Phi = 1.2 \times 10^{-3}$ Wb (accept T m^2) <u>Example of calculation</u> $\Phi = 200 \times 3.0 \times 10^{-2}$ T$\times$ 2.0×10^{-4} m s^{-1} $\Phi = 1.2 \times 10^{-3}$ Wb	**(1)** **(1)**	**2**
18(b)(i)	Time = 0.125 (s) **Or** Time = 1/8 (s) Use of $\varepsilon = (-)\mathrm{d}(N\Phi)/\mathrm{d}t$ ε =(-)9.6 x 10^{-3} V (ecf $N\Phi$ from (a)) <u>Example of calculation</u> $\varepsilon = 1.2\times 10^{-3}$ Wb /0.125 s ε = 9.6 mV	**(1)** **(1)** **(1)**	**3**
18(b)(ii)	Maximum values when coil is horizontal **Or** maximum values when the coil is parallel to the magnetic field **Or** minimum value when coil vertical **Or** minimum value when the coil is perpendicular to the magnetic field e.m.f. determined by rate of change of flux **Or** see $\varepsilon = (-)\mathrm{d}(N\Phi)/\mathrm{d}t$ Greatest rate of change of flux as coil goes through horizontal **Or** greatest rate of change of flux occurs when θ=90° **Or** least rate of change of flux as it goes through vertical **Or** least rate of change of flux occurs when θ=0°	**(1)** **(1)** **(1)**	**3**
18(b)(iii)	Peaks would be smaller amplitude **Or** maximum e.m.f. smaller Rate of change of flux (linkage/cutting) less	**(1)** **(1)**	**2**
18(c)(i)	Energy required to turn generator Transferred from kinetic energy of the car	**(1)** **(1)**	**2**
18(c)(ii)	Greater rate of kinetic energy transfer/loss at high(er) speeds At slower/low speeds there is less/negligible braking effect (so car would not fully stop)	**(1)** **(1)**	**2**
	Total for question 18		**14**

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