

# Mark Scheme (Final Standardisation) Summer 2007

GCE

## GCE Physics (6735/01)

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### 6735 Unit Test PHY 5 final version, agreed and implemented at standardisation.

1.			
a)	Show that		
	See 'v = $\frac{2\pi r}{T}$ ' OR ' $\omega = \frac{2\pi}{T}$ '	√	
	Substitution of $(60 \times 60 \times 24)$ s or 86400s for T (giving $7.27 \times 10^{-5}$ , no u.e.)	$\checkmark$	
	<u>Unit of <math>\omega</math></u>		
	$s^{-1} / rad s^{-1}$	$\checkmark$	3
b)	Height above Earth's surface		
	Statement / use of $\frac{GM_Em}{r^2} = \frac{mv^2}{r}$ OR $\frac{GM_Em}{r^2} = mr\omega^2$ [Equations may be given in terms of accelerations rather than forces]	$\checkmark$	
	[Third mark (from below) may also be awarded here if $(r_E+h)$ is used for r]		
	Correct value for r, i.e. $4.2(3) \times 10^7$ m	$\checkmark$	
	Use of $h =$ their $r - R_{\rm E}$	$\checkmark$	
	Correct answer = $(3.58 - 3.60) \times 10^7$ m [no ecf]	√	4
	Example of answer:		
	$\frac{GM_Em}{r^2} = \frac{mv^2}{r}$		
	$\rightarrow \frac{GM_E}{r^2} = \frac{v^2}{r} = \frac{(\omega r)^2}{r} = \omega^2 r$		
	$\therefore GM_E = \omega^2 r^3$		
	$\therefore r = \sqrt[3]{\frac{GM_E}{\omega^2}} = \sqrt[3]{\frac{6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2} \times 5.98 \times 10^{24} \text{ kg}}{(7.27 \times 10^{-5} \text{ s}^{-1})^2}}$		
	$=4.23\times10^7$ m		
	$\therefore h = 4.23 \times 10^7 \text{ m} - 6.38 \times 10^6 \text{ m}$		
	$= 3.59 \times 10^7 \text{ m}$	17 ma	
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2.	
	Add to diagram.
	Arrows at A and B, both pointing directly away from the nucleus. [Arrow end (head or tail) need not touch A /B, but direction must be correct. Gauge by eye, accept dotted construction lines as indication of intent]
	Calculation of force
	Use of $F = \frac{Q_1 Q_2}{4\pi\varepsilon_0 r^2}$ or $F = \frac{kQ_1 Q_2}{r^2}$ [ignore error/omission of '2' and/or '79' or 'e' or '1.6 × 10 <sup>-19</sup> , for this first mark, providing numerator clearly has a product of charges and denominator a distance <u>value</u> squared. Ignore power of 10 errors in values of $Q$ or $r$ ]
	$2 \times 1.6 \times 10^{-19}$ C and $79 \times 1.6 \times 10^{-19}$ C seen (consequential mark, dependent upon correct use of equation previously)
	Correct answer = $1.6 - 1.7 \text{ N}$ $\checkmark$ 3
	Example of answer:
	$F = \frac{Q_1 Q_2}{4\pi\varepsilon_o r^2} = \frac{(79 \times 1.6 \times 10^{-19} \text{ C}) \times (2 \times 1.6 \times 10^{-19} \text{ C})}{4\pi \times 8.85 \times 10^{-12} \text{ F m}^{-1} \times (1.5 \times 10^{-13} \text{ m})^2}$
	= 1.62 N
	Effect on motion of $\alpha$
	Slows down [decelerates] and then speeds up again [accelerates]. (both needed) [accept 'slows down <b>at</b> A and speeds up <b>at</b> B]
	Total 5 marks

#### 6735 Unit Test PHY 5

3.	
a)	How capacitors are connected
	Box A = in parallel Box B = in series $\left. \right\}$ [Accept diagrams] [ <b>N.B.</b> If A 'in series' and B 'in parallel', max 3 in explanation section below]
	Explanation
	Answer with no word or symbol reference to energy scores 3/4 max. Answer with no reference to any relevant formulae scores 3/4 max.
	More energy stored in A ['A' may be implied by argument]
	The same p.d. (' $V$ ') $\checkmark$
	(So) $C_A > C_B$ [or demonstration by numerical example]
	Use of* W = $\frac{1}{2}CV^2$ [e.g. $\frac{1}{2}C_A V^2 > \frac{1}{2}C_B V^2$ ]
	OR use/statement of $E = \frac{1}{2}QV$ AND $Q = CV$
	Use of* either equivalent capacitance formula [correctly stated; may be word equation]
	<ul> <li>* i.e. Referred to as part of explanation. Do not credit bald transcription of equations given in the list at the back of the paper without context, nor as marginalia].</li> <li>[Award marks for correct, non-contradictory statements even if the candidate has given the wrong combinations at a(i), up to a maximum of 3 marks]</li> </ul>
b)	Addition of large resistor in discharging circuit
	Valid observation in terms of <b>brightness</b> or <b>duration of illumination</b> $\checkmark$
	Supporting explanation in terms of circuit behaviour
	[Max 1 mark if explanation does not support observation, or is internally contradictory, or if description does not include a visual observation]
c)	Addition of large resistor in charging circuit
	Valid observation in terms of <b>brightness</b> or <b>duration of illumination</b> $\checkmark$
	Supporting explanation in terms of circuit behaviour $\checkmark$
	[Max 1 mark if explanation does not support observation, or is internally contradictory, or if description does not include a visual observation]
	Total 9 marks

#### 6735 Unit Test PHY5

4.		
	Explanation of kicking	
	Answer with no reference to moments scores 4/5 max. Ignore references to electromagnetic induction/Lenz's Law	
	QoWC	$\checkmark$
	'(Fleming's) left hand rule' / magnetic fields interact/combine/overlap [not 'i 'interfere'] / reference to current flowing <b>in</b> magnetic field /catapult field	repel', nor ✓
	Force acting on the wire linked to moment [not just 'pivoting'] (about P)	$\checkmark$
	Force to right / anticlockwise moment [detail of direction]	$\checkmark$
	When wire leaves mercury, current $\rightarrow 0$ / force $\rightarrow 0$ / moment $\rightarrow 0$ . [not just 'circuit is incomplete']	$\checkmark$
	Idea that wire's weight produces a moment (returning it to mercury)	$\checkmark$
		Max 5
	Show that	
	Use of moment equation, i.e. $5.0 \times 10^{-4}$ N m = $F \times d$ [accept any numerical value for <i>d</i> between 1.5 (cm) and 10.5 (cm)]	✓
	Use of $6 \times 10^{-2}$ m for d	$\checkmark$
	Correct answer = $8.3 \times 10^{-3}$ (N) [no u.e.] [Reverse argument scores 2/3]	√ 3
	Example of answer:	5
	$F = \frac{Moment}{d} = \frac{5.0 \times 10^{-4} \text{ N m}}{(1.5 + 4.5) \times 10^{-2} \text{ m}} = 8.33 \times 10^{-3} \text{ N}$	
	<u>Circuit current</u>	
	Use of $F = BIl$ [or correct rearrangement] with $l = 9$ cm [Ignore powers of 10. No ecf for their force if different; beware use of $5.0 \times 10^{-10}$	✓ 0 <sup>-4</sup> ]
	Answer = $2.2/2.3$ A	✓ 2
	Example of answer: $F = BIl \rightarrow I = \frac{F}{Bl}$ $8.33 \times 10^{-3}$ N	
	$\therefore I = \frac{3.35 \times 10^{-1} \text{ N}}{4.0 \times 10^{-2} \text{ T} \times 9.0 \times 10^{-2} \text{ m}} = 2.31 \text{ A} \qquad [8x10^{-3} \text{N} \to 2.22 \text{A}]$	
	Total	10 marks

#### 6735 Unit Test PHY5

5.			
a)	Direction of e.m.f.?		
	Hub '-' and Rim '+'. [Allow mark for either on its own, but not if contradicted.]	✓	
	Why a constant e m f ?		1
	Reference to flux cutting / rate of change of flux / change of flux linkage due motion / spokes moving at right angles to field / Reference to Faraday's Law	e to sp ✓	oke
	Constant rate of spin implies constant rate of flux cutting. [Link made clear] [continuous process does not mean constant rate]	✓	2
	The time for one revolution		
	Use of $\varepsilon = \frac{BA}{t}$ with 'A' recognisable as area of a circle [ignore power of 10 errors for e.m.f. and radius values, and inclusion of N=24]	√	
	Correct substitution of all values [ but only N = 1 acceptable here]	$\checkmark$	
	Correct answer $0.31 - 0.32$ s [t = 7.6s scores 1/3; t = 1.12s scores 0/3, t = 0.64s scores 1/3 here]	✓	2
	Example of answer:		3
	$\varepsilon = \frac{\varphi}{t} = \frac{BA}{t} \rightarrow t = \frac{BA}{\varepsilon}$ $\therefore t = \frac{2.8 \times 10^{-5} \text{ T} \times \pi \times (30 \times 10^{-2} \text{ m})^2}{25 \times 10^{-6} \text{ V}} = 0.317 \text{ s}$		
	Alternative answer		
	Use of $\varepsilon = Blv$ with $v = (mean)$ velocity of spoke.	(🗸)	
	$\rightarrow v = 2.98 \text{ ms}^{-1}$	(✓)	
	Hence rim velocity = $2.98 \times 2 = 5.96 \text{ ms}^{-1}$ .		
	$\rightarrow t = \frac{2\pi r}{v_{RIM}} = \frac{2\pi \times 0.3 \text{ m}}{5.96 \text{ ms}^{-1}} = 0.316 \text{s}.$	<b>(</b> ✓)	
	[t = 0.63s  scores  2/3  here]		

What effect?
(i) Reduced [accept 'halved'] AND
Rate of flux cutting is reduced / Fewer field lines are being cut / Component of Earth's field perpendicular to the wheel is less /Flux through wheel is less / Area of wheel perpendicular to field is less / Wheel is no longer perpendicular to the field ✓
[do not credit answers suggesting changes in the field strength itself]
(ii) Increased / increasing AND
Rate of flux cutting [etc.] would be increasing
(iii) (Reduced to) zero [but not 'very small' / 'negligible', etc.] AND
No flux cut by spoke(s) / No component of the Earth's field perpendicular to the wheel / No flux through wheel / Wheel is spinning parallel to the field / in plane of field $\checkmark$ [but not just ' $\Delta \Phi = 0$ ', nor 'motion is not perpendicular to field']
[Allow 1/3 for three correct statements of ' $\epsilon$ ' outcome without any explanation, but <b>only</b> if score would otherwise be zero.]
[Disallow 'breaking' for 'cutting' on first occasion in entire question, but allow, ecf, thereafter]
3
Total 9 marks