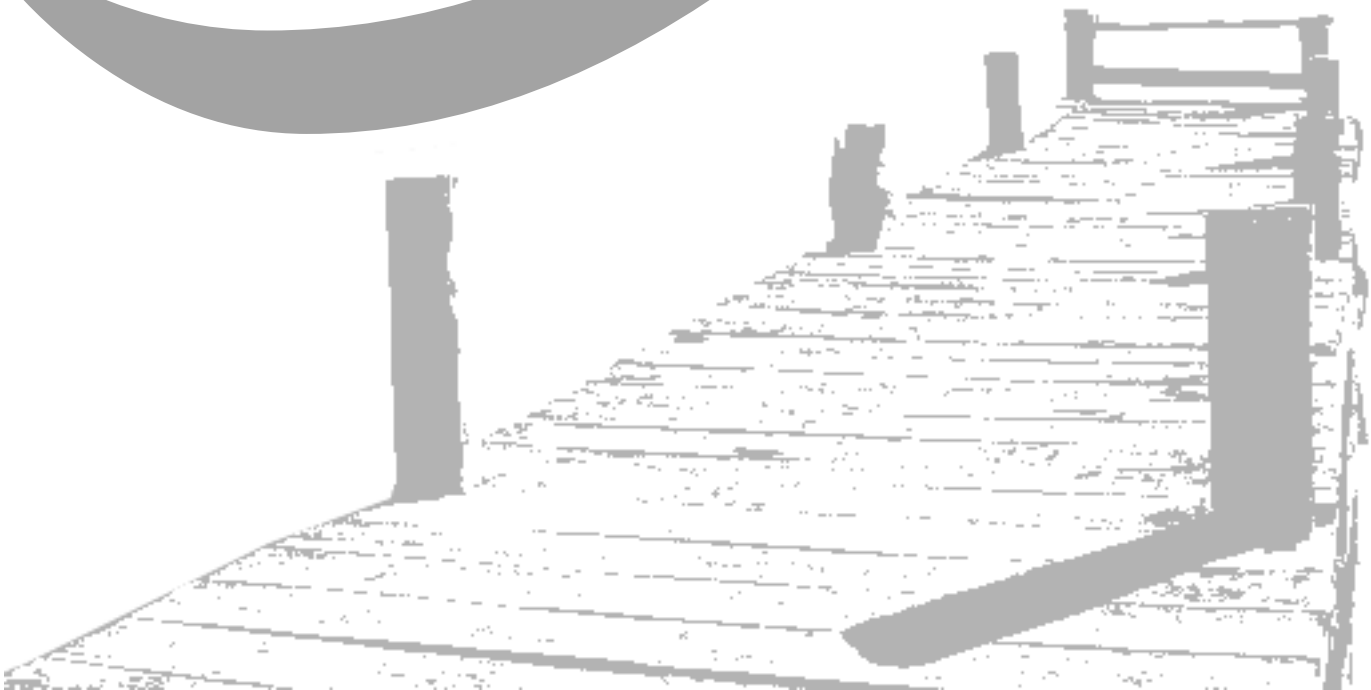
GCE
AS and A Level

Physics A

AS exams 2009 onwards
A2 exams 2010 onwards

Unit 4: Approved specimen mark scheme

Version 1.2



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ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Education

Physics 2451

Specification A

PHYA4 Fields and Further Mechanics

Mark Scheme

The specimen assessment materials are provided to give centres a reasonable idea of the general shape and character of theplanned question papers and mark schemes in advance of the first operational exams.

Mark schemes are prepared by the Principal Examiner and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation meeting attended by all examiners and is the scheme which was used by them in this examination. The standardisation meeting ensures that the mark scheme covers the candidates' responses to questions and that every examiner understands and applies it in the same correct way. As preparation for the standardisation meeting each examiner analyses a number of candidates' scripts: alternative answers not already covered by the mark scheme are discussed at the meeting and legislated for. If, after this meeting, examiners encounter unusual answers which have not been discussed at the meeting they are required to refer these to the Principal Examiner.
It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of candidates' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

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PHYA4: Fields and Further Mechanics

	Keys to Objective Test Questions	
	1 **D** 2 **B** 3 **C** 4 **A** 5 **B** 6 **B** 7 **A** 8 **C** 9 **A** 10 **B** 11 **C** 12 **D** 13 **B** 14 **A** 15 **D** 16 **B** 17 **D** 18 **A** 19 **C** 20 **D** 21 **C** 22 **D** 23 **C** 24 **B** 25 **C**	

Question 1			
(a)		*kinetic* energy is not conserved ✓ (or velocity of approach equals velocity of separation)	**1**
(b)	(i)	(use of $p = mv$ gives) p $= 4.5 \times 10^{-2} \times 60$ ✓ $= 2.7\,\text{kg m s}^{-1}$ ✓	**4**
	(ii)	(use of $F = \frac{\Delta(mv)}{\Delta t}$ gives) $F = \frac{2.7}{15\times10^{-3}}$ ✓ $= 180$ N ✓ [or $a = \frac{v-u}{t} = \frac{60}{15\times10^{-3}} = 400\ (\text{m s}^{-1})$] ✓ $F = ma = 4.5 \times 10^{-2} \times 4000 = 180\,\text{N}$ ✓	
		Total	**5**

Question 2			
(a)	(i)	$mg = ke$ ✓ $k = \left(\frac{0.25\times9.81}{40\times10^{-3}}\right) = 61(.3)\,\text{N m}^{-1}$ ✓	**4**
	(ii)	$T = \left(= 2\pi\sqrt{\frac{m}{k}}\right) = 2\pi\sqrt{\frac{0.69}{61.3}}$ ✓ (= 0.667 s) $f\left(=\frac{1}{T}\right) = \frac{1}{0.667}$ ✓ (= 1.5(0) Hz)	

(b)	The marking scheme for this part of the question includes an overall assessment for the Quality of Written Communication (QWC). There are no discrete marks for the assessment of QWC but the candidates' QWC in this answer will be one of the criteria used to assign a level and award the marks for this part of the question.	
Level	**Descriptor** an answer will be expected to meet most of the criteria in the level descriptor	**Mark range**
Good **3**	- answer supported by an appropriate range of relevant points - good use of information or ideas about physics, going beyond those given in the question - argument well structured with minimal repetition or irrelevant points - accurate and clear expression of ideas with only minor errors of spelling punctuation and grammar	**5-6**
Modest **2**	- answer partially supported by relevant points - good use of information or idea about physics given in the question but limited beyond this - the argument shows some attempt at structure - the ideas are expressed with reasonable clarity but with a few errors of spelling, punctuation and grammar	**3-4**
Limited **1**	- valid points but not clearly linked to an argument structure - limited use of information or ideas about physics - unstructured - errors in spelling, punctuation and grammar or lack of fluency	**1-2**
0	- incorrect, inappropriate or no response	**0**
(i) (ii) (iii)	examples of the sort of information or idea that might be used to support an argument • forced vibrations (at 0.2 Hz) ✓ • amplitude fairly large (≈ 30 mm) ✓ • in phase with driver ✓ • resonance (at 1.5 Hz) ✓ • amplitude very large (> 30 mm) ✓ • oscillations may appear violent ✓ • phase difference at 90º ✓ • forced vibrations (at 10 Hz) ✓ • small amplitude ✓ • out of phase with driver or phase lag of π on driver ✓	
	Total	**10**

Question 3			
(a)		period is 24 hours (or equal to period of Earth's rotation) ✓ remains in fixed position relative to surface of Earth ✓ equatorial orbit ✓ same *angular* speed as Earth (or equatorial surface) ✓	**max 2**
(b)	(i)	$\frac{GMm}{r^2} = m\omega^2 r$ ✓ $T = \frac{2\pi}{\omega}$ ✓ $r \left(= \frac{GMT^2}{4\pi^2}\right) = \left(\frac{6.7\times10^{-11}\times6.0\times10^{24}\times(24\times3600)^2}{4\pi^2}\right)^{1/3}$ ✓ (gives $r = 42.3 \times 10^3$ km)	**6**
	(ii)	$\Delta V = GM\left(\frac{1}{R} - \frac{1}{r}\right)$ ✓ $= 6.67 \times 10^{-11} \times 6 \times 10^{24} \times \left(\frac{1}{6.4\times10^6} - \frac{1}{4.23\times10^7}\right) = 5.31 \times 10^7 (\text{J kg}^{-1})$ ✓ $\Delta E_P = m\Delta V (= 750 \times 5.31 \times 10^7) = 3.98 \times 10^{10}$ J ✓ (allow ecf for value of ΔV)	
(c)	(i)	signal would be too weak at large distance ✓ (or large aerial needed to detect/transmit signal, or any other acceptable reason) the signal spreads out more the further it travels ✓	**4**
	(ii)	**for** road pricing would reduce congestion stolen vehicles can be tracked and recovered uninsured/unlicensed vehicles can be apprehended **against** road pricing would increase cost of motoring possibility of state surveillance/invasion of privacy ✓✓ any 2 valid points (must be for both for **or** against)	
		Total	**12**

Question 4		
(a)	$T \cos 6^\circ = mg$ ✓ $T \sin 6^\circ = F$ ✓ hence $F = mg \tan 6^\circ$ ✓ [or by use of triangle: sides correct ✓ 6º correct ✓ tan 6º = F/mg ✓]	**3**
(b)	(use of $E = \frac{V}{d}$ gives) $E = \frac{4200}{60\times10^{-3}} = 7.0 \times 10^4\ \text{V m}^{-1}$ ✓ (use of $Q = \frac{F}{E}$ gives) $Q\left(\frac{mg\tan 6^\circ}{E}\right) = \frac{2.1\times10^{-4}\times9.81\tan 6^\circ}{7.0\times10^{-4}}$ ✓ $= 3.1 \times 10^{-9}\,\text{C}$ ✓ (allow ecf for value of E from (i))	**3**
	Total	**6**

Question 5			
(a)	(i)	$E\ (= ½\ CV^2 = 0.5 \times 180 \times 10^{-6} \times 100^2) = 0.90\,\text{J}$ ✓	**2**
	(ii)	$W\ (= QV = CV^2 = 180 \times 10^{-6} \times 100^2) = 1.8\,\text{J}$ ✓	
(b)	(i)	$(V = V_0 e^{-t/RC})$ gives $30 = 100\ e^{-t/RC}$ ✓ $\therefore\ t = (-RC \ln (30/100) = -1.5 \times 180 \times 10^{-6} \times -1.204\ \text{s})$ $= 3.3 \times 10^{-4}\ \text{s}$ ✓	**4**
	(ii)	image would be less sharp (or blurred) because the discharge would last longer and the image would be photographed as it is moving ✓ image would be brighter because the capacitor stores more energy and therefore produces more light ✓	
		Total	**6**

Question 6		
(a)	greater flux (linkage) or more flux lines (at same distance) [or stronger magnet produces flux lines closer together] ✓ greater rate of change of flux (linkage) [or more flux lines cut per unit time] ✓ induced emf ∝ [or =] rate of change of flux (linkage) ✓ [or using $\epsilon = \text{NA}\ \frac{\Delta B}{\Delta t}$ ✓ ΔB is larger since magnet is stronger ✓ N, A and Δt are the same at the same speed $\therefore \epsilon$ is larger ✓]	**3**
(b)	area swept out $\Delta A = lv\Delta t$ ✓ $\Delta\Phi\ (= B\Delta A) = Blv\Delta t$ ✓ $\epsilon\left(=(N)\frac{\Delta\Phi}{\Delta t}\right) = \frac{Blv\Delta t}{\Delta t}$ gives result ✓	**3**
(c) (i)	$\omega\ (= 2\pi f) = 2\pi \times 16$ ✓ $= 101\ \text{rad s}^{-1}$ ✓	**5**
(ii)	$v\ (= r\omega) = 32 \times 10^{-3} \times 101 = 3.2(3)\ \text{m s}^{-1}$ ✓ (allow ecf for value of ω from (i))	
(iii)	$\epsilon\ (= Blv) = 28 \times 10^{-3} \times 64 \times 10^{-3} \times 3.23$ ✓ $= 5.7(9) \times 10^{-3}\ \text{V}$ ✓ (allow ecf for value of v from (ii)) [or accept solutions using $\epsilon = Bf\pi r^2$ to give $5.7(9) \times 10^{-3}\ \text{V}$]	
	Total	**11**

	Assessment Objectives – Section A					
	1 – AO1	2 – AO2	3 – AO2	4 – AO1	5 – AO2	
	6 – AO2	7 – AO1	8 – AO2	9 – AO2	10 – AO1	
	11 – AO2	12 – AO1	13 – AO2	14 – AO2	15 – AO2	
	16 – AO1	17 – AO1	18 – AO2	19 – AO2	20 – AO2	
	21 – AO1	22 – AO2	23 – AO1	24 – AO2	25 – AO3	
					Total	**25**

	Summary	
Marks	*Ability tested*	*%*
9	AO1 Knowledge and Understanding	36
15	AO2 Application	60
1	AO3 How Science Works	4

		Assessment Objectives – Section B	
Question No		*Ability tested*	*Marks*
1	(a)	AO1	**1**
	(b)	AO1/AO2	**4**
		Question Total	**5**
2	(a)	AO2	**4**
	(b)	AO1	**6**
		Question Total	**10**
3	(a)	AO1	**2**
	(b)	AO2	**6**
	(c)	AO1/AO3	**4**
		Question Total	**12**
4	(a)	AO2	**3**
	(b)	AO1/AO2	**3**
		Question Total	**6**
5	(a)	AO2	**2**
	(b)	AO1	**1**
	(c)	AO2	**3**
		Question Total	**6**

6	(a)	AO1	**3**
	(b)	AO2	**3**
	(c)	AO2	**5**
		Question Total	**11**
		Total	**50**

	Summary	
Marks	*Ability tested*	*%*
17	AO1 Knowledge and Understanding	34
31	AO2 Application	62
2	AO3 How Science Works	4

	Summary – Total Unit	
Marks	*Ability tested*	*%*
26	AO1 Knowledge and Understanding	35
46	AO2 Application	61
3	AO3 How Science Works	4