GCE A2

Physics

January 2007

Mark Scheme

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NORTHERN IRELAND GENERAL CERTIFICATE OF SECONDARY EDUCATION (GCSE)
AND NORTHERN IRELAND GENERAL CERTIFICATE OF EDUCATION (GCE)

MARK SCHEMES (2007)

Foreword

Introduction

Mark Schemes are published to assist teachers and students in their preparation for examinations. Through the mark schemes teachers and students will be able to see what examiners are looking for in response to questions and exactly where the marks have been awarded. The publishing of the mark schemes may help to show that examiners are not concerned about finding out what a student does not know but rather with rewarding students for what they do know.

The Purpose of Mark Schemes

Examination papers are set and revised by teams of examiners and revisers appointed by the Council. The teams of examiners and revisers include experienced teachers who are familiar with the level and standards expected of 16- and 18-year-old students in schools and colleges. The job of the examiners is to set the questions and the mark schemes; and the job of the revisers is to review the questions and mark schemes commenting on a large range of issues about which they must be satisfied before the question papers and mark schemes are finalised.

The questions and the mark schemes are developed in association with each other so that the issues of differentiation and positive achievement can be addressed right from the start. Mark schemes therefore are regarded as a part of an integral process which begins with the setting of questions and ends with the marking of the examination.

The main purpose of the mark scheme is to provide a uniform basis for the marking process so that all the markers are following exactly the same instructions and making the same judgements in so far as this is possible. Before marking begins a standardising meeting is held where all the markers are briefed using the mark scheme and samples of the students' work in the form of scripts. Consideration is also given at this stage to any comments on the operational papers received from teachers and their organisations. During this meeting, and up to and including the end of the marking, there is provision for amendments to be made to the mark scheme. What is published represents this final form of the mark scheme.

It is important to recognise that in some cases there may well be other correct responses which are equally acceptable to those published: the mark scheme can only cover those responses which emerged in the examination. There may also be instances where certain judgements may have to be left to the experience of the examiner, for example, where there is no absolute correct response – all teachers will be familiar with making such judgements.

The Council hopes that the mark schemes will be viewed and used in a constructive way as a further support to the teaching and learning processes.

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[A2Y11]

FRIDAY 12 JANUARY, AFTERNOON

MARK SCHEME

Subject-specific Instructions

In numerical problems, the marks for intermediate steps shown in the mark-scheme are for the benefit of candidates who do not obtain the correct final answer. A correct answer and unit, if obtained from a valid starting-point, gets full credit, even if all the intermediate steps are not shown. It is not necessary to quote correct units for intermediate numerical quantities.

Note that this "correct answer" rule does not apply to formal proofs and derivations, which must be valid in all stages to obtain full credit.

Do not reward wrong physics. No credit is given for consistent substitution of numerical data, or subsequent arithmetic, in a physically incorrect equation. However, answers to later parts of questions that are consistent with an earlier incorrect numerical answer, and are based on a physically correct equation, must gain full credit. Designate this by writing **ECF** (Error Carried Forward) by your text marks.

The normal penalty for an arithmetical and/or unit error is to lose the mark(s) for the answer/unit line. Substitution errors lose both the substitution and answer marks, but 10^n errors (e.g. writing 550 nm as 550×10^{-6} m) count only as arithmetical slips and lose the answer mark.

						AVAILABLE MARKS
1	**(a)**	**(i)**	**125** N m^{-1}		[1]	
		(ii)	Compression = 8 mm		[1]	
			Wd = $\frac{1}{2}Fx = \frac{1}{2}(1)(8 \times 10^{-3})$ or $\frac{1}{2}kx^2 = \frac{1}{2}(125)(8 \times 10^{-3})^2$		[1]	
			(= **4** × **10^{-3}** (J))		[2]	
	(b)	**(i)**	WD = strain energy			
			gpe gained = 3.3×10^{-3} (J)		[1]	
			efficiency = $\frac{3.3}{4}$	or e.c.f. from their g.p.e.	[1]	
			= **82%**	or e.c.f. from their g.p.e.	[1]	[3]
		(ii)	power = $\frac{4.0 \times 10^{-3}}{0.12}$ = **33** mW		[1]	
	(c)	**(i)**	Heat energy required to raise the temperature of unit mass by 1 degree		[1]	
		(ii)	$Q = mc\Delta\theta$			
			Q to cause 1° temp rise = $0.24 \times 10^{-3}(450)(1)$ = 0.108 J subs		[1]	
			$\frac{0.108}{4 \times 10^{-4}}$ = **270** times		[1]	[2]
						10
2	**(a)**		Heat over range of temperatures			
			Allow time for temp to steady or stir			
			Read/record temperature			
			How volume calculated or length of trapped air measured			
					Any **three** points	[3]
			Quality of written communication		[1]	
	(b)		$\frac{V_1}{T_1} = \frac{V_2}{T_2}$		[1]	
			Correct temp conversion (291, T_2–273)		[1]	
			Subs of lengths or correctly calc volumes eg $\frac{20}{291} = \frac{22}{T_2}$		[1]	
			Ans = **47** °C		[1]	[4]
	(c)		y-axis labelled Volume or length and app unit		[1]	
			x-axis labelled Temp/°C		[1]	[2]
						10

							AVAILABLE MARKS
3	**(a)**	**(i)**	$\frac{8 \times 2\pi}{4.5}$	subs	[1]		
			or $\mathbf{3.6\pi}$				
			$= \mathbf{11.2}$ rad s^{-1}		[1]	[2]	
		(ii)	use of $v = r\omega$ and subs		[1]		
			$\mathbf{1.12}$ m s^{-1} or e.c.f. from **(i)**		[1]	[2]	
	(b)	**(i)**	linear showing direct proportion		[1]		
		(ii)	Subs into $a = r\omega^2$		[1]		
			$a = 19$ m s^{-2} when $r = \mathbf{15}$ cm or e.c.f. from **(a)(i)**		[1]	[3]	
	(c)		Subs into $F = mr\omega^2$		[1]		
			$\mathbf{14.49}$ rad s^{-1}		[1]	[2]	9
4	**(a)**		acceleration is directly proportional to displacement		[1]		
			always directed towards fixed point		[1]	[2]	
	(b)	**(i)**	electrostatic/electric force			[1]	
		(ii)	$T = 2\pi\sqrt{\frac{m}{k}}$				
			$T = 2\pi\sqrt{\frac{3.82 \times 10^{-26}}{110}}$	subs	[1]		
			$(T = 1.17 \times 10^{-13}$ s)				
			$f = \frac{1}{T}$		[1]		
			$f = \mathbf{8.54 \times 10^{12}}$ Hz		[1]	[3]	
		(iii)	Ans consistent with freq obtained in **(b)(ii)**		[1]		
			Reason: if resonance natural freq = forced freq		[1]	[2]	8

AVAILABLE MARKS

5 **(a)** **(i)** Any **two** from:

Above equator

Period = 24 hours/same as earth **or** Remains in fixed position relative to earth **or** Same angular speed as earth

Moves in same direction as earth [2]

(ii) $\frac{GMm}{r^2} = m\omega^2 r$ or $\frac{GM}{\omega^2} = r^3$ [1]

$\omega = \frac{2\pi}{24(60)(60)} = 7.27\times10^{-5}$ [1]

$r = \sqrt[3]{\frac{(6.67\times10^{-11})(6.0\times10^{24})}{(7.27\times10^{-5})^2}}$ [1]

$r = \mathbf{4.23\times10^{7}}$ m [1] [4]

(b) $\Delta g = \frac{G\Delta M}{r^2}$ or $g = \frac{GM}{r^2}$

$0.001\times9.81 = \frac{(6.67\times10^{-11})(\Delta M)}{(6.38\times10^{6})^2}$ for two masses, or Δm eqn [1] subs [1]

$\Delta M = 6.0\times10^{21}$ kg [1]

time = $\frac{6.0\times10^{21}}{7.9\times10^{7}}$

time = $\mathbf{7.6\times10^{13}}$ years [1] [4] 10

Alternative: calculate new M from increased g, give $\Delta M = 6.3\times10^{21}$ kg

time = 8.0×10^{13} years [4] [4]

					AVAILABLE MARKS
6	**(a)** $F = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r^2}$				
	Correct base units of q – A s, F – kg m s^{-2} and r – m	all three	[1]		
	Rearrange to $\mathbf{A^2\ s^4\ kg^{-1}\ m^{-3}}$		[1]	[2]	
	(b) **(i)** $F = 9\times10^9\ \frac{(3\times10^{-6})(6\times10^{-6})}{(30\times10^{-3})^2}$	subs	[1]		
	$F =$ **180** N	ans	[1]	[2]	
	(ii) Opposite charges			[1]	
	(c) Electric field strength uniform between parallel plates,		[1]		
	varies as $\frac{1}{r^2}$ for point charge		[1]		
	Diagrams correct for uniform field and for point charge with signs on plates/point charge and arrows on field lines		[1]	[3]	8

AVAILABLE MARKS

7 **(a)** Decreases drag force [1]

improves efficiency **or** uses less fuel **or** moves faster [1] [2]

(b) Measures approx area from page in range 9 cm^2 – 18 cm^2 [1]

Works out scale from measured area [1]

Length ratio 1 cm on drawing = **18** cm to **25** cm range [1] [3]

(c) **(i)** **38.5** N [1]

(ii) **(1)** y-axis, log F_D; x-axis, log v 1 each [2]

(2) n = gradient [1]

(3)

Log v	Log F_D
1.00	1.23
1.18	1.59
1.30	1.83
1.40	2.03
1.48	2.19
1.54	2.32

headings [1]

6 pairs (one or two errors, –1) [2]

3 sig fgs [1] [4]

(iii) Suitable scale on axis [1]

Axis labelled [1]

Points correctly plotted ($-\frac{1}{2}$ each error, round down) [2]

Best fit line [1] [5]

(iv) Large triangle [1]

Correct values in $\frac{\Delta y}{\Delta x}$ [1]

Candidate's value of n [1]

no units [1] [4]

(v) Values of log F_D and log v from graph or F_D and v from Table 7.1 [1]

Subs into eqn [1]

Value of C_D approx **0.49** [1]

No units [1] [4]

					AVAILABLE MARKS
(d)	**(i)**	y-axis: F_D	[1]		
		x-axis: v^2 or v^n	[1]	[2]	
	(ii)	gradient	[1]		
		$C_D = \dfrac{2\ gradient}{\rho A}$	[1]	[2]	
(e)	**(i)**	$T\rho$ = constant = 353 (value needed)	[1]		
		At least 3 sets of values used	[1]	[2]	
	(ii)	$T(1.225) = 353$			
		$T = \mathbf{288}$ K		[1]	
	(iii)	$\Delta\rho = 0.089$	[1]		
		$\Delta F_D = \mathbf{9.74}$ N	[1]	[2]	35
				Total	**90**