GCE A2

Physics

January 2009

Mark Scheme

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

MARK SCHEMES (2009)

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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ADVANCED
General Certificate of Education
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Physics

Assessment Unit A2 1

assessing

Module 4: Energy, Oscillations and Fields

[A2Y11]

TUESDAY 13 JANUARY, AFTERNOON

MARK SCHEME

					AVAILABLE MARKS
1	**(a)**	**stress** = F/A	[1]		
		strain = x/L	[1]	[2]	
	(b)	Diagram: To show wire clamped at one end, load, marker, pulley	[1]		
		Detail: marker in sensible place ($\geqslant \frac{1}{2}$ length	[1]		
		Allow vernier (Searle) method		[2]	
		Procedure: Measure original length, from clamp to marker	[1]		
		Add load, measure new length	[1]		
		Measure diameter	[1]		
		How: extension, metre rule or vernier	[1]		
		diameter, micrometer screw gauge	[1]	[5]	
		Results: Graph of x against F *or*			
		Graph of x/L against $4F/\pi d^2$	[1]		
		Use linear part of graph	[1]		
		E = (1/gradient) × ($4L/\pi d^2$) *or*			
		E = (1/gradient) *or*	[1]	[3]	
		Equivalent e.g. $\frac{4F}{\pi d^2}$ against $\frac{x}{L}$			
		Slope = E [1] [1]			
		Alternative graph: average "linear" marks	[2]		
		Quality of written communication			
		Sense at first reading	[1]		
		Use of appropriate vocabulary, spelling, punctuation, grammar	[1]	[2]	14
2	**(a)**	Moving electrons and lattice vibrations	[1]		
		Interionic forces/separation	[1]	[2]	
	(b)	**(i)** (Internal energy U = sum of k.e. of all molecules)			
		$U = N(\frac{1}{2}m<c^2>) = 3NkT/2$ (N = no of atoms)	[1]		
		$Nk = nR$ (n = no of mols)	[1]		
		$U = (3/2) \times 1.20 \times 8.31 \times 300$ subs	[1]		
		Internal energy = **4500 J** (4490 J)	[1]	[4]	
		(ii) K.e. of sprinter = $\frac{1}{2}mv^2 = 0.5 \times 80 \times (100/9.8)^2$ subs	[1]		
		= 4200 (4165) J	[1]		
		Ratio = **1.1** (1.07, 1.08) or e.c.f. from (1)	[1]	[3]	9

						AVAILABLE MARKS
3	**(a)**	**(i)**	**rate of change of angular displacement (θ) or** θ/t		[1]	
		(ii)	$\omega = v/r$ *or* $v = r\omega$		[1]	
	(b)	**(i)**	radially inwards (towards the axis of rotation)/centre of circle		[1]	
		(ii)	by the **tension in the string**		[1]	
		(iii)	**towards the ball**		[1]	
		(iv)	1. Ball moves **tangentially** (to the arc of the swing)		[1]	
			2. gravitation *or* weight *or* gravity	[1]		
			accelerates downwards	[1]		
			projectile *or* parabola *or* curved path	[1]	[3]	9
4	**(a)**		x = **displacement**	[1]		
			a = **acceleration** (not centripetal)	[1]		
			ω = **2π/*T*, where *T* is the period of the s.h.m.**	[1]	[3]	
			or **2πf where f is the frequency (Hz) of s.h.m.**			
			or **angular frequency** (not angular velocity)			
			or **pulsatance**			
	(b)	**(i)**	**kg s^{-2}**		[1]	
		(ii)	r.h.s. $(\text{kg}/\text{kg}\,\text{s}^{-2})^{\frac{1}{2}}$ = s (l.h.s.)		[1]	
	(c)	**(i)**	$T = 2\pi(7.50/130)^{\frac{1}{2}}$ subs	[1]		
			Period = **1.51** s must see to > 2s.f.	[1]	[2]	
		(ii)	**Damped** oscillations	[1]		
			Attach card to mass [1] to increase air resistance/ absorb energy [1]	[2]	[3]	
			or mass in water [1] to increase resistance [1]			
			not "slow it down"			
		(iii)	**Forced** oscillations		[1]	
		(iv)	**Resonance**	[1]		
			Frequency = (1/1.51 or 1/1.5) = **0.66** Hz *or* **0.67** Hz	[1]	[2]	
		(v)	Period for cousin = $2\pi\sqrt{(6.0/130)}$ (1.35 s) *or*			
			use $f = \frac{1}{2}\pi\sqrt{\frac{k}{m}}$ subs	[1]		
			Frequency = **0.74** Hz	[1]	[2]	
			or			
			frequency proportional to $\sqrt{(1/m)}$			
			$f_g/f_b = \sqrt{m_b/m_g}$	[1]		
			$f_g/0.66 = \sqrt{(7.5/6.0)}$ *or* subs			
			Frequency = **0.74** Hz	[1]		15

AVAILABLE MARKS

5	**(a)**	**Gravitational force** *or* **weight** *or* **gravity** (this one force only)		[1]	
	(b) (i)	Mean = **3.35** (× 10^{24}) $km^3\ yr^{-2}$ ignoring 10^n		[1]	
	(ii)	Factor = $(10^3)^3/(3.16 \times 10^7)^2$ = $\mathbf{1.00 \times 10^{-6}}$		[1]	
	(iii)	Mean = $\mathbf{3.35 \times 10^{18}}$ $m^3\ s^{-2}$ to 3 s.f., correct 10^n		[1]	
	(iv)	$M_s = (4\pi^2/G)(r^3/T^2)$ M_s as subject of Eqn	[1]		
		$= (4\pi^2/6.67 \times 10^{-11})(3.35 \times 10^{18})$ subs	[1]		
		Mass = $\mathbf{1.98 \times 10^{30}}$ kg to 3 s.f. [1]	[1]	[4]	8
		[$= 5.92 \times 10^{11} \times$ **(iii)**, e.c.f]			
6	**(a) (i)**	1. **Four** significant figures	[1]		
		2. **Zero** decimal places	[1]	[2]	
	(ii)	Lower limit = **2500.5** K	[1]		
		Upper limit = **2501.4** K	[1]	[2]	
	(iii)	Can't take logarithms of units [*not* "logs don't have units"]	[1]		
		To deal with pure number, must divide *T* by its unit (hence *T*/K)	[1]	[2]	
	(iv)	Take gradient	[1]		
		Gradient should be equal to 4	[1]	[2]	
	(v)	Best straight line (examiner's judgment)		[1]	
	(vi)	Large triangle (one side at least 5 cm)	[1]		
		Reads off points, subs into gradient formula	[1]		
		Power **in range 3.9 to 4.1** (quality) (rounded)	[1]	[3]	
	(vii)	Steepest acceptable straight line (examiner's judgment)	[1]		
		Reads off points and gradient formula subs	[1]		
		Gradient (expect in range 4.2 to 4.1, but not quality yet)	[1]		
		Difference from candidate's value in **(vi)** up to **±0.3** (quality) (use of %. scores first three marks)	[1]	[4]	
	(viii)	Maximum value = 1	[1]		
		$\varepsilon = 1$ makes **Equation 6.3** identical with Stefan Law equation, and can't do better than a perfect black body	[1]	[2]	
	(ix)	Pair of values of lg *T*, lg *P* (e.g. 3.30, 0.04)	[1]		
		Evaluates lg $(\varepsilon\sigma A) = -4 \times 3.30 + 0.04$ (e.g.) $= -13.16$	[1]		
		$\varepsilon\sigma A$ = antilg $(-13.16) = 6.92 \times 10^{-14}$	[1]		
		$\varepsilon = 6.92 \times 10^{-14}/(5.67 \times 10^{-8} \times 1.5 \times 10^{-6}) = 0.81$ subs, ans	[1]	[4]	
		allow in range ε = **0.75–0.85**			

AVAILABLE MARKS

(b) **(i)** Horizontal axis (1) T *or* (2) $1/T$
Vertical axis $1/\lambda_m$ λ_m *or* axes transposed [1]

(ii) (1) B = 1/gradient
or (2) B = gradient [1]

(iii)

T/K	λ_m/µm	$(1/\lambda_m)$/µm^{-1} *or*	$(1/T)/10^{-4}$ K^{-1}			
				hdgs with slash	[1]	
1200	2.42	0.41	8.3			
1400	2.07	0.48	7.1			
1600	1.81	0.55	6.3	values	[1]	
2000	1.45	0.69	5.0			
2366	1.24	0.81	4.3			[2]

(iv) Graph: Axes labelled (with units) [1]
Suitable scales [1]
Five points plotted [2]
Best straight line [1] [5]
[correct plot, wrong graph max $\frac{3}{5}$]

(v) Finds gradient: large triangle, points and subs [1] their value of grad [1] [1]
B in range **2800 to 3000 (µm K)** [1]
or **2.8×10^{-3} to 3.00×10^{-3} (m K)** (quality) [1]
Unit: **µm K** or **m K** (only if consistent with 10^n) [1] [4] 35

Total **90**