Published Mark Schemes for GCE AS Physics

January 2009

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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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Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
January 2009

Physics

Assessment Unit AS 1

Module 1: Forces, Energy and Electricity

[AY111]

TUESDAY 27 JANUARY, MORNING

MARK SCHEME

				AVAILABLE MARKS

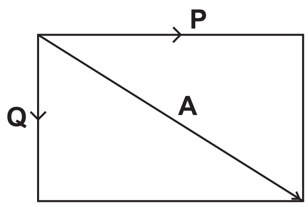
1 **(a)** Length, Mole, Temperature — all three [2]
Each error or addition, –1

(b) **kg m^2 s^{-2}** [1]

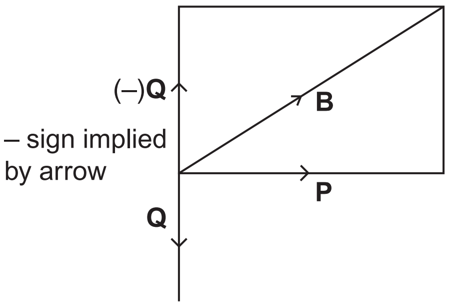
(c) **(i)** Scalar has magnitude only [1]
Vector has magnitude and direction [1] [2]

(ii) All energies are scalars
or squaring removes sense of direction
or energy has magnitude only [1]

(d) Completion of rectangle, vector **A** marked
(all arrows and labels shown) [1]



Reverse direction of **Q** [1]
Completion of rectangle, vector **B** marked (this mark only if direction of Q reversed)
(all arrows and labels shown) [1]



[3] — 9

[arrows missing, –1 once only]

2 **(a)** **(i)** 1. non uniform acceleration
2. zero acceleration
3. uniform deceleration — [1 mark each] [3]

(ii) $F = ma$; $a = \frac{1200}{1800} = (-)0.667\ \text{m s}^{-2}$ [1]

$v = u + at$ [1]
$0 = 16.7 - 0.667t$ — subs [1]
$t =$ **25.1 s** [1] [4]

(b) **(i)** $t = s/v$ (= 2.37/14.0) eqn(, subs) [1]
Time = **0.169 s** [1] [2]

(ii) $s = (ut) + \frac{1}{2}at^2$ eqn [1]
$s = 0 + 0.5 \times 9.81 \times (0.169\,\text{m})$ subs [1]
Vertical distance y = **0.140 m** (0.141 m) ans to 3 s.f. [1]
(g = 10 gives 0.142 m 3/3) [3]
(*or* e.c.f. from **(i)**)

(iii) Speed of dart should be **decreased** [1]
Time to reach board must increase [1]
so that dart falls further [1] [3]

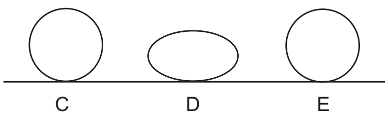
(c) Dart strikes **at point A** [1]
Because mass does not come into projectile equations *or* [1] [2] 17
motion independent of mass

3 **(a)** Force = **12 N** [1]
Constant speed means zero resultant force, *or* force from man equals frictional force *or* no resultant force [1] [2]

(b) **(i)** **(1)** Δ (Kinetic energy) = **24.8 J** [1]
(2) Use of $m\,g\,x \sin\theta$ [1]
Δ (Potential energy) = **18.8** x J or $(m\,g \sin 5°)\,x$ [1]
(3) $\boldsymbol{x}$ = **1.3 m** *or* e.c.f. [1] [4]

(ii) Recognises component of weight =
Additional force (= $mg \sin 5.0°$) [1]
= 22 × 9.8 × sin 5.0° = 18.8 N [1]
Total force = **31 N** (30.8 N) [1] [3] 9
(*or* e.c.f. from **(a)**)

4 **(a)**



C and E undeformed/same shape [1]
D squashed, flattened bottom [1] [2]
(i.e. flatter than C, E)
(need not be in contact with horizontal axis)

(b) **(i)** (**Gravitational) potential (energy)** [1]

(ii) **(Gravitational) potential (energy) and kinetic (energy)** [1]

(iii) **Elastic/strain/kinetic energy** [1] [3]

(c) Collision **inelastic** [1]
Some energy converted (allow "lost") to heat (and/or sound) at D [1] [2]

Quality of written communication throughout question
(not more than three spg errors) [1] 8

AVAILABLE MARKS

5 **(a)** Charge **passing a point** per second *or* rate of flow of charge **at any point** [1]

(b) $I = \frac{dQ}{dt} = \frac{5 \times 10^{20} \times 1.6 \times 10^{-19}}{25} = \mathbf{3.2\ A}$ [1]

(c) (i) $v = s/t$ so $t = s/v = 0.45/8 \times 10^{6} = 5.625 \times 10^{-8}\ s$ [1]

(ii) $Q = It = 1.85 \times 10^{-3} \times 5.625 \times 10^{8} = \mathbf{1.04 \times 10^{-10}\ c}$ [1]

$Q = Ne$

$N = 1.04 \times 10^{-10}/1.6 \times 10^{-19} = \mathbf{6.5 \times 10^{8}}$ [1] [3] 5

6 **(a)** $R = \frac{\rho l}{A}$ [1]

Where A is the (cross sectional) area, l is length. [1]

(b) $R = \frac{V}{I} = \frac{0.12}{3.5} = 0.034\ \Omega$ [1]

$0.034 = \frac{\rho \times 2}{\pi(0.56 \times 10^{-3})^2}$ other subs [1] area subs [1] [2]

$\boldsymbol{\rho} = \mathbf{1.67 \times 10^{-8}\ \Omega\,m}$ [1] [4]

(c) **(i)** radius is halved, area decreased by a factor of 4 [1]

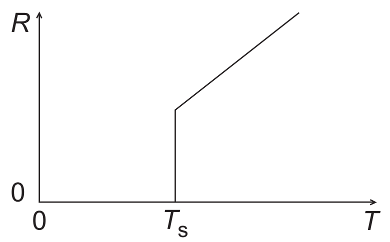
resistance increases by a factor of 4 [1] [2]

or $R \propto 1/A$, $A \propto \text{radius}^2$

(ii) resistivity does not change [1]

resistivity is property of material [1] [2]

(d)



Zero between $T = 0$ and $T = T_s$ [1]

Step and linear, positive gradient [1] [2] 11

						AVAILABLE MARKS
7	**(a)**	**(i)**	Resistance of upper series path between X and Y = resistance of lower series path = 20 Ω	[1]		
			Resistance of two 20 Ω paths in parallel = **10** Ω	[1]	[2]	
		(ii)	**(1)** Total circuit resistance = 20 Ω Current in main circuit = 6/20 = **0.3 A**		[1]	
			(2) I_1 = **0.15 A** or e.c.f. from **(i)**		[1]	
	(b)	**(i)**	Equal potential drops between X and B and between X and C, (so zero p.d. between B and C) (not Voltages the same)		[1]	
		(ii)	The same as before, because p.d. between B and C still 0 *or* no current in BC ∴ same *I* as before		[1]	
		(iii)	$V = IR$			
			$6 = I(10)$ subs	[1]		
			$\boldsymbol{I}$ **= 0.6 A** ans	[1]	[2]	8
8	**(a)**		$P = \frac{V^2}{R}$ or $P = VI$, $V = IR$ use (but $P = I^2R$ 0) eqn	[1]		
			$30 = \frac{12^2}{R}$ subs	[1]		
			R = **4.8 Ω** ans	[1]	[3]	
	(b)		p.d. = **12 V**		[1]	
	(c)		p.d. = **12 V**		[1]	
	(d)		Resistance BC = R		[1]	
	(e)		$\frac{1}{R} = \frac{1}{3R} + \frac{1}{4.8}$ eqn	[1]		
			$\left(3 = 1 + \frac{3R}{4.8}\right)$			
			$\boldsymbol{R = 3.2\,\Omega}$ ans	[1]	[2]	8
					Total	**75**

New Specification

Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
January 2009

Physics

Assessment Unit AS 2

Module 2: Waves, Photons and Medical Physics

[AY121]

WEDNESDAY 28 JANUARY, MORNING

MARK SCHEME

AVAILABLE MARKS

1 (a) (i) **Table 1.1**

Wave	Wave category	Typical wavelength/m
Radio waves	**Transverse**	10^5 to 0.1
Visible light waves	**Transverse**	4.0 to 7.0 × 10^{-7}

$4 \times \frac{1}{2}$, round down [2]

(ii) 1. **Longitudinal** [1]

2. $\lambda = \frac{v}{f} = \frac{340}{40}$ subs [1]

= **8.5** m ans [1] [2]

(iii)

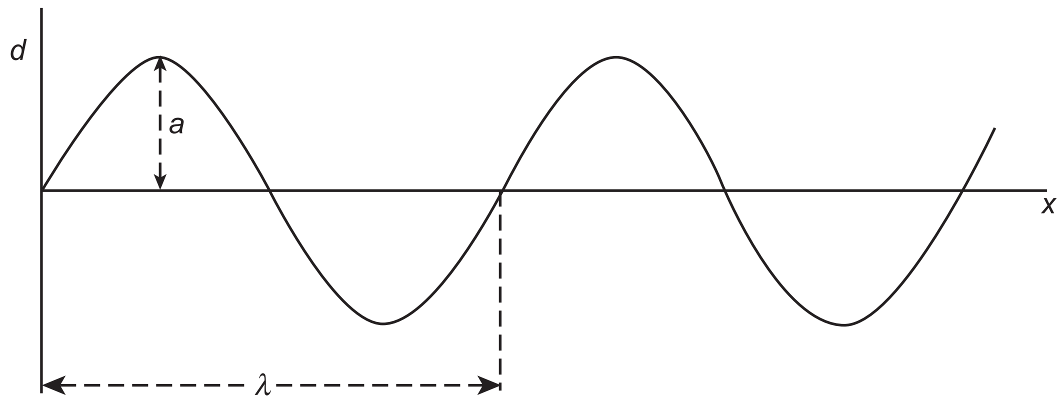


Fig. 1.1 Graph

Axes and sin/cos shape [1]
amplitude *a* [1]
Wavelength λ [1] [3]

(b) Wavelength $\lambda = \frac{40}{50} = 0.8$ m [1]

Fraction of cycle or wavelength = $\frac{0.3}{0.8}$ = 0.375 [1]

1 cycle or wavelength = 360° [1]

Phase difference 0.375 × 360 = **135°** ans [1] [4] 12

						AVAILABLE MARKS
2	(a)	(i)	Normal drawn and			
			i marked correctly	[1]		
			r marked correctly	[1]		
			correct emergent ray (parallel to incident)	[1]	[3]	
		(ii)	Calculate sin *i* and sin *r*	[1]		
			Graph sin *i* against sin *r* . . . straight line through origin	[1]		
			Measure gradient/slope to obtain refractive index/n	[1]		
			[If by calculation and average [2] max]		[3]	
	(b)	(i)	Ray emerges on surface i.e. 90° angle of refraction	[1]		
			Total internal reflection would occur	[1]	[2]	
		(ii)	$\sin C = \frac{1}{n}$	Eq [1]		
			Critical angle $C = \sin^{-1}\frac{1}{1.39} =$ **46.0°**	*C* angle [1]	[2]	
		(iii)	hence angle of refraction = (90 – 46) = 44.0°	*r* angle [1]		
			$\frac{\sin\theta}{\sin 44} = 1.39$	subs in eq [1]		
			θ = **74.9°** or e.c.f. from **(ii)**	ans [1]	[3]	13

AVAILABLE MARKS

3 (a) (i)

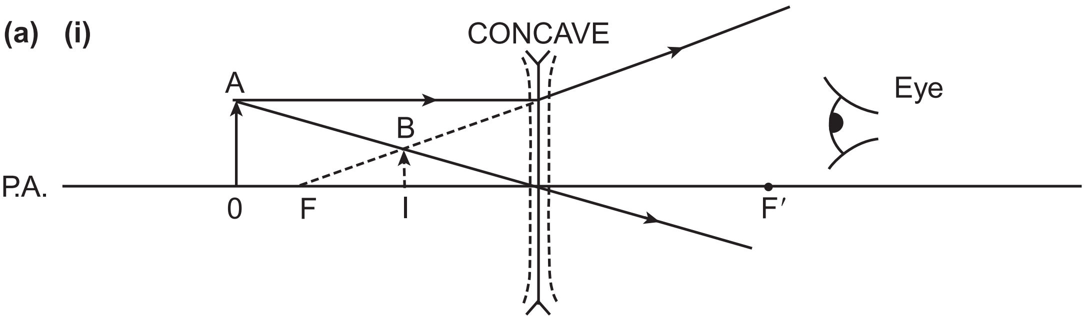


Fig. 3.1

Concave lens (or by shape in diagram) + F labels [1]
two correct rays [2]
Label image IB + eye correct [1]

Penalties: Once only [incorrect rays or no arrows –1]
[virtual rays not dashed –1] [4]

Correct diagram for convex lens: max 2/4

(b) (i)

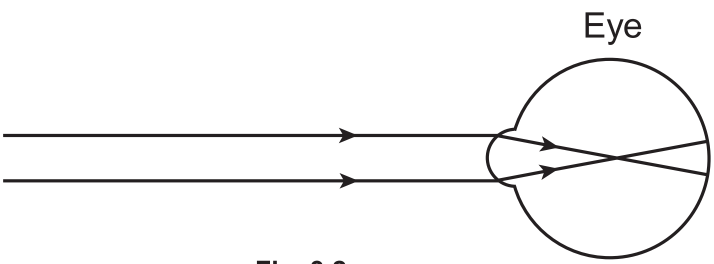


Fig. 3.2

Rays focused inside the eye [1]
(must reach retina)

(ii)

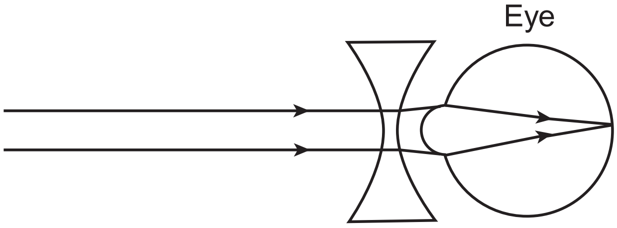


Fig. 3.3

Concave/diverging lens used (label or shape in diagram) [1]
Rays focused on the retina [1] [2]

(iii) **Converging/convex** lens [1]

$\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$

$\frac{1}{25} + \frac{1}{(-35)} = \frac{1}{f} = (0.0114\,\text{cm}^{-1})$ subs [1]

f = **87.5** cm ans [1] [2]

(iv) $\frac{1}{f}$ = power

power $= \frac{1}{87.5 \times 10^{-2}}$ subs [1]

Power = **1.14** D or e.c.f. from **(iii)** (ignore sign) ans [1] [2]

12

4 **(a)** **(i)**

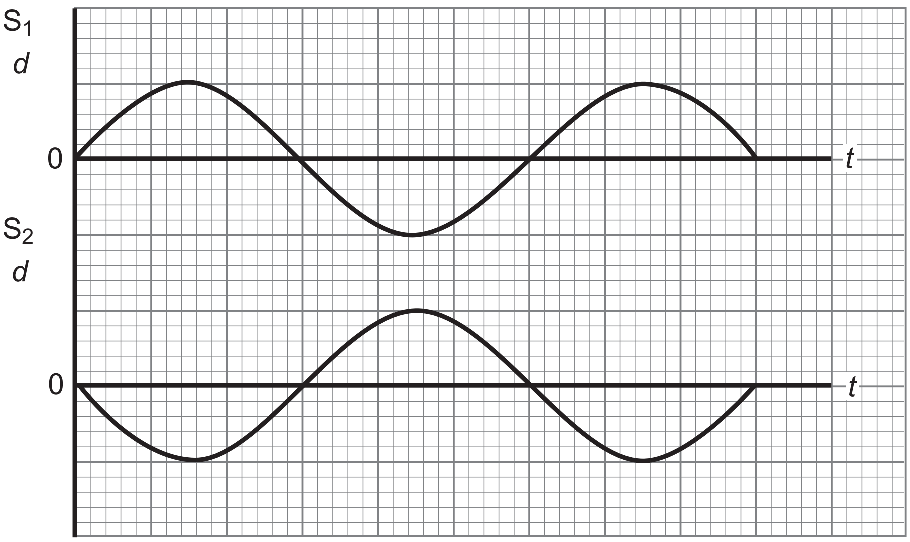
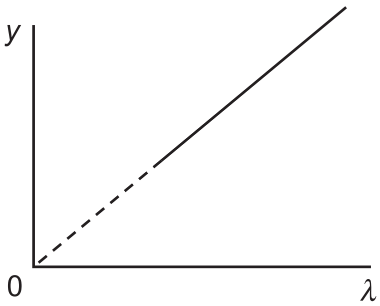


Fig. 4.1

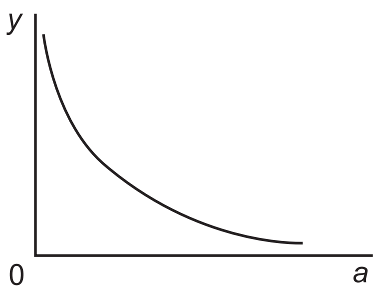
waves equal amplitude [1]
waves 180° phase difference [1] [2]

(ii) Waves (totally) **in phase** (or 360° out of phase) [not "coherent"] [1]

(b) **(i)**



Straight line
Through origin (tendency)



Correct decreasing curve
Asymptotic both axes
$4 \times 1 = $ [4]

(ii) $a = d\frac{\lambda}{y}$ (on sheet) $y = 0.042 \times 10^{-3}$ m [1]

$= \frac{1.3 \times 589 \times 10^{-9}}{0.042 \times 10^{-3}}$ (m) subs in eq [1]

Slit separation = **18.2 mm** ans [1] [3] 10

[36.4 mm, allow 2/3]

AVAILABLE MARKS

5 **(a)** 1. Consists of two bundles of optical fibres, one for illumination, the other for observation. [1]
2. Incoherent bundle provides illumination light using a random bundle of optical fibres (50 μm dia). [1]
3. Coherent bundle produces images for observation using fibres with the same spatial relationship at each end of the bundle. [1]
4. Coherent bundle may be connected to eyepiece or video camera to give appropriate images (or both). [1]
5. Control cables also present to allow manipulation for change of view or operate tools. [1]
6. Tube facility for irrigation purposes. [1]

or other **equivalent** point

any four different points [4]

(b) **(i)** **1 μs pulse** [1]
1 to 15 MHz [1]

(ii) 1. Action: US pulse sent out and the return signals received after reflections (echo) from boundary surfaces inside the body. [1]
2. Display: The returned signals (sometimes amplified) are displayed on a CRO. The horizontal trace of spikes (pulses) allow the time of return signals to be processed into depth/position information. [1]
3. Information: The information obtained e.g. position of boundaries, location of tumours, the thickness of organs etc. (common in ophthalmology, brain scans etc.) [1] [3]

(iii) A scan signal gives one dimensional *or* positional information, B scan gives two dimensional *or* image information. [1] [1]

Quality of written communication [2] 12

Quality of written communication

2 marks
The candidate expresses ideas clearly and fluently, through well-linked sentences and paragraphs. Arguments are generally relevant and well structured. There are few errors of grammar, punctuation and spelling.

1 mark
The candidate expresses ideas clearly, if not always fluently. Arguments may sometimes stray from the point. There are some errors in grammar, punctuation and spelling, but not such as to suggest a weakness in these areas.

0 marks
The candidate expresses ideas satisfactorily, but without precision. Arguments may be of doubtful relevance or obscurely presented. Errors in grammar, punctuation and spelling are sufficiently intrusive to disrupt the understanding of the passage.

AVAILABLE MARKS

6 (a) (i)

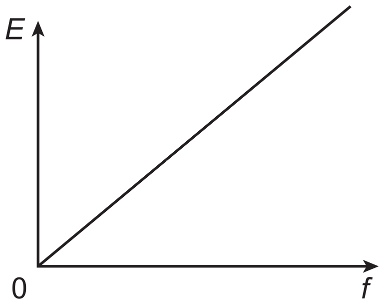


Fig. 6.1

Linear increase through origin [1]

(ii) **Incorrect** with appropriate explanation, e.g. Light (as photons) has different speeds in different media, hence speed not always the same. (It is constant in any particular medium.) [1] [2]

(b) The work function is the **minimum** [1] amount of (electromagnetic radiation) energy to release an electron from a metal. [1]
or The amount of (em radiation) energy to remove an electron [1] situated on the **surface** of a metal. [1] [2]

(c) $E_1 - E_2 = h\,f$ Eq [1]

[1]

$$f = \frac{(3.39 - 0.53) \times 1.6 \times 10^{-19}}{6.63 \times 10^{-34}}$$

eV to J [1] 3.39 – 0.53 = 2.86 [1] [2]

frequency = **6.90** × $\mathbf{10^{14}}$ Hz ans [1] [4] 8
[fails to convert to J, 4.31 × 10^{33} Hz, 2/4]

			AVAILABLE MARKS

7 (a) Reward . . . Suitable experiment + Experimental evidence e.g.

1. Wave behaviour: displayed in experiments of polarisation, diffraction *or* interference (e.g. with a diffraction grating; Young's slits) [1]

Evidence: Only waves explain the behaviour in such experiments mostly with a phase consideration in the explanation. Splitting of wavefront. [1]

2. Particle behaviour: displayed in the photoelectric experiment. [1]

Evidence: e.g. Max. KE depends on frequency, not intensity; or Immediate emission of electrons i.e. no accumulation effect of energy collection gradually as from waves. [1] [4]

(b) $\lambda = \pi \times 1.08 \times 10^{-10}$ (3.39×10^{-10}) subs **or** λ [1]

$\lambda = \frac{h}{p} = \frac{h}{mv}$ (on sheet)

conversion to $v = \frac{h}{\lambda m_{(e)}}$ [1]

$$v = \frac{6.63 \times 10^{-34}}{\pi \times 1.08 \times 10^{-10} \times 9.11 \times 10^{-31}}$$ subs [1]

Speed = $\mathbf{2.15 \times 10^{6}}$ m s^{-1} ans [1] [4] 8

Total **75**