Published Mark Scheme for GCE A2 Physics

January 2010

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

MARK SCHEMES (2010)

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.

CONTENTS

New Specification

Rewarding Learning

ADVANCED
General Certificate of Education
January 2010

Physics

Assessment Unit A2 1

assessing

Momentum, Thermal Physics, Circular Motion, Oscillations and Atomic and Nuclear Physics

[AY211]

THURSDAY 28 JANUARY, AFTERNOON

MARK SCHEME

AVAILABLE MARKS

1 **(a)** Momentum = *mv*
$= 0.5 \times 9$ — subs [1]
$= 4.5$ — ans [1]

Unit Ns or kg m s^{-1} accept 4500 g m s^{-1} $\rightarrow$ 2/3
(NOT kgm s^{-1}) — Unit [1]

(b) Momentum conserved
$0.1 \times 9 - 0.5 \times 9 = 0.6v_a$ — Correct Momenta [1] – sign [1] — subs [2]
Common velocity = 6 m s^{-1} — ans [1]
Direction = Same direction as 500 g originally or equivalent Dir — [1]

(c) Inelastic + (explanation)
KE is **NOT conserved** — [1] — 8

2 **(a)** **(i)** liquid; .... GIVEN Max 2/3 for SHC of **solid** experiment
Additional Items
1. Liquid container/vessel/calorimeter
2. Insulation provision for container/vessel/calorimeter
   e.g. lid OR box enclosure
3. Heater coil OR equivalent
4. Thermometer
5. Stirrer
6. Circuit ammeter and voltmeter OR wattmeter OR joulemeter
7. Variable power supply OR series variable resistor with battery
8. Timer or stopclock
9. Scales or balance

Any $6 \times \frac{1}{2}$
Round down — [3]

(ii)
- Below room temperature, surroundings supplies heat to apparatus, — [1]
- this compensates for heat loss when apparatus is above room temperature, hence heat exchange error minimised. — [1]

(b) **(i)** $12 \times 2.6 \times 410 = 0.075 \times 0.39 \times 10^3 \times 13 + 0.24 \times 13 \times SH$
energy in (12 792) = energy received (380.25) + (3.12 SH)
[1] [1] = subs [2]

$SH = 3.98 \times 10^3$ J kg^{-1} °C^{-1} (4.0×10^3)
S.E. 4100 J kg^{-1} K^{-1} $\rightarrow$ 1/3 ans [1]

(ii) Result is higher than accepted value. [1]

Explanation: heat losses do occur, hence modified heat balance equation is
Input energy – losses = same calculated heat received (from correct data)
Hence this will give a lower value for specific heat, so the previous value would be higher.
OR Equivalent [1] 10

3 **(a)** The angle turned through in unit time (s^{-1}).
OR Rate of change of angular displacement. [1]

(b)

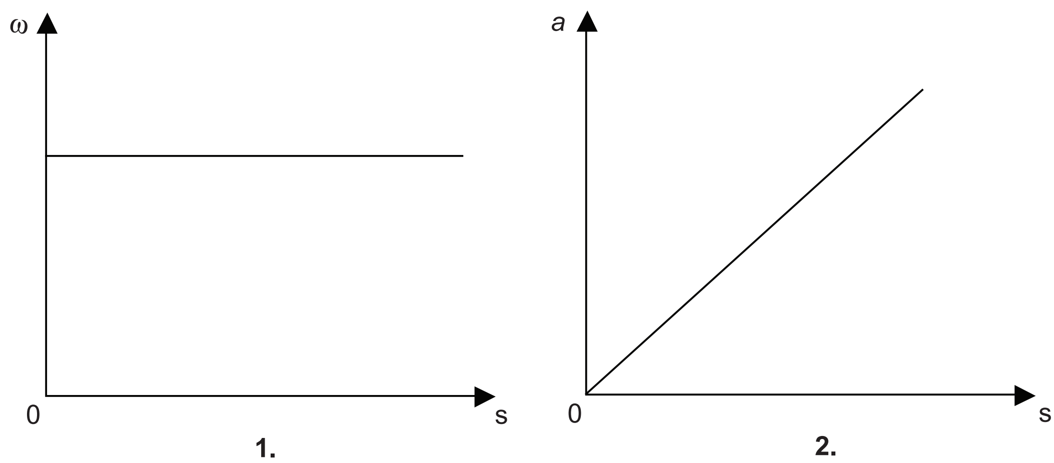


Fig 3.2

Horizontal straight line [1] Straight line through origin [1]
[2]

AVAILABLE MARKS

(c) **(i)** Angular velocity = $v/r = \frac{153}{600}$ Eqn or subs [1]

$= 0.255 \text{ rad s}^{-1}$ ans [1]

(ii) Acc = $v^2/r = \frac{153^2}{600}$ Eqn or subs [1]

$= 39.0 \text{ m s}^{-2}$ ans [1]

allow ecf for ω if using a = $\omega^2 r$ in **(c)(i)**

(iii) (Always) towards the centre of the turn or circle [1]

(iv) Force = $ma = 75 \times 39.0$ subs [1]

$= 2920$ N (2917.6) ans [1]

allow ecf for *a* from **(c)(ii)** 10

4 **(a)** **(i)** *x* is the displacement (of the mass) **from** the centre or fixed or equilibrium position (of the motion). [1]

(ii) Minus sign indicates the acceleration (or restoring force) is always opposite in direction to the displacement or towards the centre. [1]

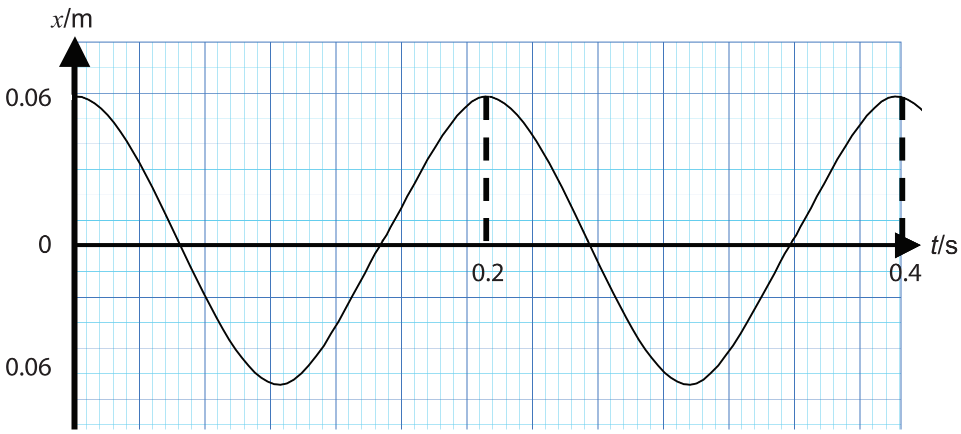
(b) **(i)** Displacement $x = A \cos \omega t$ on sheet

A = amplitude = 0.06 [1]

$\omega = 2 \times 3.14 \times 100/20$

$= 31.4$ (rad s^{-1}) accept 10π [1]

(ii)



Graph must start at +*x* for *t* = 0 (cos shape) [1]

x label 0.06 m corresponding to the amplitude [1]

t label corresponding to period 0.2 s [1]

AVAILABLE MARKS

(iii) 1. **Draw** a tangent (to curve at the required time instant) [1]
2. Measure the gradient of the tangent to obtain velocity [1]

(iv) Use of equation OR e.c.f. (b)(i) or (ii) for A
$x = 0.06 \cos (31.4 \times 0.13)$ subs [1]
(0.06 cos (234°)
x = (–)0.035 (m) consistent evaluation ans [1]

Displacement position is 0.035 m on **opposite** side of central position compared to start position.
statement OR equivalent [1] — 12

- Accept correct interpretation of their displacement
- Use of graph may score for position only.

5 **(a)** 1. Source of alpha-particles (radon gas)
2. **Fine (pencil)** beam of alpha-particles
3. **Thin** metal **foil** (gold)
4. Zinc sulph**ide** screen (scintillation/fluorescent screen)
5. Microscope (rotatable)
6. Vacuum in the container

$6 \times \frac{1}{2}$ (round up) [3]

(b) To detect alpha-particles **after** scatter. [1]
Each detected alpha-particle produces a scintillation (light flash) then observed by the microscope. [1]

(c) **(i)** Atom mostly empty space OR nucleus very small [1]

(ii) nucleus +ve (strong ES repulsion) **and** nucleus is very small (else there would be more direct back scatters.) [2] — 8

AVAILABLE MARKS

6 **(a)** **(i)** Time for half the number of radioactive <u>nuclei</u> (not "atoms", "particles" etc.) present to decay.
OR Time for the activity of radioactive sample to decay to half of some <u>initial</u> value. [1]

(ii) After 2 half-lives of X:
No. of X nuclei = $^{n}/_{4}$ [1]
No. of Y nuclei = $^{3n}/_{16}$ [1]
Ratio $^{Y}/_{X}$ = $^{3}/_{4}$ [1]

(b) **(i)** 210 g of polonium contains N_A nuclei (6.02×10^{23})
1.5 mg contains $6.02 \times 10^{23} \times 1.5 \times 10^{-3}/210$ nuclei ($= 4.3 \times 10^{18}$ nuclei)
subs OR number [1]

$A = \lambda N$ on sheet
$A = 5.8 \times 10^{-8} \times 4.3 \times 10^{18}$ subs [1]
$A = 2.49 \times 10^{11}$ (Bq) ans [1]

(ii) $A = A_0\, e^{-\lambda t}$ on sheet
$= 2.49 \times 10^{11}\, e^{-5.8 \times 10^{-8} \times 65 \times 24 \times 3600}$ ecf (b)(i) subs [1]
$= 2.49 \times 10^{11}\, e^{-0.325} = 1.80 \times 10^{11}$ [1]
No. remaining = $A/\lambda = 3.10 \times 10^{18}$ ans [1]

Or

$N = N_0\, e^{-\lambda t}$ Eqn [1]
$N = 4.3 \times 10^{18}\, e^{-0.325}$ Sub [1]
$N = 3.10 \times 10^{18}$ Ans [1] 10

AVAILABLE MARKS

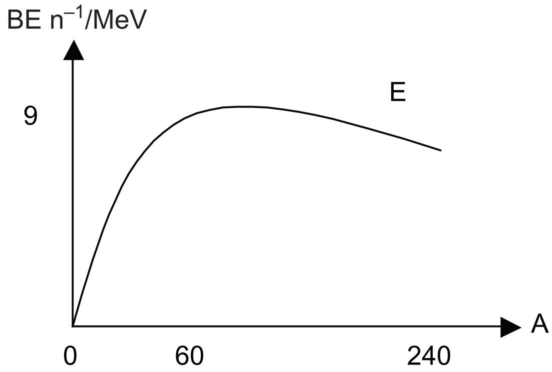
7 **Points of merit for evaluation, e.g.**

GRAPH

1. Axes + shape [1]

2. Establish scales $y \to$ 0-9, x $\to$ 60, 240 [1]

3. Fission or fusion region identified [1]



Mass and Energy

1. Mass deficit (reactants–products) gives higher binding energy and energy release.

2. Mass and energy are equivalent

3. $E = mc^2$ relationship quantifies energy from mass

4. Higher binding energy in processes yields mass deficit $\to$ Energy

Fission/fusion

1. Energy source processes fission/splitting or fusion/joining

2. Some detail of process but not operation detail

3. Fission output 1 Mev/nucleon

OR OTHER VALID POINTS

[1] per point, **max [3] per area**, to max [7]

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. [2] 9

AVAILABLE MARKS

8 **(a)** **(i)** Two light nuclei fusing together to form a heavier nucleus (with a higher BE/nucleon) (and a release of energy) [1]

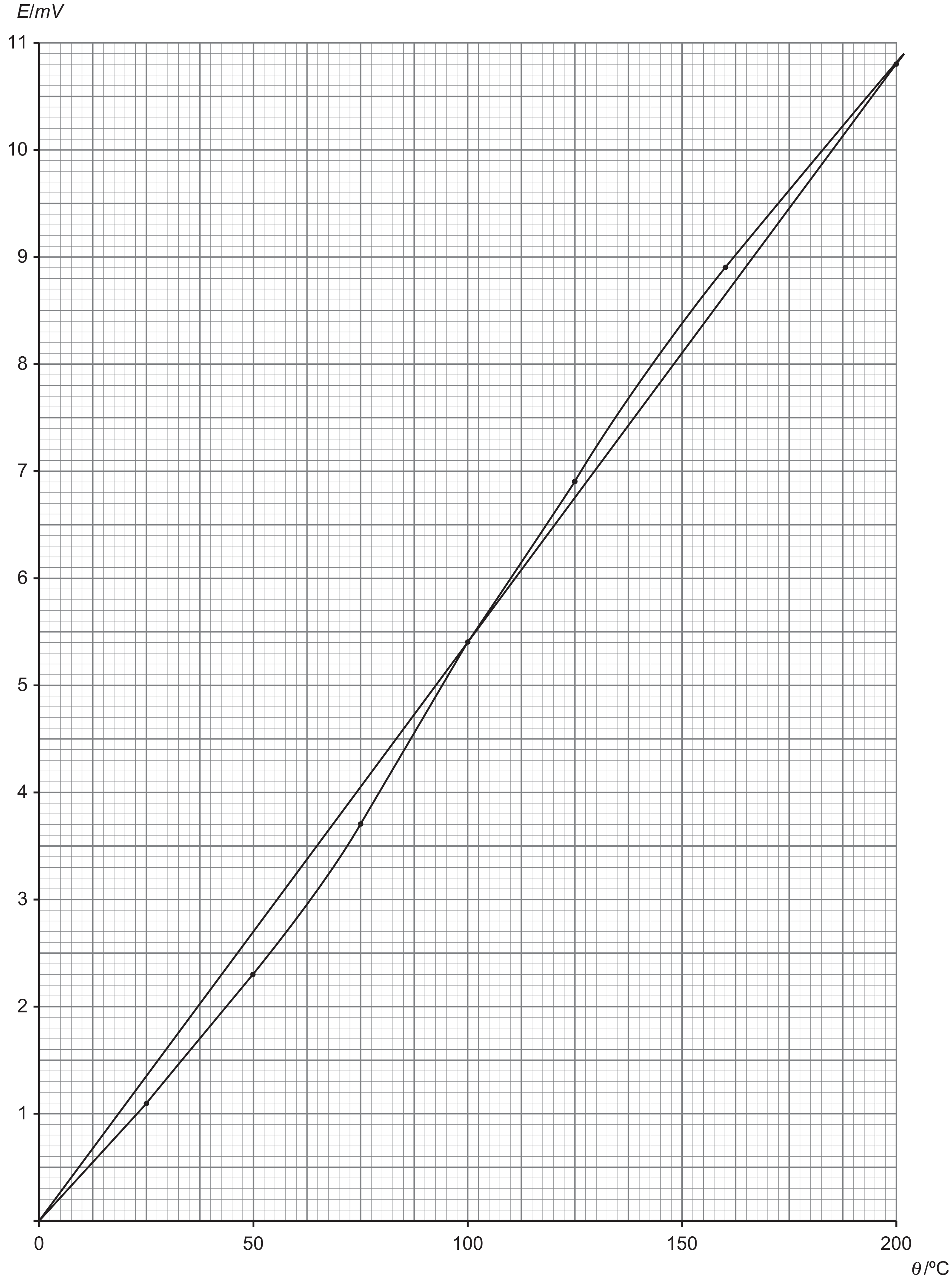
(ii) 1. The temperature required for this (deuterium-tritium) reaction is relatively lower than other reactions (e.g. D-D).
2. Energy yield (18 MeV per fusion) is good compared to other reactions e.g. D-D (3.7 MeV)
3. The plasma is "less difficult" to control long enough for fusion.
4. Abundance of fuel and detail
5. Single event reaction any two [2]
OR Any other equivalent reason

(b) Any two from:
electrons, + protons, (+) ions, nuclei [1]

(c) A plasma is a charged fluid (on which magnetic fields exert forces).
i.e. force or its action [1]
This contains the plasma away from the walls of the containment vessel which would cool/or slow down the nuclei and prevent fusion reactions, or not vaporise walls [1]

(d) $\frac{1}{2}m < c^2 > = \frac{3}{2}kT$ on sheet assume its use [1]
$T = \frac{2}{3} \times \frac{1}{2} \times 3.34 \times 10^{-27} \times (1.33 \times 10^6)^2 / 1.38 \times 10^{-23}$ subs [1]
Temperature = 1.43×10^8 K ans [1] 9

			AVAILABLE MARKS
9	**(a)** 2.295 to 2.304 mV	[1]	
	(b) Graph **Fig 9.2**: Scales on axes	[1]	
	Plot Points (–1 each error) ± 1 square	[2]	
	Sensible continuous curved line through points	[1]	
	(c) **(i)** Units = $mV°C^{-2}$	[1]	
	(ii) Work to be shown for *E* at 200 °C = 10.8 mV		
	$E = 5.21 \times 10^{-2} \times 200 + 0.950 \times 10^{-5} \times 200^2$	sub [1]	
	= 10.42 + 0.38 = (10.8 (mV))		
	either value given	ans [1]	
	(iii) Draw straight line through origin and point (10.8 mV)	[1]	
	(d) **(i)** e.g. Error at 8.0 mV = (143 – 148)	magnitude [1]	
	= –(4 to 6) °C consistent to graph ± 1 square	"–" sign [1]	
	(ii) Point Accuracy = (5 × 100/148) %		
	= (–)<u>3.5</u> % approx (constant with (d)(i))	[1]	
	(iii) Below circled	[1]	
	(e) Prose to indicate Point accuracy would remain the same (but the thermocouple would take longer to attain a stable temperature in any measurement situation (slower heat transfer)) OR Would not be suitable (accurate) for measuring rapidly changing temperatures.	[1]	14
		Total	**90**


E/mV
11
10
9
8
7
6
5
4
3
2
1
0
50
100
150
200
θ/ºC