GCE A2

Physics

Summer 2009

Mark Schemes

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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
General Certificate of Education
2009

Physics

Assessment Unit A2 1

assessing

Module 4: Energy, Oscillations and Fields

[A2Y11]

THURSDAY 21 MAY, AFTERNOON

MARK SCHEME

Subject-specific Instructions

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Note that this “correct answer” rule does not apply for 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)** (Total) momentum remains constant **or** (Total) momentum before collision = (total) momentum after	[1]		
Provided no external (**or** resultant) forces act **or** closed system	[1]	[2]	
(b) **(i)** $15 \times 10^{-3} \times 250 =$ **3.75 kg m s^{-1}**	[1]		
(ii) (Total momentum before = 0) Momentum of bullet forward = momentum of rifle backward [Not in terms of "action and reaction"]	[1]		
(iii) $4.2\,v = 3.75$ $v =$ (–)**0.89** m s^{-1} (**or** e.c.f. from **(b)(i)**)	[1]	[3]	
(c) **(i)** $3.75 = (3 + 15 \times 10^{-3})\,v$	[1]		
$v =$ **1.2(4)** m s^{-1} (**or** e.c.f. from **(b)(i)**) Omits mass of bullet, 0/2	[1]	[2]	
(ii) k.e. $= \frac{1}{2} m v^2$ $= \frac{1}{2}\,(3 + 15 \times 10^{-3})(1.24)^2$	subs [1]		
= **2.3(2) J** **or** e.c.f. from **(c)(i)**	[1]	[2]	
(iii) k.e. = mgh $h = (2.32)/(3 + 15 \times 10^{-3}) \times 9.81$	eqn [1]		
= **0.078 m** **or** e.c.f. from **(c)(i)**	subs, ans [1]	[2]	
(iv) (not all k.e. goes to p.e.,) some converted to sound or heat	[1]		
(v) **Momentum, total energy** (must have **both**)	[1]	[2]	13
2 **(a)** **(i)** **fixed mass**	[1]		
Explanation: Must have the same number of molecules **or** mass changes affect volume **or** pressure	[1]		
(ii) **Constant temperature**	[1]		
Explanation: Temperature changes affect the volume **or** pressure	[1]		
(iii) **inversely proportional to pressure**	[1]		
Explanation: volume decreases as pressure increases	[1]	[6]	
(b) **(i)** $p_1/T_1 = p_2/T_2$	eqn [1]		
$p_2 = 277 \times (301/285)$ (= 292.6 kPa)	subs [1]		
pressure above atmospheric = **190.6 kPa**, **191 kPa**	ans [1]	[3]	
(ii) Optimal tyre pressure can be used *or* Keeps tyre flat/car at correct height above ground *or* Best road grip	[1]	[1]	10

AVAILABLE MARKS

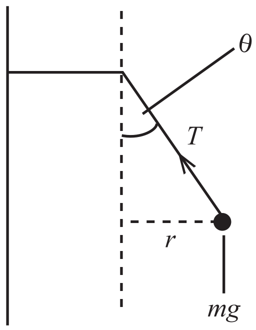
3 **(a)** **(i)** As seat goes round, swings outwards and upwards [1] [1]
or moves faster in a bigger circle
or moves faster and upwards

(ii) $T = 4.0\,\text{s} = 2\pi/\omega_1$
ω_1 = **π/2 or 1.57 rad s^{-1}** [1] [1]

(iii) 1. Seat moves in a circle (about rotating shaft) [1] [1]

2. Horizontal component [1]
Of tension in the chain (**or** from clear diagram) [1] [2]

(b) **(i)** $T \sin \theta = 12 \times 21$
or centripetal force = 12×21 [1]
$T \cos \theta = 12 \times 9.81$ [1]
$\tan \theta = 2.14$ $\quad \theta = 65.0°$ [1]
$T = \dfrac{12 \times 9.81}{\cos 65.0°}$ = **278 N** [1] [4]



(ii) $\sin 65.0 = \dfrac{r}{2.8}$ [1]
$r = 2.54$ **m** [1]
R = **4.94 m** **or** e.c.f. from their θ in **(b)(ii)** [1] [3] 12

4 **(a)** 800 rev per min = 13.3 Hz
or Mirror is forced to vibrate near its natural frequency [1]
Resonance **or** large vibrations (– hence image shakes) [1] [2]

(b) Image becomes clear [1]
Mirror vibrating much greater than **or** not at natural frequency
or at 50 Hz [1]
Amplitude of vibration is small **or** equivalent [1] [3]

(c) Yes **or** not completely [1]
Foam absorbs energy of vibration **or**
Vibrations are (heavily) damped **or** amplitude reduced [1] [2]

Quality of written communication [2] 9

					AVAILABLE MARKS
5	**(a)**	Force per unit charge	[1]		
		Positive charge	[1]	[2]	
	(b)	**(i)** $E_{Q1A} = (9 \times 10^9)(2 \times 10^{-6})/(x)^2$ correct eqn, correct subs	[1]		
		$E_{Q2A} = (9 \times 10^9)(4.5 \times 10^{-6})/(20 - x)^2$ i.e. use of (20 – 2)	[1]		
		$(9 \times 10^9)(2 \times 10^{-6})/(x)^2 = (9 \times 10^9)(4.5 \times 10^{-6})/(20 - x)^2$	[1]		
		$x =$ **8 cm** i.e. equates	[1]	[4]	
		(ii) Force = 0	[1]		
		$F = qE$	[1]	[2]	
		(iii) Moving against the opposing/repulsive force of Q_2,	[1]		
		This is greater than the helpingrepulsive force from Q_1,	[1]		
		refer to force × distance moved = energy	[1]	[3]	11

6 **(a)** **(i)** y – axis sin θ
x – axis λ **or** transposed (both) [1] [1]

(ii) Gradient of graph = A **or** consistent [1] [1]

(iii)

λ/nm	θ/°	sin θ
656	79.7	0.994
486	46.8	0.729
434	40.6	0.651
410	38.0	0.616
400	36.8	0.599

sin θ **or** sin (θ/°) Heading [1]
[not sin θ/°] values [2]
each error [–1]
3 significant figures [1] [4]

(iv) See attached
scale [1]
axes labelled [1]
points [2]
each error [–1]
straight line [1] [5]

(v) large triangle ⩾ 5 cm on one side [1]
subs [1]
answer (guide 1.5×10^6 lines/m) [1] [3]

(vi) shows that 400 nm gives sin θ >1 for $n = 2$ [2]
sin θ >1 not possible [1] [3]

(b) (i) (ignore unit or 10^n)

λ/nm	θ/°	$\sin\theta$	$A = \sin\theta/\lambda$
656	79.7	0.984	1.50×10^6
486	46.8	0.729	1.50×10^6
434	40.6	0.651	1.50×10^6
410	38.0	0.616	1.50×10^6
400	36.8	0.599	1.50×10^6

5 values of A@$\frac{1}{2}$, rounded up [3]

Average A = $\mathbf{1.50 \times 10^6}$ m^{-1} values not to 3 sf, –1 once only [1] [4]

(ii) Calculation better

Graph Can't plot to 3 s.f. **or** Scale does not allow accurate plotting [1]

Points very close together at lower end

Gradient of line subject to error

Choice of best straight line

Calculation gives consistently same value [3 × 1] [4]

or Graph better

very good straight line [1]

graph does averaging [1] [2]/[4]

(c) (i)

λ/mm	θ/°
656	29.5
486	21.4
434	19.0
410	17.9
400	17.5

5 values @$\frac{1}{2}$

All to 1 d.p. $\frac{1}{2}$ round down [3]

(ii) use of $n\lambda = d \sin\theta$ [1]

λ = 900 nm [1]

outside visible range [1] [3]

(iii) Unsuitable [1]

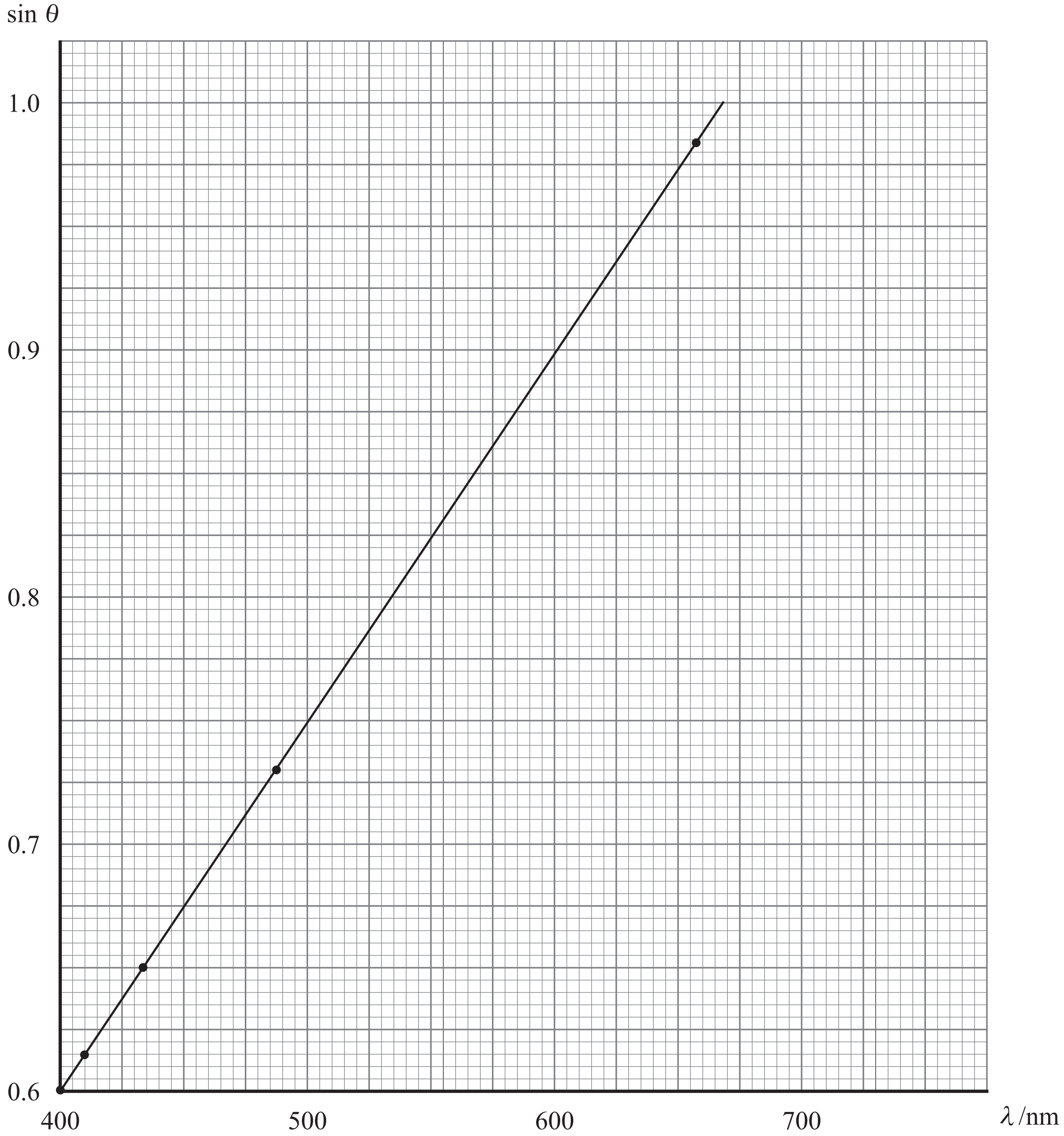
Angles, particularly at lower values, are very close [1]

Probably undetectable or not able to plot [1] [3]

(iv) Could use the second order [1] [1]

AVAILABLE MARKS
35

Total **90**


sin θ
1.0
0.9
0.8
0.7
0.6
400
500
600
700
λ /nm

Rewarding Learning

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2009

Physics

Assessment Unit A2 2

assessing

Module 5: Electromagnetism and Nuclear Physics

[A2Y21]

THURSDAY 28 MAY, MORNING

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AVAILABLE MARKS

1 **(a)** $E = \frac{1}{2}CV^2$ or C Q/V, $E = \frac{1}{2}Q/V$ eqn [1]
$V^2 = 5.76 \times 10^{-4} \times 2(2 \times 10^{-6})$ subs [1]
V_{C1} = **24.0 V** ans [1]
Repeat for V_{C2} = **12.0 V** ans [1]
or Reverse order [4]

(b) **(i)** Charge on $C_1 = (CV) = 2 \times 10^{-6} \times 24 = 48 \times 10^{-6}$ (C)
subs or value [1]
Charge on $C_2 = 8 \times 10^{-6} \times 12 = 96 \times 10^{-6}$ (C)
subs or value [1]
Total charge = $Q_{Total} = (48 + 96) \times 10^{-6}$ subs in correct eqn [1]
Total capacitance $C_{Total} = (2 + 8) \times 10^{-6}$ subs in correct eqn [1]
Potential Difference = (Q_{Total}/C_{Total}) = **14.4 V** ans [1]
allow ECF from (**a**) [5]
(15.2 V from assumption that energy conserved [2]/[5])

(ii) Prose to indicate
1. The total charge on the capacitors remains constant [1]
2. Charge *from the capacitor C_1* transfers *to the capacitor C_2* [1]
3. Why: from higher potential to lower potential [1]
4. Until the PD is equal across both capacitors [1] [4] 13

2 **(a)** **(i)** The magnitude of the induced e.m.f./voltage is (directly) proportional to the rate of change of flux linkage/cutting
or equal to
or equivalent (e.g. "produced", "generated" for "induced") [2]

(ii)

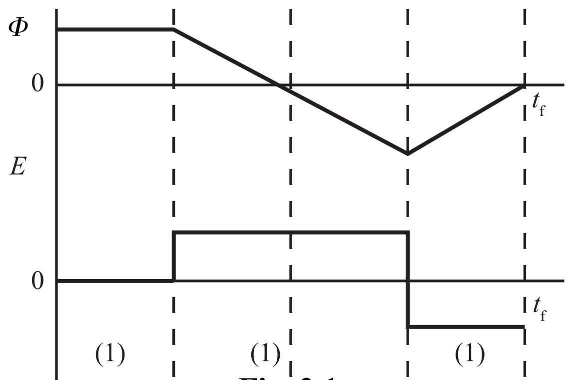

Fig. 2.1

Correct shape of E in three time periods of graph [3 × 1] [3] [5]
(inversion max 2/3)

(b) **(i)** $2\pi f = 314$ eqn [1]
f = **50** Hz ans [1]

(ii) $E = 320 \sin(314t)$ (given eqn 2.1)

$\sin(314t) = \frac{160}{320} = \frac{1}{2}$ subs in eqn [1]

$314t = \sin^{-1}(\frac{1}{2}) = \frac{\pi}{6}$ hence [1]

t = **1.66** ms (45.9 ms from deg/rad error, [2]/[3]; 2.5 ms from linear approximation, [2]/[3]) ans [1] [5] 10

AVAILABLE MARKS

3 (a) (i) The ratio of the charge **of an electron** to its mass (e/m_e) [1]
(e/m_e with terms defined [1])

(ii) Specific charge $= 1.6 \times 10^{-19}/9.11 \times 10^{-31}$ subs [1]
$= \mathbf{1.8 \times 10^{11}}$ any ans to 2 significant figures [1]
Unit **C kg^{-1}** [1] [4]

(b)

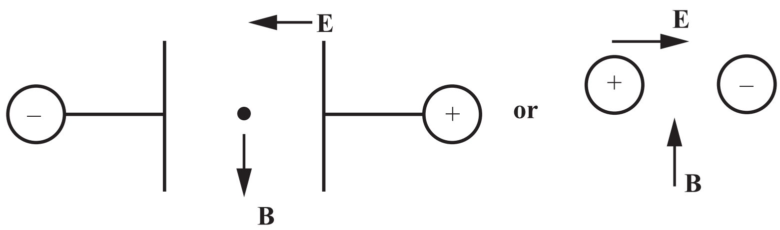

Fig. 3.1

Electric field polarity with corresponding **E** direction [1]
correct corresponding **B** direction [1]

Yes still null deflection. The force produced by each field would have the same magnitude but opposite direction, hence would still cancel for null deflection. (Explanation required)
or equivalent [1] [3]

(c) $B\,e\,v = E\,e$ eqns [1]
$v = 1.78 \times 10^4/1.5 \times 10^{-3}$ subs [1]
$v = \mathbf{1.19 \times 10^7}$ m s^{-1} ans [1] [3] 10

4 (a)

Table 4.1

Radiation	Speed/m s^{-1}	Range/cm	Ionisation Ability
α-particles	2×10^7	2.0	high
β-particles	2×10^8	10	medium
γ-radiation	3×10^8	2×10^3	low

9 correct [3] 7, 8 correct [2] 4, 5, 6 correct [1] [3]

(b) $A = 238 - 8(4) =$ Nucleon number $= \mathbf{206}$ [1]
$Z = 92 + 6 - 8(2) =$ Proton number $= \mathbf{82}$ [1] [2]

(c) (i) The number of disintegrations per second in a sample. [1]
(**not** "counts")

(ii) The decay constant is the fraction of the total number of nuclei present to decay per unit time/second [2]

or Probability per unit time that a nucleus will undergo decay.
In terms of half-life $0.693/t_{\frac{1}{2}} = \lambda$ allow [1]
In terms of constant to indicate relative instability allow [1]

AVAILABLE MARKS

(iii) $\lambda = \frac{0.693}{t_{\frac{1}{2}}} = \frac{0.693}{5} = 0.14$ (days) subs in eqn **or** value [1]

Use $A = A_0 e^{-\lambda t}$

$\frac{A}{A_0} = e^{-0.14(15/24)}$ subs in eqn [1]

$= 0.92$ [0.916] value [1]

Loss of activity = **8% (8.3%)** ans [1] [7] 12

5 (a) (i) bombard: direct (a beam of high speed) particles/ electrons to make impacts/collisions [1]

(ii) anode/s: (metal) electrode with positive charge or polarity w.r.t. another electrode (cathode) [1]

(iii) oil coolant: liquid used (to make good thermal contact) to remove or absorb/transfer heat energy [1]

(iv) seal: a region of contact designed to make a permanent joint or to keep something closed [1]

(v) melting point: **temperature** at which **solid** changes to **liquid** [1]

(vi) intensity: strength of (em) radiation **energy per unit time per unit area** ($J\,s^{-1}\,m^{-2}$ or $W\,m^{-2}$) **or** power per unit area [1]

(vii) bevelled edge: a shape cut at an angle or a slope made at the boundary or side (of the cylindrical disk) [1]

(viii) glow: Emit visible light (due to high temperature) **or** be luminous [1] [8]

(b) (i) Current = 75 mA = $75 \times 10^{-3}\,C\,s^{-1}$ **or** use of $I = Q/t$ [1]

Hence $75 \times 10^{-3} \times 1.5$ C [1]

$= \frac{75 \times 10^{-3} \times 1.5}{1.6 \times 10^{-19}}$ electrons [1]

(7.03×10^{17})

Number of electrons = 1% × 7.03×10^{17} = $\mathbf{7.03 \times 10^{15}}$ ans [1] [4]

(ii) Energy of electron = $1.6 \times 10^{-19} \times 60 \times 10^3$ (J) [1]

$(9.6 \times 10^{-15}$ J)

Energy in target ($Ms\Delta T$) = $11.3 \times 10^{-4} \times 142 \times \Delta T$ [1]

$11.3 \times 10^{-4} \times 142 \times \Delta T = 9.6 \times 10^{-15}$ equates energies [1]

ΔT = $\mathbf{6.00 \times 10^{-14}}$ **K** (5.98) ans [1] [4]

(iii) $n\Delta T = 1.3$

No of impacts $= \dfrac{1.3}{6.0 \times 10^{-14}}$ subs [1]

$= \mathbf{2.17 \times 10^{13}}$ ans [1] [2]

(or e.c.f. from **(ii)**)

(c) Prose to indicate

(i) Conduction from
1. Through glass tube wall from anode to oil
2. From tungsten target to copper anode
3. From hot (target) end of anode to cool end in oil
4. Through walls of enclosure to air

any 2 instances + heat flow (2 × [2]) [4]

(ii) Convection
1. Container of oil from tube to enclosure wall
2. From casing to air outside enclosure (residual gas inside tube)

any instance + heat flow [2] [6]

(d) **(i)** expansion of copper $= 48.5 \times 1.71 \times 10^{-5}\,\Delta T \sim$ (8.294×10^{-4} mm) [1]

expansion of glass $= 48.5 \times 1.63 \times 10^{-5}\,\Delta T \sim$ (7.906×10^{-4} mm) [1]

$\Delta T\,(8.29 - 7.91) \times 10^{-4} = 0.0045$ obtains the difference [1]

$\Delta T =$ **118 °C** = Temperature (in range 112 °C–118 °C) ans [1] [4]

(ii) Prose to indicate
1. vacuum lost or air leaks into tube [1]
2. electrons collide with air molecules **or** electrons have less energy [1]
3. tube current reduced **or** less e impacts on target [1]
4. emission of X-rays substantially reduced or stopped [1]
5. filament may burn out (oxidise) [1]

or other sensible point

any [4] from [5] [4]

Quality of written communication **(c)(i)**, **(ii)**: **(d)(ii)** [2]

meaning clear first reading
answer in context of question
satisfactory use of physics terms
effective spelling, punctuation and grammar

AVAILABLE MARKS

(e) **(i)** $A = 2\pi r \times \text{width}$ (allow $\pi r_1^2 - \pi r_2^2$) eqn
$= 2 \times 3.14 \times 42.0 \times 10^{-3} \times 2.3 \times 10^{-3}$ **or** subs [1]
$= \mathbf{6.07 \times 10^{-4}}\,\text{m}^2$ [1] [2]

(ii) $Q = \sigma T^4$
Energy emitted $= 5.7 \times 10^{-8} \times (1200 + 273)^4 \times 6.07 \times 10^{-4} \times 1.5$
temp [1] + other subs [1] [2]
heat loss = $\mathbf{2.44 \times 10^2}$ J ans [1] [3]
(or e.c.f from **(i)**)

(iii) Rate of emission $\propto T^4$
New rate $\propto (.9T)^4 = 0.656\,T^4$ [1]
Hence fractional reduction = (1 – 0.656) = 0.344 = **34.4%** ans [1] [2]
(Allow **40**%)

(f)

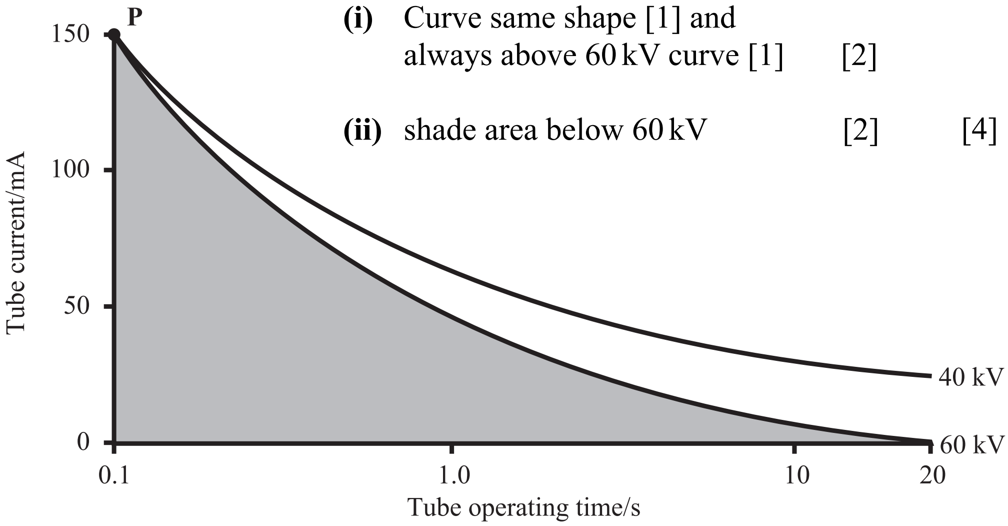

Fig. 5.3

(i) Curve same shape [1] and always above 60 kV curve [1] [2]

(ii) shade area below 60 kV [2] [4]

45

Total **90**

Rewarding Learning

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General Certificate of Education
2009

Physics

Assessment Unit A2 3A

assessing

Module 6: Particle Physics

[A2Y31]

WEDNESDAY 10 JUNE, AFTERNOON

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AVAILABLE MARKS

1 (a) (i) r_0 = (mean) nucleon radius or proton radius **or** (single) nucleon radius **Not** "proportionality constant" [1]
A = mass number **or** nucleon number **or** number of protons and neutrons [1] [2]

(ii) $2.50 \times 10^{-15} = r_0\,(4 + 5)^{1/3}$ subs [1]
$r_0 = 1.20 \times 10^{-15}$ m [1]
r_0 = **1.2(0) fm** [1] [3]
(Recall answer only, no calculation, [1]/[3])

(iii) $\log_{10} r = \log_{10} r_0 + \frac{1}{3}\log_{10} A$ [1]
Intercept C = **0.0792** ("log 1.2" [0]) ("–14.9" [0]) [1]
Gradient m = **1/3 (0.333)** [1] [3] 8
(e.c.f. from **(ii)** for C)

2 (a) Plentiful fuel supply, **or** little radioactivity produced, **or** no greenhouse gas or acid rain emissions **or** can't get out of control other valid point [1]
("safe" [0] without explanation)

(b) (i) Electrons and ions (and free nuclei) **or** ionised gas [1]
(No credit for "hot")

(ii) Magnetic confinement [1]
To hold the plasma away from the walls so that KE or temperature is not reduced [1] [2]

(iii) Proton KE must be greater than proton–proton repulsion energy [1]

(iv) $E = \Delta mc^2$ [1]
$E = 1.66 \times 10^{-27}(2.014102 + 3.016049 - 4.002603 - 1.008665) \times (3.00 \times 10^8)^2$ [1]
mass defect to energy conversion [1]
E = **17.6 (MeV)** [1] [4] 9
or use 931 or 934 MeV = 1 u

3 (a) (i) Bottom terminal **NEGATIVE**, top **POSITIVE** [1]
Repelled from the electrode B, it leaves and is attracted to the next one C [1] [2]

(ii) Electron in (successive) drift tubes for same length of time [1]

(b) $3 \times 1.6 \times 10^{-19}$ [1]
200×10^3 = $\mathbf{9.6 \times 10^{-14}}$ **J** [1] [2]
(omits 3× (3.2×10^{-14} J) [1]/[2])

(c) (i) Top box – **antielectron or positron**, bottom box – **antiproton** [1]

(ii) (Each pair) have same mass and opposite charge **or** opposite spin [1] 7
(similarity) (difference)

AVAILABLE MARKS

4 (a) Have a quark triplet structure [1]

(b) (i) (1) Decays **1** and **2** [1]

(2) **Strangeness not conserved** [1]

(ii) **Baryon number not conserved** [1]
(Not "strangeness not conserved" as well)

(iii)

Force	Gauge Boson
Strong	**Gluon**
Weak	$W^+ W^- Z^0$
Gravitational	**Graviton**
Electromagnetic	photon

$4 \times [\frac{1}{2}]$, round down [2] 6

5 (a) ${}_1n_2 = c_1 / c_2$ or $2.42 = 3.00 \times 10^8 / c_2$ eqn or subs [1]
$c_{diamond} = \mathbf{1.24 \times 10^8}$ (m s^{-1}) [1] [2]

(b) (i) Electron behaves as wave [1]
Regularity in atomic arrangement [1]
In order to get observable diffraction [1] [3]

Quality of written communication [1]

(ii) $0.1 \times 10^{-9} = 6.63 \times 10^{-34} / p$ subs in de Broglie eqn [1]
$p = 9.11 \times 10^{-31} v$ [1]
$v = \mathbf{7.3 \times 10^6\ (7.28 \times 10^6)}$ (m s^{-1}) [1] [3]

(c) (i) $E = \dfrac{Fl}{Ax}$ or $F = \dfrac{EAX}{l}$ eqn [1]

$F = 1.1 \times 10^{12} \times \frac{\pi}{4}(1.2 \times 10^{-9})^2 \times 0.15 \times 10^{-6}/80 \times 10^{-6}$ subs [1]

$F = \mathbf{2.3 \times 10^{-9}}$ N ans [1] [3]

(ii) Energy $= 0.5 \times 2.3 \times 10^{-9} \times 0.15 \times 10^{-6}$ (e.c.f. **(i)**) [1]
Energy $= \mathbf{1.7 \times 10^{-16}}$ **(J)** [1] [2]

				AVAILABLE MARKS
(d) **(i)** mA in series and mV in parallel			[1]	
(ii) Linear graph through origin			[1]	
(iii) $I = nAve$	eqn or recognisable subs [1]			
$R = \rho l/A$	eqn or recognisable subs [1]			
$V = IR$	eqn or recognisable subs [1]			
$v = \mathbf{2.4 \times 10^{-6}}$ (m s^{-1})	ans [1]		[4]	20
			Total	**50**

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Assessment Unit A2 3B

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Module 6: Experimental and Investigative Skills

Session No. 1

[A2Y32]

MONDAY 18 MAY, AFTERNOON

MARK SCHEME

					AVAILABLE MARKS
1	**(a)**		Timing a stated number of oscillations (≥3)	[1]	
			Repeat and average	[1]	
			Calculating ***T*** correctly	[1]	
			5 sets of values	[1]	
			d in mm	[1]	
			consistent d.p. in ***T*** column	[1]	
	(b)		Diameter recorded to ± 0.01mm, in range **0.27 mm–0.33 mm**	[1]	
			Correct error (0.01mm or 0.005mm)	[1]	
			Percentage error correctly calculated (allow e.c.f. on their values, expect ~3% or ~1.5%)	[1]	
	(c)		Headings & units e.g. 1g (***T***/s) both	[1]	
			log **d** correctly calculated	[1]	
			log **T** correctly calculated	[1]	
	(d)	**(i)**	Points correctly plotted	[2]	
			Axis labelled & units consistent with table	[1]	
			Scale as instructed for x – axis; y – axis to spread points over >2cm	[1]	
			Best fit line	[1]	
		(ii)	Large triangle (≥5cm one side)	[1]	
			Correct values into equation	[1]	
			Correct gradient (quality **1.8-2.2**)	[1]	
		(iii)	Read off intercept correctly **or**	[2]	
			Subs of values from best fit line into $y = mx + c$	[1]	
			or Correct intercept from their values	[1]	
		(iv)	1g ***A*** = their intercept	[1]	
			Reason: Compare $y = mx + c$ with log form of equation	[1]	
			Take Antilog of intercept	[1]	25

AVAILABLE MARKS

2 **(b)** 1 mark each set of readings for θ, t (including 0°) [5]

(c) **(i)** length recorded **to nearest mm** [1]
error ± 0.05 or ± 0.1 cm or ± 0.2 cm [1]

(ii) Correct values calculated [1]

(iii) flow rate changes [1]
rate decreases as water flows out [1]

(iv) judgement of when passes marker A/B
Error in measuring length, e.g. metre rule, parallax (two possible)
Error in timing
Any 3, 1 mark each [3]

(v) **0**
water is moving faster therefore it is more difficult to make judgement [2]
or
55° – water is at a bigger angle therefore it is difficult to judge when it is moving past the marker [2]

(d) **(i)** Values of cos θ calculated [1]
Sig Fig consistently 2 or 3 (ignore $\theta = 0$) [1]

(ii) $R = k \cos \theta$ [1]
Calculation of k for at least 3 values [1]
Conclusion consistent with result [1]

(iii) axes: R and cos θ [1]
Straight line [1]
Through origin [1]

(iv) Points are **not close to origin** [1]
Difficult to judge if it is a straight line through origin [1] 25

				AVAILABLE MARKS
3	**(a)**	12×1.60 mm	[1]	
		1.92 cm	[1]	
	(b)	Measure x with ruler or vernier Measure s with metre rule or ruler Range spread between 0 cm and 9 cm At least 5 values Method of marking impact point eg sand tray, carbon paper on ground Repeat and average s values for each compression	1 each [6]	
		QWC	[1]	
	(c)	Equates ½ mv^2 and ½ kx^2	[1]	
		Evidence of rearranging to correct equation	[1]	
	(d)	**(i)** Get a range of values of F and x (extension or compression)	[1]	
		Either use $F = kx$ or plot F against x	[1]	
		Calculate k for at least 3 sets of readings & average or k = gradient of graph	[1]	
		(ii) Large percentage error	[1]	
		weigh a number of ball bearings together	[1]	
		Divide by the total number	[1]	
		(iii) Graph of s against x	[1]	
		Find gradient	[1]	
		$A = \text{gradient} \sqrt{\dfrac{m}{k}}$	[1]	20
			Total	**70**

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Assessment Unit A2 3B

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Module 6: Experimental and Investigative Skills

Session No. 2

[A2Y33]

WEDNESDAY 20 MAY, MORNING

MARK SCHEME

					AVAILABLE MARKS
1	(a)		Value of d to nearest mm	[1]	
			Timing a stated number of oscillations (≤3)	[1]	
			Repeat and average	[1]	
			Calculating T correctly	[1]	
			5 sets of values	[1]	
			Consistency of d.p. in T column	[1]	
	(b)		Diameter recorded to ± 0.01mm, in range 0.27mm – 0.33mm	[1]	
			Correct error 0.01mm or 0.005mm	[1]	
			Percentage error calculated	[1]	
	(c)		Headings & units eg 1g (T/s), 1gn	[1]	
			log n correctly calculated	[1]	
			log T correctly calculated	[1]	
	(d)	(i)	Points correctly plotted	[2]	
			Axis labelled & units consistent with table	[1]	
			Scale x axis to include 1gT = 0, y axis to spread points over > 2cm	[1]	
			Best fit line	[1]	
		(ii)	Large triangle	[1]	
			Correct values into equation	[1]	
			Correct gradient quality **-1.8- -2.2**) Includes negative sign	[1]	
		(iii)	Read off intercept correctly **or**	[2]	
			Subs of values from best fit line into $y = mx + c$	[1]	
			Correct intercept	[1]	
		(iv)	1g A = their intercept	[1]	
			Reason: Compare $y = mx + c$ with log form of equation	[1]	
			Take Antilog of intercept	[1]	25

				AVAILABLE MARKS
2	**(b)**	1 mark each set of readings for θ, t (including 0°)	[5]	
	(c) **(i)**	length recorded **to nearest mm** error ± 0.05cm or ± 0.1cm or ± 0.2cm	[1] [1]	
	(ii)	Correct values calculated	[1]	
	(iii)	time changes time increases as water flows out	[1] [1]	
	(iv)	judgement of when passes marker A or B Error in measuring length eg metre rule [1], parallax [1] Error in timing Any 3, 1 mark each	[3]	
	(v)	**0** water is moving faster therefore it is more difficult to make judgement **or** **55°** – water is at a bigger angle therefore it is difficult to judge when it is moving past the marker.	[2] [2]	
	(d) **(i)**	Values of $1/\cos\theta$ calculated Sig Fig 3 or 4 (ignore $\theta = 0$)	[1] [1]	
	(ii)	$T = k/\cos\theta$ Calculation of k for at least 3 values Conclusion consistent with result	[1] [1] [1]	
	(e) **(i)**	axes: T and $1/\cos\theta$ Straight line Through origin	[1] [1] [1]	
	(ii)	Points are **not close to origin** Difficult to judge if it is a straight line through origin	[1] [1]	25

				AVAILABLE MARKS
3	**(a)**	12 × 0.80mm **0.96cm**	[2]	
	(b)	Measure x with ruler or vernier Measure s with metre rule or ruler Range spread over 0 to 13cm At least 5 values Method of marking impact point eg sand tray, carbon paper on ground Repeat and average s values for each compression 1 each, max 6	[6]	
		QWC	[1]	
	(c)	Equates ½ mv^2 and ½ kx^2 Evidence of rearranging to correct equation	[1] [1]	
	(d)	**(i)** Get a range of values of F and x Either use $F = kx$ or plot F against x Calculate k for at least 3 sets of readings & average or k = gradient of graph	[1] [1] [1]	
		(ii) Large percentage error weigh a number of ball bearings together Divide by the total number	[1] [1] [1]	
		(iii) Graph of x against s Find gradient A = gradient $\sqrt{\frac{k}{m}}$	[1] [1] [1]	20
			Total	**70**