OCR
RECOGNISING ACHIEVEMENT

GCE

Physics A

Advanced GCE **7883**

Advanced Subsidiary GCE **3883**

Mark Schemes for the Units

June 2007

3883/7883/MS/R/07

OCR (Oxford, Cambridge and RSA Examinations) is a unitary awarding body, established by the University of Cambridge Local Examinations Syndicate and the RSA Examinations Board in January 1998. OCR provides a full range of GCSE, A level, GNVQ, Key Skills and other qualifications for schools and colleges in the United Kingdom, including those previously provided by MEG and OCEAC. It is also responsible for developing new syllabuses to meet national requirements and the needs of students and teachers.

This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by Examiners. It does not indicate the details of the discussions which took place at an Examiners' meeting before marking commenced.

All Examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the Report on the Examination.

OCR will not enter into any discussion or correspondence in connection with this mark scheme.

Any enquiries about publications should be addressed to:

OCR Publications
PO Box 5050
Annesley
NOTTINGHAM
NG15 0DL

Telephone: 0870 870 6622
Facsimile: 0870 870 6621
E-mail: publications@ocr.org.uk

CONTENTS

GCE Physics A (7883)

Advanced Subsidiary GCE Physics (3883)

MARK SCHEMES FOR THE UNITS

Mark Scheme 2821
June 2007

ADVICE TO EXAMINERS ON THE ANNOTATION OF SCRIPTS

1. Please ensure that you use the **final** version of the Mark Scheme.
   You are advised to destroy all draft versions.

2. Please mark all post-standardisation scripts in red ink. A tick (✓) should be used for each answer judged worthy of a mark. Ticks should be placed as close as possible to the point in the answer where the mark has been awarded. The number of ticks should be the same as the number of marks awarded. If two (or more) responses are required for one mark, use only one tick. Half marks (½) should never be used.

3. The following annotations may be used when marking. No comments should be written on scripts unless they relate directly to the mark scheme. Remember that scripts may be returned to Centres.

   x = incorrect response (errors may also be underlined)
   ^ = omission mark
   bod = benefit of the doubt (where professional judgement has been used)
   ecf = error carried forward (in consequential marking)
   con = contradiction (in cases where candidates contradict themselves in the same response)
   sf = error in the number of significant figures

4. The marks awarded for each part question should be indicated in the margin provided on the right hand side of the page. The mark total for each question should be ringed at the end of the question, on the right hand side. These totals should be added up to give the final total on the front of the paper.

5. In cases where candidates are required to give a specific number of answers, (e.g. 'give three reasons'), mark the first answer(s) given up to the total number required. Strike through the remainder. In specific cases where this rule cannot be applied, the exact procedure to be used is given in the mark scheme.

6. Correct answers to calculations should gain full credit even if no working is shown, unless otherwise indicated in the mark scheme. (An instruction on the paper to 'Show your working' is to help candidates, who may then gain partial credit even if their final answer is not correct.)

7. Strike through all blank spaces and/or pages in order to give a clear indication that the whole of the script has been considered.

8. An element of professional judgement is required in the marking of any written paper, and candidates may not use the exact words that appear in the mark scheme. If the science is correct and answers the question, then the mark(s) should normally be credited. If you are in doubt about the validity of any answer, contact your Team Leader/Principal Examiner for guidance.

Mark Scheme Page 1 of 6	Unit Code 2821	Session JUNE	Year 2007	Version FINAL
Abbreviations, annotations and conventions used in the Mark Scheme	/ = alternative and acceptable answers for the same marking point ; = separates marking points NOT = answers which are not worthy of credit ( ) = words which are not essential to gain credit ___ = (underlining) key words which **must** be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument			

Question 1	Expected Answers	Marks
1 (a) (i) 1	**Horizontal component = 24cos30** **= 21 (20.8) (N)**	**C1** **A1**
2	**vertical component = 24sin30** **= 12 (12.0) (N)**	**A1**
(ii)	**vertical force = 65 + 12** **= 77**	**M1** **A0**
(iii)	**horizontal force = 20.8 (note ecf for 20.8 component)** **resultant = $[(77)^2 + (20.8)^2]^{1/2}$** **= 80 (79. 8) (N)** **(or by vector triangle need correct labels and arrows for C1 mark)**	**C1** **A1**
(iv)	**80 (79.8)(N) / equal to (iii) allow ecf** **the resultant force needs to be zero or forces need to balance above value to give no acceleration or constant velocity**	**B1** **B1**
(b) (i)	**P = F / A** **= 77 / 4.2 x 10^{-3}** **= 18000 (18333) (Pa)**	**C1** **A1**
(ii)	**more / increases** **downward / vertical component (of P) will be greater (for larger angles)**	**B1**
		Total: 11

Mark Scheme Page 2 of 6	Unit Code 2821	Session JUNE	Year 2007	Version FINAL
Abbreviations, annotations and conventions used in the Mark Scheme	/ = alternative and acceptable answers for the same marking point ; = separates marking points NOT = answers which are not worthy of credit ( ) = words which are not essential to gain credit ___ = (underlining) key words which **must** be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument			

Question	Expected Answers	Marks
2 (a)	**The(single) point where the weight of an object (may be taken to) acts** **Weak answers score one only e.g. where the weight acts**	**B2**
(b) (i) 1	**The (distribution of the) mass of the lawn mower is not uniform**	**B1**
2	**One correct moment about A stated**	
	B x 110 or 350 x 20	**B1**
	B = (350 x 20) / 110 (moments equated)	**B1**
	B = 63.6 (N)	**A0**
3	**A = 350 – 63.6 = 286(.4) (N)**	**A1**
(b)(ii)	**A goes down and B goes up**	**B1**
	Turning effect of B is less / B needs greater force to produce the same moment / if distance goes down force needs to go up (to maintain the same turning effect)	**B1**
		Total: 8

Mark Scheme Page 6 of 6	Unit Code 2821	Session JUNE	Year 2007	Version FINAL
Abbreviations, annotations and conventions used in the Mark Scheme	/ = alternative and acceptable answers for the same marking point ; = separates marking points NOT = answers which are not worthy of credit ( ) = words which are not essential to gain credit ___ = (underlining) key words which **must** be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument			

Question 6	Expected Answers	Marks
6 (a)	**Vertical motion:** • **Initial speed (down) is zero** • **Initial acceleration (down) is g / 9.8 m s^{-2}** • **Initial force (down) is weight / no drag force** • **Speed (down) increases** • **Acceleration decreases** • **Drag force increases (with speed) / force is weight – air resistance** • **Reaches terminal velocity / speed is constant** • **Acceleration is zero** • **Drag force equals weight** **Maximum of 5 marks for vertical motion** **Horizontal motion:** • **Initial velocity is the same as the aircraft** • **Air resistance will reduce this horizontal velocity**	
	Maximum of six marking points required	**B6**
(b)	• **Reduce air resistance** • **Fall head first / fall vertically / reduce area in direction of fall** • **Fall with arms to the side / in line with body / streamline body** • **Wear tight fitting clothes / smooth surface**	
	Good physics mark	
	Maximum of four marking points required	**B4**
QWC	**SPAG (greater than two errors)**	**B1**
	TECHNICAL LANGUAGE	**B1**
		Total: 12

Mark Scheme Page 3 of 6	Unit Code 2821	Session JUNE	Year 2007	Version *FINAL*
Abbreviations, annotations and conventions used in the Mark Scheme	/ = alternative and acceptable answers for the same marking point ; = separates marking points NOT = answers which are not worthy of credit ( ) = words which are not essential to gain credit ____ = (underlining) key words which **must** be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument			

Question	Expected Answers	Marks
3 (a) (i)	$s = ut + ½ at^2$	C1
	$1.20 = 0 + ½ \times 9.81 \times t^2$ or $u = 0$ and $s = ½ \times a \times t^2$	A1
	$t^2 = 2.4 / 9.81 / 0.2446$	A1
	$t = 0.494(6)$ s	A0
(ii) 1	horizontal component = distance / time	C1
	$= 11.9 / 0.495$	
	$= 24.0(6)$ (m s^{-1})	A1
2	vertical component = u + at	C1
	$= 0 + 9.81 \times 0.495$	
	$= 4.86$ (m s^{-1})	A1
(b)	(loss of / change in) potential energy = mgh	C1
	$= 6 \times 10^{-2} \times 9.81 \times 1.2$	
	= 0. 71 (0.706)(J) 2 sf needed	A1
		Total: 9

Mark Scheme Page 4 of 6	Unit Code 2821	Session JUNE	Year 2007	Version FINAL
Abbreviations, annotations and conventions used in the Mark Scheme	/ = alternative and acceptable answers for the same marking point ; = separates marking points NOT = answers which are not worthy of credit ( ) = words which are not essential to gain credit ___ = (underlining) key words which **must** be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument			

Question	Expected Answers	Marks
4 (a)	**Young modulus = stress / strain**	**B1**
(b) (i)	**Density = mass / volume** **Area x length = mass / density** **Area = (2.0 x 10^{-3}) / (7800 x 0.5) or 2.56 x 10^{-7} / 0.5** **= 5.1(3) x 10^{-7} m^2**	**B1** **B1** **A0**
(ii)	**E = (F x l) / (A x e) / stress = F / A (1.6 x 10^{8} and strain = e / l (8 x 10^{-4})** **F = (E x A x e) / l** **= (2 x 10^{11} x 5.1 x 10^{-7} x 4.0 x 10^{-4}) / 0.5** **=82 (N) (81.6)**	**C1** **C1** **A1**
(iii)	**Diameter for D is half G hence area is ¼ of G** **Extension is 4x greater** **Tension required is the same = 82 (N)**	**A1**
(iv)	**The extension is proportional to the force / Hooke's law (OWTE)**	**B1**
		Total: 8

Mark Scheme Page 5 of 6	Unit Code 2821	Session JUNE	Year 2007	Version FINAL
Abbreviations, annotations and conventions used in the Mark Scheme	/ = alternative and acceptable answers for the same marking point ; = separates marking points NOT = answers which are not worthy of credit ( ) = words which are not essential to gain credit ___ = (underlining) key words which **must** be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument			

Question	Expected Answers	Marks
5 (a)	**Large surface area (of tyres) (in contact with road)** **large area in contact with the road**	**B1**
(b)(i)	**$K = ½ mv^2$**	**C1**
	$= 0.5 \times 3000 \times (26)^2$	**C1**
	$= 1014000$ (J) 1.01×10^6(J)	**A1**
(ii)	**$v^2 = u^2 + 2as$** **$a = -26^2 / (2 \times 52)$**	
	deceleration = 6.5	**A1**
	unit: $m\ s^{-2}$	**B1**
(iii)	**using F = ma** **or work done = F x d**	**C1**
	$= 3000 \times 6.5$ **$F = 1.01 \times 10^6 / 52$**	
	= 19500 (N) **= 19400 (N)**	**A1**
(c)(i)	**smooth / rough surface less / more friction longer / shorter distance** **ice surface less friction greater distance** **dry / wet more / less friction longer / shorter distance** **up slope / down slope refer to weight component and effect** **smaller mass**	**B2 max**
(ii)	**same force gives larger deceleration** **or less braking force (from off-road) B1 gives less deceleration B1**	**B1** **B1**
		Total: 12

Mark Scheme 2822
June 2007

ADVICE TO EXAMINERS ON THE ANNOTATION OF SCRIPTS

1 Please ensure that you use the **final** version of the Mark Scheme.
You are advised to destroy all draft versions.

2 Please mark all post-standardisation scripts in red ink. A tick (✓) should be used for each answer judged worthy of a mark. Ticks should be placed as close as possible to the point in the answer where the mark has been awarded. The number of ticks should be the same as the number of marks awarded. If two (or more) responses are required for one mark, use only one tick. Half marks (½) should never be used.

3 The following annotations may be used when marking. No comments should be written on scripts unless they relate directly to the mark scheme. Remember that scripts may be returned to Centres.

x	= incorrect response (errors may also be underlined)
^	= omission mark
bod	= benefit of the doubt (where professional judgement has been used)
ecf	= error carried forward (in consequential marking)
con	= contradiction (in cases where candidates contradict themselves in the same response)
sf	= error in the number of significant figures
10^n	= error in the power of 10 in a calculation
wp	= wrong physics (e.g.: quoting an erroneous equation)
naq	= Not answered question

4 The marks awarded for each part question should be indicated in the margin provided on the right hand side of the page. The mark total for each question should be ringed at the end of the question, on the right hand side. These totals should be added up to give the final total on the front of the paper.

5 In cases where candidates are required to give a specific number of answers, (e.g. 'give three reasons'), mark the first answer(s) given up to the total number required. Strike through the remainder. In specific cases where this rule cannot be applied, the exact procedure to be used is given in the mark scheme.

6 Correct answers to calculations should gain full credit even if no working is shown, unless otherwise indicated in the mark scheme. (An instruction on the paper to 'Show your working' is to help candidates, who may then gain partial credit even if their final answer is not correct.)

7 Strike through all blank spaces and/or pages in order to give a clear indication that the whole of the script has been considered.

8 An element of professional judgement is required in the marking of any written paper, and candidates may not use the exact words that appear in the mark scheme. If the science is correct and answers the question, then the mark(s) should normally be credited. If you are in doubt about the validity of any answer, contact your Team Leader/Principal Examiner for guidance.

CATEGORISATION OF MARKS

The marking schemes categorise marks on the MACB scheme.

B marks: These are awarded as independent marks, which do not depend on other marks. For a **B**-mark to be scored, the point to which it refers must be seen specifically in the candidate's answers.

M marks: These are method marks upon which **A**-marks (accuracy marks) later depend. For an **M**-mark to be scored, the point to which it refers must be seen in the candidate's answers. If a candidate fails to score a particular **M**-mark, then none of the dependent **A**-marks can be scored.

C marks: These are compensatory method marks which can be scored even if the points to which they refer are not written down by the candidate, providing subsequent working gives evidence that they must have known it. For example, if an equation carries a **C**-mark and the candidate does not write down the actual equation but does correct working which shows the candidate knew the equation, then the **C**-mark is given.

A marks: These are accuracy or answer marks, which either depend on an **M**-mark, or allow a **C**-mark to be scored.

Abbreviations, annotations and conventions used in the Mark Scheme	/	= alternative and acceptable answers for the same marking point
	;	= separates marking points
	NOT	= answers which are not worthy of credit
	( )	= words which are not essential to gain credit
	____	= (underlining) key words which **must** be used to gain credit
	ecf	= error carried forward
	AW	= alternative wording
	ora	= or reverse argument

1

(a)(i) The field is reversed / down (the page) (AW) B1

(a)(ii) There are more field lines / lines are closer (Not 'stronger field') B1

(b) Correct terms in boxes. ('Clockwise': force/motion: field : current) B2
(Two items correct: 1/2 Only one item correct: 0/2)

(c) *B* : (magnetic) flux density (Allow '(magnetic) field strength') B1
I : current B1
L : length (of conductor) in the field B1

(d) ampere B1

[Total: 8]

2

(a) Finite resistance at 0^{o} C B1
Resistance increases B1

(b)(i) Any four from:
1. The resistance of the thermistor decreases (as temperature is increased) B1
2. The total resistance (of circuit) decreases B1
3. The voltmeter reading increases B1
4. Explanation of 3. above in terms of 'sharing voltage' / $\frac{V_1}{V_2} = \frac{R_1}{R_2}$ / $V = \frac{R_2}{R_1 + R_2} \times V_0$ B1
5. The current increases / ammeter reading increases B1
6. Explanation of current increase in terms of $I = \frac{V}{R_{\text{total}}}$ B1

(Allow ecf for statements 3. and 5. if statement 1. is incorrect – maximum score of 2/4)

(b)(ii) $I = \frac{3.6}{1200} (= 3.0 \times 10^{-3})$ / $\frac{V_1}{V_2} = \frac{R_1}{R_2}$ / $V = \frac{R_2}{R_1 + R_2} \times V_0$ C1

$R = \frac{1.4}{3.0 \times 10^{-3}}$ / $\frac{R}{1200} = \frac{1.4}{3.6}$ / $1.4 = \frac{R}{R + 1200} \times 5.0$ C1

R = 467 (Ω) ≈ 470 (Ω) A1

(When 1.4 V and 3.6 V are interchanged, then $R = 3.1 \times 10^3$ (Ω) can score 2/3)

(Calculation of total circuit resistance of 1.67×10^3 (Ω) can score 2/3)

(Use of $I = \frac{5.0}{1200}$ scores 0/3)

[Total: 9]

3

(a) (Semiconductor) diode B1

(b) The diode symbol circled (No ecf allowed) B1

(c) $R = \frac{V}{I}$ C1

At 0.20 V, R = infinite / very large A1

At 0.70 V, $R = (\frac{0.70}{0.020} =) 35\,(\Omega)$ (Allow answers in the range: {31.82 to 38.89}) A1

(d) p.d across diode = 0.75 (V) / (R_t = $\frac{4.5}{0.060} =$) 75 (Ω) C1

p.d across resistor = 4.5 – 0.75 = 3.75 (V) / (R_d = $\frac{0.75}{0.060} =$) 12.5 (Ω) C1

$R = (\frac{3.75}{0.060} = 62.5 \approx) 63\,(\Omega)$ / R = (75 -12.5 = 62.5 ≈) 63 (Ω) A1

(Use of 0.70 V across the diode gives R = 63.3Ω - This can score 2/3)

(e) Straight line through the origin M1

Line of correct gradient (with line passing through 0.63 V, 0.01 A) [Possible ecf] A1

[Total: 10]

4

(a) Electromotive force /e.m.f. B1

(b) ohm / (1) Ω B1

(c) Coulomb / C B1

(d) The sum of the currents entering a point / junction is equal to the sum of the currents leaving (the same point) Or 'Algebraic sum of currents at a point = 0' B2
(-1 for the omission of 'sum' and -1 for omission of 'point'/ 'junction')
(Do not allow $I_1 + I_2 = I_3 + I_4$ unless fully explained)

(e)(i) S_2 closed and S_1 open. B1

(e)(ii) $R = \frac{\rho L}{A}$ (Allow any subject) C1

$\rho = \frac{RA}{L} = \frac{4.0 \times 2.3 \times 10^{-8}}{0.15}$ C1

ρ = $6.133 \times 10^{-7} \approx 6.1 \times 10^{-7}$ (Answer of 6.1×10^{-9} can score 2/3) A1

unit: Ω m B1

(e)(iii)1. $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$ / $R = \frac{R_1 R_2}{R_1 + R_2}$ C1

resistance of parallel combination = $\frac{12 \times 4.0}{12 + 4.0} = 3.0$ (Allow 1 SF) C1

total resistance = 8.0 + 3.0 = 11 (Ω) A1

(e)(iii)2. $P = \frac{V^2}{R}$ / $I = 4.5/11 \, (= 0.4091 \, \text{A})$ C1

$P = \frac{4.5^2}{11}$ / $P = 0.4091^2 \times 11$ or $P = 4.5 \times 0.4091$ C1

$P = 1.84 \approx 1.8 \, (\text{W})$ (Possible ecf from (iii)1.) A1

(e)(iii)3. ratio = $(\frac{V/12}{V/4.0} = \frac{4.0}{12} =) 0.33$ / ratio = $\frac{1}{3}$ / 1:3 B1

[Total: 17]

5

(a)(i) particle / particulate / quantum / photon B1

(a)(ii) wave B1

(b) Any three from points 1 to 6:

1. Photon mentioned B1
2. Surface electrons are involved B1
3. A single photon interacts with a single electron B1
4. Energy is conserved in the interaction between photon and electron B1
5. $hf = \phi + KE_{(max)}$ M1
6. *hf* is the energy of the photon, ϕ is the work function (energy) and $KE_{(max)}$ is the (maximum) kinetic energy of the electron. A1

The frequency of blue light is greater than the red light / the wavelength of blue light is shorter than the red light (ora) B1

The photon of blue light has energy greater than the work function energy / the frequency of blue light is greater than the threshold frequency (ora) B1

Intensity does not change the energy of a photon B1

QWC

The answer must involve physics, which attempts to answer the question.

Structure and organisation -

Award this mark if the whole answer is well structured. B1

Spelling and Grammar mark -

More than two spelling mistakes or more than two grammatical errors means the SPAG mark is lost. B1

(c)(i) $E = 2.0 \times 1.6 \times 10^{-19}$ (= 3.2×10^{-19} J) C1

$E = hf$ / $E = \frac{hc}{\lambda}$ / $f = \frac{3.2\times10^{-19}}{6.63\times10^{-34}}$ (= 4.83×10^{14} Hz))

$\lambda = \frac{6.63\times10^{-34}\times3.0\times10^{8}}{3.2\times10^{-19}}$ / $\lambda = \frac{3.0\times10^{8}}{4.83\times10^{14}}$ C1

$\lambda = 6.22 \times 10^{-7}$ (m) ≈ 6.2×10^{-7} (m) A0

(c)(ii) visible / 'red' (Allow: 'light') (No ecf allowed) B1

(d) gradient = $5.6(7) \times 10^{-8}$ (Allow range: 5.5×10^{-8} to 5.9×10^{-8}) B1

gradient = $\frac{h}{m}$ / $m = \frac{6.63\times10^{-34}}{(\text{value of } \lambda)\times(\text{value of } v^{-1})^{-1}}$ C1

$m = \frac{6.63\times10^{-34}}{5.67\times10^{-8}} = 1.1(7)\times10^{-26}$ (kg) /*m* in the range: 1.1×10^{-26} to 1.2×10^{-26} (kg) A1

(Possible ecf for the last two marks)

(The 10^{-4} factor is not very clear on the v^{-1} axis; therefore allow **full credit** for using 10^{4}. This gives a gradient of 5.7×10^{-16} and mass *m* of 1.17×10^{-18} kg)

[Total: 16]

Mark Scheme 2823/01
June 2007

1. (a) (i) (***f***) vibrations/waves/wavelengths/cycles per second/unit time ---------- B1 **[1]**
(ii) (λ) distance between neighbouring crests/troughs/pts in phase (WTTE) B1 **[1]**
{idea of **minimum** distance is essential i.e. look next or equivalent word;
allow diagrams but do not allow "length of a wave"}

(b) $v = f\lambda$ ---------- B1
ANY VALID AND CONVINCING justification ----------B1 **[2]**
e.g. distance travelled in one second (v) = ***f*** (waves) x λ **(**length of each wave)
{**most** will probably **not score** this additional mark}
*{*** N.B. mark allocation has been reduced from 3 to **2 marks**}*

(c) (i) **time for light** to travel 1km is **negligible** OR **1000/3x10^{8}** OR **3.3x10^{-6}**s -- B1
time for sound to travel 1km = **1000/340** ---------- B1
hence time interval = **2.94 s** (allow **2.9** or **3**) ---------- B1 **[3]**
{also allow cal^{ns} :(2.94 – 3.3x10^{-6}) = 2.939996667 s, OR (2.9 – 3.3x10^{-6}) = 2.8999967s !!! }
{N.B. 2.94 automatically scores 2 marks, 3rd mark for cal^{n} OR 'time for light is very small'}
{N.B. give 2 marks for correct method but wrong final answer e.g. being artificially low}

(ii) time interval **divided by 3** (or 2.9) {*OR time X 340* } ---------- M1
gives distance in **km** {*OR gives distance in **m*** } ---------- A1 **[2]**
{also allow: time interval **divided by 5** gives distance in **miles(**!) for 2 marks}
*{***N.B. mark allocation has been increased from 1 to **2 marks** }*

(d) Any 2 differences, e.g.: light is transverse (sound is longitudinal) ---------- B1+B1 **[2]**
light travels in vacuum (sound cannot) OR light can be polarised (sound cannot);
λ is bigger for sound than light OR f is smaller for sound than light
{N.B. maximum of 1 mark if anything is incorrect}

[Total = 11]

2. (a) (i) the angle **C** correctly labelled on Fig. 2.1 ---------- B1 **[1]**
(ii) correct path – **along the interface**.(allow slightly ABOVE but not below) B1 **[1]**
(iii) **0**^{O} ---------- B1 **[1]**

(b) (i) (**i** < ***C***) 'ray **1**' labelled and shown **refracted away from normal** ---------- B1 **[1]**
(ii) (**i** > ***C***) 'ray **2**' labelled and shown as **internally reflected** (ignore angle) B1 **[1]**
{N.B maximum of 1 mark for just one or no incident rays}
{for fully correct diagram with rays 1 and 2 the wrong way round award 1 mark}

(c) (i) correct substitution into n = 1/sinc e.g. 1.54 = 1/sin**C** ---------- C1
hence ***C* = 40.5^{o}** ---------- A1 **[2]**
(ii) recall of n = the speed of light in air/ the speed of light in glass (or v_1/v_2) -C1

speed in glass = 3x10^{8} /1.54 ---------- C1

speed in glass = **1.95 x 10^{8}** (1.948 x 10^{8}) m/s ---------- A1 **[3]**

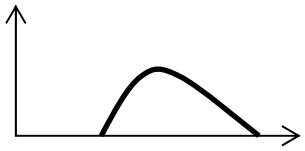
(iii) recall of n =sini/sinr ---------- C1
correct substitution: e.g. 1.54xsin30= sinr ---------- C1

hence r = **50.4°** (50.354) ---------- A1 **[3]**
{N.B. 18.9^{O} scores 1 mark, but 30/1.54 = 19 scores zero!}

Total = 13]

3. (a) reduced height AND **wider** (ignore shape, ignore areas) ---------- B1 **[1]**

For example



(b) (i) **MULTIPATH-DISPERSION** {award this mark if SEEN ANYWHERE e.g. in (ii)} - B1 **[1]**
(ii) DIFFERENT PATHS/LENGTHS (OR 'reflected at different angles') (WTTE) -------- B1
' rays' arrive at DIFFERENT TIMES (WTTE) (do not allow 'some rays travel faster') B1 **[2]**
{ignore arguments based on changes in intensity/energy}

(c) any valid suggestion e.g. use a **thin fibre**/MONOMODE fibre ---------- B1
OR a fibre with a high critical angle OR graded-index fibre
This **reduces the number of paths** (allow single path) (WTTE) ---------- B1 **[2]**

[Total = 6]

4. (a) (i)(wave sources have) **constant phase difference** (WTTE)---------- B1 **[1]**
{do not allow "in phase" but accept "same phase difference"}
(ii) difference in length between detector and each wave source (WTTE) -- B1 **[1]**

(b) **1** path diff. = nλ (where n= 0,1,2 etc) {allow 0, OR λ, OR 2λ etc} ---------- B1 **[1]**
2. path diff = (n + ½)λ (where n=0,1,etc) {allow = 0.5λ OR,1.5λ, etc} --------- B1 **[1]**
{do not allow answers purely about phase diff. e.g with degrees or π used and no ref to λ }
(ii) recall of formula **λ = ax/D** ---------- C1
correct substitution for a, λ and D: e.g $x = (4.86 \times 10^{-7} \times 2)/0.5 \times 10^{-3}$ C1

$x = 1.94 \times 10^{-3}$ m (1.9 or 1.944) ---------- A1 **[3]**

(iii) **central white** fringe ---------- B1
other fringes are **coloured** (WTTE: e.g. allow spectrum formed) ---------- B1 **[2]**

[Total = 9]

5. (a) ANY **2 points** made from the following:

B1 + B1 **[2]**

- reference to **nodes AND antinodes** OR **constructive AND destructive** interference
- correct link for either **antinodes with constructive** OR **nodes with destructive**
- (meeting/superposing) waves must be COHERENT (allow "in phase")

(b) **two** antinodes labelled (with **A**) at centres of hot zones (please look closely!) B1 **[1]**
{N.B. two or more correct scores 1, any incorrect scores zero),

(c) recall of speed of microwaves = **3 x10^8** (m/s) ---------- B1
correct substitution: e.g. λ = v/f = 3 x 10^8 / 2.45 x 10^9 ---------- C1
λ= 1.22 x 10^{-1} m = **0.122 m** ---------- A1 **[3]**

[Total = 6]

Mark Scheme 2823/03
June 2007

Planning Exercise - Skill P

A1 Diagram of workable arrangement of apparatus. **1**
[Source, method of splitting light (filter/prism/diffraction grating), LDR]

A2 Correct procedure **1**
(i.e. Illuminate LDR with a wavelength and measure *I*/*V*/*R* in LDR circuit, change wavelength and measure new output – allow graph or table).

A3 Circuit diagram for LDR **1**

B1 Calibration curve of intensity against *I*/*V*/*R* **1**
or use of light meter

B2 Method to determine wavelength. **1**
Look up filter data/Young's slit/Diffraction grating

B3 Perform experiment in a darkened room. **1**

C1 Safety precautions: Do not look directly at lamp **1**

C2 Keep output of lamp constant **1**

C3 Keep distance between lamp and LDR constant **1**

D1/2/3 Any further relevant detail. Examples of creditworthy points might be; max **3**

Typical resistance range of LDR
Range of ammeter/ohmmeter/voltmeter for potential divider circuit with reasoning
Discussion of determination of wavelength e.g. Young's slit/diffraction grating experiments
Response of LDR for different wavelengths e.g. sensitivity against wavelength
Method of maintaining power of lamp constant
Method of maintaining constant distance for diffraction grating
Light reflected from filters
Evidence of preliminary investigation in the laboratory

R1/2 Evidence of the sources of the researched material **2/1/0**
Two or more (vague) independent references or one detailed reference score one mark.
Two or more independent detailed references scores two marks.
Detailed references should have page numbers or be internet pages.

Q Quality of written communication **2/1/0**
This is for the organisation and sentence construction. Accounts that are rambling, or where the material is not presented in a logical order will not score these marks.
Do not award both of these marks if the word count exceeds the recommended length by more than 50%.

16 marks total.

Question 1

(b) Values of 1/*R* and 1/*V*. **2/1/0**
One mark for 1/*V*
One mark for 1/*R* *(Ignore units, rounding errors and POT errors)*

(c) Justification of significant figures in 1/*R* **2/1/0**
Relates to sf in *I* and *V* scores 1 mark
No. of sf in 1/*R* is the same or one more than sf in raw data/*I* and/or *V* scores 1 mark
Answers in terms of decimal places, resistance, graphs score zero.

(d) Measurements **2/1/0**
Write the number of readings as a ringed total next to the table of results.
Six sets of values for *I* and *V* scores 2 marks. Five sets scores 1 mark
Minor help from Supervisor then –1.
Major help (equipment set up for the candidate) then -2.

(d) Column headings in the table **2/1/0**
One mark for *I* and *V* headings. Correct quantity and unit required.
One mark for 1/*R* and 1/*V* headings. Correct quantity and unit required.
Expect to see indice notation
Ignore units in the body of the table.

(d) Consistency of raw readings **2/1/0**
One mark for raw *I* which must be to the same number of d.p.
One mark for raw *V* which must be to the same number of d.p.
Penalise trailing zeros.

(e) Axes **2/1/0**
One mark for each correct axis.
Sensible scales must be used. Awkward scales (e.g. 3:10, 6:10, 7:10) are not allowed.
The scales must be labelled with the quantities plotted. Ignore units.
Do not allow more than three large squares without a scale label.
Plotted points must occupy at least half the graph grid in both *x* and *y* directions (i.e. 4 x 6 large squares). If false origin, indicate with "FO"

(e) Plotting of points **2/1/0**
Count the number of plots and write as a ringed number on the graph grid.
All observations must be plotted. Check a suspect plot. Tick if correct otherwise indicate the correct position.
If plots are omitted then zero.
If the plot is accurate ≤ half a small square, then two marks awarded.
One mark if the plot is out by > half a small square and < than one small square.

(e) Line of best fit **1/0**
Judge by scatter of points about the line.
There must be a fair scatter of points either side of the straight line of best fit.
Allow line through five trend plots for full credit (if done well).
Annotation required if mark not awarded.
Do not allow a line through a curved trend.

(e) Quality of results **1/0**
Judge by scatter of points about the line of best fit.
Five good trend plots on the graph grid needed for mark to be scored.

(f)(i) Gradient **2/1/0**
The hypotenuse of the Δ must be $\geq$ half the length of the drawn line. 1 mark.
Read-offs must be accurate to half a small square and ratio correct. 1 mark.

(f)(ii) *y*-intercept **1/0**
Expect the value to be read from the *y*-axis to an accuracy of half a small square.
Or correct substitution from point on line into $y = mx + c$.

(g) (i) Candidate's *y*-intercept equated with $1/E$ (can be implied from working)
Value of *E* using candidate's *y*-intercept with correct unit.
Sig Figs of *E*: allow 2 or 3 only. **3/2/1/0**
Substitution methods may only score sf mark

(g) (ii) Candidate's gradient value equated with P/E (can be implied from working)
Value of *P* in the range 40 - 55.
Sig Figs of *P*: allow 2 or 3 only
Unit of *P* (Ω). **4/3/2/1/0**

(h) Random error **1/0**
Reference to scatter of points and appropriate conclusion

(i) Calculation of percentage difference **1/0**
Method of calculation scores one mark
Expect to see difference/either *E* value x 100 or equivalent

28 marks available. Write the mark in the ring on page 7.

Question 2

(b) (ii) Value of h_A to the nearest mm and in the range 10 mm ≤ h_A ≤ 100 mm **1**

(c) Δh = 1-5 mm (whole number of mm) **1**
percentage uncertainty ratio correct. **1**

(d) Value of h_B larger than h_A **1**

(e) Inverse proportionality ideas
Method to prove or disprove inverse proportionality
(e.g. determines constant of proportionality) **1**
Appropriate conclusion based on their method of proving or disproving inverse proportionality. Vague answers will not score this second mark. **1**
No method or wrong method loses both these marks

(f) Use a travelling microscope
Detailed bead method (including volume and length) **1**
Repeat measurements at least twice and find average **1**

(g) Evaluation of procedure **6**
Relevant points must be underlined and ticked with the appropriate marking letter.

	Problem	**Solution**
A	Difficulty in seeing liquid in tube	Place card behind/ use dye
B	Parallax /meniscus/ refraction problems/rule too far away	Eye to be level/move rule close to tube
C	Difficulty with measuring *h* accurately (Getting end of ruler in water, tube and ruler moving, not vertical)	Use travelling microscope Use pin markers/vernier callipers Clamp tube and/or rule Mark scale on tube Method for ensuring tube/rule is vertical
D	Water droplets in tube will affect *h* Impurities/dirt in tube will affect *h*	Dry tube thoroughly before use Clean tube before use
E	Two sets of readings are not enough to verify the suggestion. Do not allow repeats or averaging ideas	Use many different diameters of tube and plot a graph relating *h* and *d*.

One mark for each box to a maximum of 6.

No credit for simple 'repeats', human error

Quality of written communication (i.e. spelling, sentence construction, grammar) **2/1/0**
Capital letters at the beginning of sentences, full stops at the end scores one mark
Correct spelling scores one mark. Allow max two errors.
At least half a side is needed to assess QWC.

16 marks total.

Results

Question 1

I / mA	V / V	R / Ω	1/R / Ω^{-1}	1/V / V^{-1}
54.9	2.09	38.07	0.0263	0.478
47.7	2.46	51.57	0.0194	0.407
42.7	2.71	63.47	0.0158	0.369
39.2	2.86	72.96	0.0137	0.350
36.5	3.00	82.19	0.0122	0.333
32.5	3.20	98.46	0.0102	0.313

Plotting a graph of 1/*V* against 1/*R* produces:
Gradient = 10.3
y-intercept = 0.21

y-intercept = 1/*E*
E = 1/0.21 = 4.76 V

gradient = *P*/*E*
P = 4.76 x 10.3 = 49 Ω

Question 2

d_A = 1.20 mm
d_B = 0.60 mm

h_A = 2.4 cm

h_B = 4.6 cm

k_A = 2.4 x 1.20 = 2.88
k_B = 4.6 x 0.60 = 2.76

Since *k* is approximately constant *h* is inversely proportional to *d*

Summary of shorthand notation which may be used in annotating scripts:

SFP	Significant figure penalty
ECF	Error carried forward
AE	Arithmetical error
POT	Power of ten error
NV	Not valid
NR	Not relevant
GAP	Insufficient scale markings on an axis
NBL	Not best line
FO	False origin
NGE	Not good enough
BOD	Benefit of the doubt
R	Point repeated (no further credit)
NA	Not allowed
SV	Supervisor's value
SR	Supervisor's report
OOR	Candidate's value is out of range
CON	contradictory physics not to be credited
✓△	Used to show that the size of a triangle is appropriate (gradient calculation)
✓A1	Used to show the type of mark awarded for a particular piece of work
✓C	Used to show that the raw readings are consistent
✓d	Used to show that the raw readings have correct spacing
✓SF	Used to show calculated quantities have been given to an appropriate number of significant figures
^	Piece of work missing (one mark penalty)
^^	Several pieces of work missing (more than one mark penalty)
↔	Scale can be doubled in the x-direction
↕	Scale can be doubled in the y-direction

Mark Scheme 2824
June 2007

Mark Scheme	Unit Code 2824	Session June	Year 2007	Final Version

Abbreviations, annotations and conventions used in the Mark Scheme

/ = alternative and acceptable answers for the same marking point
; = separates marking points
() = words which are not essential to gain credit
ecf = error carried forward
AW = alternative wording

Question			Expected Answers	Marks	
1	a	i	Q = VC; W = ½ VC.V (= ½ CV^2)	2	
		ii	parabolic shape passing through origin	1	
			plotted accurately as W = 1.1 V^2	1	4
	b	i	T = RC; = 6.8 x 10^3 x 2.2 = 1.5 x 10^4 s = 4.16 h	2	
		ii	ΔW = ½ C(V_1^2 – V_2^2) = 1.1(25 - 16) ; = 9.9 (J)	2	
		iii	4 = 5 exp(-t/1.5 x 10^4) ; giving t = 1.5 x 10^4 x ln 1.25 = 3.3 x 10^3 (s)	2	
		iv	P = $\Delta W/\Delta t$ = 9.9/3.3 x 10^3 = 3.0 mW *ecf b(ii) and (iii)*	1	7
			allow P = V_{av}^2 /R = 4.5^2/6.8 x 10^3 = 2.98 mW		
			Total		11
2	a		n = m/M; ρ = m/V; p = nRT/V = (m/V)RT/M = ρRT/M	3	3
	b	i	suitable test, i.e. ratio test, half-height,etc	1	
			carried out successfully	1	
	c		$p/p_o = \rho/\rho_o$; p at 8 km = 3.5 ± 0.3 x 10^4 Pa; ρ = 0.35 x 1.3 = 0.46 (kg m^{-3})	3	
	d		p/ρT = constant; 10^5/1.3 x 293 = 3 x 10^4/ρ x 250; ρ = 0.46 (kg m^{-3})	3	8
			Total		11
3	a	i	suitable pattern; arrows from + ion to - ion	2	
		ii	$F = kQ_1Q_2/r^2$; $Q_1 = Q_2 = e$	2	
			F = 9 x 10^9 x 1.6^2 x 10^{-38}/25 x 10^{-20} = 9.2 x 10^{-10} (N)	2	6
	b		(N2 gives) $F_H = m_H a_H$ and $F_I = m_I a_I$	1	
			(N3 gives) $F_H = F_I$ *can be implicit*	1	
			SHM gives a α -x	1	
			hence $x_H/x_I = a_H/a_I = m_I/m_H$ = 127	1	4
	c	i	sine or cosine curve; amplitude 8.0 x 10^{-12} m; period = 1.5 x 10^{-14} s	3	3
		ii	resonance situation; driving frequency of radiation = natural	1	
			frequency of oscillation of molecule/AW	1	2
			Total		15

Mark Scheme	Unit Code 2824	Session June	Year 2007	Final Version

Question			Expected Answers	Marks	
4	a		arrow towards centre of planet	1	1
	b	i	$g = GM/R^2$	1	
		ii	$g_S/g_O = R^2/25R^2$; $g_S = 40/25$ (= 1.6 N kg^{-1})	2	
		iii	$g_C/g_O = R^2/16R^2$ giving $g_S = 40/16$ (= 2.5 N kg^{-1})	1	
		iv	average g = (2.5 + 1.6)/2 = 2.(05)	1	
			Δp.e. ($= mg_{av}R$) = 3.0 x 10^3 x 2.05 x 2.0 x 10^7 ; = 1.2 x 10^{11} (J)	2	7
	c		$g = v^2/r$; $= 4\pi^2(5R)/T^2$	2	
			1.6 = 4 x 9.87 x 1.0 x $10^8/T^2$ giving $T^2 = 24.7 \times 10^8$ and T = 5.0 x 10^4 (s)	2	4
			Total		12
5	a	i	Mass x velocity/mv with symbols defined	1	
		ii	$0 = m_Av_A \pm m_Bv_B$ or $m_Av_A = m_Bv_B$	1	
			$v_A/v_B = \pm m_B/m_A$	1	3
			max 1 mark for final expression without line 1		
	b	i	v_A = (10/5 =) 2.0 (ms^{-1}) and v_B = (10/10 =) 1.0 (m s^{-1})	1	
		ii	t_1 = 3.0/2.0 = 1.5 (s) *ecf b(i)*	1	
		iii	x = 2.1 – 1.0 x 1.5 = 0.6 (m)	1	
		iv	$v = v_B + (5/50)v_A$ = 1.0 + 0.2 (= 1.2 m s^{-1})	1	
		v	$t_2 = t_1$ + 0.6/1.2 = 2.0 (s)	1	
		vi	At collision the container (and fragments) stop	1	
			By conservation of momentum, total momentum is still zero/AW	1	
		vii	straight lines from (0,0) to (1.5,0); (1.5,0) to (2.0,0.1); (x,0.1) for all x >2	3	10
			Total		13
6	a		A: the number of (undecayed) <u>nuclei</u> which decay per second/rate of decay of <u>nuclei</u>	1	
			λ: the probability of a given nucleus decaying in the next second or in unit time/the (decay) constant relates the activity to the number of undecayed nuclei	1	
			N: the number of <u>undecayed nuclei</u>/nuclei of the original nuclide (remaining)	1	3
	b	i	90 and 234	1	
		ii	2 x 10^{-6} x 7.0 x 10^6 = 14 (kg)	1	
		iii	N = (m/M) N_A = 14 x 10^3 x 6 x $10^{23}/238$ (= 3.5 x 10^{25})	1	
		iv	$\lambda = 0.69/T = 0.69/4.5 \times 10^9 \times 3.2 \times 10^7 = 4.8 \times 10^{-18}$ (s^{-1})	1	
			$A = \lambda N = 4.9 \times 10^{-18} \times 3.5 \times 10^{25} = 1.7 \times 10^8$; s^{-1} or Bq	2	6
	c		change of state/water changes to steam; requiring latent heat;	2	
			for heating steam, calculation requires a different specific heat capacity;	1	1	3
			energy/heat losses to surroundings not included/AW *max 3 marks*		
			give 1 mark for **formula only gives energy needed to heat water to 100°C**		
			Total		12

Mark Scheme	Unit Code 2824	Session June	Year 2007	Final Version

Page 3 of 3

Question		Expected Answers	Marks	
7	a	force per unit (positive) charge	1	
		force per unit mass	1	
		force per unit length of conductor carrying unit current;	1	
		perpendicular to field and current	1	
		examples of similarities:		
		all explain action at a distance	1	
		all forces per unit something….	1	
		field lines never cross; density of lines indicates relative strength of field	2	
		E and g have the same laws/geometry, e.g. for point and/or plane distributions;	1 2	
		for E and g force in direction of field; field lines perpendicular to surface		
		examples of differences:		
		forces caused by different entities; and act differently i.e. E and g	1	
		different to B; force caused by stationary versus moving charge;	2	
		direction of force for B given by F.L.H.rule, etc.	2	
		g is only attractive, E (and B) can cause attractive and repulsive forces	1 1	7
		field lines for B field closed loops others start and finish on m,Q magnitudes of forces very different for unit ……; detail.*max 7 marks*	2	
	b	magnetic flux = BA	1	
		meanings of B and A, i.e. flux density or field strength and area ⊥ to it	1	
		magnetic flux linkage refers to the flux linking/passing through a coil;	1	
		and equals N x flux where N is the number of turns (of the coil)	1	
		Faraday's law: induced e.m.f./voltage is proportional to rate of change of flux linkage through it /correct mathematical formulation/AW	1	
		Lenz's law: the direction of the induced e.m.f./voltage is such as to oppose the motion/change that produced it	1	
		relationship of Lenz's law to conservation of energy or other valid explanation/discussion/description *max 5 marks*	2	5
		quality of written communication		4
		Total		16

Mark Scheme 2825/01
June 2007

1	a.	planet moves in opposite direction/ backwards		1
		compared to position of stars		1
	b.	planets move with different orbital periods/ speeds		1
		Earth moves past/ overtakes planet		1
	c.i.	$v = 2\pi \times 1{,}100 \times 6.4 \times 10^6 / 365 \times 24 \times 3600$		1
		$v = 1.4 \times 10^3$ m s^{-1}		1
	c.ii.	any 2 from		
		Earth would have a relatively large speed	1	
		objects would not fall vertically to ground	1	
		a wind would be expected	1	
		expect to observe stellar parallax	1	
		Copernican system required epicycles	1	2
			total	8
2.	a.i.	the brightness of a star as observed from Earth		1
	a.ii	apparent mag decreases/ apparent magnitude more negative		1
		Intensity α (distance)$^{-2}$ / same energy over smaller area		1
	a.iii	$m - M = 5\lg(d/10)$		1
		$d/10 = 10^{-0.116}$		1
		d = 7.6(6) pc		1
	b.	any 3 from		
		fusion of protons/ <u>hydrogen</u> nuclei	1	
		helium nuclei formed	1	
		energy from loss of mass / $E = \Delta mc^2$	1	
		detail of p-p reactions	1	3
	c.i.	$2 \times 10^{28} / 5.2 \times 10^{30} = 3.8 \times 10^{-3}$ (W kg^{-1})		1
	c.ii.	power/mass = 60 x 9.81 x 2.5 / 10 x 60		1
		power/mass = 2.45 (W kg^{-1}) accept 2.5		1
	c.iii	ratio = 2.45 / 3.8 x 10^{-3} = 645 ecf from (i) and (ii)		1
	c.iv	accept any **sensible** remark		
		fusion limited to stellar core / most mass not contributing to reaction	1	
		energy released per reacting nucleon in Vega greater than in human so fewer atoms per kg required	1	1
			total	14

3.	a.	(apparent) change in position of a star		1
		due to change in position of Earth		1
	b.i	distance = 1/ parallax angle		1
		distance = 1/ 0.314 = 3.2 pc		1
	b.ii	3.2 x 3.1 x 10^{16} = 9.9 x 10^{16} m		1
	c.i.	all points plotted correctly		1
	c.ii.	best straight line drawn		1
	c.iii.	1. gradient = 2.1 x 10^{-18}		1
		unit: sec^{-1}		1
		2. 1/ gradient = 4.8 x 10^{17} (s) ECF		1
	c.iv.	gradient is Hubble's constant		1
		1/ gradient is approximate age of Universe		1
	d.	galaxies (stars) are more distant than that in part a.		1
		parallax too small for accurate measurement		1
				total 14
4.	a.i.	arm <u>each side</u>		1
		bulge in <u>centre</u>		1
	a.ii.	elliptical		1
	b.i	luminosity/ <u>absolute</u> magnitude		1
		temperature increasing right to left		1
		main sequence: diagonal, top left to bottom right		1
	b.ii.	X on lower half of line drawn		1
	c.	any 2 from		
		<u>larger mass stars</u> have greater temperature	1	
		<u>larger mass stars</u> have greater rates of fusion	1	
		<u>larger mass stars</u> are shorter lived	1	2
				total 9

5.	a.	isotropic: appears the same in every direction			1
		homogenous: (on a large scale) the same number of galaxies in any given volume / owtte			1
	b.i.	volume = mass / density = $2 \times 10^{30} / 3.3 \times 10^{23}$			1
		volume = 6.1×10^{6} pc^3			1
	b.ii.	any 3 from			
		density less than critical density	1		
		open universe	1		
		universe will expand forever	1		
		critical density; universe expands to limit	1		
		allow energy argument: any 3 from			
		required pe is now lessened/ ke of galaxies > Δpe	1		
		open universe	1		
		universe will expand forever	1		
		idea of escape velocity	1		3
				total	7
6.	a.	Any 5 from			
		Emission: light from surface of star	1		
		continuous spectrum	1		
		Absorption : (continuous) crossed by dark lines	1		
		absorption in stellar atmosphere	1		
		reference to role of electrons	1		
		elements have a unique spectrum	1		
		elements identified by comparison of dark lines with spectra on Earth	1		
		red/blue shift	1		
		other detail eg spectral broadening	1		5
	b.	X rays: most are absorbed by atmosphere			1
		Ultra-violet: most are absorbed by atmosphere			1
		visible: most pass through			1
		radio: most pass through			1
				total	9

7.	a.	Any 5 from		
		Rocket, light and observer	1	
		Rocket accelerates	1	
		Time between flashes measured	1	
		Time between flashes increases for lamp behind	1	
		Principle of equivalence	1	
		Rate of clocks is less in gravitational field	1	5
	b.i.	orbit rotates		1
		centred on sun		1
	b.ii.	gravitational field from Sun is strongest		1
	b.iii.	provides evidence for General Theory of Relativity		1
				total 9

2825 Common Question

(a) (i) load = 5000 x 9.81 (accept mg) [1]
k = 5000 x 9.81/ 0.04 [1]

(ii) f = 1/2π (1.2 x 10^6 / 1.25 x 10^3) [1]
f = 4.9(3) Hz (accept 4.98 or 5) [1]
(use of m = 5000kg: f = 2.4(7) Hz scores 1)

(b) (i) R = 50/ 12000 = 4.17 x 10^{-3} [1]

(ii) P = 50 x 12000 = 600 kW ECF for R [1]

(iii) E = 15 x 420 x (1000 -20) [1]
E = 6.17 x 10^6 J (accept 2SF or 1SF) [1]

(iv) t = 6.17 x 10^6 / 600,000 (ECF from iii) [1]
t = 10.3 s [1]

(c) Any **two** from:
conduction through each contact [1]
conduction through air [1]
convection (in air) [1]
radiation/ infra red/ visible light [1]
rate of loss increases with temperature (difference) [1]
energy to heat water (in contacts) [1] [2]
longer time increases the energy losses [1] [3]

(d) (i) Any two from:
cross-sectional area is increased 4 times [1]
resistance is decreased 4 times [1]
R = pl/A [1] [2]

(ii) maximum of 3 marks
power (accept current) is increased 4 times [1]
mass is increased 4 times [1]
so time unchanged [1] [3]

(d) (ii) spring constant increased/ smaller extension/ stiffer spring [1]
natural frequency will increase. [1]

[Total: 20]

Mark Scheme 2825/02
June 2007

1 (a)(i)

- F x 25 sin15 / F x 0.25 sin 15 for one moment. **(1)**
- 450 x 40 cos 30 / 450 x 0.4 cos 30 for the other moment. **(1)**
- moments equated or stated, even if not correct. *[Do not accept forces resolved vertically]* **(1)**
- Answer F = 2409 (N). **(1)**

(a)(ii)

- Answer F = 951 (N). **(1)**

(b)

- Link large force (2409N) with small angle (30^0) / The more nearly horizontal / the smaller the angle with the horizontal your back is, the greater the force needed (from the muscles). **(1)**
- the force is large because the anti-clockwise moment is large **(1)**
- the anti-clockwise moment is large because the perpendicular distance to the pivot is large. **(1)**

(First 3 points + any one of the following:) **(1)**

- consequence, eg tendon 'goes', etc.
- (Therefore) keep your back as vertical / upright as possible,
- … with the load close to your body …
- … and bend your knees / use leg muscles to do some of the lifting.
- ..back is strong in compression / weak in shear, etc.

2 (a) (to a maximum of 7 marks) e.g.

- X-ray source + detectors round patient …
- … rotated around patient …/ the signal / X-ray passes through the same section of the body from different directions.
- … producing a (thin) slice / cross-section.
- Idea of absorption / less gets through / more is absorbed …
- by dense material / bone / material of high Z / High Z related to materials such as bone / Low Z to materials such as soft tissue
- attenuation is by the photo-electric effect
- the possibility of using a contrast medium.
- better than a simple X-ray at differentiating other organs.
- patient is moved a small distance and the process is repeated / process continues in a spiral.
- a computer (analyses the data) / identifies the position of organ/bone …
- … and forms a 3-D image.

(b)

- Patients are exposed to ionising radiation. **(1)**
- (Ionising radiation) could cause cancer / damage cells **(1)**

Plus a maximum of ONE from:-e.g. **(1)**

- It's expensive.
- Time consuming / uses valuable resources, etc..

3 (a)

- Top frequency less than a stated value for normal ear (e.g. 16 – 20 kHz). **(1)**
- Bottom frequency is higher than a stated value for normal ear (20 – 25 Hz) **(1)**
- Minimum detectable intensity is higher than for a normal ear since it can only detect to about 10^{-11} W m^{-2} / cannot detect 10^{-12} W m^{-2}. **(1)**

  A qualitative statement that the frequency range is less than that for a normal ear scores one of the first two marks.)

(b)(i)

$65 = 10 \lg I / 10^{-12}$ **(1)**

$I = 10^{6.5} \times 10^{-12}$ $(= 10^{-5.5})$ **(1)**

$I = 3.2 \times 10^{-6}$ W m^{-2} **(1)**

$65 = 10 \lg I / 10^{-11}$ **(0)**

$I = 10^{6.5} \times 10^{-11}$ **(1)**

$I = 3.2 \times 10^{-5}$ W m^{-2} **(1)**

(b)(ii)1

- A comment from the graph that at 65 dB sound cannot be detected at frequencies below a stated value in the range100 – 200 Hz *[but ecf will need to be applied from (b)(i) where possible]* **(1)**
- A sensible comment relating to the conversation, **(1)** e.g.
  - Some distortion due to lower frequencies being missing.
  - It would need to be louder for the lower frequencies to be detected.
  - 65 dB is loud for normal talking (40 – 60 dB).
  - Sound (of a given sound intensity) is louder (with increasing frequency) up to 2-3 kHz.

(b)(ii)2

- Bass not detected / bass not loud enough to be heard **(1)**
- Singing can be heard well at the higher pitch (or higher frequency) / but lower range missing or not loud enough to hear **(1)**
- Top end of percussion cannot be heard / frequencies above 5 – 8 kHz cannot be heard **(1)**

4 **(a)** (to a maximum of 2 marks) **(1) (1)**
Focusing from ∞ to near:

- The shape of the lens changes from thin to fat.
- The power of the lens increases / its focal length decreases.
- The (ciliary) muscles go from relaxed to taut.

(b)

- $p = 1/u + 1/v$ or substitution $\Delta p = 1/0.25 – 1/\infty$ **(1)**
- $p = 4.0$ **(1)** unit: D **(1)**

(c)

- (Most of the) refraction happens at the (air-)cornea (interface). **(1)**
- Distant objects will be clear(est) / close objects will be (most) blurred. **(1)**
- For a **distant object** the lens has least effect on the focusing / the lens is relaxed / its power is lowest. **(1)**
- For a **close object** the lens has most effect on the focusing / its power is strongest. **(1)**

  (If the answer scores none of the above three marks, but clearly implies that objects will still be visible but blurred, allow 1/3.)

(d) (i)

- $10 \times 3 \times 5000$ (= 150000) **(1)**
- $(150000) \times 100 / 85$ **(1)**
- $= 1.8 \times 10^5$ **(1)**

(d) (ii)

- $E = h c / \lambda$ **(1)**
- $E = 6.6 \times 10^{-34} \times 3 \times 10^8 / 4.0 \times 10^{-7} = 4.95 \times 10^{-19}$ J **(1)**
  $1.8 \times 10^5 \times 4.95 \times 10^{-19}$
- $= 8.9 \times 10^{-14}$ W **(1)** ecf (i)

5 **(a)** *[to a max. of **5**]*

- A p.d. / voltage must be applied …
- … causing the (piezoelectric) <u>crystal</u> to change shape.
- A named crystal (eg quartz, lead zirconate titanate [PZT], lithium sulphate, barium titanate)
- An <u>alternating</u> p.d. causes the crystal to <u>oscillate</u> / <u>vibrate</u> (accept resonate).
- If the frequency applied matches the natural frequency of the crystal, resonance occurs.
- The crystal is damped / stops vibrating when the applied voltage stops …
- … <u>due to</u> the backing material / epoxy resin …
- … which also absorbs backward-travelling sound waves (which might give spurious reflections).

(b)(i)

- 5.4 cm +/- 0.1 cm read from the graph **(1)**
- = 5.4 x 20 μs cm^{-1} x 1.5 x 10^3 m s^{-1} **(1)**
- = 0.162 m **(1)**
- 0.162 / 2 = 0.081 m or 8.1 cm **(1)**

(b)(ii)

- High reflection at the air-skin boundary / Little ultrasound enters the body / A very large peak right at the start … **(1)**
- … due to large difference in acoustic impedance / allow '…due to large difference in density'. **(1)**
- Very low peaks / no (subsequent) peaks (not just 'nothing') **(1)**

6 (a)

- It kills cells **(1)**
- Cells are most susceptible when dividing / malignant cells divide more often / malignant cells are more vulnerable than healthy cells **(1)**

(b)(i)

- Number of ion pairs = 25 x 10^{-6} / 1.6 x 10^{-19} = 1.6 x 10^{14} **(1)**

(b)(ii)

- 34 x 1.6 x 10^{-19} x answer to (b)(i) *[which should be 1.6 x 10^{14}]* **(1)**
- = 8.5 x 10^{-4} *[allow ecf]* **(1)**
- Gy / J kg^{-1}. **(1)**

(c)(i)

- = 38 x 25 x 10^{-6} **(1)**
- = 9.5 x 10^{-4} Gy **(1)**

(c)(ii)

- An appropriate reference to the values in the table (e.g. for 30 keV : large difference in factor between muscle and bone)
- Bone absorbs more / more attenuation in bone.
- Treatment of malignant cells in bones / bone can be targeted / less damage to surrounding healthy tissue.

(c)(iii)

- Dose equivalent = Q x absorbed dose or 1.71 x 10^{-3} / 9.5 x 10^{-4} = Q **(1)**
  1.71 x 10^{-3} / ans to (c)(i)
- Q = 1.8 **(1)**

2825 Common Question

(a) (i) load = 5000 x 9.81 (accept mg) [1]
k = 5000 x 9.81/ 0.04 [1]

(ii) $f = 1/2\pi\ (1.2 \times 10^6 / 1.25 \times 10^3)$ [1]
f = 4.9(3) Hz (accept 4.98 or 5) [1]
(use of m = 5000kg: f = 2.4(7) Hz scores 1)

(b) (i) $R = 50/ 12000 = 4.17 \times 10^{-3}$ [1]

(ii) P = 50 x 12000 = 600 kW ECF for R [1]

(iii) E = 15 x 420 x (1000 -20) [1]
$E = 6.17 \times 10^6$ J (accept 2SF or 1SF) [1]

(iv) $t = 6.17 \times 10^6 / 600{,}000$ (ECF from iii) [1]
t = 10.3 s [1]

(c) Any **two** from:
conduction through each contact [1]
conduction through air [1]
convection (in air) [1]
radiation/ infra red/ visible light [1]
rate of loss increases with temperature (difference) [1]
energy to heat water (in contacts) [1] [2]
longer time increases the energy losses [1] [3]

(d) (i) Any two from:
cross-sectional area is increased 4 times [1]
resistance is decreased 4 times [1]
R = pl/A [1] [2]

(ii) maximum of 3 marks
power (accept current) is increased 4 times [1]
mass is increased 4 times [1]
so time unchanged [1] [3]

(d) (ii) spring constant increased/ smaller extension/ stiffer spring [1]
natural frequency will increase. [1]

[Total: 20]

Mark Scheme 2825/03
June 2007

1 (a) (i) Atomic arrangement is random / has no pattern. [1]

(ii) Atoms are arranged in repeating patterns; (1)
occupying the least possible space or wtte / Each atom has 12 nearest neighbours. (1) [2]

(b) (i) Graph through origin with (short) linear section then reducing gradient. [1]

(ii) Straight section - elastic; (1)
Curved section - plastic. (1) [2]

(c) (i) Atoms increase separation (in direction of force applied); (1)
Atoms return to equilibrium / original separation when force removed. (1) [2]

(ii) Planes / layers of atoms slide past each other / Bonds between atoms break;(1)
Atoms remain in new position / only partly recover when force removed.(1) [2]

(d) (i) Volume of atom = $4/3 \times \pi \times (1.28 \times 10^{-10})^3 = 8.8 \times 10^{-30}$ m^3 (1)

No of atoms in 1 m^3 = $0.74 / 8.8 \times 10^{-30}$ (1)

= 8.4×10^{28} (1) [3]

(ii) Structure includes grain boundaries (1); vacancies (1); dislocations (1);
impurity atoms (1). max[2]

[Total: 15]

2 Trolleys move / accelerate towards each other due to magnetic attraction until buffers touch; (1)
Motion slows / decelerates as buffers compress and cause repelling force; (1)
Repulsive force proportional to compression of spring; (1)
(Short) period of vibration about final position before motion stops; (1)
Motion stops when energy used in compressing springs = energy gained from magnetic field; (1)
Trolleys stationary when attractive force of magnets = repulsive force of buffers; (1) max[4]

Atoms have attractive and repulsive forces; (1)
Atoms must be very close before forces come into play; (1)
Attractive force occurs at longer range than repulsive force; (1)
Attractive and repulsive forces between atoms are electrostatic / due to electric charges; (1)
Atoms have a final / equilibrium separation when forces balance; (1)
Atoms continue to vibrate about equilibrium position (due to thermal energy).(1) max [4]

[Total: 8]

3 **(a)** $E = hc/\lambda$ (1)
$= 6.63 \times 10^{-34} \times 3.0 \times 10^{8} / 650 \times 10^{-9} = 3.06 \times 10^{-19}$ (J) (1)
$= 3.06 \times 10^{-19} / 1.60 \times 10^{-19} = (1.91\ eV)$ (1) [3]

(b) **(i)** Photons (of the red light); (1)
have enough energy; (1)
to promote electrons (in the atoms of the LDR) from the valence band to the conduction band; (1) [3]

(ii) With light of greater intensity there is greater number of photons (per sec);(1)
More electrons are promoted so (with same voltage) current will be greater and resistance smaller. (1) [2]

(c) **(i)** Critical wavelength = hc / E $= 6.63 \times 10^{-34} \times 3.0 \times 10^{8} / (1.5 \times 1.6 \times 10^{-19})$(1)
$= 8.29 \times 10^{-7}$ m = 829 nm. (1) [2]

(ii) Infra-red. [1]

[Total: 11]

4 **(a)** Electrons have high speed random motion; (1)
r.m.s. speed defined / linked to random motion; (1)
Electrons make (random) collisions with atoms; (1)
Slower speed motion in opposite direction to current / towards + terminal; (1)
This motion superimposed on the random motion; (1)
Drift velocity is the <u>mean / average</u> (resultant) velocity (of the free electrons)(1) max[4]

(b) Voltmeter connections at opposite points on long edges of slice. [1]

(ii) 1 $v = V_H / Bd$ (1)
$= 0.016 / (0.065 \times 0.005)$ $(= 49.2\ m\ s^{-1})$ (1) [2]

2 $n = I / A\ e\ v = 0.200 / (0.005 \times 0.0012 \times 1.6 \times 10^{-19} \times 49.2)$ (1)
$= 4.2 \times 10^{21}$ (1)
m^{-3} / per m^3 (1) [3]

(c) More thermal energy; (1)
so more electrons promoted to conduction band / number density / n is greater;(1)
drift velocity / v is smaller because $I = nAve$; (1)
Hall voltage / V_H is smaller because $V_H = Bvd$. (1) [4]

[Total: 14]

5 **(a)** **(i)** Efficiency = power output / power input or as percentage. [1]

(ii) Power input = power output / efficiency = 200 / 0.96 = 208.3 W (1)
Power loss = 208.3 - 200 = 8.3 W (1) [2]

(b) Power loss due to hysteresis effects; (1)
Due to the energy used to move domain walls / change alignment of dipoles (in the core material); (1)
In 1 cycle is represented by / proportional to area enclosed by a hysteresis loop; (1)
is proportional to frequency; (1)
is proportional to area of hysteresis loop x number of cycles in 1 sec. (1) max [4]

Power loss due to eddy currents; (1)
Power loss given by I^2R; (1)
Changing flux causes induced voltage in the core; (1)
Eddy currents are caused by / proportional to induced voltage; (1)
Induced voltage / eddy currents increase as rate of change of flux increases
So power loss increases with frequency. (1) max [4]

[Total: 11]

6 **(a)** **(i)** The energy gap between the valence and conduction band in an insulator may be greater than the photon energy of all the given wavelengths; (1)
These photons will pass through the insulator without being absorbed. (1) [2]

(ii) Energy levels of electrons in the conduction band are finely spaced; (1)
Photons of all visible light wavelengths have sufficient energy to excite an electron (in a surface atom) to a higher energy level; (1)
Photons are re-emitted from the surface as reflected light. (1) [3]

(b) The green and blue wavelengths have photon energies greater than the band gap and are absorbed; (1)
The red wavelength has photon energy less than the band gap and passes through; (1)
The insulator appears red to the observer. (1) [3]

(c) (Amount of) Rayleigh scattering is proportional to $1/\lambda^4$ (1)
Reduction in intensity of red light = $\frac{450^4}{650^4} \times 5$ (1)
= 1.15 % (1) [3]

[Total: 11]

2825 Common Question

(a) (i) load = 5000 x 9.81 (accept mg) [1]
k = 5000 x 9.81/ 0.04 [1]

(ii) $f = 1/2\pi\ (1.2 \times 10^6 / 1.25 \times 10^3)$ [1]
f = 4.9(3) Hz (accept 4.98 or 5) [1]
(use of m = 5000kg: f = 2.4(7) Hz scores 1)

(b) (i) $R = 50/ 12000 = 4.17 \times 10^{-3}$ [1]

(ii) P = 50 x 12000 = 600 kW ECF for R [1]

(iii) E = 15 x 420 x (1000 -20) [1]
$E = 6.17 \times 10^6$ J (accept 2SF or 1SF) [1]

(iv) $t = 6.17 \times 10^6 / 600{,}000$ (ECF from iii) [1]
t = 10.3 s [1]

(c) Any **two** from:
conduction through each contact [1]
conduction through air [1]
convection (in air) [1]
radiation/ infra red/ visible light [1]
rate of loss increases with temperature (difference) [1]
energy to heat water (in contacts) [1] [2]
longer time increases the energy losses [1] [3]

(d) (i) Any two from:
cross-sectional area is increased 4 times [1]
resistance is decreased 4 times [1]
R = pl/A [1] [2]

(ii) maximum of 3 marks
power (accept current) is increased 4 times [1]
mass is increased 4 times [1]
so time unchanged [1] [3]

(d) (ii) spring constant increased/ smaller extension/ stiffer spring [1]
natural frequency will increase. [1]

[Total: 20]

Mark Scheme 2825/04
June 2007

ADVICE TO EXAMINERS ON THE ANNOTATION OF SCRIPTS

3. Please ensure that you use the **final** version of the Mark Scheme.
   You are advised to destroy all draft versions.

4. Please mark all post-standardisation scripts in red ink. A tick (✓) should be used for each answer judged worthy of a mark. Ticks should be placed as close as possible to the point in the answer where the mark has been awarded. The number of ticks should be the same as the number of marks awarded. If two (or more) responses are required for one mark, use only one tick. Half marks (½) should never be used.

3. The following annotations may be used when marking. No comments should be written on scripts unless they relate directly to the mark scheme. Remember that scripts may be returned to Centres.

   x = incorrect response (errors may also be underlined)
   ^ = omission mark
   bod = benefit of the doubt (where professional judgement has been used)
   ecf = error carried forward (in consequential marking)
   con = contradiction (in cases where candidates contradict themselves in the same response)
   sf = error in the number of significant figures

4. The marks awarded for each part question should be indicated in the margin provided on the right hand side of the page. The mark total for each question should be ringed at the end of the question, on the right hand side. These totals should be added up to give the final total on the front of the paper.

5. In cases where candidates are required to give a specific number of answers, (e.g. 'give three reasons'), mark the first answer(s) given up to the total number required. Strike through the remainder. In specific cases where this rule cannot be applied, the exact procedure to be used is given in the mark scheme.

6. Correct answers to calculations should gain full credit even if no working is shown, unless otherwise indicated in the mark scheme. (An instruction on the paper to 'Show your working' is to help candidates, who may then gain partial credit even if their final answer is not correct.)

8. Strike through all blank spaces and/or pages in order to give a clear indication that the whole of the script has been considered.

8. An element of professional judgement is required in the marking of any written paper, and candidates may not use the exact words that appear in the mark scheme. If the science is correct and answers the question, then the mark(s) should normally be credited. If you are in doubt about the validity of any answer, contact your Team Leader/Principal Examiner for guidance.

Abbreviations, annotations and conventions used in the Mark Scheme	/ = alternative and acceptable answers for the same marking point ; = separates marking points NOT = answers which are not worthy of credit ( ) = words which are not essential to gain credit ___ = (underlining) key words which **must** be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument

Question	Expected Answers	Marks
1 (a) (i)	gradient = 2.7×10^{-45} (m^3) ans. (1); accept values between 2.7 and 2.8 $\times 10^{-45}$	1 [1]
(ii)	quotes $r^3 = A r_0^3$ *or* $r = A^{1/3} r_0$ deduces $r_0 = \sqrt[3]{}$(gradient) calculates $r_0 = 1.4 \times 10^{-15}$ m allow 1.39 to 1.41 $\times 10^{-15}$ m if values from graph used, max 2/3 answer without working scores 2/3 allow ecf from **(i)**	1 1 1 [3]
(b)	$\rho = m / V$ *or* $\rho = m / [(4/3)\pi r^3]$ equation *either* $= \dfrac{12 \times 1.67 \times 10^{-27}}{12 \times 4/3\,\pi\,(1.4 \times 10^{-15})^3}$ subs. $= 1.45 \times 10^{17}$ kg m^{-3} ans. allow ecf for r_0 from **(a)(ii)** omission of one 12 factor can score max 2/3 omission of conversion factor from u to kg can score max 1/3 *or* reads off $12r^3$ where $A = 12$ from graph then $\rho = \dfrac{12 \times 1.67 \times 10^{-27}}{4/3\,\pi \times 3.28 \times 10^{-44}}$ (1) $= 1.46 \times 10^{17}$ kg m^{-3} (1)	1 1 1 [3]
(c)(i)	ratio = $\dfrac{1.45 \times 10^{17}}{3530} = 4.12 \times 10^{13}$	1 [1]
(ii)	mass of nucleus is about the same as mass of atom *either* most of atom is empty space or AW *or* nucleus occupies only (very) small part of volume of atom; *or* link betwen mass and volume e.g. same mass in larger / smaller volume;	1 1 [2]
		10
2 (a)(i)	(neutrons) having energies comparable with thermal energies / slow moving / low kinetic energy / energy in range 6 - 100 eV / energy similar to (energy of) atoms of surroundings ;	1 [1]
(ii)	*either* thermal neutrons will be captured / absorbed (by U-235 nuclei) *or* higher energy neutrons do not get absorbed;	1 [1]

(b)(i)	3 points plotted; any point incorrect loses this mark	1	
(ii)	curve through 3 points and heads down towards zero;	1	
	line peaks between Br and origin;	1	[3]
(iii)	BE per *nucleus* of $^{235}_{92}U$ = 7.60 x 235 (= 1786 MeV)		
	BE of products = 8.20 x 146 + 8.60 x 87 (= 1197 + 748 MeV) both lines	1	
	so energy released = (1197 + 748) - 1786	1	
	= 159 MeV	1	[3]
	omits multiplication by nucleon number to get 9.2 MeV gets 0,1,0 = 1		
	graph: 2 humps;	1	
	sensibly symmetrical with minimum between 110 and 125;	1	[2]
(iv)	on Fig. 2.1 two labels **F** near to Br and La;	1	
(v)	two regions shaded / marked / ringed around Br and La with gap between;	1	
	labels etc. on Fig. 2.2 scores zero		[2]
(c)(i)	speed after collision = 0.93 x speed before collision		
	so after 120 collisions, final speed = $(0.93)^{120}$ x speed before collision	1	
	= 2.48×10^{3} m s^{-1}	1	[2]
(ii)	this is collision is head-on but other collisions may not be;	1	[1]
			15
3(a)	confines / pulls together plasma / nuclei / ions / nucleons / protons; (1)		
	so increases density/ concentration / number per unit volume; (1)		
	and increases frequency / number of collisions among nuclei; (1)		
	gravitational attraction heats plasma / gravitational p.e. changed to heat; (1) any 3	3	[3]
(b)	*either* area is potential / stored energy / work done / energy to overcome coulomb barrier		
	or minimum k.e. at infinity or AW;	1	
	it is (minimum) energy needed for fusion;	1	[2]
(c)	E_k = $2.07 \times 10^{-23} \times 15 \times 10^{6}$ (= 3.1×10^{-16} J)		
	so for two nuclei, E_k = 6.2×10^{-16} J	1	[1]

(d)	combined (mean) k.e. << required p.e. / energy needed for fusion; (1) aware there is a range / spread of (nuclear) k.e.s; (1) (very) small proportion of $^{1}_{1}H$ nuclei have enough energy to cause fusion;(1) aware (quantum) tunnelling can occur so fusion at distances > x_0 or AW;(1) any 3	3	[3]
(e)(i)	reactant mass = 2 x 1.007 276 = 2.014 552 u product mass = 2.013 553 + 0.000 549 = 2.014 102 u so $\Delta m = 4.5 \times 10^{-4}$ u $E = \Delta m c^2$ $= 4.5 \times 10^{-4} \times (1.66 \times 10^{-27}) \times (3.0 \times 10^{8})^2 \quad = 6.7 \times 10^{-14}$ J allow conversion using 1 u = 931 MeV	1 1 1	[3]
(ii)	positron and electron annihilate	1	[1]
			13

4		**acceleration**	
	1	both accelerate (charged particles) by moving them through a p.d. / electric field / attraction/repulsion due to charged electrodes; (1)	
	2	p.d. constant in cyclotron, varies / changes in synchrotron; (1)	
	3	both accelerate (particles) many times; (1)	
	4	both accelerate only when particle is in gap between electrodes; (1)	
	5	no acceleration / speed increase when particles inside electrodes; (1)	
		synchronisation	
	6	both have frequency of p.d. equal to frequency of transit or AW; (1)	
	7	in cyclotron, frequency is constant but in synchrotron frequency varies; (1)	
	8	cyclotron orbit radius allowed to increase but synchrotron radius is constant; (1)	
		curved path	
	9	both use magnetic field (at right angles to direction of motion) to produce a curved path / circular motion; (1)	
	10	both *B* fields exert centripetal force on particle; (1)	
	11	cyclotron has uniform field but synchrotron field varies round ring (due to gaps); (1)	
	12	magnetic field is constant in cyclotron but can vary in synchrotron (with respect to time); (1)	
		energy	
	13	maximum energy / speed in cyclotron is (much) less than for synchrotron;(1)	
	14	cyclotron limit due to (relativistic) change of mass as particle approaches speed of light (but no limit in synchrotron); (1)	
	15	hence particles in cyclotron get out of synch. with accelerating fields (but this does not happen in synchrotron); (1)	
	16	synchrotron loses energy (as radiation) so energy input is needed to maintain particles in ring; (1)	
		advantages	
	17	synchrotron accelerates (particles) to energy high enough to create new particles / investigate structure of particles; (1)	
	18	can be used to produce synchrotron radiation; (1)	
	19	cyclotron can be used to synthesise / make / produce radioisotopes; (1)	
	20	cyclotron is (much) more compact / would fit into a laboratory or AW; (1)	

21	cyclotron can be used to treat eye cancer / for radiotherapy; (1)	
22	synchrotron allows colliding opposed beams (of particles); (1) any 12	12 **12**
5(a)	number of *decayed* U-238 nuclei = ½ x number of *undecayed* U-238 nuclei; so $^1/_3$ of U-238 has decayed and $^2/_3$ of U-238 has not decayed; (so ratio = $^2/_3$)	1 1 [2]
(b)	*either* $\lambda = 0.693 / T_{½} = 0.693 / (4.47 \times 10^9)$ $(= 1.55 \times 10^{-10}\ y^{-1})$ subs. $N = N_0 e^{-\lambda t}$ so $N / N_0 = e^{-\lambda t}$ and $\ln (N / N_0) = -\lambda t$ $\ln (0.667) = -1.55 \times 10^{-10}\ t$ alg. / arith. so $t = 2.61 \times 10^9$ y ans. *or* $N / N_0 = (½)^x$ so $0.667 = (½)^x$ and $\ln (0.667) = x \ln(0.5)$ and $x = 0.584$ then $t = x T_{½} = 0.584 \times 4.47 \times 10^9 = 2.61 \times 10^9$ y	1 1 1 [3]
(c)	*either* $N_0 = (5.00 / 238) \times 6.02 \times 10^{23}$ subs. $= 1.26 \times 10^{22}$ atoms ans. *or* $N_0 = (5.00 \times 10^{-3}) / (1.67 \times 10^{-27} \times 238)$ (1) $= 1.26 \times 10^{22}$ atoms (1)	1 1 [2]
(d)	exponential decay graph for U: starts from N_0 and approaches t axis; exponential growth of Pb from zero: approaches a constant value of N_0 ; lines sensibly 'mirror images';	1 1 1 [3] **10**
6(a)(i)	leptons;	1 [1]
(ii)	neutrino / muon / tau(on);	1 [1]
(b)(i)	up down down / udd;	1 [1]
(ii)	Q B S u $(+)^2/_3$ $(+)^1/_3$ 0 u values d $-^1/_3$ $(+)^1/_3$ 0 d values	 1 1
(iii)	so for neutron $Q = 0$ $B = 1$ $S = 0$	 1 [3]

(c)	*either* express in quarks: u + u-bar τ d + u u d s-bar d d d compares quarks: (u: u + u + u-bar τ u u's cancel, so balances) *either* d: d + d τ d + d + d no balance *or* s: 0 τ s-bar so no balance concludes reaction not possible *or* (*Q*: 1 - 1 τ 0 + 0 *B*: 1 + 0 τ 0 + 1) *S*: 0 + 0 τ 1 + 0 correct *S* equation gets 2, 0 + 0 = -1 + 0 gets 1 ; (2) not possible because *S* does not balance; (2) 'not possible' unsupported gets zero	1 1 1 1 [4] **10**

2825 Common Question

(a) (i) load = 5000 x 9.81 (accept mg) [1]
k = 5000 x 9.81/ 0.04 [1]

(ii) $f = 1/2\pi\ (1.2 \times 10^6 / 1.25 \times 10^3)$ [1]
f = 4.9(3) Hz (accept 4.98 or 5) [1]
(use of m = 5000kg: f = 2.4(7) Hz scores 1)

(b) (i) $R = 50/ 12000 = 4.17 \times 10^{-3}$ [1]

(ii) P = 50 x 12000 = 600 kW ECF for R [1]

(iii) E = 15 x 420 x (1000 -20) [1]
$E = 6.17 \times 10^6$ J (accept 2SF or 1SF) [1]

(iv) $t = 6.17 \times 10^6 / 600{,}000$ (ECF from iii) [1]
t = 10.3 s [1]

(c) Any **two** from:
conduction through each contact [1]
conduction through air [1]
convection (in air) [1]
radiation/ infra red/ visible light [1]
rate of loss increases with temperature (difference) [1]
energy to heat water (in contacts) [1] [2]
longer time increases the energy losses [1] [3]

(d) (i) Any two from:
cross-sectional area is increased 4 times [1]
resistance is decreased 4 times [1]
R = pl/A [1] [2]

(ii) maximum of 3 marks
power (accept current) is increased 4 times [1]
mass is increased 4 times [1]
so time unchanged [1] [3]

(d) (ii) spring constant increased/ smaller extension/ stiffer spring [1]
natural frequency will increase. [1]

[Total: 20]

Mark Scheme 2825/05
June 2007

Mark Scheme Page 1 of 5	Unit Code 2825	Session June	Year 2007	Version
Question 1	Expected Answers			Marks

(a) Amplitude Modulated transmission (do not accept AM) ①

(b) The 50 kHz carrier is modulated with a pure sine wave only
So no information is being transmitted
Pure sine waves have no harmonic content
Pure sine waves are excruciating to listen to (or wtte) any two ①①

(c) Bandwidth = 10 ① kHz ①

(d) Waveband = Long Wave or Low Frequency ①

From 30 kHz to 300 kHz ①

(e) Any symmetrical AM waveform drawn ①

RF period shown to be 1 / 50 kHz ①

RF period drawn as 20 μs ①

AF period shown to be 1 / 5 kHz ①

AF period drawn as 200 μs ①

(f) Drawing of any carrier line with two sideband continuums ①

Carrier centred on 50kHz and sidebands symmetrical and not square ①

Any information / music will contain a broad range of frequencies
Hence sideband will not be a single line but a continuum of frequencies
The peaks in the sidebands are constantly changing with time any one ①

Mark Scheme Page 2 of 5	Unit Code 2825	Session June	Year 2007	Version
Question 2	Expected Answers			Marks

(a) (i) Signal-to-noise ratio = ratio of signal power to noise power ①

(ii) <u>Decreases</u> ①
because power decreases with distance (ie attenuation)
noise power remains more or less constant either ①

(b) (i) signal-to-noise ratio = 28 = $10 \lg P_1 / P_2$ ①
= $10 \lg P_1 / 0.24 \times 10^{-6}$ ①
received signal power P_1 = 1.51×10^{-4} ①
= 151 μW

(ii) Attenuation in cable = 65×0.32 ①
= 20.8 dB ①

(iii) Attenuation = 20.8 = $10 \lg P_1 / 1.51 \times 10^{-4}$ ①
transmitted signal power P_1 = 0.0182
= 18.2 mW ①
(allow 1/2 if answer 20.8 = 10 log 150 / Pso P = 1.26×10^{-6})

(c) (i) Laser ①

(ii) Monomode fibres are tiny and only lasers can inject sufficient power ①
(allow either monochromatic laser reduces chromatic distortion
or lasers can be switched on and off at high frequency)

(d) (i) Analogue signal is analagous to physical property which generated it
signal varies continuously with time between two limits ①
Digital signal is a coded representation of an instantaneous sample
signal is composed of only two voltage levels ①

(ii) Digital can be perfectly regenerated (because noise can be removed)
(do not accept "digital signals do not suffer from noise")
Digital can have extra codes added to check for errors
Digital can be encrypted to ensure only authorised users have access
Digital can have a greater dynamic range
Digital can be companded to ensure efficiency in transmission
Digital can be easily stored in memory
Digital can be easily controlled by computers
Digital allows time-division multiplexing
(do not allow any considerations of expense) any three ① ① ①

Mark Scheme	Unit Code	Session	Year	Version
Page 3 of 5	2825	June	2007	
Question 3	Expected Answers			Marks

(a) Position of North Pole indicated at right angles to equator / satellite orbit ①
(position of pole must allow satellite to be in a reasonable loop/circle around resulting equator)

(b) Satellite requires power from somewhere so sun (if no RTG used) is only source
Solar panels are not always in direct sunlight (sometimes in Earth's shadow)
Batteries are required to maintain steady power consumption
(allow marks even if battery not explicitly mentioned but implied in answer) (any two) ① ①

(c) Input power to solar panel = $1.6 \times 10^3 \times 4.5$ ①
= 7200 W ①
Efficiency = 1080 / 7200
= 15 % ①

(d) Power into footprint = 0.9×750 = 675 W ①
Power received by dish = $\{ \pi (1.1 \div 2)^2 / \pi (1200 \times 10^3 \div 2)^2 \} \times 675$ ①
= $\{ 1.1^2 / 1200000^2 \} \times 675$ ①
= 5.67×10^{-10} W ①

(if 750W used instead of 675W then answer is 6.3×10^{-10} so allow 3/4)
(if there is a 10^6 error because km have been used for m then allow up to 3/4)
(in a poor answer, allow a mark for Area of dish = 0.95 m^2 or for Area of footprint = 1.13×10^{12} m^2)

(e) Carrier frequencies used are in the order of GHz. ①

The TV station transmits from (a parabolic dish) Earth directly to satellite and
the satellite picks up this signal, amplifies it and transmits it back to Earth ①

The satellite changes the carrier frequency of this signal (eg from 14 GHz to 11 GHz)
In order to avoid feedback / interference / swamping incoming signal with outgoing ①

(f) Satellite system covers huge area with one single transmitter on one carrier frequency
Terrestrial system would require very large number of transmitters
Each operating on slightly different frequencies
So uses bandwidth much more efficiently
Satellite reception is not affected by mountainous terrain (or wtte)
Satellites use higher frequency wavebands so more information/channels can be carried
Satellite system is more cost effective (or wtte) any two ① ①

Mark Scheme Page 4 of 5	Unit Code 2825	Session June	Year 2007	Version
Question 4	Expected Answers			Marks

(a) (i) Inverting amplifier correctly drawn ①
(non-inverting (+) input connected to 0V line with input and feedback resistors correctly added)

Microphone correctly wired ①
(one end connected to input resistor other connected to 0V line)

Op-amp output connected to LED via resistor ①

LED biased permanently on ①
(eg anode to +15V line or cathode to -15V line or summing amp used)

(ii) Maximum voltage gain of amplifier ≈ ½ $V_{saturation}$ / 30 mV
(if biased, eg with summing amplifier, so that output only ever swings positive)
≈ 7.5 / 0.03 ≈ 250 ①
(but if biased via LED cathode to -ve rail then output can swing both +ve and -ve)
≈ 15 / 0.03 ≈ 500

(iii) Ratio of amplifier resistors R_f / R_{in} equal to voltage gain ①

The current limiting LED resistor ≈ { [15 or 30] - 2 } / 10 mA ①
≈ 1300 Ω or 2800 Ω
≈ allow 1 to 3 k Ω ①
(ignore the omission of the 2V switch-on voltage of the LED)

(iv) The microphone produces voltage wobbles around 0V
The small voltage wobbles are amplified by the amplifier ①
The LED is biased on at all times
So a wobbly light intensity is transmitted down the fibre without distortion ①
(allow 1/2 for a decent answer which does not involve the LED bias on)

(b) (i) Any photodiode symbol correctly drawn (but allow LDR) ①

Photodiode in reverse bias and resistor in series across power supply ①
(or with anode of photo diode linked via feedback resistor to the -ve rail)

Capacitor connected to link junction of diode to op-amp input resistor ①
(allow capacitor connected in series to loudspeaker to remove dc bias)

Ratio of amplifier resistors R_f / R_{in} equal to voltage gain of (>) about 100 ①

Loudspeaker connected to output of amplifier and to 0V (ignore series resistors) ①

(ii) Wobbly light intensity from fibre has a dc bias which is removed by capacitor ①

The ac wobble or speech is amplified to produce sound in speaker ①

Mark Scheme Page 5 of 5	Unit Code 2825	Session June	Year 2007	Version
Question 5	Expected Answers			Marks

Surface waves	VLF LF and MF ie waves with carrier frequencies <u>below 3 MHz</u>.	①
	(Large wavelength waves)	
	Follow curvature of Earth by diffraction (do not allow "travels along the surface")	①
Sky waves	HF waves with frequencies between <u>3 MHz to 30 MHz</u>	①
	Short waves reflect off <u>ionosphere</u> and surface of Earth	①
	(Multiple reflections enable waves to travel all over Earth)	
Space waves	Any wave of frequency <u>greater than 30 MHz</u>	①
	(Small wavelength means very little diffraction is apparent)	
	And waves travel by line-of-sight	①

2825 Common Question

(a) (i) load = 5000 x 9.81 (accept mg) [1]
k = 5000 x 9.81/ 0.04 [1]

(ii) $f = 1/2\pi (1.2 \times 10^6 / 1.25 \times 10^3)$ [1]
f = 4.9(3) Hz (accept 4.98 or 5) [1]
(use of m = 5000kg: f = 2.4(7) Hz scores 1)

(b) (i) $R = 50/ 12000 = 4.17 \times 10^{-3}$ [1]

(ii) P = 50 x 12000 = 600 kW ECF for R [1]

(iii) E = 15 x 420 x (1000 -20) [1]
$E = 6.17 \times 10^6$ J (accept 2SF or 1SF) [1]

(iv) $t = 6.17 \times 10^6 / 600{,}000$ (ECF from iii) [1]
t = 10.3 s [1]

(c) Any **two** from:
conduction through each contact [1]
conduction through air [1]
convection (in air) [1]
radiation/ infra red/ visible light [1]
rate of loss increases with temperature (difference) [1]
energy to heat water (in contacts) [1] [2]
longer time increases the energy losses [1] [3]

(d) (i) Any two from:
cross-sectional area is increased 4 times [1]
resistance is decreased 4 times [1]
R = pl/A [1] [2]

(ii) maximum of 3 marks
power (accept current) is increased 4 times [1]
mass is increased 4 times [1]
so time unchanged [1] [3]

(d) (ii) spring constant increased/ smaller extension/ stiffer spring [1]
natural frequency will increase. [1]

[Total: 20]

Mark Scheme 2826/01
June 2007

1 (a) e.g. person in a car on a motorway {1}
travelling with constant velocity (do not allow constant speed) {1}[2]
(1) for situation, (1) for detail

(b) **(i)** e.g. object travelling (at constant speed) in a circle {1}
(ii) e.g. person in a car which is braking {1} [2]

(c) e.g. ball at the top of a vertical throw {2}
(1) for position (1) for zero horizontal velocity [2]

(d) e.g. idea of there being a torque or couple acting on it {1}
and rotating {1}[2]

[Total : 8]

2. (a) Correct use of excess temperature {1}
Value 22 ± 1 °C {1}
Average of at least two readings OR over two half-lives {1}[3]
(Values you might find candidates using −

temperature /°C	temperature excess /°C	half temperature excess /°C	final temperature /°C	time /min
95	80	40	55	22.0 – 0 = 22.0
85	70	35	50	26.4 – 3.8 = 22.6
75	60	30	45	31.4 – 8.6 = 22.8
65	50	25	40	37.0 – 14.6 = 22.4
55	40	20	35	44.0 – 22.0 = 22.0

Allow 1 for 94 – 23.5 takes 66 min therefore average = 33 min)

(b) e.g. ½ = exp(-22 λ) {1}
ln 0.5 = -22 λ {1}
λ = 0.032 OR = 5.3×10^{-4} {1}
unit: $minute^{-1}$ OR unit = s^{-1} {1}[4]

(c) e.g. wind across surface, insulation around liquid/container
surface area humidity
stirring mass /volume/no. of moles
specific heat capacity of liquid temp. of liquid/temp of surroundings
3 required from separate lists(1) mark each {3}[3]

(d) (Δ)Q = mc(Δ)T with clear knowledge of what the symbols mean {1}
= 0.160 x 4200 x (71 to 72) {1}
= 48000 (J) {1}[3]

[Total : 13]

3. (a) DO NOT allow answers which answer the question "Why are power stations near coal mines"
e.g. infra structure in place
cost of re-location {2}[2]

(b) e.g pollution – dirty atmosphere
smell – cleaning gases still leads to an acidic smell
noise – running day and night
(1) for each fact x2+ (1) for valid comment {3}[3]

(c) plenty of cooling water available {1}[1]

(d) (i) knowledgeable use of P = V x I {1}
= 11 000 V x 800 A
= 8 800 000 (W) {1}[2]

(ii) knowledgeable use of V = I x R {1}
= 800 x 5 = 4000 (V) {1}[2]

(iii) 11 000 – 4000 = 7000 (V) {1}[1]

(iv) 7000 V x 800 A {1}
= 5 600 000 (W) {2}[2]

(v) 5.6 MW / 8.8 MW OR 7000 V / 11 000 V {1}
= 0.64 = 64% {1}[2]

(e) working from power lost in the cables {1}
power of 2 MW lost in 5 Ω {1}
$2 \times 10^6 = I^2 \times 5$ $I = \sqrt{400\,000} = 632$ A {1}
Allow the following (2) marks as e.c.f from incorrect current
$1.0 \times 10^8 = V \times 632$ {1}
$V = 1.0 \times 10^8 / 632 = 158\,000$ V {1} [5]

[Total : 20]

4 (a) one (or more) electrons removed (or added) to an atom {1}[1]

(b) $E = hf = hc/\lambda$ together with knowledge of symbol meaning {1}

$$= \frac{6.63x10^{-34}x3.00x10^{8}}{238x10^{-9}}$$ {1}

$= 8.36 \times 10^{-19}$ (J) {1}[3]

(c) frequency of UV is greater than frequency of light OR alternative statement in terms of wavelength.
so photon energy of visible light is less than photon energy of UV {1}
PLUS one of the idea of conservation of energy
it is not possible for a low energy photon to give a high energy photon
this is a one to one process {1}[2]

(d) E = V/d and power of 10 correct for d {1}
= 30/0.00020 = 150 000 {1}
V m^{-1} {1}[3]
[Total : 9]

5. (a) P.E. at top = 80 x 9.8(1) x 150 = 118 000 (J) {1}
K.E. at bottom and at top = 0 {1}
Elastic P.E. at top = 0, at bottom = P.E. at top for ecf = 118 000 J {1}[3]

(b) 24 N m^{-1} x 100 m = 2400 N {1}
[1]

(c) elastic P.E. is area under F-x graph {1}
graph is a straight line so energy is area of triangle {1}
elastic P.E. = ½ x kx x x = ($\frac{1}{2}kx^2$) {1}[3]

(d) loss of P.E. = 100 x 9.8(1) x 150 = 147 000 J {1}
gain of elastic P.E. = ½ x 26.7 x 105^2 = 147 000 J {1}[2]

(e) idea that a given (unit) extension for a shorter rope requires a greater force {1}[1]
[Total: 10]

Mark Scheme 2826/03
June 2007

Question 1

(a) (ii)	Value of V_0, must be between 50mV and 500mV. If POT error here due to misreading of scale, do not penalise again.	**1**
(b) (ii)	Readings Write the number of readings as a ringed total by the results table. 6 sets of readings in the table scores one mark. Values of n must be in range, up to at least n = 17, and reasonably spaced ($\Delta n \geq 2$), one mark. Check a value for ln(V). Underline checked value and ✓ if correct, at least 2 d.p., one mark. Log values do not score this mark. If minor help has been given then –1. Excessive help given then –2. Please indicate when help has been given to a candidate by writing **SR** at the top of the front page of the candidate's script. Also, please indicate the type of help that has been given by writing a brief comment by the table of results.	**3/2/1/0**
(b) (ii)	Repeat readings of voltage. This mark not to be awarded if all repeats are identical.	**1**
(b) (ii)	Column headings (voltage only) There must be some distinguishing mark between the quantity and its unit. E.g.V/mV , V(mV), V in millivolts, are OK, but not (V)mV , V_{mV} , or just "millivolts"	**1**
(b) (ii)	Consistency of raw readings Applies to V only. All values must be to at least the nearest mV (≤ 10mV if analogue meter has been used). No trailing zeros. Indicate using $\checkmark_C$ at the foot of the column if correct.	**1**
(b) (ii)	Quality of results Judge by scatter of points about line of best fit. 5 trend plots needed. Allow a very slight curve at n = 2 end.	**1**
(c) (i)	Axes. Each axis must be labelled with a quantity. Ignore unit. One mark for each axis. Scales much be such that the plotted points occupy at least half the graph grid in both the x and y directions. Do not allow more than 3 large squares between scale markings. Do not allow awkward scales (e.g. 3:10, 6:10, 7:10, 8:10 etc.). Axes wrong way round. Penalise here, then ecf.	**2/1/0**
(c) (i)	Plotting of points. Count the number of plots on the grid and write this value by the line and ring it. Do not allow plots in the margin area. The number of plots must correspond with the number of observations. Do not award this mark if the number of plots is less than the number of observations. Check one suspect plot. Circle this plot. Tick if correct. If incorrect then mark the correct position with a small cross and use an arrow to indicate where the plots should have been. Allow errors up to and including half a small square.	**1**

(c) (i)	Line of best fit There must be a reasonable balance of points about the line of best fit. If one of the points is a long way from the trend of the other plots then allow this plot to be ignored when the line is drawn. The mark can be awarded if the line of best fit is 'reasonable' but not quite right. This mark can only be awarded if a straight line has been drawn through a linear trend.	**1**
(c)(ii)	Measurement of gradient. Read-offs must be accurate to half a small square and the ratio must be correct, one mark. Please indicate the vertices of the triangle used by labelling with Δ. The hypotenuse must be greater than half the length of the drawn line, one mark. Negative value given for negative gradient, one mark.	**3/2/1/0**
(c) (ii)	y-intercept Check the read-off. Accept correct substitution from a point on the line into y = mx + c. No need to check calculation, but algebraic manipulation must be correct, with sensible answer.	**1**
(d)	Ln V = ln A - Bn, or implied from the working.	**1**
(d)	Value of A (<u>from $e^{y\text{-intercept}}$</u>), allow $10^{y\text{-intercept}}$ if log has been used. Ignore unit.	**1**
(d)	Value of B (<u>from gradient</u>). B = - gradient. Ecf from (c) (ii).	**1**
(d)	SF in A and B. Allow 2 or 3 sf in both quantities.	**1**
(e) (i)	Micrometer screw gauge reading for microscope slide thickness t. Must be ±0.10 mm of SV. One mark. Raw values must be given to nearest 0.01 mm (or 0.001 mm if SV is to 0.001mm). One mark.	**2/1/0**
(e) (ii)	Percentage uncertainty in value of t. Sensible Δt (0.01mm, 0.02 mm), or half range, one mark. Correct ratio idea and 'x 100', one mark. Ignore final calculated answer. Insist on correct method of working.	**2/1/0**
(f)	Problem stated or implied: find value of t when voltage = $V_0/2$ or A/2, since A ought to equal V_0. One mark. Substitute in formula lnV = lnA - Bn to find n. (OR ln(0.5) = -Bn). Allow ecf. Check calculation. One mark. Thickness = t x n. One mark, only if correct method for n. Final answer must be sensible.	**3/2/1/0**
(g)	Would a single piece of glass be equivalent to a pile of slides of the same thickness? Answer: no, because with the slides much energy is lost by internal reflections, (and/or reflections between the slides).	**1**

[Total 28]

Question 2

(a) (i)	Raw time > 5s, recorded to 2 dp, one mark. T correct (= t/n), one mark. Do not credit miscounting of n. T should be about 1 second.	**2/1/0**
(a) (ii)	Justification for number of sf in T. i.e. same sf as t (i.e same sf as raw data), or a sensible reference to human reaction time. Ignore references to dp. Answers must be consistent with (a) (i).	**1**
(b)	New value of T (< first value of T), one mark.	**1**
(c)	$T \propto \sqrt{m}$ or $T^2 \propto m$ One mark for comparison of ratios, or calculation of k's. One mark for conclusion that $T \propto \sqrt{m}$, or $T^2 \propto m$ (only if k values are within 10% of each other).	**2/1/0**
(d)	Evaluation of procedure. Relevant points must be underlined and ticked. One mark for each. Some of these might be: P = problem S = solution P Raw time too small/one T reading not enough S Time more oscillations S Use correctly positioned motion sensor (but <u>not</u> videoing the mass). S Repeat readings, and <u>average</u> for a final value of T. P Problem with pendulum behaviour S Use small amplitude S Take care not to give sideways impulse on launch (do not allow tubes). S Use different masses, must explain why this would work P Human error in timing / hard to see beginning or end of oscillation Do <u>not</u> credit difficulty in starting watch and oscillation together. S Use a marker (in any position). S Place (fiducial) marker at <u>centre</u> of oscillation P Two readings of T and m are not enough S Use a greater range of values of m and plot a <u>graph</u> S This graph should be of T^2 against m, or T against $\sqrt{m}$, (and be a straight line). Do not allow draughts, closing windows, etc. Do not allow vague "light gates", "use a computer", unless further clarification is given. Allow other relevant points (8 maximum).	
	2 marks are reserved for quality of written communication (SPAG)	**2/1/0**

16 marks maximum to be awarded

June 2007

Mark Scheme – Plan – Radioactivity

A1	Labelled diagram showing sensible layout of equipment., including source, Al, GM tube	**1**
A2	Workable method, measure Al thickness t and count-rate; alter t and measure count-rate again until a set of several readings is obtained. Count-rate should be measured or averaged for at least a minute, or repeated ratemeter use.	**1**
A3	(Sr90), because of long half-life.	**1**
B1	Expected results in the form of thickness/count-rate graph (or ln count-rate). Allow exponential graphs or straight line log graphs. Line must touch y-axis. (See D).	**1**
B2	Micrometer used to measure Al thickness t	**1**
B3	Measurement of background radiation and subtract from count-rate.	**1**
C1	Safety precautions. Tongs or gloves. Do not credit goggles. Don't award this mark if precautions are over the top i.e. lead screens everywhere etc.	**1**
C2	Factory environment. Electrons (β particles) are deflected (do not allow attracted) by stray magnetic fields, so install magnetic shield of iron/steel. Not Faraday cages.	**1**
D	Good further detail/research of material. Examples of creditworthy answers might be: Labelled diagram of GM tube / further details Source should be collimated (explain or made clear in diagram). Awareness of random source fluctuations Evidence of preliminary work Awareness of sensible range of aluminium thicknesses, perhaps 0.1mm to at the most 5 mm. Log or ln version of calibration graph, curved, showing secondary emission section. Awareness that some sources also emit α and γ rays (detail needed). Awareness of energy spectrum of Sr90. Use of soft iron/μ metal for shielding. Allow other materials if references given. Show on graph, and explain, secondary emission. Underline and tick each relevant point in the body of the text. The ticks must have a subscript showing which marking point has been awarded (e.g.✓$_{A2}$).	**4/3/2/1/0**
R	Evidence of research of material. More than one source (books or internet), with page numbers, for 2 marks. Two vague sources, one mark. One vague source, no marks.	**2**
Q	2 marks are reserved for quality of written communication (organisation). Rambling and poorly presented material cannot score both marks.	**2**

16 marks for this question

Summary of shorthand notation which may be used in annotating scripts:

SFP	Significant figure penalty
ECF	Error carried forward
TE	Transferred error
AE	Arithmetical error
POT	Power of ten error
NV	Not valid
NR	Not relevant
GAP	Insufficient scale markings on an axis
NBL	Not best line
FO	False origin
NE	Not enough
NGE	Not good enough
BOD	Benefit of the doubt
R	Point repeated (no further credit)
NA	Not allowed
SV	Supervisor's value
SR	Supervisor's report
OOR	Candidate's value is out of range
wtte	Words to that effect
eeoo	Each error or omission
CON	Contradictory physics not to be credited
✓△	Used to show that the size of a triangle is appropriate (gradient calculation)
✓A3	Used to show the type of mark awarded for a particular piece of work (in plan)
✓C	Used to show that the raw readings are consistent
✓SF	Used to show calculated quantities have been given to an appropriate number of significant figures
^	Piece of work missing (one mark penalty)
^^	Several pieces of work missing (more than one mark penalty)
↔	Scale can be doubled in the x-direction
↕	Scale can be doubled in the y-direction

Results for Light Absorption Expt. Q1 2826/03 June 2007

V/mv	n	ln V
430	0	6.064
418	2	6.035
408	4	6.011
398	6	5.986
389	8	5.964
378	10	5.935
371	12	5.916
360	14	5.886
353	16	5.866
347	18	5.849
341	20	5.832

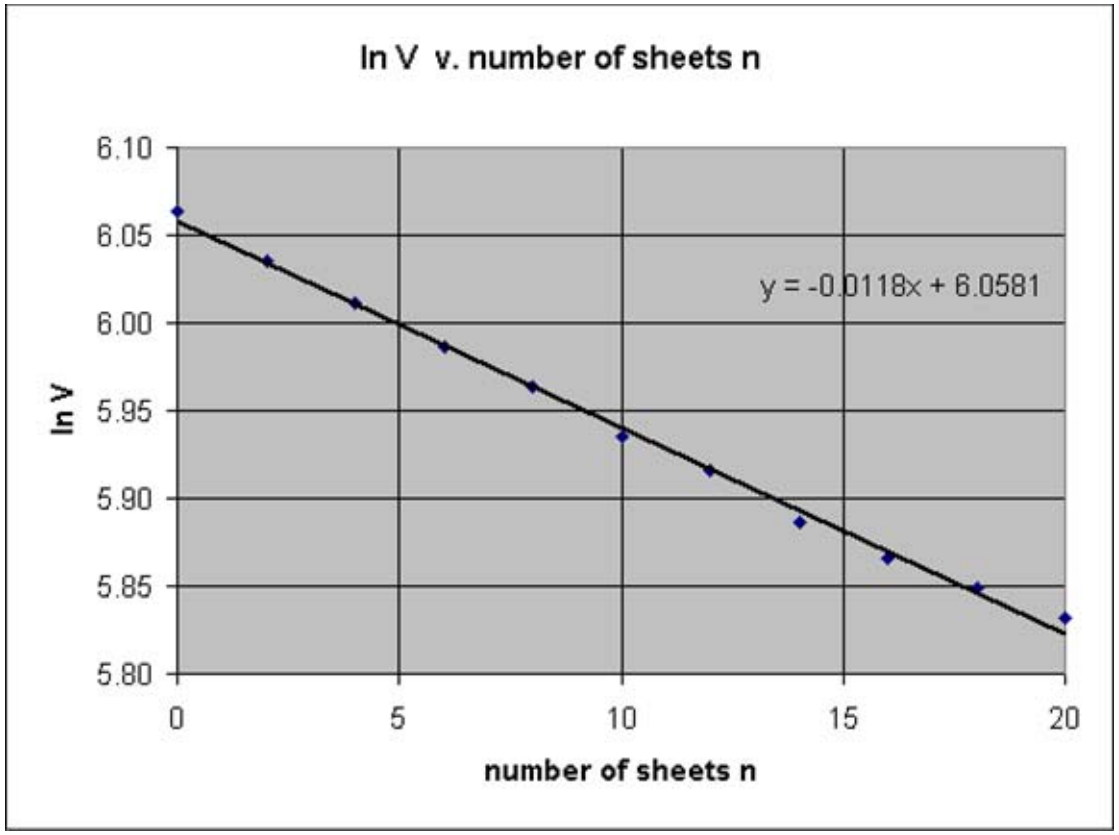
Thickness of slide = 1.17mm

Gradient = -0.012; B = 0.012

Intercept = 6.058; A = 428 (v)

When V = V0/2, equation leads to n = 58

hence thickness necessary to halve
brightness = 58 x 1.17 = 68mm


ln V v. number of sheets n
6.10
6.05
6.00
5.95
5.90
5.85
5.80
ln V
y = -0.0118x + 6.0581
0
5
10
15
20
number of sheets n

Advanced GCE Physics 3883/7883
June 2007 Assessment Series

Unit Threshold Marks

	Unit	**Maximum Mark**	**a**	**b**	**c**	**d**	**e**	**u**
2821	Raw	60	45	39	33	28	23	0
	UMS	90	72	63	54	45	36	0
2822	Raw	60	47	42	37	32	27	0
	UMS	90	72	63	54	45	36	0
2823A	Raw	120	93	82	71	61	51	0
	UMS	120	96	84	72	60	48	0
2823B	Raw	120	93	82	71	61	51	0
	UMS	120	96	84	72	60	48	0
2823C	Raw	120	88	79	70	61	52	0
	UMS	120	96	84	72	60	48	0
2824	Raw	90	60	53	46	39	33	0
	UMS	90	72	63	54	45	36	0
2825A	Raw	90	65	59	53	47	41	0
	UMS	90	72	63	54	45	36	0
2825B	Raw	90	61	54	48	42	36	0
	UMS	90	72	63	54	45	36	0
2825C	Raw	90	68	61	55	49	43	0
	UMS	90	72	63	54	45	36	0
2825D	Raw	90	59	52	45	39	33	0
	UMS	90	72	63	54	45	36	0
2825E	Raw	90	64	57	50	43	37	0
	UMS	90	72	63	54	45	36	0
2826A	Raw	120	89	79	69	60	51	0
	UMS	120	96	84	72	60	48	0
2826B	Raw	120	89	79	69	60	51	0
	UMS	120	96	84	72	60	48	0
2826C	Raw	120	86	78	70	62	55	0
	UMS	120	96	84	72	60	48	0

Specification Aggregation Results

Overall threshold marks in UMS (i.e. after conversion of raw marks to uniform marks)

	Maximum Mark	A	B	C	D	E	U
3883	300	240	210	180	150	120	0
7883	600	480	420	360	300	240	0

The cumulative percentage of candidates awarded each grade was as follows:

	A	B	C	D	E	U	Total Number of Candidates
3883	20.0	37.6	54.7	70.7	83.8	100.0	7263
7883	27.2	49.6	69.8	84.6	95.3	100.0	5774

For a description of how UMS marks are calculated see;
http://www.ocr.org.uk/exam_system/understand_ums.html

Statistics are correct at the time of publication

OCR (Oxford Cambridge and RSA Examinations)
1 Hills Road
Cambridge
CB1 2EU

OCR Customer Contact Centre

(General Qualifications)
Telephone: 01223 553998
Facsimile: 01223 552627
Email: general.qualifications@ocr.org.uk

www.ocr.org.uk

For staff training purposes and as part of our quality assurance programme your call may be recorded or monitored