RECOGNISING ACHIEVEMENT

GCE

Physics A

Advanced GCE **7883**

Advanced Subsidiary GCE **3883**

Mark Schemes for the Units

June 2006

3883/7883/MS/R/06

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
Annersley
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 ON THE UNITS

Mark Scheme 2821
June 2006

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)	energy, power and speed underlined	B1
	any error loses this mark	
(ii)	vector has magnitude / size	B1
	vector has a direction	B1
(b)	Scale diagram: correct triangle / parallelogram drawn on Fig. 1.1	M1
	scale stated and correct resultant arrow	A1
	resultant force 25 to 26 (N)	B2
	resultant force 24 to 27 (N)	B1
	Value calculated: correct triangle drawn	M1
	correct triangle labelled (arrows and labels which includes the resultant with an arrow in the correct direction)	A1
	valid method of calculation: (e.g. cosine rule) / resolve into horizontal (12 + 16cos50) and vertical (16sin50) components and use of Pythagoras	C1
	25.(4) (N)	A1
		Total: 7

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)(i)	$v^2 = 0 + 2 \times 9.8(1) \times 30$	C1
	v = 24. (3) (m s^{-1}) (-1 if g = 10 is used ,once only on the paper) (zero scored if s = 36 m is used)	A1
(ii)	$s = ut + ½ at^2$ or $v = u + at$ or $s = (u+v)t / 2$	
	$30 = 0 + ½ \times 9.8(1) \times t^2$ $t = 24.3 / 9.8$ $t = 2 \times 30/24.3$	C1
	t = 2.5 (s)	A1
(b)	In the air: weight / force due to gravity (allow air resistance if included as well)	B1
	(Hence) constant acceleration / acceleration at 9.8 m s^{-2} (allow reduced acceleration / terminal velocity if air resistance included)	B1
	In water: weight and (large) fluid resistance / upthrust / buoyancy	B1
	Hence deceleration / slows down	B1
		Total: 8

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)	**V_h = 10 cos 53**	**B1**
	= 6.0(18) m s^{-1})	**A0**
(ii)	**speed = distance / time**	**C1**
	time = 4.9 / 6.0	
	= 0.8(2) (s)	**A1**
(iii)	**gain in potential energy = mgh**	**C1**
	= 50 x 10^{-3} x 9.8(1) x 3.3	**C1**
	= 1.6(2) (J)	**A1**
(b)(i)	**change in velocity = (-) 10 (m s^{-1})**	**B1**
	acceleration = (v – u) / t / 10 / 0.16	
	= 62.5 **unit: m s^{-2}**	**A1** **B1**
(ii)	**F = ma** **= 50 x 10^{-3} x 62.5** **= 3.1(3) (N)** **direction: left**	**C1** **A1** **B1**
(iii)	**kinetic energy = ½ m v ^{2}**	**C1**
	loss in kinetic energy = ½ x 50 x 10^{-3} (4^2 – 6^2)	**C1**
	= 0.5(0) (J)	**A1** **Total: 15**

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) (i)	**(one of the) force x <u>perpendicular distance between the forces</u>**	**B1**
(ii)	**torque = 1200 x 0.4**	**C1**
	= 480 Nm **[allow one mark for 1200 x 0.2 = 240 (N m)]**	**A1**
(b)(i)	**work = force x distance (moved)**	**B1**
	= 2 x 1200 x 2 x π x 0.2	**B1**
	= 3016 (J)	**A0**
(ii)	**power = work done / time**	**C1**
	= 3000 / (1/40)	
	= 1.2 x 10^5 (W)	**A1**
		Total: 7

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)	**One reading from the graph e.g. 1.0 N causes 7 mm**	**C1**
	Hence 5.0 (N) causes 35 ± 0.5 (mm) **(allow one mark for 35 ± 1 (mm))**	**A1**
(b) (i)	**Force on each spring is 2.5 (N)**	**C1**
	extension = 17.5 (mm) allow 18 (mm) or reading from graph **[allow ecf from (a)]**	**A1**
(ii)	**strain energy = area under graph / ½ F x e**	**C1**
	= 2 x 0.5 x 2.5 x 17.5 x 10^{-3}	
	= 0.044 (J) **[allow ecf from (b)(i)]**	**A1**
(c)	**E = stress / strain**	**C1**
	Stress = force / area and strain = extension / length	**C1**
	extension = (F x L) / (A x E)	
	= (5 x 0.4) / (2 x 10^{-7} x 2 x 10^{11})	
	= 5.(0) x 10^{-5} (m)	**A1**
(d)	**strain <u>energy</u> is larger in the spring**	**B1**
	extension is (very much larger) (for the same force) for the spring	**B1**
		Total: 11

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**
6 (a)	**Tyre exerts downward force on the road which is balanced by an upward force from the road** **Engine / car generates a torque on the wheels / or axle / force <u>turns</u> the wheels** **Tyre pushes <u>back</u> on the road** **Road pushes tyre forwards / in opposite direction (by Newton's third law)** **Brakes generate a torque on the wheels** **Tyres exert a force on the road in the same direction as the motion** **Push from road on tyres is in the opposite direction to the motion** **[Max of three marks for either engine or brakes explanation and one mark for indicating the other is then the reverse argument]** **Motive / braking force between the tyre and the road is friction** **The greater the friction the greater the acceleration / deceleration** **The greater the engine motive force / torque supplied the greater the acceleration or the greater the braking force greater the deceleration**	**Max 5**

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**
6 (b)	**Definition of braking distance [the distance a car travels after the brakes are applied until it comes to rest]** **Greater the speed the greater the b. d. plus explanation** **Poor brake pads / discs greater the b. d. plus explanation** **Road conditions given to suggest reduced / greater friction plus explanation e.g. ice / wet and the appropriate effect on b. d.** **tyre tread example and effect on b. d.** **plus explanation e.g. tyre tread and the effect on channelling water away.** **Greater mass plus explanation and effect on b.d.** **Gradient of road plus explanation and effect on b.d.** **2/3 factors unexplained can score 1**	
QWC	**≥4 factors unexplained can score 2** **Spelling, punctuation and grammar** **Technical**	**Max 5** **B1** **B1** **Total: 12**

Mark Scheme 2822
June 2006

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) Correct direction shown (anticlockwise) B1

(a)(ii) Direction in which positive charges / ions move /
Direction / flow / current / from positive to negative /
Flow of (positive) charge from positive to negative /
Direction / flow opposite to electron flow B1

(a)(iii) $Q = It$ (Allow any subject with or without delta notation)
C1

$$I = \frac{0.76}{5.0 \times 60}$$ C1

current = 2.53×10^{-3} (A) ≈ 2.5×10^{-3} (A) A1
(0.152 / 0.15 (A) scores 1/3)

(b) The compass /needle points in the <u>opposite</u> direction
B1
(Magnetic) <u>field</u> is circular (about the wire) / in opposite direction / clockwise
B1
(Both marks can be scored on diagram)

[Total: 7]

2

Any <u>three</u> properties from: (-1 for each error or contradiction) B1 × 3

1. Travel at the speed of light / c / 3×10^8 <u>m s^{-1}</u> (NOT 'same speed')
2. Travel through vacuum / 'free space'
3. Have oscillating electric <u>and</u> magnetic fields
4. They are (all) transverse waves / can be polarised
5. Allow: 'They show diffraction / reflection / refraction / interference'
6. Allow: 'Consist of photons'

Any <u>three</u> regions from the list below:
B1 × 3
Gamma (rays / radiation) / γ (rays) ; X-rays ; u.v ; ir ; microwaves ; radio waves
(NOT 'radio')

<u>One</u> suitable application for the opted region.
B1
(E.g.: Gamma rays for radiotherapy / sterilisation;
X-rays for taking pictures of skeleton / bones; u.v for tanning; ir for TV remote control;
microwaves for cooking / mobile phones; radio waves for communication)

(Note: Reference to alpha, beta and gamma can only score the last marking point)

[Total: 7]

3

(a) current ∝ p.d / voltage (for a metallic conductor) M1
as long as temperature is constant / physical conditions remain constant
A1

(b)(i) $(R =) \dfrac{0.15}{4.3} (= 0.0349)$ B1

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

$\rho = \dfrac{RA}{L} = \dfrac{0.035 \times (0.012 \times 0.012)}{0.09}$ C1

resistivity = 5.6×10^{-5}
A1
unit: ohm metre / Ω m (Allow V m A^{-1})
A1
(5.6×10^{-n} without unit or incorrect unit and n ≠ 5 or 3 – can score 2/4)
(5.6×10^{-3} Ω m – can score 3/4)
(5.6×10^{-3} Ω cm – can score 4/4)

[Total: 7]

4

(a) Parallel
B1

(b)(i) $I = \dfrac{12}{8.0}$ C1

current = 1.5 (A) A1

(b)(ii) $P = \dfrac{V^2}{R}$ / $P = IV$ / $P = I^2R$ C1

$P = \dfrac{12^2}{8}$ / $P = 1.5 \times 12$ / $P = 1.5^2 \times 8.0$ (Possible ecf) C1

power = 18 (W) A1

(b)(iii) $\dfrac{1}{R} = \dfrac{1}{R_1} + \dfrac{1}{R_2} + (\dfrac{1}{R_3})$ / $\dfrac{1}{R} = \dfrac{1}{8} + \dfrac{1}{8} + \dfrac{1}{8}$ C1

$\dfrac{1}{R} = 3 \times \dfrac{1}{8}$ C1

resistance = 2.67 ≈ 2.7 (Ω) (Allow answer expressed as 8/3) A1
(0.375 or 3/8 scores 2/3)

(b)(iv) energy = 0.018 × 12 × 3 C1
energy = 0.648 ≈ 0.65 (kW h) (Possible ecf) A1
(0.22 (kW h) scores 1/2)
(648 (kW h) scores 1/2)
(2.3×10^6 (J) scores 1/2)

(c) It will be brighter B1
The current is larger / correct reference to: $P \propto 1/R$
B1

[Total: 13]

5

(a) current <u>and</u> current B1

(b) energy B1

(c)(i) (NTC) thermistor B1

(c)(ii) Resistance decreases when temperature is increased. (ora) B1
(Allow correct credit for a PTC thermistor)

(c)(iii)1 I = (0.032-0.006 =) 0.026 (A) B1

(c)(iii)2 (V_{200} = 0.026 × 200 =) 5.2 (V) / (V_{720} = 0.006 × 700 =) 4.2 (V) C1
E = 5.2 – 4.2 (Allow E = 4.2 – 5.2) C1
E = 1.0 (V) (Allow 1 sf answer) A1
(9.4 (V) scores 1/3)

[Total: 8]

6

(a) Maximum of <u>three</u> from points 1 to 6:
B1 × 3

1. Photon mentioned (e.g: photons interact with the surface electrons)
2. Energy is conserved (between the photon and the electron / in the interaction)
3. $hf = \phi + KE_{(max)}$
4. A single photon interacts with a single electron / It is a one-to-one interaction
5. Electron is removed when photon energy is greater than / equal to the work function (energy) / ϕ (Allow ora)
6. Electron removed when frequency is greater than / equal to the threshold frequency (Allow ora)

----

7. (Visible) <u>light</u> has lower frequency than the threshold frequency / Energy of (visible) <u>light</u> photon is less than the work function (energy) (ora with <u>uv</u>)
B1
8. Greater intensity of (visible) <u>light</u> means more photons (per unit time) / energy of a photon remains the same B1

QWC - Spelling, punctuation and grammar B1
QWC - Organisation B1

(b)(i) kinetic energy = 1.5 × 1.6 × 10^{-19} C1
kinetic energy = 2.4 × 10^{-19} (J)
A1

(b)(ii) $E = hf$ / $E = \dfrac{hc}{\lambda}$ / $f = 7.69 \times 10^{14}$ (Hz) / (E =) 5.1×10^{-19} (J) C1

$\phi = 5.1 \times 10^{-19} - 2.4 \times 10^{-19}$ (Possible ecf) C1

work function energy = 2.7×10^{-19} (J)
A1

[Total: 12]

7

(a)

✓

✓

×

×

(Four correct: 3 marks, three correct: 2 marks, two correct: 1 mark) B3

(b) $\lambda = \dfrac{h}{mv}$ / $\lambda = \dfrac{h}{p}$ (Any subject) C1

$v = \dfrac{6.63 \times 10^{-34}}{6.8 \times 10^{-11} \times 2.0 \times 10^{-26}}$ C1

speed = 490 (m s^{-1}) A1

[Total: 6]

Mark Scheme 2823/01
June 2006

1. (a) c_i = speed of light in air/vacuum/free space (accept speed of incident ray) B1
{reject ‘speed in medium1’}
c_r = speed of light in medium (allow glass.water/perspex) OR speed of refracted ray B1 [2]

(b) (i) normal drawn correctly (ignore labelling of normal) B1
angle of incidence correctly shown with 60^o or i, B1
corresponding angle of refraction r correctly labelled <u>must be < 60^O OR i,</u>(allow 36^O) B1 [3]
{ambiguous diagrams with normal and interface indistinguishable score max of 1 mark}
(ii) recall of n =sini/sinr C1
correct substitution: e.g. 1.48 = sin 60/sinr OR sinr = sin60/1.48 C1
correct determination of r $\Rightarrow$ r = 36^O (35.8, 35)) A1 [3]

(iii) n =$\lambda_{air}/\lambda_{med}$ OR $6.48 \times 10^{-7}/\lambda_{med}$ OR n= c_1/c_2 AND c = fλ (OR v=fλ) C1
λ_{med} = (6.48 x 10^{-7})/1.48 = 4.38 x 10^{-7} m (allow 4.36, 4.37 4.3, 4.4) A1
f_{med} = f_{air} OR f_{med} = 4.63 x 10^{14} Hz –(allow 4.6) OR ‘stays the same’- B1 [3]

[N.B Change of total from question paper] [Total = 11]

---

2. (a) (i) *C* correctly labelled on ray Y B1
(ii) ray X refracted into the air away from the normal (ignore any reflected ray) B1
ray Y refracted ALONG INTERFACE (ignore any reflected ray) B1
ray Z TOTALLY INTERNALLY REFLECTED (at any angle in glass) B1 [3]
(iii) correct substitution into n=1/sinC : e.g. n = 1/sin44 C1
= 1/0.695 = 1.44 (allow 1.43, 1.45 or 1.4) A1 [2]

(b) ANY valid practical application of TIR stated and described e.g.: endoscope (telecommunication, periscope, binoculars, SLR camera, cycle reflectors, cats-eyes) B1
reference to optic fibres OR prisms (allow diagrams) B1 [2]

[Total = 8]

---

3. Maximum of 2 marks for correctly identifying the 4 errors OR stating the 2 correct notes:
i.e. errors in notes 1, 2, 3, and 6 (shown anywhere) B2
{5 or 6 or 2 or 1 notes nominated scores ZERO, 4 correct scores 2, 3 correct scores 1}

Valid corrections score 1 mark each: do not allow “NOT” corrections apart from note 3
Note 1: In longitudinal waves vibrations are <u>parallel</u> to wave direction (WTTE) B1
{OR in <u>transverse</u> waves vibrations are perpendicular to wave direction (WTTE}

Note 2 <u>light</u> (or any of the <u>em waves</u>) can travel through a vacuum (WTTE) B1
{ allow sound/longitudinal waves cannot travel thro’ a vacuum}

Note 3: waves carry energy/disturbance (not displacement or info) from….. (WTTE) B1
{allow “waves do not carry the medium” and “the medium carries the waves from…….” }

Note 6: wavelength = distance from crest to crest/trough to trough/max to max ((WTTE) B1 [6]

[N.B. Change of total from question paper] [Total = 6]

4. (a) diagram showing
laser/light source placed directly behind double slit AND screen placed in front of slits B1 [1]
{single slit NOT required; no labelling required}
(i) *D*: allow any value between 30cm and 10m B1
(ii) *a*: allow any value between 0.1mm and 2mm B1 [2]
(b) (i) evidence of good practice: i.e distance for nx measured e.g. 5x = 18mm C1
x = 3.6 mm (OR 3.5 OR 3.7) A1 [2]
{x = 3.4, 3.8, 3.9, 4.0, or 4 mm, implying x is directly measured, and score 1 mark)
(ii) for O path difference = 0 B1
for A path difference = 3(λ) B1
for B path difference = 1.5(λ) B1 [3]

(c) recall of λ= ax/D OR x =λD/a OR x $\propto$ λ B1
λ is smaller for blue light (than red light) hence x is SMALLER (WTTE) B1 [2]

[N.B. Change of total from question paper] [Total = 10]

---

5. (a) ANY valid differences: e.g.
Sound is longitudinal (light is not) OR light is transverse (sound is not) B1 +B1 [2]
OR sound waves have longer wavelengths' OR sound travels much slower
Light can be polarised (sound cannot)
Light can travel though a vacuum, (sound cannot)

(b) (i) a straight object (allow paddle, NOT dipper) B1
vibrating (or oscillating) (WTTE) (in the water) B1 [2]

(ii) reduce frequency of motor OR reduce speed of motor OR reduce current in motor
OR reduce frequency/increase period <u>of vibration</u>
(do not accept 'reduce speed of vibration'; 'reduce frequency'; 'increase speed of waves')
OR increase depth of water B1 [1]

(iii) reduce depth of water (WTTE) {no ecf from (ii)} B1 [1]

(c) circular arcs (penalise anything flat) B1
same constant wavelength before and after gap – judged by eye or labelled B1 [2]
this means at least <u>3 wavefronts need to be drawn</u>

(d) for noticeable diffraction $\lambda\approx$ gap size (WTTE) B1
λ for sound much bigger than for light (WTTE) B1[2]

[Total = 10]

Mark Scheme 2823/03
June 2006

Planning Exercise - Skill P

A1	Diagram of physical arrangement of apparatus. Source, detector and indication of distance are needed for this mark. Ignore circuit errors.	**1**
A2	Correct procedure (i.e. measure distance and output from photocell; change distance source/detector distance and measure new output – allow graph or table). Method must be workable.	**1**
A3	Sensible range of distances Maximum distance of their range must be greater than equal to 1 m	**1**
B1	Circuit diagram for candidate's detector circuit including appropriate output meter e.g. photodiode, LDR with ammeter + e.m.f. source; LDR with ohmmeter; LDR with voltmeter & potential divider Photo detector with voltmeter Photovoltaic cell with voltmeter Penalise incorrect circuits (e.g. voltmeter across e.m.f. source)	**1**
B2	Stated range for output meter	**1**
B3	Keep output of infra-red source constant. An explicit statement is needed.	**1**
C1/2	Methods of reducing spurious radiations Carry out experiment in the dark (e.g. dark room/in a tube) (Screen) body heat Keep ambient temperature constant/avoid background radiation	**2/1/0**
R1/2	Evidence of the sources of the researched material Two or more independent detailed references scores two marks. Two or more (vague) references and/or one detailed reference score one mark. Detailed references should have page or chapter numbers or be internet pages.	**2/1/0**
D1/2/3/4	Any further relevant detail. Examples of creditworthy points might be; Safety precautions, e.g. do not look directly at source Use of i.r. filter Typical i.r. wavelength stated Evidence of preliminary investigation in the laboratory Research linked to use of meters Method of producing point source Measurement of background radiation (e.g. with source switched off) Method of keeping source output constant Method of aligning source and detector	max **4**
QWC	Quality of written communication 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%.	**2/1/0**

16 marks total.

Question 1

(c) Justification of number of significant figures in $1/I$ **2/1/0**
Relates sf in $1/I$ to sf in I scores 1 mark
Number of sf in $1/I$ is the same or one more than sf in I scores 1 mark
Answers in terms of decimal places, raw data or graphs score zero.

(d) Measurements **2/1/0**
Write the number of readings as a ringed total next to the table of results.
Six (or more) sets of values for I and x scores 1 mark.
Values of $1/I$. Underline checked value. Tick if correct and award 1 mark.
If incorrect write in correct value. Ignore minor rounding errors.
Minor help from Supervisor then –1.
Major help (equipment set up for the candidate) then -2.
Indicate nature of help and mark front of script "SR"

(d) Column headings in the table **2/1/0**
One mark for x and I column headings and units correct.
One mark for $1/I$ heading and unit correct.
Ignore units in the body of the table.

(d) Consistency of raw readings **2/1/0**
One mark for x which must be to the nearest mm
One mark for I which must be be to the same no of d.p.

(e) Axes **2/1/0**
Sensible scales must be used. Awkward scales (e.g. 3:10, 6:10, 7:10, 8:10) 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.
If false origin, indicate with "FO"
One mark for each correct axis.

(e) Size of graph **2/1/0**
Plotted points must occupy at least half the graph grid in both x and y directions (i.e. 4 x 6 large squares).
One mark for each correct axis.

(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 $\leq$ 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 **2/1/0**
Judge by scatter of points about the line.
There must be a fair scatter of points either side of the line of best fit.
Allow line through five trend plots for full credit (if done well).
Do not allow a line through a curved trend.

(f) (i) Gradient **2/1/0**

The hypotenuse of the Δ must be ≥ 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 gradient value equated with ρ/AE (can be implied from working)
Method of calculating ρ using gradient (gradient x A x E)
Value of ρ using gradient between 1 x 10^{-6} and 3 x 10^{-6}
Sig Figs of ρ: allow 2 or 3 only
Unit of ρ (Ωm) **5/4/3/2/1/0**

(g) (ii) *y*-intercept equated with R/E (can be implied from working)
Method of calculating R using *y*-intercept (*y*-intercept x E)
Sig Figs of R: allow 2 or 3 only
Unit of R (Ω) **4/3/2/1/0**

28 marks available. Write the mark as a ringed total at the bottom of page 6.

Question 2

(a) (vi) Calculates *T* correctly ignore minor rounding errors **1**

(b) Percentage uncertainty in *L*
ΔL = 1 - 5 mm **1**
ratio idea correct ($\Delta L/L$x100%) POT loses this mark **1**
A bald answer with no working loses both of these marks.

(c) *L* approximately halved, *T* calculated and smaller **1**

(d) Direct proportionality ideas
Method to prove or disprove proportionality
(e.g. determines constant of proportionality twice or calculates constant then calculates new value of *T*) **1**
Appropriate conclusion based on their method of proving or disproving proportionality.
Vague answers will not score this second mark. **1**
No method loses both these marks

(e) Evaluation of procedure **8**
Relevant points from the table must be underlined and ticked with the appropriate marking letter.

	Problem	Solution
A	Difficulty in making equilateral triangle or keeping sides same length	Use protractor ; use a template; measure sides of triangle
B	Problems with keeping sides of the triangular structure – coplanar	Use a mould or guide or plane surface (e.g. table top)
C	Difficulty in knowing when to stop timing	Use of a reference mark (e.g. plumb line), slow motion video.
D	Oscillations not always in the vertical plane or wobbling or blu-tack distorts the orientation of the triangle. Do not allow blu-tack affects period.	Use a stiffer (stronger/harder) wire/solder the ends or glue triangle, make the join in the centre of the bottom side.
E	Time taken for 10 oscillations is too short	Time more oscillations / repeat timings and find average
F	Two readings of *L* and *T* are not enough to verify the suggestion	Take many readings of *L* and plot a graph (e.g. T^2 v *L* or *T* v *L*)

One mark for each box to a maximum of 8.

No credit for simple ‘repeats’ or ‘using a computer’.
Do not allow vague human error in measuring *L* or *T*.

Quality of written communication (i.e. spelling, punctuation and grammar). **2/1/0**
Correct spelling scores one mark. Allow max two errors.
Capital letters at the beginning of sentences, full stops at the end scores one mark.
This mark may only be assessed if there is at least half a page or writing.

16 marks available. Write the mark as a ringed total at the bottom of page 11..

Results

Question 1

Using analogue meter

x / m	I / A	1/I / A^{-1}
0.200	0.44	2.27
0.250	0.38	2.63
0.300	0.34	2.94
0.350	0.30	3.33
0.400	0.28	3.57
0.450	0.25	4.00
0.500	0.23	4.35

Plotting a graph of $1/I$ against x gives:
Gradient = 6.85
Intercept = 0.90

E = 5 V
A = 0.0590 mm^2

$\rho = 2.0 \times 10^{-6}\ \Omega m$

R = 4.5 Ω

Question 2

(a) L = 16.0 cm
t = 7.78 s, 7.69 s, average t = 7.735 s
T = 0.77 s

(d) L = 8.0 cm
t = 5.56 s, 5.50 s, average t = 5.53 s
T = 0.55 s

(e) If directly proportional T^2/L = constant, k

When L = 16.0 cm, k = 3.70
When L = 8.0 cm, k = 3.78

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
✓$_{\Delta}$	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
AWK	Scale is difficult to use

Mark Scheme 2824
June 2006

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**		(mv =) 300 ; kg m s^{-1} **or** N s	**2**	**2**
	b	**i**	(The speed of the bar increases so) it is accelerated forwards/AW; this requires a resultant (forward) force/F = ma idea	**1** **1**	
		ii	Arrow in direction of motion/to right	**1**	
		iii	(t = s/v = 3.0/0.60 =) 5.0 s	**1**	
		iv	F = m (v – u)/t ; = 500 x 1.2/5.0 ; = 120 (N) *ecf b (iii)*	**3**	**7**
	c		γ ray source; the <u>only</u> radiation with sufficient penetrating power/ability to discriminate between different thicknesses/AW	**1** **1**	**2**
			Total		**11**
2	**a**	**i**	Force per unit mass (placed at that point)	**1**	
		ii	$g = GM/R^2$	**1**	
		iii	Choosing a correct pair of values from the graph, e.g. 6.4 x 10^6 & 9.8, 10 x 10^6 & 4.0;	**1**	
			substitute, 9.8 = 6.67 x 10^{-11} x M/ (6.4 x 10^6)^2 to show M = 6.0 x 10^{24} kg	**1**	
		iv	<u>linear</u> graph <u>through origin/from 0</u> to R	**1**	
		v	64 km; 1/100 of R as linear graph under Earth/AW	**2**	
			64000 km; $g \propto 1/r^2$ so for 1/100 g r = 10R	**2**	**9**
	b		$GM_e/R_1^2 = GM_m/R_2^2$; $M_e = 81\ M_m$;	**2**	
			M_m = 6.0 x 10^{24}/81 = 7.4 x 10^{22} (kg) *ecf a(iii)*	**1**	**3**
			or any acceptable alternative method i.e. correct method; correct figures; processed to correct answer		
			Total		**12**
3	**a**	**i**	A motion in which the acceleration/force is proportional to the displacement; directed towards the centre of oscillation/equilibrium position/AW **or** $a \propto -x$ **or** $a = -\omega^2 x$ **or** $a = -4\pi^2 f^2 x$; symbols must be identified	**1** **1**	
		ii	T = 0.25 s or f = 1/T; f = 4 (Hz)	**2**	
		iii	$a = -4\pi^2 f^2 A$; = 4 x 9.87 x 16 x 0.005 ; = 3.2 (m s^{-2}) *ecf a(ii)*	**3**	**7**
	b	**i**	Resonance occurs at /close to the natural frequency of an oscillating object/system; caused by driving force (at this frequency); when maximum energy transfer between driver and driven/maximum amplitude achieved *3 marking points in any sensible order*	**1** **1** **1**	
		ii.1	reduced amplitude; as resonance frequency lower **or** resonance will occur at lower frequency; as greater inertia/reduced natural frequency/AW in terms of amplitude change	**2**	
		2	reduced amplitude; as resonance frequency higher **or** resonance will occur at a higher frequency; as larger restoring force/increased natural frequency/AW in terms of amplitude change	**2**	**7**
			Total		**14**

Question			Expected Answers	Marks	
4	a	i	5.0 (V)	1	
		ii	10.0 (V)	1	2
	b	i	Q = CV ;= 1.0 x 10^{-3} (C)	2	
	b	ii	The total capacitance of each circuit is the same (namely 100 μF) ;	1	
			because capacitors in series add as reciprocals/ in parallel add/ supply	1	
			voltage is the same and Q = VC, etc. *max 2 marks*		2
	c	i	A1 will give the same reading as A2; because the two ammeters are	1	
			connected in series /AW	1	
			answer only in terms of exponential decrease for a maximum of 1 mark		
		ii	A4 will show the same reading as A2 at all times;	1	
			A3 will show half the reading of A2 initially; and at <u>all</u> subsequent times	2	5
			Total		**11**
5	a		Positive as E-field is downwards/top plate is positive/like charges repel/AW	1	1
	b	i	k.e. = QV; = 300 x 1.6 x 10^{-19} = (4.8 x 10^{-17} J)	2	
		ii	1/2mv^2 = 4.8 x 10^{-17}; = 0.5 x 2.3 x 10^{-26} x v^2 so v^2 = 4.17 x 10^9;	2	4
			(giving v = 6.46 x 10^4 m s^{-1})		
	c		E = V/d ; so d = V/E = 600/4 x 10^4 = 0.015 m	2	2
	d	i	semicircle to right of hole *ecf(a); (a) and d(i) to be consistent*	1	
		ii	mv^2/r; = BQv;	2	
			giving r = mv/BQ = 2.3 x 10^{-26} x 6.5 x 10^4/(0.17 x 1.6 x 10^{-19});	1	
			r = 55 mm ;so distance = 2r = 0.11 m	2	6
			Total		**13**
6	a	i	138	1	
		ii	86	1	2
	b	i	λ = 0.693/1600 x 3.16 x 10^7 = 1.4 x 10^{-11} s^{-1}	1	
		ii	A = λN; N = 6.02 x 10^{23}/226 ; evidence of calculation to give 3.6 or	2	
			3.7 x 10^{10} Bq	1	4
	c		Δm = 0.0053 u (= 8.8 x 10^{-30} kg) ;	1	
			E = c^2Δm ; = 9 x 8.8 x 10^{-14} = 7.9 x 10^{-13} (J)	2	3
	d		Q = mcθ; so 0.8 x 3.7 x 10^{10} x 7.9 x 10^{-13} = 0.001 x 110 θ:	2	
			giving θ = 0.213 K s^{-1}; and t = 1/θ = 4.7 s	2	
			or Q = mcθ; Q/K = 0.001 x 110 = 0.11 J K^{-1};	2	
			Q/s = 0.0234 J ; so t = 0.11/0.0234 = 4.7 s	2	4
			Total		**13**

Question		Expected Answers	Marks	
7	**a**	Faraday's law: the emf/voltage induced across a coil/component/circuit is	**1**	
		proportional to the rate of change of flux (linkage) through it /AW	**1**	
		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 *max 5*	**1**	**5**
	b	sine or cosine wave of regular period and amplitude	**1**	
		V doubles when the speed v of rotation of the coil doubles;	**1**	
		when v doubles the rate of change of flux linking the coil doubles;	**1**	
		the frequency of the a.c. signal doubles/period halves/AW	**1**	
		V doubles when the number n of turns on the coil doubles;	**1**	
		when n doubles there is twice as much flux linking the coil/AW;	**1**	
		the frequency/period of the signal is unchanged;	**1**	
		without iron core flux linking coil is much less/flux would spread in all directions/flux not channelled through low reluctance path/AW	**1**	
		amplitude of output voltage is smaller *actually is tiny/negligible/mV rather than V* *max 7*	**1**	**7**
		Quality of Written Communication		**4**
			Total	**16**

Mark Scheme 2825/01
June 2006

1.	**Maximum of 6 marks**	
	Copernicus: heliocentric	[1]
	Copernicus:circular orbits	[1]
	Kepler: elliptical motion Sun at one focus	[1]
	Kepler/ Copernicus correct reference to epicycles	[1]
	Any 3 from:	
	Newton imagined gravitational forces between bodies/ gravitational force changes planetary path	[1]
	Use Newton's law to predict position of planets/moons	[1]
	force α mass	[1]
	force α 1/ r^2	[1]
	universe static/universe infinite in extent	[1]
		[total 6]
2.(a)	(i)planet less than ¼ way around	[1]
	(ii)planet sweeps out equal areas in equal times	[1]
	speed increases moving closer to Sun/ area swept out from P to X is ¼ total area of ellipse	[1]
(b)	T^2 / r^3 = constant	[1]
	$80^2 / r^3 = T^2 / (0.4r)^3$	[1]
	T = 20.2y	[1]
		[total 6]

3.(a)	<u>absolute</u> magnitude/luminosity on y-axis (accept **M**)	[1]	
	temperature /spectral class on x-axis (accept **T**)	[1]	
	main sequence indicated <u>in correct orientation</u>	[1]	
	white dwarfs in bottom left, labelled correctly	[1]	
	red giants in top right, labelled correctly	[1]	
(b)	**any 4 from**:		
	end of H burning/red giant/supergiant	[1]	
	onset of He fusion/fusion of heavier nuclei	[1]	
	<u>gravitational</u> collapse of core	[1]	
	supernova explosion/ star explodes	[1]	
	suitable mass limit (chanderasekha limit 1.4M)	[1]	
	supported against gavity by neutron gas pressure/ ref to Fermi pressure	[1]	
	internal structure protons and electrons combined/ very thin atmosphere/ metallic crust	[1]	[4]
(c)	(i)volume = $4\pi (10{,}000)^3 /3 = 4.2 \times 10^{12}$	[1]	
	density = $3.5 \times 10^{30} / 4.2 \times 10^{12}$ ecf	[1]	
	density = 8.4×10^{17} kg/m^3	[1]	
	(ii)any **two** from		
	density (very) much greater than material on Earth	[1]	
	quotes typical density on Earth $1 - 10^4$ kg m^{-3}	[1]	
	atomic structure collapsed / density same as atomic nucleus	[1]	[2]
		[total 14]	

4.(a) (i) apparent magnitude: brightness seen from Earth [1]
absolute magnitude: brightness at 10pc [1]

(ii) absolute magnitude uses same distance for all stars/
compares luminosities (true brightness/energy) of stars [1]

(b) (i) $m - M = 5 \lg (r / 10)$ [1]
substitution of m_2 and r_2 [1]

(ii) $m_1 = -26.7 + 5 \lg (2.7 \times 10^{17} / 1.5 \times 10^{8})$ [1]
$m_1 = 19.5(8)$ [1]

(iii) any two from
absorption by interstellar gas/ stellar objects in light path/
deflection of light by gravitational fields [2]

[total 9]

.

5.(a)	(i) energies/temperatures irreproducible on Earth / laws of Physics break down	[1]	
	(ii)temperature decreases	[1]	
	universe expanding/work done against attractive forces/ energy converted to mass	[1]	
	(iii)**any 3** from		
	protons and electrons separate initially	[1]	
	matter-radiation equilibrium/charge prevents passage of em waves	[1]	
	proton-electron recombination /formation of atoms	[1]	
	gamma/ em waves no longer absorbed	[1]	[3]
(b)	**any 5** from:		
	star-light shows red shift	[1]	
	galaxies (stars) receding from Earth	[1]	
	recessional velocity proportional to distance	[1]	
	cosmological microwave background radiation (CMBR)	[1]	
	uniform intensity in all directions	[1]	
	small ripple	[1]	
	(black body temperature) 2.7 K (3K)	[1]	
	High ratio of helium to hydrogen	[1]	
	Indicates very high temperatures existed	[1]	
	ratio too high to originate from stellar fusion	[1]	[5]

[total 11]

6.(a)	isotropic	[1]	
	homogenous	[1]	
(b)	(i)$H_0 = 75 / 3.1 \times 10^{19}$	[1]	
	$t_0 = 1 / H_0 = 4.13 \times 10^{17}$ s	[1]	
	$t_0 = 4.13 \times 10^{17}$ s / 365 x 24 x 3600 = 1.3×10^{10}y	[1]	
	(ii)any two from		
	universe expands to a limit/ flat universe	[1]	
	but never reaches that limit	[1]	
	density of universe = critical density	[1]	[2]
	(iii)curve: passes through P	[1]	
	curves over and back to time axis	[1]	
	iv)Universe not so old (no ecf from (iii)/ Universe will end in big crunch(no ecf from iii) / universe has finite lifetime	[1]	
		[total 10]	
7.(a)	Newton; measured/ (rate of) time is same for all observers/ everywhere	[1]	
	Relativity: measured/ (rate of) clocks dependent on inertial frame	[1]	
(b)	(i)both correct: - 0.65, -0.82.	[1]	
	(ii)any 5 points correct	[1]	
	sixth point correct	[1]	
	(iii)best straight line drawn	[1]	
	(iv)k = (-) gradient of graph	[1]	
	value of k between -1.6×10^{-4} and -1.7×10^{-4} m^{-1}	[1]	
	(v)$T_{1/2} = 0.693 / 3 \times 10^8 \times 1.6 \times 10^{-4}$	[1]	
	$T_{1/2} =$ s	[1]	
	(vi) $1.44 \times 10^{-5} = t_0 / \sqrt{(1 - v^2/c^2)}$	[1]	
	$\sqrt{(1 - v^2/c^2)} = 0.11$	[1]	
	$t_0 = 1.54 \times 10^{-6}$ s	[1]	
	(vi)ref. to experimental evidence for special theory of relativity	[1]	
		[total 14]	

	2825 SYNOPTIC QUESTION JUNE 2006	
8(a)	Light energy is <u>reflected</u> or Light energy is absorbed and converted to <u>heat</u> or thermal energy	1
(b)(i)	Minimum surface area = 360 / 1500 x 100/16 = 1.5 m^2	1 1
(ii)	The satellite will sometimes be in the shadow cast by Earth - so no sunlight (or not in direct sunlight) The electrical circuits or battery are not themselves 100% efficient - energy wasted as heat Satellite requires extra power for position control or other stated function Panels may not be perpendicular to sunlight Radiation damage (from cosmic rays) reduces number of useful cells (ignore any reference to any variation in solar output)	Any two 1, 1
(c)	The intensity of sunlight is too small (inverse square law) or The area of panel required would be too large/massive to launch	1
(d)(i)	Energy required = V I t = 12 x 5 x 120 x 60 = 4.32 x 10^5 J	 1 1
(ii)	Steady power required = (4.32 x 10^5 x 100/25) ÷ 24 x 3600 = 20 W (18.5W if 0.40MJ used) (or P = VI = 12 x 5 = 60W for 2h so only 5W for 24h if 100% efficient but = 5 / 0.25 = 20W)	1 1
(iii)	Energy carried by alpha = 5 x 10^6 x 1.6 x10^{-19} = 8.0 x 10^{-13} J Activity required = 20 ÷ (8 x 10^{-13}) = 2.5 x 10^{13} Bq (or 0.432MJ / 8 x 10^{-13} J alphas per day = 0.432 MJ / 8 x 10^{-13} / 24 x 3600 alphas per sec)	1 1
(e)	Decay constant of Pu 238 = 0.69 / $T_{½}$ = 0.69 / 88 x 365 x 24 x 3600 = 2.5 x 10^{-10} sec $^{-1}$ (allow mark for conversion of 88 years to 2.78 x 10^9 seconds)	1 1

	Number of nuclei required $= A / \lambda = 2.5 \times 10^{13} / 2.5 \times 10^{-10}$ $= 1.0 \times 10^{23}$ (allow mark for formula $A = \lambda N$) Mass required $= 1.0 \times 10^{23} \times 238 / 6.02 \times 10^{23}$ $= 40$ gms $= 0.040$ kg	1 1 1 1
(f)	On launch, the rocket gives the spacecraft a huge kinetic energy (in order to escape) Failure at this point could cause spacecraft and contents to "burn up" in atmosphere But plutonium would still be radioactive and being vaporised it could be ingested. Sensible comment on danger periods of launch (or re-entry) Sensible comment on mechanism of ingesting Plutonium Allow one sensible comment on no risks in the isolation of deep space	1 1

Mark Scheme 2825/02
June 2006

1 (a) correct order (1)
overlapping (1)
within visible range (1) allow 350 – 780 nm

(b)(i) daytime vision / only occurs at high intensity / in bright light (1)
the adding of the response of each cone gives colour discrimination / colour vision / the cones are responsible (1)

(ii) colour fades / clarity fades / vision becomes black and white (1)
rods (1)

2(a)(i) 61.3 – 2.50 (1) or $61.3 = 1/0.4 + 1/v$
58.8 D (1)

(ii) $58.8 = 1/\infty + 1/v$ ecf 2a(i) (1) (allow f = v)
$v = 0.017$ m (1)

(b) $p = 1/0.25 + 1/0.017$ (1) ecf (ii)
$p = 62.8$ D (required) (1)

62.8 – 61.3 = (+) 1.5 D (1)

3 (a)(i) $Il = 10 \lg (3.00 \times 10^{-7}) / (1.0 \times 10^{-12}) = 54.8$ dB (1)
$Il = 10 \lg (6.00 \times 10^{-7}) / (1.0 \times 10^{-12}) = 57.8$ dB (1)
57.8 – 54.8 = 3.0 dB (1)

alternative method: change in I.L. $= 10 \log (I_2 / I_1)$ (1)
$= 10 \log (6.0 \times 10^{-7} / 3.0 \times 10^{-7})$ (1)
$=$ log 2 or 3.01 dB (1)

(ii) sensitivity increases with frequency (to a maximum) and then decreases with increasing frequency (1)
maximum sensitivity at 1 - 3 kHz (1)

(b) $35 = 10 \lg I / 10^{-12}$ (1)
$I = 3.16 \times 10^{-9}$ (1)
$75 = 10 \lg I / 10^{-12}$ $I = 3.16 \times 10^{-5}$ (1)
$3.16 \times 10^{-5} / 3.16 \times 10^{-9} = 10^4$ (1)

alternative method: $40 = 10 \log (I_2 / I_1)$ (2)
$10^4 = I_2 / I_1$ (2)

or change in I.L. = 75-35 = 40 dB (1)
40 / 3 = 13.3 (1)
$2^{13.3} = 10^4$ (2)

(c) $I = p / a$ $p = I \times a$ (1)
$p = 3.16 \times 10^{-5} \times 60 \times 10^{-6}$
$p = 1.9 \times 10^{-9}$ W (1) allow 2×10^{-9} with working

4 (a)(i) $v = f \times \lambda$ (1)
330 / 2000 = (1)
0.165 m (1)

(ii) length = $\lambda / 4$ = 0.041 m (1) ecf (i)

(b) eardrum vibrates (1)
ossicles vibrate / ossicles connected to ear drum or oval window (1)
oval window vibrates / oval window connected to fluid or ossicles (1)

area of eardrum is large compared wih the oval window (1)
so as $p = f/a$, pressure is amplified (1)

ossicles / bones arranged as a lever system (1) (allow diagram with fulcrum labelled)
amplifying force to the oval window (1) (allow numerical explanation)
detail mark (1)

to maximum of 7

5 X-ray (photons) penetrate patient (1)
attenuation by different media / bones attenuate more than soft tissue (1)
less X-rays reach film under bone / shadow effect (1)
intensity of X-rays is proportional to darkening of film / ref. To fogging or blackening (1)

X-ray photons hit crystals / atoms in intensifying layer (1)
atoms become excited / fluorescence occurs (1)
emitting light (photons) (1)
detail: as they return to ground state (1)
so extra fogging of film (1)
detail: metal backing stops X-rays passing through / film more sensitive to light than X-rays / most X-rays pass through the film / double sided / photographic film / more contrast but not clearer (1)

Response is quicker / less X-rays needed (1)
so less exposure (1) **to maximum of 8**

6(a) the total charge (of one sign) produced (by ionisation) per unit mass of air (1)
(allow 'per kg')

(b)(i) $D = f \times$ Exposure (0)
$D = 80 \times 2.5 \times 10^{-5}$ (0)
$D = 2.0 \times 10^{-3}$ (1)

Gy or J kg^{-1} (1)

(ii) 1 ref. to type of radiation / energy distributed by the radiation m^{-1} penetrated (1)

2 H = Q x D (0) H = 1.2 x 2.0 x 10^{-3} = 2.4 x 10^{-3} (1) ecf (i)
Sv (1)

7 (a) alternating voltage or alternating E-field across crystal (1)
at resonant frequency (1) allow reference to resonance of crystal

(b) (i) position of 3 lower oxygen ions closer to positive plate (1)

(ii) ref. to change in dimension / shape / distort/ it gets longer (1)

(c) (i) Z for air is 429 (kg m^{-2} s^{-1}) and
Z for skin is 1.71 x 10^6 (kg $m^{-2}s^{-1}$) (1)

Substitution into equation leading to F = 0.999 (1)

(ii) with gel, more ultrasound enters body / without gel, most ultrasound is reflected (1)

most ultrasound is reflected (without gel) when the difference in Z is large
or
most ultrasound enters body when the different in Z is small (1)

(d) **1.5** cm x 1 x 10^{-5} = 1.5 x 10^{-5} s (1)

s = vt or **4080** x 1.5 x 10^{-5} (1)

s = 6.12 cm (1) ecf if speed is wrong

/2 = 3.06 cm (1)

8 (a)(i) any sensible comment e.g.
cell death / failure of cell division / function / uncontrolled cell division / cancer (1)
disruption of functions e.g. failure of nervous system / bone marrow function (1)
skin burn (1)
death of whole body (1)
change to DNA (1)
reference to mutation (1)
cancer (1)
damage to cell membrane (1) **to a max of 3**

(ii) sensible comment e.g.
nature of the radiation (1)
tissue type / part of the body exposed to radiation (1)
dose received / time of exposure (1)
intensity / rate at which dose is received (1)
in fractions or all at once (1)

ref.to distance from source (1)
ref. to cell multiplying (1)
to a max 3

(b) all rows correct (2) 2 rows correct (1)

	2825 SYNOPTIC QUESTION JUNE 2006	
8 (a)	Light energy is <u>reflected</u> or	
	Light energy is absorbed and converted to <u>heat</u> or thermal energy	1
(b)(i)	Minimum surface area = 360 / 1500 x 100/16	1
	= 1.5 m^2	1
(ii)	The satellite will sometimes be in the shadow cast by Earth - so no sunlight (or not in direct sunlight) The electrical circuits or battery are not themselves 100% efficient - energy wasted as heat Satellite requires extra power for position control or other stated function Panels may not be perpendicular to sunlight Radiation damage (from cosmic rays) reduces number of useful cells	Any two 1, 1
	(ignore any reference to any variation in solar output)	
(c)	The intensity of sunlight is too small (inverse square law) or The area of panel required would be too large/massive to launch	1
(d)(i)	Energy required = V I t	
	= 12 x 5 x 120 x 60	1
	= 4.32×10^5 J	1
(ii)	Steady power required = (4.32×10^5 x 100/25) ÷ 24 x 3600	1 1
	= 20 W (18.5W if 0.40MJ used)	
	(or P = VI = 12 x 5 = 60W for 2h so only 5W for 24h if 100% efficient but = 5 / 0.25 = 20W)	
(iii)	Energy carried by alpha = $5 \times 10^6 \times 1.6 \times 10^{-19} = 8.0 \times 10^{-13}$ J	1
	Activity required = 20 ÷ (8×10^{-13}) = 2.5×10^{13} Bq	1
	(or 0.432MJ / 8×10^{-13} J alphas per day = 0.432 MJ / 8×10^{-13} / 24 x 3600 alphas per sec)	

(e)	Decay constant of Pu 238 = $0.69 / T_{½}$ = 0.69 / 88 x 365 x 24 x 3600 = 2.5×10^{-10} sec $^{-1}$ (allow mark for conversion of 88 years to 2.78×10^{9} seconds) Number of nuclei required = A / λ = 2.5×10^{13} / 2.5×10^{-10} = 1.0×10^{23} (allow mark for formula A = λN) Mass required = 1.0×10^{23} x 238 / 6.02×10^{23} = 40 gms = 0.040 kg	1 1 1 1 1 1
(f)	On launch, the rocket gives the spacecraft a huge kinetic energy (in order to escape) Failure at this point could cause spacecraft and contents to "burn up" in atmosphere But plutonium would still be radioactive and being vaporised it could be ingested. Sensible comment on danger periods of launch (or re-entry) Sensible comment on mechanism of ingesting Plutonium Allow one sensible comment on no risks in the isolation of deep space	1 1

Mark Scheme 2825/03
June 2006

1	(a)	Graph: passing through x = 0.22 nm, F = 0;	(1)	
		minimum at x = 0.28 mm, F = - 1.8×10^{-10} N;	(1)	
		correct shape.above x-axis;	(1)	
		correct shape below x-axis.	(1)	[4]
	(b)	(i) resultant force is difference between repulsive and attractive forces / (vector) sum of repulsive and attractive forces.		[1]
		(ii) repulsive force is difference between candidate's resultant force at x = 0.25 nm and 3.3×10^{-10} N.	(1)	[1]
	(c)	(i) Use of 1.8×10^{-10} N;	(1)	
		Tensile force needed = $2.5 \times 10^{15} \times 1.8 \times 10^{-10}$ N = 4.5×10^{5} N.	(1)	[2]
		(ii) Cross-section may have grain boundaries;	(1)	
		impurity atoms;	(1)	
		missing atoms;	(1)	
		dislocations;		
		Plastic deformation may take place before fracture;	(1)	
		Rod may form a neck;	(1)	
		There may be cracks on surface of a brittle material.	(1)	
		Forces may not be vertical.	(1)	max [2]
2	(a)	(I) zero;	(1)	
		(ii) infinity.	(1)	[2]
	(b)	(i) Use material to make a solenoid;	(1)	
		Cool below T_c;	(1)	
		Pass a (very) large current through the solenoid.	(1)	[3]
		(ii) (Very) large current can be passed without heat generation;	(1)	
		No need for iron core / Space inside solenoid is available;	(1)	
		Long running times possible (as no need to switch off for cooling down).	(1)	
		Field produced is very stable	(1)	max [2]
	(c)	(i) Correct substitution;	(1)	
		B = 0.152 T	(1)	[2]
		(ii) (Since B α I) maximum B means maximum I / Current in solenoid generates the field.		[1]
		(iii) (At T = T_c, B = 0 so) I = 0.		[1]

3	(a)	(i)	Atomic magnets / dipoles within a domain are aligned.		[1]
		(ii)	1. Random array / Domains include closure showing zero net magnetisation.	(1)	
			2. Domains in direction of field larger;	(1)	
			Not all parallel to field.	(1)	
			3. Single domain or few domaina all parallel to field.	(1)	[4]
	(b)	(i)	Count of squares for hard iron: allow 60 – 70;	(1)	
			Count of squares for soft iron: allow 14 – 18;	(1)	
			Ratio correct from candidate's count of squares.	(1)	[3]
			(Allow 1 mark for realisation of correct approach but with subsequent errors.)		
		(ii)	$Q = mc\Delta\Theta$ / $\Delta\Theta = Q/mc$	(1)	
			$Q = 0.030 \times 50 \times 60$ (= 90 J)	(1)	
			$\Delta\Theta = 0.030 \times 50 \times 60 / (0.15 \times 450) = 1.33$ K	(1)	[3]
		(iii)	(Eddy) <u>currents in the ring;</u>	(1)	
			induced by the changing magnetic field;	(1)	
			causing heating effects due to the resistance of the ring / $P = I^2R$.	(1)	max [2]
			(First mark required to gain subsequent mark)		
4	(a)	(i)	3.9 eV = $3.9 \times 1.6 \times 10^{-19}$ J (= 6.24×10^{-19} J)	(1)	
			$\lambda = hc/E = 6.63 \times 10^{-34} \times 3.0 \times 10^{8} / 3.9 \times 1.6 \times 10^{-19}$ (= 320×10^{-9} m)	(1)	[2]
		(ii)	Visible light has wavelengths greater than 320 nm;	(1)	
			so energy of all visible light photons is less than 3.9 eV;	(1)	
			This energy is lower than the band gap (so cannot be absorbed by / will pass through the insulator).	(1)	[3]
	(b)	(i)	Circuit with variable d.c. power supply / fixed voltage power supply with potentiometer;	(1)	
			connected to LED, correct symbol or labelled, with voltmeter in appropriate position. Orientation of LED ignored at this stage.	(1)	[2]
		(ii)	Connect LEDs in turn to power supply;	(1)	
			with LED is in forward direction (mark obtainable from circuit in (b)(i));	(1)	
			View LED through tube made of dark material / perform measurements in darkened room;	(1)	
			For each LED increase voltage (from zero) until LED just begins to glow;	(1)	
			Record the voltage / calculate voltage from potentiometer position;	(1)	
			Relevant equation stated;	(1)	
			Calculate frequency / (1/ wavelength) for light emitted from LEDs; this may be shown in heading of a column of a table;	(1)	
			Plot graph of voltage against f or 1/ λ / Show axes of graph with y-axis labelled voltage and x-axis labelled f or 1/ λ;	(1)	
			Determine gradient of graph;	(1)	
			Gradient of graph is (h/e) / (hc/e)	(1)	max [8]

5	(a)	An electron in the conduction band (of the copper);	(1)	
		able to take part in conduction.	(1) max	[2]
	(b)	With no current in the wire:		
		r.m.s.speed is square root of mean of squares of the speed of free electrons;	(1)	
		r.m.s. speed depends on / increases with increasing temperature;	(1)	
		free electrons move (fast) in random directions;	(1)	
		colliding with atoms (in the lattice);	(1)	
		With current in the wire:		
		free electrons move in opposite direction to current / electric field;	(1)	
		free electrons accelerate between collisions with atoms;	(1)	
		this motion is superimposed on the random motion;	(1)	
		Drift velocity is the mean value of electrons' velocities due to this motion;	(1)	
		value depending on current, cross-section of wire, free electron concentration and electron charge / I, A, n and e.	(1) max	[7]
	(c)	(i) $n = I/Aev$	(1)	
		$= 0.75 / (4.0 \times 10^{-7} \times 1.6 \times 10^{-19} \times 1.4 \times 10^{-4}) = 8.4 \times 10^{28}$	(1)	[2]
		(ii) 1 drift velocity = 4.7×10^{-5} m s^{-1}		[1]
		2 drift velocity = 3.5×10^{-5} m s^{-1}		[1]
6	(a)	(i) At least 3 field lines inside solenoid parallel to axis;	(1)	
		Lines equally spaced over some of length of solenoid.	(1)	
		Arrows on lines pointing left to right.	(1)	[3]
		(ii) (Large faces of Hall wafer) perpendicular to field lines.		[1]
	(b)	(i) $B = V_H/vd$	(1)	
		$= 46 \times 10^{-6} / (36 \times 5.0 \times 10^{-3})$	(1)	
		$= 2.56 \times 10^{-4}$ T	(1)	[3]
		(ii) Reference to Earth's field or external field.		[1]

	2825 SYNOPTIC QUESTION JUNE 2006	
7 (a)	Light energy is <u>reflected</u> or Light energy is absorbed and converted to <u>heat</u> or thermal energy	1
(b)(i)	Minimum surface area = 360 / 1500 x 100/16 = 1.5 m^2	1 1
(ii)	The satellite will sometimes be in the shadow cast by Earth - so no sunlight (or not in direct sunlight) The electrical circuits or battery are not themselves 100% efficient - energy wasted as heat Satellite requires extra power for position control or other stated function Panels may not be perpendicular to sunlight Radiation damage (from cosmic rays) reduces number of useful cells (ignore any reference to any variation in solar output)	Any two 1, 1
(c)	The intensity of sunlight is too small (inverse square law) or The area of panel required would be too large/massive to launch	1
(d)(i)	Energy required = V I t = 12 x 5 x 120 x 60 = 4.32×10^5 J	 1 1
(ii)	Steady power required = (4.32×10^5 x 100/25) ÷ 24 x 3600 = 20 W (18.5W if 0.40MJ used) (or P = VI = 12 x 5 = 60W for 2h so only 5W for 24h if 100% efficient but = 5 / 0.25 = 20W)	1 1
(iii)	Energy carried by alpha = $5 \times 10^6 \times 1.6 \times 10^{-19} = 8.0 \times 10^{-13}$ J Activity required = 20 ÷ (8×10^{-13}) = 2.5×10^{13} Bq (or 0.432MJ / 8×10^{-13} J alphas per day = 0.432 MJ / 8×10^{-13} / 24 x 3600 alphas per sec)	1 1
(e)	Decay constant of Pu 238 = 0.69 / $T_{½}$ = 0.69 / 88 x 365 x 24 x 3600 = 2.5×10^{-10} sec^{-1} (allow mark for conversion of 88 years to 2.78×10^9 seconds)	1 1

	Number of nuclei required $= A / \lambda = 2.5 \times 10^{13} / 2.5 \times 10^{-10}$ $= 1.0 \times 10^{23}$ (allow mark for formula $A = \lambda N$) Mass required $= 1.0 \times 10^{23} \times 238 / 6.02 \times 10^{23}$ $=$ 40 gms $=$ 0.040 kg	1 1 1 1
(f)	On launch, the rocket gives the spacecraft a huge kinetic energy (in order to escape) Failure at this point could cause spacecraft and contents to "burn up" in atmosphere But plutonium would still be radioactive and being vaporised it could be ingested. Sensible comment on danger periods of launch (or re-entry) Sensible comment on mechanism of ingesting Plutonium Allow one sensible comment on no risks in the isolation of deep space	1 1

Mark Scheme 2825/04
June 2006

Question	Expected Answers	Marks
1 (a)(i)	r : radius of nucleus / nuclei r_0 : radius of nucleon / proton / neutron / hydrogen nucleus; A : number of nucleons / (protons + neutrons) / mass number;	 1 1 [2]
(ii)	line curves in correct sense from origin but doesn't become horizontal; any part drawn with ruler loses this mark	1 [1]
(b)(i)	$r = r_0 A^{1/3} = 1.41 \times 10^{-15} \times 56^{1/3}$ $= 5.39 \times 10^{-15}$ m do not allow 5.4×10^{-15} m	1 1 [2]
(ii)	$m = V\rho$ allow $m = {}^4/_3\,\pi r^3 \rho$ $= {}^4/_3\,\pi\,(5.39 \times 10^{-15})^3 \times 1.44 \times 10^{17}$ (= 9.45×10^{-26} kg)	1 1 [2]
(c)(i)	protons: 26, neutrons: 30;	1 [1]
(ii)	mass = $26 \times 1.673 \times 10^{-27} + 30 \times 1.675 \times 10^{-27} = 9.37(48) \times 10^{-26}$ kg allow ecf from **(c)(i)** allow 2 sf	1 [1]
(d)	difference in mass = $0.08 \times 10^{-26} = 8 \times 10^{-28}$ (kg) accept $7 - 10 \times 10^{-28}$ (kg) wrong unit 0/1 allow ecf from **(b)(ii)** and **(c)(ii)**	1 [1]

(e)	$E = (\Delta)m\,c^2$ $= 8 \times 10^{-28} \times (3 \times 10^8)^2 = 7.2\ 10^{-11}$ J accept $6.3 - 9.0 \times 10^{-11}$ J allow ecf from **(d)** allow 1 sf	1 1	 [2] **12**
2(a)	similar mass means large momentum transfer (in collision); hence fewer collisions are needed; neutron colliding with heavy nucleus bounces off with similar speed / k.e. scores 1/2 max. neutron colliding with similar mass nucleus transfers large k.e. / speed scores 1/2 max.	1 1	 [2]

(b)(i)	${}^{236}_{92}U$ -> ${}^{110}_{45}Rh$ + ${}^{121}_{47}Ag$ + $5\,{}^{1}_{0}n$ allow ${}^{235}_{92}U$ + ${}^{1}_{0}n$ -> ${}^{110}_{45}Rh$ + ${}^{121}_{47}Ag$ + $5\,{}^{1}_{0}n$ no neutrons 0/2, incorrect number of neutrons 1/2 $5\,{}^{1}_{0}N$ gets 1/2 max. ${}^{5}_{0}n$ gets 0/2 if ${}^{1}_{0}$ missing from neutron symbol, 1/2 max. ${}^{236}_{92}U$ + ${}^{1}_{0}n$ -> ${}^{110}_{45}Rh$ + ${}^{121}_{47}Ag$ + $6\,{}^{1}_{0}n$ gets 1/2	2	[2]
(ii)	plots 5 or 6 points correctly 4 points plotted correctly gets 1/2 3 or less points correct gets 0/2 allow points using (relative yield)/2	2	[2]
(iii)	line passes through all 6 points; graph is sensibly symmetrical; uses only ruler allow 1/2 max. for symmetry if no points plotted allow 1/4 max. for parts **(ii)** and **(iii)**	1 1	 [2]
(iv)	accept 0.01% □ yield □ 0.02% allow ecf for minimum greater than 0.02%	1	[1]
(c)(i)	${}^{121}_{47}Ag$ -> ${}^{121}_{48}X$ + ${}^{0}_{-1}\beta$ / ${}^{0}_{-1}e$ + ${}^{(0)}_{(0)}\nu$–bar; omits ν–bar, 1/2 max. omits ${}^{0}_{-1}$ from β symbol, 1/2 max. if *A* or *Z* number incorrect, -1 each error	2	[2]
(ii)	protons: +1 neutrons: -1	1	[1] **12**

3(a)	neutron is udd / proton is uud;
	quarks are: up down strange top bottom charm;
	either up / u has Q = (+)2/3, B = (+)1/3;
	or down / d has Q = -1/3, B = (+)1/3;
		1
		1
		
		1	

	quarks are fundamental particles; (1) for every quark there is an antiquark; (1) antiquarks have opposite values of Q, B and S (compared to quark) (1) quarks are held together by strong force / gluons (1) Q, B and S are conserved in (quark) reactions (1) any 2	2	[5]
(b)(i)	charge: 1 + (-1) -> 0 + 0 + (-1) + X_Q so X_Q = (+)1 baryon number: 1 + 0 -> 1 + 0 + 0 + X_B so X_B = 0 strangeness: 0 + 0 -> 0 + 0 + 0 + X_S so X_S = 0	1 1 1	[3]
	working need not be shown has <u>NO</u> strangeness gets 0/1 has <u>NO</u> baryon number gets 0/1		
(ii)	π^+ particle / antiparticle to π^- / meson with quark composition of (up + not-down) do not allow positron	1	[1]
			9

4(a)	(consists of) positive ions / nuclei and electrons; not just electrons stripped from nuclei	1	[1]
(b)	ions / nuclei / electrons are charged; moving charge / ions / electrons experience force in magnetic field; ions / nuclei / electrons spiral along field lines;	1 1 1	 [3]
(c)(i)	calculates b.e. per *nucleus* : 1.11×2 (= 2.22) 2.57×3 (= 7.71) both expressions so energy released = $7.71 - 2 \times 2.22$ (= 3.27 MeV) = $3.27 \times 10^6 \times 1.6 \times 10^{-19}$ = $5.2(3) \times 10^{-13}$ J omits multiplication by 2 and 3, 1/3 max.	 1 1 1	 [3]
(ii)	reaction 2 generates more energy (than reaction 1);	1	[1]
(d)	initial mtm. = final mtm. so $0 = m_H v_H + m_n v_n$ $0 = (4 m_n) v_H + m_n v_n$ so $v_n = 4 v_H$ k.e. of ${}^4_2$He = $\frac{1}{2} m_H v_H^2$ k.e. equation applied (to n or He) = $\frac{1}{2}(4m_n) v_H^2 = 2 m_n v_H^2$ k.e. of ${}^1_0$n = $\frac{1}{2} m_n v_n^2 = \frac{1}{2} m_n (4v_H)^2 = 8 m_n v_H^2$ alg. *either* k.e. of ${}^1_0$n = 4 x (k.e. of He) *or* ${}^1_0$n has 80% of total energy 80% unsupported scores 1/5 k.e. stated to be proportional to 1/(mass) scores 2/5 if correct answer obtained	 1 1 1 1 1	 [5]
(e)	**1.** neutron carries most of available energy / a lot of / high energy **2.** neutron can escape from / is unaffected by *B* field because it is uncharged	1 1	 [2] **15**

5(a)	sketch / describe: 2 dees sensibly placed and reference to magnetic field;	1	
	magnetic field (through) dees is uniform and perpendicular to dees; (1)		
	a.c. source connected across dees;	1	
	charged particles gain energy / accelerate inside electric (not magnetic) field / due to p.d. / attraction / repulsion from dees;	1	
	electric field / energy gain /acceleration is between (not inside) D-shaped electrodes; (1)		
	B field exerts force on particle at right angles to motion / acts as centripetal force;	1	
	changes direction, not speed; (1)		
	particles take constant time to pass through each electrode / dee;	1	
	linac (also) accelerates particle many times;	1	
	in linac, acceleration / energy gain (also) occurs between electrodes / due to field / p.d. / attraction / repulsion from dees; (1)		
	linac (also) uses constant frequency (for $v << c$); (1)		
	particles spend a constant / equal time inside each electrode; (1)		
	any 3	3	[9]

(b)(i)	In J: $E = mc^2$ $= (2 \times 1.67 \times 10^{-27}) \times (3.0 \times 10^8)^2$ (= 3.0×10^{-10} J) subs. In GeV: $3.0 \times 10^{-10} = 3.0 \times 10^{-10} / (1.6 \times 10^{-19} \times 10^9)$ = 1.88 GeV ans. allow 1.9 GeV uses only one mass, can get 2/3 max.	1 1 1	 [3]
(ii)	particle mass increases with energy / speed; accelerating voltage gets out of step with passage of particle between electrodes / if voltage out of synch. proton energy cannot increase or AW; 1.88 GeV is high enough to cause (significant) mass increase;	1 1 1	 [3] **15**
6(a)	Np graph: graph has exponential shape / there is exponential decay of Np nuclei / number (of Np nuclei) is halved in 2.3 days / constant time / in its half life; Pu graph: sum of Pu + Np nuclei = 3.0×10^{20} at all times; (1) *either* because <u>one</u> Np nucleus decays to <u>one</u> Pu nucleus *or* rate of decay of Np and formation of Pu are equal; (1) and half life of Pu >> / <u>much</u> bigger than half life of Np; (1) any 2	1 2	 [3]
(b)	time required = time for Np nucleus to fall to 0.30×10^{20}; then *either* $N = N_0 (½)^{t/T½}$ so $N/N_0 = (½)^{t/T½}$ $\lg(N/N_0) = t/T_{½} (\lg 0.5)$ $\lg(0.1) = t/2.36 \lg(0.5)$ $t = 7.8$ days *or* uses $N = N_0 e^{-\lambda t}$ where $\lambda = \ln 2 / 2.36$ (= 0.294 day^{-1}) (1) so $0.1 = e^{-0.294\,t}$ (1) $\ln(0.1) = -0.294\,t$ $t = 7.8$ days (1) *or* $\lambda = \ln 2 / (2.36 \times 24 \times 3600) = 3.41 \times 10^{-6}$ s^{-1} $0.1 = e^{-3.41 \times 10\exp(-6)\,t}$ $\ln(0.1) = -3.41 \times 10^{-6}\,t$ $t = 6.76 \times 10^5$ s $= 6.76 \times 10^5 / (24 \times 3600) = 7.8$ days	1 1 1 1	 [4]

	calculates time for Np to fall to 2.7×10^{20} / Pu to rise to 0.3×10^{20} = 0.36 day gets 0 1 1 1 = 3/4 uses $T_{½}$ for plutonium can get 2/4 max. attempts to use repeated halving of *N* can get 2/4 max. if using 0.3 (not 2.7)	**7**

7	**2825 SYNOPTIC QUESTION JUNE 2006**	
(a)	Light energy is reflected or	
	Light energy is absorbed and converted to heat or thermal energy	1
(b)(i)	Minimum surface area = 360 / 1500 x 100/16	1
	= 1.5 m^2	1
(ii)	The satellite will sometimes be in the shadow cast by Earth - so no sunlight (or not in direct sunlight) The electrical circuits or battery are not themselves 100% efficient - energy wasted as heat Satellite requires extra power for position control or other stated function Panels may not be perpendicular to sunlight Radiation damage (from cosmic rays) reduces number of useful cells	Any two 1, 1
	(ignore any reference to any variation in solar output)	
(c)	The intensity of sunlight is too small (inverse square law) or The area of panel required would be too large/massive to launch	1
(d)(i)	Energy required = V I t	
	= 12 x 5 x 120 x 60	1
	= 4.32 x 10^5 J	1
(ii)	Steady power required = (4.32 x 10^5 x 100/25) ÷ 24 x 3600	1 1
	= 20 W (18.5W if 0.40MJ used)	
	(or P = VI = 12 x 5 = 60W for 2h so only 5W for 24h if 100% efficient but = 5 / 0.25 = 20W)	
(iii)	Energy carried by alpha = 5 x 10^6 x 1.6 x10^{-19} = 8.0 x 10^{-13} J	1
	Activity required = 20 ÷ (8 x 10^{-13}) = 2.5 x 10^{13} Bq	1
	(or 0.432MJ / 8 x 10^{-13} J alphas per day = 0.432 MJ / 8 x 10^{-13} / 24 x 3600 alphas per sec)	
(e)	Decay constant of Pu 238 = 0.69 / $T_{½}$ = 0.69 / 88 x 365 x 24 x 3600	1 1
	= 2.5 x 10^{-10} sec^{-1}	

	(allow mark for conversion of 88 years to 2.78×10^{9} seconds) Number of nuclei required $= A / \lambda = 2.5 \times 10^{13} / 2.5 \times 10^{-10}$ $= 1.0 \times 10^{23}$ (allow mark for formula $A = \lambda N$) Mass required $= 1.0 \times 10^{23} \times 238 / 6.02 \times 10^{23}$ $= 40$ gms $= 0.040$ kg	1 1 1 1
(f)	On launch, the rocket gives the spacecraft a huge kinetic energy (in order to escape) Failure at this point could cause spacecraft and contents to "burn up" in atmosphere But plutonium would still be radioactive and being vaporised it could be ingested. Sensible comment on danger periods of launch (or re-entry) Sensible comment on mechanism of ingesting Plutonium Allow one sensible comment on no risks in the isolation of deep space	1 1

Mark Scheme 2825/05
June 2006

1 (a) At frequencies up to 3.4 kHz we can recognise a caller's voice

The early system was never designed for Hi Fi music so higher frequencies were unnecessary

Limiting the bandwidth of the information means more efficient use of channel bandwidth

any one sensible point ①

(b)

(i) Sampling frequency = 1 / 125 μs ①

= 8000 Hz ①

This is more than 2 x highest frequency (3.4kHz) in audio signal

or

This is necessary to avoid the generation of an Alias frequency ①

(ii) Total number of bits produced = 30 x 60 sec x 8000 samples/sec x 8 bits/sample ①

= 1.152×10^8 bits ①

(iii) Total bit duration of 30 min call = 1.152×10^8 x 2.5 ns ①

= 0.288 seconds ①

(accept use of 1.2×10^8 which produces 0.3 sec)

(c) Multiplexing <u>The process of allowing two or more users to share same line</u> ①

TDM Information from each user is broken up into samples every 125μs

Each sample lasts for much less than 125μs

Each sample is fitted into a time slot ① ①

In the "dead" time between samples, other user's samples are fitted in ①

Why important Because it reduces the cost per user (or wtte) ①

(d) Maximum number = 30 minutes / 0.288 seconds ①

= 6250 ①

(e) In practice, some of the time slot has to be used for addressing / identifying / control codes ①

(do not allow "because of time added to avoid overlap")

2 (a) TX LED or Laser ①

RX Photodiode or phototransistor (do not allow LDR) ①

(b) Frequency of signal = 1 / period of 40μs ①

= 25 kHz ①

(c)

(i) Time delay = 6 divisions = 24 μs ①

(ii) Speed of light in fibre = $3 \times 10^8 / 1.5$ ①

= 2×10^8 ms^{-1} ①

(iii) Length of fibre = speed x time ①

= $2 \times 10^8 \times 24 \times 10^{-6}$

= 4800 m ①

(d) Area The voltage / power / energy in the received pulse is less ①

due to attenuation (energy loss) in the fibre. ①

Duration The pulse lasts for a longer time due to multipath dispersion ①

Different rays take different length paths through fibre

Depending on the angle of incidence / number of multiple reflections ①

Outline The signal appears to have picked up noise ①
Apparent as random fluctuations in signal voltage ①
Conclusion This must be a multi-mode step-index optic fibre ①

3 (a) Period 24 hours ①

Satellite must stay locked into Earth's period of rotation (or wtte) ①

Plane Equatorial ①

Centre of orbit must be centre of Earth because axis of orbit must be spin axis of Earth ①

(gravitational force above equator is only force available to provide centripetal force in a synchronised orbit, otherwise an engine is required)

Direction Same as Earth's rotation ①

(otherwise satellite and Earth would counter rotate)

(b)

<u>Terrestrial TV coverage from a single broadcast aerial is only of the order of 40 km</u> ①

<u>Satellite TV uses one single transmitter to broadcast to huge area</u> ①

Analogue TV signals require an information bandwidth in MHz.

So carrier frequencies are chosen from VHF or UHF wavebands

Therefore many hundreds of transmission aerials would have to be erected

And many different carrier frequencies used to avoid interference

Very quick and politically very economical method of TV coverage over many countries

Each satellite can carry multiple channels

Very easy to pick up and study foreign cultures

(any three further points ① ① ①)

(c)

(i) Polar orbit correctly drawn (passing over both poles - low Earth orbit) ①

(ii) Low earth orbit means satellite moves quickly (time period much less than 24 hrs)

Earth itself spins slowly under fast moving satellite

Therefore sooner or later satellite will be above every point on Earth

This makes them ideal for remote and efficient sensing ① ① ①

(iii) Uses Military reconnaissance

Meteorology

Geological prospecting

Oceanography

Cartography ①①

4 (a)

The circuit of Fig.4.1 is known as a ... VIRTUAL ① ... earth amplifier. This is because..NEGATIVE ①.. feedback

Is used to keep both .INPUTS ①. at the same potential. As the ..NON-INVERTING ①.. input is

directly connected to zero volts then the .INVERTING ① input must be ..ZERO VOLTS ①..

(if symbols + and - or positive and negative are incorrectly used instead of words non-inverting and inverting then deduct 1 mark)

(b) Voltage gain = V_B / V_A ①
(allow V_B = 4 V_A)

(c) Voltage gain = (-) R_f / R_i ①

= (-) 60 / 15

= (-) 4 ①
(ignore omission of -ve sign but penalise in (d))

(d) Drawing of V_B Any triangular waveform of same frequency ①

180° out of phase with input signal ①

Slope shows a voltage gain of 4 ①
(allow ecf from (c))

Saturation at ± 12V ①
(or thereabouts)

5. (a) User's computer links into PSTN (makes telephone call)

To their Internet Service Provider (ISP) who provides access to internet

File Transfer Protocol (or HTTP) causes information / data to be broken into packets

Packets contain limited volume of information + addresses etc

Packets are not transmitted as one continuous stream

Packets from the same database do not necessarily follow the same switched line / route

Packets do not necessarily arrive in the same order as that in which they were sent

Packets contain a time to live code which reduces as they pass nodes / routers

Missing packets are noticed and requests to resend are made

Receiver's ISP links back to PSTN (makes telephone call) to receiving computer

(any five relevant points ①①①①①)

(b) Many jobs have been created to provide technical maintenance for Internet

Many jobs have been created to provide software for Internet

Many jobs have been created to sell goods and services over the Internet

Internet provides alternative to traditional shopping

Internet allows easy communication by e-mail

Internet allows people with little expertise easy access to huge volumes of information

Internet allows remote information gathering (eg medical without visiting doctor)

Internet allows many individuals to work from home

(any four sensible and valid points ①①①①)

	2825 SYNOPTIC QUESTION JUNE 2006	
6 (a)	Light energy is reflected or Light energy is absorbed and converted to heat or thermal energy	1
(b)(i)	Minimum surface area = 360 / 1500 x 100/16	1
	= 1.5 m^2	1
(ii)	The satellite will sometimes be in the shadow cast by Earth - so no sunlight (or not in direct sunlight) The electrical circuits or battery are not themselves 100% efficient - energy wasted as heat Satellite requires extra power for position control or other stated function Panels may not be perpendicular to sunlight Radiation damage (from cosmic rays) reduces number of useful cells (ignore any reference to any variation in solar output)	Any two 1, 1
(c)	The intensity of sunlight is too small (inverse square law) or The area of panel required would be too large/massive to launch	1
(d)(i)	Energy required = V I t	
	= 12 x 5 x 120 x 60	1
	= 4.32 x 10^5 J	1
(ii)	Steady power required = (4.32 x 10^5 x 100/25) ÷ 24 x 3600	1 1
	= 20 W (18.5W if 0.40MJ used)	
	(or P = VI = 12 x 5 = 60W for 2h so only 5W for 24h if 100% efficient but = 5 / 0.25 = 20W)	
(iii)	Energy carried by alpha = 5 x 10^6 x 1.6 x10^{-19} = 8.0 x 10^{-13} J	1
	Activity required = 20 ÷ (8 x 10^{-13}) = 2.5 x 10^{13} Bq	1
(e)	(or 0.432MJ / 8 x 10^{-13} J alphas per day = 0.432 MJ / 8 x 10^{-13} / 24 x 3600 alphas per sec)	

	Decay constant of Pu 238 = $0.69 / T_{½}$ = $0.69 / 88 \times 365 \times 24 \times 3600$ = 2.5×10^{-10} sec^{-1} (allow mark for conversion of 88 years to 2.78×10^{9} seconds) Number of nuclei required = A / λ = 2.5×10^{13} / 2.5×10^{-10} = 1.0×10^{23} (allow mark for formula A = λN) Mass required = 1.0×10^{23} x 238 / 6.02×10^{23} = 40 gms= 0.040 kg	1 1 1 1 1 1
(f)	On launch, the rocket gives the spacecraft a huge kinetic energy (in order to escape) Failure at this point could cause spacecraft and contents to "burn up" in atmosphere But plutonium would still be radioactive and being vaporised it could be ingested. Sensible comment on danger periods of launch (or re-entry) Sensible comment on mechanism of ingesting Plutonium Allow one sensible comment on no risks in the isolation of deep space	1 1

Mark Scheme 2826/01
June 2006

1.	**(a)**	use tape measure to find thickness of book	{1}		
		divide by number of sheets in book	{1}	[2]	
	(b)	count a (large) number of paperclips and divide total mass by the number	{1}	[1]	
	(c)(i)	(wrap tape measure around column to) find circumference	{1}		
		divide by π to get diameter	{1}	[2]	
	(ii)	(parallax) problem in lining up tape markings with ends of diameter	{1}	[1]	
	(d)(i)	measure size of one (or a few) paving slabs or kerb stones	{1}		
		count number of slabs and multiply number of slabs by size of each	{1}	[2]	
		OR by repeated measurements {1} for statement and {1} for indication of use of assistant or careful marking. Maximum 1 for pacing			
	(ii)	time car over measured distance and divide distance by time	{1}		
		accuracy of obtaining position of car against distance measured	{1}	[2]	10

2	**(a)**	coulomb	{1}	[1]	
	(b)	farad	{1}	[1]	
	(c)	hertz	{1}	[1]	
	(d)	pascal OR newton per square metre	{1}	[1]	
	(e)	newton per kilogram	{1}	[1]	
	(f)	weber	{1}	[1]	
	(g)	becquerel	{1}	[1]	7

3	**(a)(i)**	use of area beneath graphs	{1}		
		acceleration section 125 m and deceleration section 50 m	{1}		
		constant velocity sections and total 50 m + 200 m + 125 m + 50 m = 425 m	{1}	[3]	
	(ii)	2 straight line sections correct	{1}		
		2 acceleration / deceleration sections correct	{1}		
		smooth transition between sections OR zero speed at end	{1}	[3]	
	(b)(i)	at least three points correctly calculated and drawn	{1}		
		straight line towards origin	{1}	[2]	
	(ii)	240 (V)	{1}	[1]	
	(iii)	gradient is reciprocal of the e.m.f.	{1}	[1]	
	(c)(i)	e.g. $\frac{0.18-1.16}{7.2-6.7}=-\frac{0.98}{0.5}=-1.98$ correct approach for gradient	{1}		
		1.96, 1.97, 1.98 as values for accuracy mark	{1}		
		– sign scores 1	{1}	[3]	

(ii) g α $1/r^2$ OR g inversely proportional to the square of the distance from the centre of the Earth	{1}	[1]	14

4. (a) solid → liquid

not much change in separation	{1}	
increase in speed only associated with increase in temperature	{1}	
more random movement in liquids	{1}	
more vibration in solids	{1}	
some change in p.e. component of internal energy	{1}	
other sensible suggestion	{1]	
MAXIMUM 4		[4]

liquid → gas

separation vastly increased	{1}	
speed in, say water at 100 °C = speed in steam at 100 °C	{1}	
molecules in gas have random movement	{1}	
increased distance of travel (between collisions)	{1}	
p.e. component of internal energy increased (to nearly zero)	{1}	
MAXIMUM 4		[4]

solid → liquid compared with liquid → gas

solid → liquid takes place at lower temperature	{1}	
speed of molecules less	{1}	
smaller increase in internal energy	{1}	
change of state in both cases	{1}	
MAXIMUM 2		[2]
OVERALL MAXIMUM 9		

(b)

less energy at 200 K than at 200 000 000 K	{1}		
at 200 K hydrogen gas is in molecular form	{1}		
2 atoms per molecule, each atom 1p and 1e	{1}		
at 200 000 000 K hydrogen is a plasma	{1}		
no molecular form OR enough energy to separate atoms / electrons	{1}		
electrons separated from protons OR a soup of electrons and protons	{1}		
fusion possibility between protons (to make He)	{1}		
MAXIMUM 3		[3]	12

5. (a) e.g. gaining dirt/ moisture from the atmosphere {1}

e.g. cleaning, scratching, dropping {1} [2]

do not allow change in temperature or change in pressure

(b) 1 part in 10^9 {1}

percentage uncertainty = 10^{-7} ALLOW ecf to this part from incorrect 1st line {1} [2]

(c)(i) volume = $4\pi r^3/3$ {1}

= $4\pi x\ 0.0470^3/3$ = (0.0004349) {1}

density = mass / volume ALLOW ecf to this part from incorrect volume {1}

= 1/0.0004349 = 2299 (kg m^{-3}) {1} [4]

(ii) uncertainty in volume is three times uncertainty in diameter {1}

uncertainty in diameter needs to be to 2/3 parts in 10^8 {1} [2]

(d) e.g the mass of impurity atoms will be different {1}

so dividing 1 kg by the number of silicon atoms will be incorrect {1}

OR if the structure is not regular then there will be spaces where atoms ought to be {1}

so the number of atoms assumed to be present will be incorrect {1}

i.e. {1} for the idea and {1} for its consequence [2]

(e) (i) atoms with the same number of protons (in the nucleus) but with different numbers of neutrons {1} [1]

(ii) the mass of each of the isotopes is different {1}

so the average mass of a silicon atom can only be known accurately if the proportions of each of the three isotopes is known {1} [2]

(iii) e.g. the isotopes cannot be separated by conventional (chemical) methods {1}

mass spectrometer/ diffusion methods might have to be used to separate the isotopes{1}

separation has to depend only on the atoms difference in mass {1} [2] 17

MAXIMUM [2]

[Total : 60]

Mark Scheme 2826/03
June 2006

Marking scheme for A2 Physics 2826/03 June 2006

A1 Use Hall probe to measure field / Helmholtz formula at correct separation / Gauss probe / Tesla meter / Current balance / search coil used correctly **1**

A2 Correct orientation of field with respect to vibrating sheet **1**
Could be shown on diagram. Vibration must be correct mode.

A3 Workable method **1**
(i.e. measure amplitude and field strength, change field strength and repeat)

A4 Vary current / turns in coil(s) to change magnetic flux density **1**

B1 Place magnet at antinode (usually at centre of strip) **1**

B2 Method of initiating vibrations. **1**
E.g. AC passed through strip, external magnet / S.G. and oscillator / pluck

B3 Method of measuring amplitude of vibration **2/1/0**
Motion sensor facing (plane of) vibrating sheet; one mark
Motion sensor connected to datalogger/computer; one mark
Measure amplitude from trace on screen; one mark
Any two. N.B. Allow any sensible type of motion sensor.

D Any further relevant detail, e.g. **4/3/2/1/0**

Method of fixing edges of sheet, e.g. clamps
Suitable sampling rate for logging, e.g. 1 kHz
Further details of Hall probe
Perform zero adjustment away from stray magnetic fields
Coil shown with soft iron core / use of Helmholtz coils
Circuit diagram containing coil and variable psu / resistor
Evidence of relevant preliminary experimental work done in the laboratory
Allow other creditworthy responses

R Evidence of research of material **2/1/0**
i.e. at least two detailed independent references have been given (i.e. chapter and/or page numbers must be given). Allow Internet pages to be sourced. (one slash or more)
Two or more vague references (i.e. no chapter or page reference) scores one mark.
One detailed reference scores one mark. One vague reference scores zero.

Underline and tick each relevant point in the body of the text. The ticks must have a subscript showing which marking point is being rewarded (e.g. $\checkmark_{D1}$).

Q **2 marks** are reserved for quality of written communication (organisation) **2**
Rambling and poorly presented material cannot score both marks.

16 marks in total.

Question 1

(a) (ii) Card area **1**

(a) (iii) Percentage uncertainty in A **3**
Absolute uncertainty in side length, ± 0.5mm to ± 1 mm. One mark
% uncertainty in side length, one mark OR % uncertainty in area, two marks
% uncertainty in area from 2 x % uncertainty in side length, one mark

(b) (i) Repeated readings for first value of X_{20} **1**

(b) (ii) Difficulty & improvement.
E.g. Difficulty of seeing moving pin / not at eye level; trial and improvement, or video. **2**
OR, possible pendulum motion; carefully release vertically.
One mark each**. NOT** hitting clamp stand.

(c) (ii) New card area **1**

(d) Readings **3/2/1/0**
Write the number of readings as a ringed total by the results table.
6 sets of values for X_{20} and A scores three marks; 5 sets scores two marks; 4 sets scores one mark. Less than 4 sets scores zero.
If minor help is given, then -1. If excessive help is 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.

(d) Check a value for ln X_{20}. If correct then one mark. If incorrect, write in correct value and do not award the mark. Do not allow lg X_{20}, but allow ecf in f (i). **1**

(d) Column headings **2/1/0**
The columns for X_{20} and A must be headed with a quantity and a unit. One mark each.
There must be some distinguishing mark between the quantity and its unit.
Please ✓ each correct column heading to show that it has been seen.

(d) Consistency of raw readings in the table of results **1**
Apply to X_{20} only. Expect all the values to be given to the nearest millimetre.
Values in the table must agree with the unit at the head of the column.
Trailing added zeros lose this mark.

(e) (i) Axes **1**
Each axis must be labelled with a quantity.
Scales must 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.).

(e) (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 to the number of observations. Do not award these marks 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 plot should have been. Allow errors up to and including half a small square.	**1**
(e) (ii)	Line of best fit There must be a reasonable balance of points about the line, for 5 or more trend plots. This mark can only be awarded if a straight line has been drawn through a linear trend.	**1**
(e) (ii)	Quality of results Judge by scatter of points about the line of best fit (5 or 6 trend plots needed). There must be at least five plots on the graph for this mark to be awarded.	**1**
(e) (iii)	Measurement of gradient Hypoteneuse of Δ must be ≥ half the length of the drawn line. Read-offs must be accurate to half a small square and the ratio must be correct. Please indicate the vertices of the triangle used by labelling with Δ. One mark for read-offs and ratio correct. One mark for negative value of gradient.	**2/1/0**
(e) (iii)	*y*-intercept. Allow correct <u>substitution</u> (±0.5 square) into y = mx + c.	**1**
(f) (i)	Analysis $\ln X_{20} = -kA + \ln X_0$ scores one mark (can be implied from working) Value of X_0 from $\ln X_0$ = intercept or $X_0 = e^{\text{intercept}}$, one mark. Allow ecf from (d), i.e. $X_0 = 10^{\text{intercept}}$ if logs used. Value of *k* (= -gradient) scores one mark. *k* must be positive. Unit of X_0, one mark. Unit of *k*, one mark. If the working is clear and correct allow *k* and X_0 wrong way round in error.	**5**
(f) (ii)	Alteration to give larger value of *k* e.g. use more resistive medium / more than 20 oscillations	**1**

28 marks in total.

Question 2

(a) (ii) Explanation of measurement of $\theta = 15^\circ$. Plumbline should be included in explanation. **1**

(a) (iv) Value of t_{15} **1**

(b) (iii) Value of t_{65}, which must be $> t_{15}$. **1**

(c) Ratio sin θ / t is not constant (not within 10%) **3**
One mark for calculation of sin θ
One mark for ratio idea, or calculation of k's
One mark for conclusion that sin θ is not directly proportional to t which follows from the reasoning. Allow ecf if calculated ratios are within 10%.

(d) Evaluation of procedure **8**
Relevant points must be underlined and ticked. Some of these might be:
P = problem; S = solution

P/S Timing inaccurate because tap might not be fully open / repeat with tap open

P Human error in timing
S Perform several expts. and take the average time

P Tilted meniscus/burette makes it difficult to read scale
S Mark the level of water in the burette after tilting / use same part of meniscus / empty into measuring container
S Place card behind scale to make reading easier

P Colourless liquid is difficult to see
S Add dye to the water

P Two readings is not enough to form a firm conclusion
S Take many readings of t and θ, and plot a graph

P Parallax error in reading scale on protractor / Difficult to align zero line on protractor and plumbline because protractor is not clamped (all only one marking point)
S Clamp protractor

P Difficult to open tap and start watch at the same time
S Use an assistant / fill above 50 mark and time from 50.

P Difficult to get accurate tilt
S Use projection / predrawn lines on card

Do not allow draughts / video / motion sensor etc.

Allow other relevant points (8 maximum). Each line above is a marking point.

2 marks are reserved for quality of written communication (SPAG) **2**

16 marks maximum to be awarded.

Sample results for damping investigation.

l/cm	A/cm^2	X_{20}/cm	ln (X_{20}/cm)
21	441	2.2	0.788
19	361	2.8	1.030
17	289	3.6	1.281
15	225	4.4	1.482
13	169	5.4	1.686
11	121	6.2	1.825

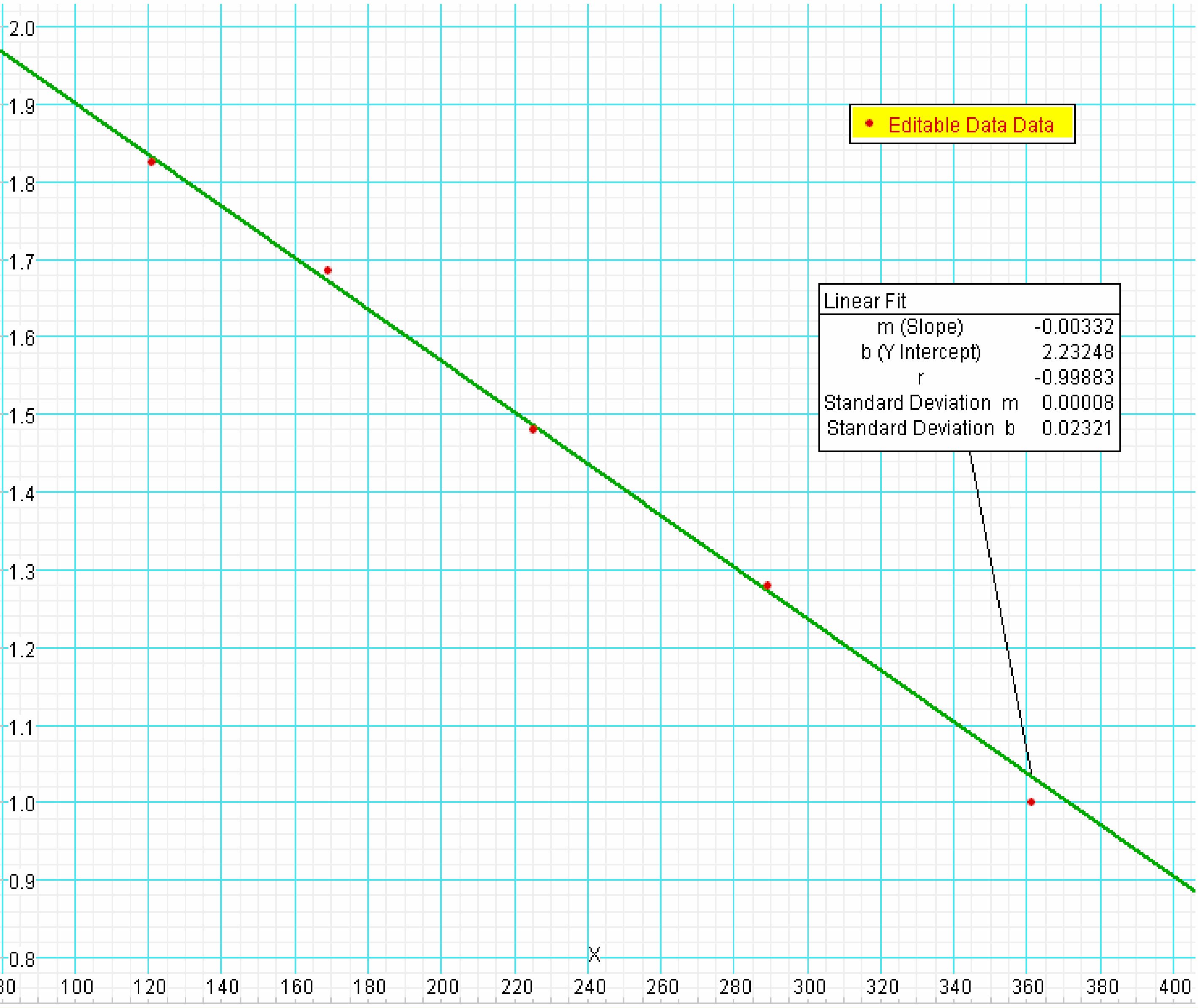
The graph of ln (X_{20}/cm) against A gives a straight line with a negative gradient of -3.3×10^{-3}.
The y-intercept is 2.23.

Sample results for burette experiment.

θ	sin θ	$t_{1/2}$/s	sin θ/ $t_{1/2}$
45^{O}	0.707	21.03	0.0336
65^{O}	0.906	27.23	0.0333

When $\theta = 15^{O}$, t = 17.72 s. The ratio is then 0.0146, so not proportional.
For angles > 45^{O} the ratio is fairly constant

Graph of sample results for question 1



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
wtte	Words to that effect
CON	Contradictory physics not to be credited
✓Δ	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
✓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

Advanced GCE Physics A 3883/7883
June 2006 Assessment Series

Unit Threshold Marks

Unit		Maximum Mark	a	b	c	d	e	u
2821	Raw	60	43	37	32	27	22	0
	UMS	90	72	63	54	45	36	0
2822	Raw	60	50	45	40	35	30	0
	UMS	90	72	63	54	45	36	0
2823A	Raw	120	96	85	75	65	55	0
	UMS	120	96	84	72	60	48	0
2823B	Raw	120	96	85	75	65	55	0
	UMS	120	96	84	72	60	48	0
2823C	Raw	120	92	83	74	65	57	0
	UMS	120	96	84	72	60	48	0
2824	Raw	90	60	53	46	40	34	0
	UMS	90	72	63	54	45	36	0
2825A	Raw	90	69	62	56	50	44	0
	UMS	90	72	63	54	45	36	0
2825B	Raw	90	68	61	54	48	42	0
	UMS	90	72	63	54	45	36	0
2825C	Raw	90	65	58	51	45	39	0
	UMS	90	72	63	54	45	36	0
2825D	Raw	90	60	53	47	41	35	0
	UMS	90	72	63	54	45	36	0
2825E	Raw	90	70	63	57	51	45	0
	UMS	90	72	63	54	45	36	0
2826A	Raw	120	88	79	70	61	53	0
	UMS	120	96	84	72	60	48	0
2826B	Raw	120	88	79	70	61	53	0
	UMS	120	96	84	72	60	48	0
2826C	Raw	120	84	77	70	63	56	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	19.1	37.6	55.5	70.9	83.3	100.0	6982
7883	26.9	48.7	69.4	85.0	95.9	100.0	5452

For a description of how UMS marks are calculated see;
www.ocr.org.uk/OCR/WebSite/docroot/understand/ums.jsp

Statistics are correct at the time of publication

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

OCR Information Bureau

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

www.ocr.org.uk

Oxford Cambridge and RSA Examinations
is a Company Limited by Guarantee
Registered in England
Registered Office; 1 Hills Road, Cambridge, CB1 2EU
Registered Company Number: 3484466
OCR is an exempt Charity

OCR (Oxford Cambridge and RSA Examinations)
Head office
Telephone: 01223 552552
Facsimile: 01223 552553