GCE

Physics A

Advanced GCE **7883**

Advanced Subsidiary GCE **3883**

Mark Schemes for the Units

January 2007

3883/7883/MS/R/07J

Oxford Cambridge and RSA Examinations

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GCE Physics A (7883)

Advanced Subsidiary GCE Physics (3883)

MARK SCHEMES ON THE UNITS

Mark Scheme 2821
January 2007

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)	**Arrows of the correct length ± 2 mm**	**B1**
(b) (i)	**At B: zero / less than / smaller**	**B1**
(ii)	**At C: smaller <u>and</u> opposite / negative direction**	**B1**
(iii)	**At D: same size / no change and no change for all three horizontal components**	**B1**
(c)	**No change in horizontal component since no air resistance / no components of forces in this direction**	**B1**
	At B maximum height (therefore no vertical component)	**B1**
	At C direction of motion has changed / falling back down / vertical component increases as acceleration is vertically down	**B1**
	At D(velocity is same magnitude but opposite direction to starting velocity) ball has accelerated (due to gravity) down to original speed / idea of time or distance down being the same as that going up	**B1**
		Total: 8

Question	Expected Answers	Marks
2 (a) (i)	Braking force is the frictional force applied by the road on the tyre (in the opposite direction to the motion of the vehicle that brings the vehicle to rest)	B1
(ii)	Braking distance is the distance travelled from the time the brakes are applied to when the vehicle <u>stops</u>	B1
(b) (i)	Kinetic energy = ½ m v^2	C1
	= ½ 1380 x $(31.1)^2$	C1
	= 667375 (J) (667 kJ) 6.7 x 10^5 (J)	A1
(ii)	$v^2 = u^2 + 2as$	
	0 = $(31.1)^2$ + 2 x a x 48.2	C1
	a = 10 .0(3) (m s^{-2})	A1
(iii)	F = ma or work = force x distance	C1
	= 1380 x 10.03 F = 667375 / 48.2	
	= 13800 (13846) (N) = 13800 (13846) (N)	A1
		Total: 9

Question	Expected Answers	Marks
3 (a) (i)	Work = force x distance moved / displacement in the direction of the force	B1
(ii)	Power = rate of doing work / work done per unit time	B1
(b)	Watt is the power used when one joule of work is done per second (allow joule / second)	B1
(c) (i)	Tension = Weight / mg = 1.5×10^3 x 9.8 using g =10 -1 = 14700 (N)	C1 A1
(ii)	time = 25 / 1.6 = 15.6 (s)	A1
(iii)	PE = mgh	C1
	PE / t = (14700 x 25) / 15.6 or 14700 x 1.6	C1
	= 24000 (23520) ($J\ s^{-1}$)	A1
	or power = F x v	C1
	= 14700 x 1.6	C1
	= 24000 (23520) ($J\ s^{-1}$)	A1
(iv)	(gain in PE per second = output power used to lift weight) power = 24000 (23520) (W) / allow those answers that suggest greater due to friction in lifting mechanism	B1 Total: 10

Question	Expected Answers	Marks
4 (a) (i)	Moment is the force x the perpendicular distance from (the line of action of) the force to the pivot/ point (missing perpendicular –1, missing from the force to the pivot / point –1)	B2
(ii)	Torque of a couple: one of the forces x perpendicular distance between (the lines of action of) the forces	B1
(b) (i) 1	3600 x 1.0 = X x 2.5 one mark for one correct moment, one mark for the second correct moment and equated to first moment	C2 A0
2	X = 1440 (N) Y = 3600 - 1440 or 3600 x 1.5 = Y x 2.5 = 2160 (N)	C1 A1 B1
(ii)	Not a couple as forces are not equal and not in opposite directions / the forces are in the same direction	B1 C1
(iii)	P = F / A = $1440 / 2.3 \times 10^{-2}$ = 62609 (6.3×10^{4}) unit Pa or N m^{-2}	B1 B1 Total: 12

Question	Expected Answers	Marks
5 (a) (i)	Stress = force / cross-sectional area	B1
(ii)	Strain = extension / original length	B1
(b) (i) 1	Elastic as returns to original length (when load is removed)	B1
2	Hooke's law is obeyed as force is proportional to the extension	B1
	Example of values given in support from table	B1
(ii)	Measure (original) length with a (metre) rule / tape	B1
	Suitable method for measuring the extension eg levelling micrometer and comparison wire or fixed scale plus vernier or travelling microscope and marker / pointer	B1
(iii)	E = stress / strain	C1
	$= (25 \times 1.72) / (1.8 \times 10^{-7} \times 1.20 \times 10^{-3})$	C1
	$= 1.99 \times 10^{11}$ (Pa)	A1
		Total: 10

Question	Expected Answers	Marks
6 (a)	At t = 0 / at start velocity is zero as gradient is zero The velocity then increases As gradient increases The velocity is then constant As the gradient is constant Velocity decreases As gradient decreases Then velocity is zero As gradient is zero Increasing velocity / in opposite/ negative direction As gradient is negative (and increasing) Velocity decreasing As gradient is decreasing It comes to rest as gradient is zero	B1 B1 B1 B1 B1 B1 B1 B1 B1 B1 B1 B1 B1 B1 Max 5
(b)	Acceleration is change in velocity divided by time taken	B1
	The velocity can be determined by the gradient of (tangent to curve) graph [max of two for explanations]	B1
	(Gradient is increasing) car is accelerating	B1
	(Then no change in gradient) no acceleration	B1
	Then (velocity decrease) deceleration occurs	B1
	Then (velocity increases) acceleration in opposite direction or deceleration continues	B1
	Then deceleration in original direction (as velocity decreases)	B1
	[max of three for statements]	Max 4
	SPAG ORGANISATION	B1 B1
		Total: 11

Mark Scheme 2822
January 2007

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)**	Any **two** from:	B1 × 2
		Travel through vacuum (allow 'free space') Travel at the speed of light \ c \ 3 × 108 m s-1 (in vacuum) Consist of oscillating electric and magnetic fields They are all transverse waves \ can be polarised Can be diffracted \ reflected \ refracted Consist of photons	
	(b)	radio (waves); Infra-red \ ir; gamma \ γ (rays\waves\radiation)	B1 × 3
	(c)	Quantum of energy \ (electromagnetic) radiation \ light \ packet of energy (Do not allow 'particle of light' – since in the stem of the question)	B1
	(d)	Planck constant (Do not allow *h*)	B1
	(e)	ratio = 0.5 \ ratio = ½ (Allow ratio = 1:2)	B1
			[Total: 8]
2	**(a)**	$Q = It$ (Allow any subject)	C1
		$Q = 0.040 \times 5.0 \times 60 \times 60$ \ $Q = 0.040 \times 1.8 \times 10^4$	
		charge = 720	A1
		(40 × 5 = 200 or 0.040 × 5 = 0.02 or 40 × 1.8 × 10^4 = 7.2 × 10^5 scores 1/2)	
		coulomb \ C \ As	B1
	(b)	It is less because the average current is less \ area (under graph) is less \ current 'drops' after 3 hours.	B1
			[Total: 4]
3	**(a)**	Current is (directly) proportional to potential difference (for a metal conductor)	M1
		provided the temperature \ (all) physical condition(s) remains constant	A1
	(b)	**(i)** **M** marked at the end of the graph	B1
	(b)	**(ii)** current is 5 (A) and p.d is 6 (V)	C1
		$P = VI$ \ $P = 6.0 \times 5.0$	
		(Allow $P = I^2R$ or $P = V^2/R$)	C1
		power = 30 (W)	A1
	(b)	**(iii) 1.** V_L = 1.0 (V) (From the *I*/*V* graph) \ R_L = 1.0/2.0 or 0.5 (Ω)	M1
		V_R = 1.2 × 2.0 \ R_T = 1.2 + 0.5	M1
		V = 1.0 + 2.4 \ V = 1.7 × 2.0	A1
		voltmeter reading = 3.4 (V)	A0
	(d)	**(iii)2.** Vr = 4.5 – 3.4 (= 1.1 V) \ 4.5 = 2.0r + 3.4 (Possible ecf)	C1
		$r = \frac{1.1}{2.0}$	
		r = 0.55 (Ω) (1.05 Ω scores 0/2 since the lamp is ignored)	A1
			[Total: 11]

4	**(a)**	At **B**: (Straight) arrow to the right			B1
		At **C**: (Straight) arrow to the left		(Judged by eye)	B1
	(b)	**(i)**	$I = \frac{V}{R} = \frac{3.0}{1.5}$		
			current = 2.0 (A)	(Allow 1 sf answer)	B1
	(b)	**(ii)**	$B = \frac{F}{IL}$	(Allow any subject)	C1
			$B = \frac{4.0\times10^{-3}}{2.0\times0.05}$	(Possible ecf)	C1
			$B = 4.0 \times 10^{-2}$ (T)	(Allow 1 sf answer)	A1
			(4.0×10^{-4} T scores 2/3)		
					[Total: 6]

5	**(a)**	Ammeter in series		B1
		Voltmeter in parallel	(across the ends of the wire)	B1
	(b)	$\rho = \frac{RA}{L}$	(Allow any subject)	M1
		R = resistance, L = length and A = (cross-sectional) area (ρ = resistivity is given in the question)		A1
		Any **four** from:		
		Measure the length of the wire using a ruler		B1
		Measure the diameter of the wire		B1
		using a micrometer \ vernier (calliper)		B1
		Calculate the (cross-sectional) area using A = πr2 \ A = πd2/4		B1
		Calculate the resistance (of the wire) using $R = \frac{V}{I}$		B1
		Repeat experiment for different lengths \ current \ voltage \ diameter (to get an average)		B1
		Plot a graph of R against L. The gradient = ρ/A.		B1
		(Or Plot V against I. The gradient is ρL/A)		
		Structure and organisation.		B1
		Spelling and grammar.		B1
				[Total: 10]

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.

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

6 **(a)** **(i)** light-dependent resistor \ LDR — B1

(a) **(ii)** Resistance of **X** decreases (as light intensity is increased) — B1
The current (in the circuit) increases — B1

(a) **(iii)** The current is halved. — B1

(b) total resistance of three in series = 6.0 (kΩ) — C1
$\frac{1}{R} = \frac{1}{2} + \frac{1}{6}$ \ $R = \frac{2 \times 6}{2+6}$ — C1
resistance = 1.5 (kΩ) — A1

(c) **(i)** p.d across 1.5 k Ω resistor = 5.0 – 1.2 = 3.8 (V) — B1

(c) **(ii)** $V = \frac{R_2}{R_1 + R_2} \times V_0$ \ $\frac{V_1}{R_1} = \frac{V_2}{R_2}$ \ current = 3.8/1.5 (=2.53 mA) — C1
$1.2 = \frac{R}{R+1.5} \times 5.0$ \ $\frac{1.2}{R} = \frac{3.8}{1.5}$ \ *R* = 1.2/2.53 — C1
R = 474 (Ω) ≈ 470 (Ω) — A1
(Using 3.8 V instead of 1.2 V gives 4.75 kΩ - allow 2/3)

[Total: 11]

7 **(a)** $\lambda = \frac{h}{mv}$ \ $\lambda = \frac{h}{p}$ — M1
λ = wavelength, *m* = (particle) mass, *v* = speed \ velocity or *p* = momentum — A1
The wavelength \ λ is a wave property — B1
The mass \ *m* (or momentum \ *p*) is a particle property — B1

(b) **(i)** **1**. The minimum frequency (of radiation \ waves) needed for electrons to be released (from the metal surface) \ for photoelectric effect — B1

(b) **(i)** **2**. Its temperature increases \ gets warm \ 'heats up' — B1

(b) **(ii)** $E = 2.2 + 1.9 (= 4.1)$ — C1
$E = 4.1 \times 1.6 \times 10^{-19} = 6.56 \times 10^{-19}$ (J) — C1
(Allow this mark for correct conversion of either 1.9 eV or 2.2 eV to joules)
$f = (\frac{6.56 \times 10^{14}}{6.63 \times 10^{-34}} =) 9.89 \times 10^{14} \approx 9.9 \times 10^{14}$ \ $\lambda = \frac{hc}{E} = \frac{6.63 \times 10^{-34} \times 3.0 \times 10^{8}}{6.56 \times 10^{-19}}$ — C1
$\lambda = 3.03 \times 10^{-7} \approx 3.0 \times 10^{-7}$ (m)
(Allow 1 sf answer) — A1
(Allow 3/4 marks for $\lambda = 4.85 \times 10^{-26}$ m when eV is not converted to joules)

[Total: 10]

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1 **(a)** the **spreading out** of waves (as they pass through a gap) (WTTE) B1 [1]

(b) **(i)** gap about same size wavelength (i.e between 0.5λ and 1.5λ) B1
semicircular arcs (ie nothing straight) B1
no change in wavelength shown or stated or labelled B1 [3]
{n.b mark this rigidly because Question suggests they label the diagram}

(ii) **LESS** diffraction (less spreading out) (WTTE) B1 [1]

[Total: 5]

2 **(a)** refractive index = ci /cr OR sini/sinr B1
ci =speed of incident light/speed in air OR i = angle of incidence
AND cr =speed of refracted light /speed in material OR r = angle of refraction
B1 **[2]**

{Allow RI = speed of light in air/speed of light in material or 2 marks}
{Allow RI = sine angle of incidence/sine angle of refraction for 2 marks}

(b) Use of n = ci /cr (WTE) seen anywhere {allow BACK CREDIT for (a)} C1

Material	Refractive Index	Speed of light in the material m s^{-1}	
Water	1.33	**2.26 (or 2.3)x10^8**	- A1
diamond	**2.42 (or 2.4)**	1.24x10^8	- A1

[3]

(c) **(i)** ray is refracted/changes direction/changes speed B1**[1]**

(ii) ray refracted towards normal AND away from normal on exit B1
amount of refraction the same at entry and exit (WTTE) B1**[2]**

(iii) <u>statement</u> that path of refracted ray is drawn (on sheet) B1
evidence of correct angles of incidence (i) AND refraction (r)
<u>measure</u> (or find) i and r B1**[3]**

[Total: 11]

3	(a)	(i)	**LESS** (WTTE)	B1 **[1]**
		(ii)	angle of incidence must be greater than critical angle (WTTE)	B1 **[1]**
	(b)		different rays follow different paths OR reflected at different angles (WTTE)	B1
			some arrive before others (WTTE)	B1
			signal is distorted/smeared/spread out (WTTE) (reject weakened)	B1 **[3]**
	(c)	(i)	correct substitution into RI = 1/sinC : e.g 1.02= 1/sinC	C1
			C = 78.5o (or 78 or 79) {NO MARKS if n= 0.98 is used}	A1 **[2]**
		(ii)	High C makes TIR less likely (WTTE)	M1
			(hence) fewer alternative paths (WTTE)	M1
			and less multipath dispersion (WTTE)	A1 **[3]**
			{The A mark can be scored provided either M mark is obtained}	
				[Total: 10]
4	(a)	(i)	amplitude = 3.75 cm {allow 3.7 to 3.8)	B1 **[1]**
		(ii)	when t = 1.8 ms displacement = ANY negative value	B1
			(-) 3.35 cm (ALLOW 3.3 TO 3.4)	B1 **[2]**
		(iii)	period = 2.64 ms (allow 2.64 to 2.68)	B1 **[1]**
		(iv)	frequency = 1/period	C1
			= 1/(2.64x10-3)= 379 Hz (379 to 373 or 380) {ecf for T}	A1 **[2]**
	(b)		recall of v=fλ	C1
			λ = v/f = 300/379 = 0.79 m (or 0.8 m) {allow ecf from (iv)}	A1 **[2]**
				[Total: 8]
5	(a)	(i)	ANY 3 correct phenomena from REFLECTION, REFRACTION, INTERFERENCE, SUPERPOSITION, DIFFRACTION, (allow transfer energy)	B2 **[2]**
			3 correct scores 2 marks, 2 correct scores 1 mark otherwise zero	
		(ii)	POLARISATION	B1 **[1]**
	(b)	(i)	it consists of nodes and antinodes / it does not transfer energy (WTTE)	B1
			formed by two identical waves travelling in opposite directions (WTTE)	B1
			(microwaves leaving transmitter) interfere (with reflected waves) (WTTE)	B1 **[3]**
			{allow superimpose/interact/cancel out/reinforce for interfere}	
		(ii)	1.wavelength of the microwaves = 2 x 1.4 = 2.8 cm	B1 **[1]**
			2. speed of microwaves in air = 3 x108 m/s OR c	M1
			frequency = 3x108 /2.8 x10-2 (allow ecf) = 1.07 x 1010 Hz	A1 **[2]**
		(iii)	Place a metal grid {allow "Polaroid"} (between T and D) and rotate (or place at 900) OR rotate grid/transmitter/detector	B1
			this causes minm/zero signal (WTTE)	B1 **[2]**
				[Total: 11]

Paper total = 5 + 11 +10 + 8 + 11 = 45

Mark Scheme 2823/03
January 2007

Planning Exercise - Skill P

A1 Diagram of workable arrangement of apparatus including appropriate support at R. **1**

A2 Correct procedure **1**

(ie measure load, measure force at F; change load and measure new force – allow graph or table). Method must be workable.

A3 **C**orrectly measures force at F **1**

A4 Adds a carried load between F and R **1**

B1 Method for suspending or supporting block of wood at F (could be on diagram) **1**

B2 Range of loads applied (0-6 kg) **1**

B3 Range of newton meter/top pan balance (0-1 N, 0-10 N, 0-50 N, 0-5 kg) **1**

C1 Safety precautions, explicit statements required **1**

Danger of heavy loads: sand below load; keep feet away from load;

place load near ground; boots with steel toe-caps.

R1/2 Evidence of the sources of the researched material **2/1/0**

Two or more (vague) references or one detailed reference score one mark.Two or more detailed references scores two marks.

Detailed references should have page or chapter numbers or be internet pages.

D1/2/3/4 Any further relevant detail. Examples of creditworthy points might be; max **4**

Find weight of wood (either by measurement or density)
Determination of newton meter/top pan balance range range
Precision of newton meter/top pan balance
Justificationof load to keep force on front axle/discussion of variation of force at F
Method of keeping carried load in the same position
Evidence of preliminary investigation in the laboratory
Use of spirit level to keep beam horizontal
Method of reducing friction at R

QWC 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

16 marks total.

Question 1

(c) Measurements **2/1/0**
Write the number of readings as a ringed total next to the table of results.
Six sets of values forT and M scores 2 marks. Five sets scores 1 mark
Minor help from Supervisor then –1.
Major help (equipment set up for the candidate) then -2.
No trend (ie random scatter of plots) then -2.

(c) Column headings in the table **2/1/0**
One mark for M heading with valid unit.
One mark for T headingwith valid unit.
Ignore units in the body of the table.

(c) Consistency of raw readings **2/1/0**
One mark for T which must be to the nearest 0.1 N
One mark for M which must be to the nearest 1 g (eg 100 g or 0.100 kg)

(d) Axes **2/1/0**
Sensible scales must be used. Awkward scales (eg 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.
One mark for each correct axis.

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

(d) 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 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.

(d) 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 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.

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

(e) 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) 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 3g/4 (can be implied from working) Value of g using gradient Value between 9.3 and 10.3 using gradient Sig Figs of g: allow 2 or 3 only Unit of g [ms-2 or Nkg-1 or equivalent]	**5/4/3/2/1/0**
(g)	**(ii)**	y-intercept equated with gR/2 Value of R using y-intercept Sig Figs of R: allow 2 or 3 only	**3/2/1/0**
(h)	**(i)**	Calculation of percentage difference Expect to see difference in R values/ an R value	**1/0**
(h)	**(ii)**	1. Random error Reference to scatter of points on graph and appropriate conclusion 2. Systematic error Reference to (percentage) differences in either g or R and appropriate conclusion	**1/0** **1/0**

28 marks available. Write the mark as a ringed total at the bottom of page 7.

Question 2

(b) **(ii)** Connects circuit correctly without help **1**
Records a current value in mA

(c) **(ii)** Method of calculating R and R/L **1**
Penalise POT but allow ecf from (b)(ii).

(d) **(i)** Calculates percentage uncertainty in emf ratio (13.3%) **1**
(ii) ΔI = 1-5 mA 1
Adds percentage uncertainties for V and I **1**

(e) Repeats experiment gaining a smaller value forI **1**

(f) Direct proportionality ideas
Method to prove or disprove proportionality
(eg determines constant of proportionality) **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

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

	Problem	**Solution**
A	Heating effect of pencil	Remove wooden sleeve/use a smaller current/take reading instantly
B	Difficult to attach crocodile clips/lead breaks	Method of improving contact with pencil/expose more lead/use mini crocodile clips
C	Current readings fluctuate	Repeat reading <u>and</u> take an average
D	Physical characteristics of lead may not be same, eg diameter/tapers at the ends/length not accurate	Check with a micrometer screw gauge or good improvement to measure length/cut long length
E	EMF not 1.5 V or internal resistance ideas	Use a voltmeter to measure the voltage across the pencil
F	Two readings of *R* and *L* are not enough to verify the suggestion	Take many readings of *L* <u>and plot a graph</u> (eg *R* v *L*)

6 maximum

No credit for simple 'repeats' or 'using a computer'or digital meters.
Do not allow vague human error in measuring *L* or parallax errors.

Quality of written communication (ie spelling, punctuation and grammar). **2/1/0**
Capital letters at the beginning of sentences, full stops at the end scores one mark
Correct spelling and grammar scores one mark. Allow max two errors.
N.B. Two marks can only be scored if greater than half a page of written work is assessed

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

Results

Question 1

m / kg	*F* / N
0.100	1.4
0.200	2.1
0.300	2.8
0.400	3.5
0.500	4.2
0.600	4.9

Plotting a graph of *F* against *m* produces:
Gradient = 7.0
y-intercept = 0.70

gradient = 3g/4
g = 9.33 Nkg^{-1}

y-intercept = Rg/2
R = 2 x 0.70 / 9.33 = 0.150 kg

Mass from top pan balance 124 g (21% error)

Results:

l = 8.5 cm

I = 85.2 mA

R = 16.4 Ω

R/l = 193 Ωm^{-1}

l = 17.2 cm

I = 64.8 mA

R = 21.6 Ω

R/l = 125 Ωm^{-1}

Since *R/l* is not constant *R* is not directly proportional to *l*

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
January 2007

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	½ $mv^2 = 7.6 \times 10^{-13}$ to give $v = \surd(2 \times 7.6 \times 10^{-13} / 6.6 \times 10^{-27}$	1	
			evidence of calculation $v = \surd 2.3 \times 10^{14}$ *or* $= 1.52 \times 10^7$ (m s^{-1})	1	
		ii	(electrostatic) repulsion between charged particles	1	
			slows alpha and accelerates nucleus/AW	1	
			momentum of system is conserved(as no external forces)	1	
			sum of momenta of alpha and nucleus must always equal initial momentum of alpha/be a constant	1	
			so speed of nucleus can be calculated as momentum = mv	1	
			max 3		
		iii	mv = MV or $V = 6.6 \times 10^{-27} \times 1.52 \times 10^7 / 3.0 \times 10^{-25}$; $= 3.3 \times 10^5$ (m s^{-1})	2	
		iv	Ft = 2mv or $9.0 \times t = 2 \times 6.6 \times 10^{-27} \times 1.52 \times 10^7$; $t = 2.2 \times 10^{-20}$ (s)	2	9
			give 1 mark for change in momentum = impulse *or* $\Delta mv = F(\Delta)t$		
	b	i	Coulomb force α distance $^{-2}$ or $F_1/F_2 = r_2^2/r_1^2$ or Fr^2 = constant	1	
			giving F = 4.0 N at 10×10^{-14} ; = 1.8 N at 15×10^{-14} m	2	
		ii	plot and draw correct curve *ecf plausible values in b(i)*	1	4
			Total		**13**
2	a		(The sum of) the <u>random</u> kinetic ; and potential energies of the atoms/molecules/particles of the gas	1 1	2
			omitting atoms/molecules/particles scores zero marks		
	b	i	n = pV/RT ; $= 2.8 \times 10^5 \times 2.1 \times 10^{-3}/(8.3 \times 288)$; = 0.246 (mol)	3	
		ii	p/T = constant; T = (290/280) x 288 = ; 298 K = 25 °C	3	
			using pV = nRT with n = 0.25 mol gives 20 °C also possible ecf from b(i)		
		iii	ratio = $T_2/T_1 = p_2/p_1$ = 1.03 or 1.04 *or 1.02* ; internal energy α T	2	8
			Total		10
3	a	i	v = 2πrf = 2π x 0.015 x 50 ; = 4.7 (m s^{-1})	2	
		ii	$a = v^2/r = 4.7^2/0.015$; $= 1.5 \times 10^3$ (m s^{-2}) *ecf(a)(i)*	2	
		iii	the belt tension is insufficient to provide the centripetal force; so the belt does not 'grip' the pulley/does not hold the belt against the pulley/there is insufficient friction to pull/push/move the belt.	1 1	
			alternative argument the belt does not 'grip' the pulley/there is insufficient friction to pull/push/move the belt; because of its inertia/insufficient to provide force for acceleration of (belt)-drum		6
	b		resonance occurs; when the natural frequency of vibration of the panel = rotational frequency of the motor	1 1	2
	c	i 1	5, 15, 25 (ms)		
		2	0, 10, 20, 30 (ms)	1	
		ii	Stating/using Є = dφ/dt	1	4
			gradient = 0.67 ± 0.05 (Wb turns ms^{-1}) ; emf = gradient x 10^3 (V)	2	
			Total		12

4	a		Q_o= CV = 1.2 x 10^{-11} x 5.0 x 10^{3} ; = 6.0 x 10^{-8}; C	3	3
	b	i	RC = 1.2 x 10^{15} x 1.2 x 10^{-11} *or* = 1.44 x 10^{4} (s)	1	
		ii	I = V/R = 5000/1.2 x 10^{15} *or* = 4.16 x 10^{-12} (A)	1	
		iii	t = Q_o/I; = 6 x 10^{-8} / 4.16 x 10^{-12} = 1.44 x 10^{4} (s)	2	
		iv	Q = $Q_o e^{-1}$; Q = 0.37Q_o so Q lost = 0.63Q_o	2	6
	c	i	capacitors in parallel come to same voltage	1	
			so Q stored α C of capacitor	1	
			capacitors in ratio 10^{3} so only 10^{-3} Q_o left on football	1	
		ii	V = Q/C = 6.0 x 10^{-8} /1.2 x 10^{-8} *or* 6.0 x 10^{-11} /1.2 x 10^{-11} *or* only 10^{-3} Q left so 10^{-3} V left; = 5.0 (V)	2	5
			Total		14
5	a	i	equally spaced horizontal parallel lines from plate to plate	1	
			arrows towards cathode	1	
		ii	½ mv^2 = qV ; v = √(2eV/m) = √(2 x 1.6 x 10^{-19} x 7000/9.1 x 10^{-31}) so	1	
			v = 4.96 x 10^{7} (m s^{-1})	1	4
	b	i	arrow perpendicular to path towards centre of arc	1	
		ii	out of paper/upwards ;using Fleming's LH rule (for conventional current)	2	
		iii	mv^2/r ; = Bqv ; r = mv/Bq = $\frac{9.1 \times 10^{-31} \times 4.96 \times 10^{7}}{3.0 \times 10^{-3} \times 1.6 \times 10^{-19}}$;= 9.4 x 10^{-2} (m)	4	7
	c		change magnitude of current in coils to change field;	1	
			change field to change deflection;	1	
			reverse field/current to change deflection from up to down *max 2 marks*	1	2
			Total		13
6	a	i	212; β	2	
		ii	208; α	2	4
	b		range/penetration/absorption experiment:		
			α place detector very close/ 2cm from source; measure count rate,	1	
			use paper screen or move back to 10 cm or more; contrast to	1	
			background count level/ other emissions from same source	1	
			β place detector eg 10 cm from source; measure count rate, add	1	
			thin sheets of Al until count drops to very low or almost constant value	1	
			aliter deflection experiment:		
			needs vacuum for α experiment;	1	
			source for radiation passes through region of E- or B- field;	1	
			deflection of particles detected by detector to distinguish emissions;	1	
			detection method *max 4 marks*	1	4
	c	i	A = λN ;= λmN_A/M ;= 0.0115 x6.02 x 10^{23} x 1 x10^{-9}/212 = 3.27 x 10^{10} min^{-1}	3	
		ii	$T_{1/2}$ = 0.693/λ = 60.3 (min)	1	
		iii	Curve passing through (0,32) (60, 16) (120,8) *ecfs from (i) & (ii)*	1	5
			Total		13

7	**a**	*Do not score the same marking point twice; some marking points appear more than once in a different context*		
		fission is splitting of nuclei:		
		neutron is absorbed by the nucleus;	**1**	
		an (unstable) nucleus splits into two (major) fragments;	**1**	
		and several/two/three neutrons	**1**	
		charges on/Coulomb repulsion pushes fragments apart;	**1**	
		loss of mass/increased binding energy accounts for k.e of fragments/release of energy	**1**	
		fusion is fusing of nuclei:		
		two light nuclei (are moving rapidly enough to overcome the Coulomb repulsion to 'touch' and) fuse; *statement in brackets gets second mark*	**1**	
		has to be very hot for nuclei to have enough kinetic energy/ only	**1**	
		happens naturally inside Sun/star *accept* H-bomb	**1**	
		loss of mass/increased binding energy accounts for release of energy		
		similarity: release of energy/total (rest) mass decrease/'increase' in binding energy /conservation of charge/mass-energy, etc	**1**	
		difference: /cold, hot/heavy, light nuclei/large (200 MeV), small (30 MeV) energy release per reaction	**1**	
		conditions: fission rate can be varied/controlled by absorbing and or slowing released neutrons in reactor where chain reaction is occurring/AW *max 2 marks*	**2**	
		fusion needs a very hot and sufficiently dense and plentiful plasma for random fusion collisions to occur, eg inside Sun/star/AW *max 2 marks*	**2**	**7**
	b	*Appreciation that key is* the difference in numbers of atoms/nuclei *or* equal number of nucleons involved *if nothing else is achieved*	**1**	
		Full argument:		
		235 g of uranium and 4 g of hydrogen/helium contain 1 mole of	**1**	
		atoms	**1**	
		there are 4.26 moles of uranium and 250 moles of helium	**1**	
		so at least 58 times as many energy releases in fusion	**1**	
		ratio of energies is only 7 fold in favour of uranium		
		therefore more energy release from 1 kg of hydrogen		
		any similar alternative argument along same lines scores 4 marks	**1**	
		eg For U each nucleon 'provides' 0.85 MeV	**1**	
		For H each nucleon 'provides' 7 MeV	**1**	
		(Approximately) same number of nucleons per kg of U or H	**1**	**4**
		so 8.2 times as much energy from H		
		Total		**11**
		Quality of Written Communication (see separate sheet)		**4**

Mark Scheme 2825/01
January 2007

1	**a)**	**i)**	1 Craters/ mountains on Earth's Moon	**1**
			2 Moons orbiting Jupiter	**1**
	a)	**ii)**	Moon not perfect (sphere)	**1**
			Earth not the centre of all orbits / confirmed heliocentric theory	**1**
	b		Position/velocity (of Uranus) not that predicted	**1**
			Another force acting (on Uranus)	**1**
			Existence of another planet/Neptune predicted	**1**
	c		galaxy/ milky way/ accept black hole	**1**
			planet	**1**
			planetary moon/ asteroid/ comet	**1**
				total 10
2	**a)**	**i)**	$m_s v^2 / r = G m_s m_e / r^2$	**1**
	a)	**ii)**	$v = 2\pi r / T$	**1**
			$4 \pi^2 r^2 / T^2 = G m_e / r$	**1**
	b)	**i)**	Time = 718 x 60 s (=43,080 s)	**1**
			$r^3 = 6.67 \times 10^{-11} \times 6 \times 10^{24} (718 \times 60)^2 / 4 \pi^2$	**1**
			$r = 2.66 \times 10^7$ m	**1**
	c)	**i)**	satellites are in moving reference frame	**1**
			satellites are in weaker/different gravitational field	**1**
	c)	**ii)**	satellites have elliptical orbits	**1**
			ref. to change in speed or height above Earth	**1**
				total 10

3	a)	change in frequency or wavelength from relative motion of source and/or observer		1 1
	b)	Any 6 from correct reference to red shift/ longer wavelength bodies are receding (from Earth)/ Universe is expanding the objects are galaxies $v/c = \Delta\lambda / \lambda$ using data from spectra (eg measure $\Delta\lambda$) reference to obtaining distance data velocity is proportional to distance / $v = H_0 r$ suggests Universe started with Big Bang / singularity age of Universe = $1/ H_0$	 1	 1 1 1 1 1 1 1 1 6
			total	**8**
4	a)	burning hydrogen H and He the major constituents/ longest or most stable part of life-span (as a star) / evolves into red giant/ radiation pressure balanced by gravitational pull		1 1
	b) i)	intensity changes/decreases with distance absolute magnitude places all stars at 10 pc/ same distance/ distance does not affect comparison of luminosities		1 1
	b) ii)	$m – M = 5\log (d/10)$ $M = 7.5 - 5\log(158.5/10)$ $M = 1.50$		1 1 1
	c) i)	any 6 points plotted correctly all points correct		1 1
	c) ii)	curve passes through all points and correct peak		1
	c) iii)	min.apparent magnitude read correctly from graph		1
	d)	supernova H burning has ended/ <u>luminosity</u> increases greatly		1 1
			total	**13**
5	a)	any 6 from <u>very</u> high temperature quarks/electrons/ positrons/ neutrinos formed temperature decreases/ inflation strong nuclear force takes effect protons/ neutrons/ pions formed annihilation/ excess matter to anti-matter synthesis of <u>helium nuclei</u> <u>hydrogen</u> atoms form 25% of mass is <u>helium</u> gamma radiation universe becomes transparent	 1	 1 1 1 1 1 1 1 1 1 1 6

b)		EITHER		
		uniform intensity/isotropic		**1**
		from era when matter and radiation strongly coupled	1	
		OR		
		temperature of 3K		**1**
		agrees with expected cooling	**1**	**2**
c)	**i)**	E = hf / E = hc/ λ		**1**
		$E = 6.63 \times 10^{-34} \times 3 \times 10^{8} / 1.1 \times 10^{-3}$		**1**
c)	**ii)**	$E = mc^2$		**1**
		$E = 1.7 \times 10^{-27} \times (3 \times 10^{8})^2$		**1**
c)	**iii)**	$(1.53 \times 10^{-10} / 10^{9} \times 1.8 \times 10^{-22})$		**0**
		8.5×10^{2}(ecf from c)i) and c)ii))		**1**
c)	iv)	Any 2 from		
		shorter photon wavelength / universe smaller		**1**
		photon energy greater		**1**
		ratio becomes smaller.	**1**	**2**
				total 15

6	**a)**		all inertial frames equivalent/ laws of physics same in all frames		**1**
			constancy of speed of light		**1**
	b)		any 6 from		
			muons moving at speed near c		**1**
			muons unstable/ decay		**1**
			measure intensity of muons		**1**
			(intensity taken) for two/range of heights		**1**
			increased range/ intensity of muons		**1**
			clocks in muon reference frame slowed		**1**
			further detail	**1**	**6**
			(eg created in upper atmosphere measurements taken on mountain zero intensity anticipated at sea-level speed = 0.99c)		
	c)	**i)**	distance moved by light in one year		**1**
	c)	**ii)**	1 t = 6 / 0.99		**1**
			t = 6.09 y		**1**
			2 $t = t_o / \sqrt{(1 - v^2/c^2)}$ / $t = \gamma t_o$		**1**
			$\sqrt{(1 - v^2/c^2)} = 0.14$ / $\gamma = 7.1$		**1**
			$t_o = 0.14 \times 6 = 0.84$y		**1**
					total 14

For mark scheme for the common question see unit 2825/05.

Mark Scheme 2825/02
January 2007

1	(a)	(i)	W = f x d	(1)
			W = 75 x 9.8 x 0.25	(0)
			W = 180 J (184 J)	(1)
		(ii)	P = W / t	(1)
			P = 184 / 0.85	(0) ecf (i)
			P = 216 W	(1)
		(iii)	eg Some energy is converted into heat in the muscles / or muscles not 100% efficient + ref. to heat	(1)
	(b)		net (clockwise) moment	(1)
			due to c.o.m. acting along a line a large distance from pivot / so toppling	(1)
	(c)		1 each to max. 5	
			knees bent	(1)
			c.o.m. kept over feet / c.o.m. over pivot	(1)
			so no moment due to zero perpendicular distance	(1)
			knees / leg muscles do work / take strain	(1)
			reduced work done by back muscles	(1)
			spine is vertical **(1)** / less stress on the back muscles	(1)
			keep load close to body	(1)
2	(a)	(i)	astigmatism	(1)
		(ii)	curvature of cornea not spherical **(1)** **allow ecf (i)**	
			different focal lengths (or power) in different planes / allow 'blurred' in some planes but not in others	(1)
		(iii)	Fig.2.2 undeviated rays **(1)** Fig.2.3 rays diverge	(1)
	(b)	(i)	1/f or p = 1/u + 1/v	(1)
			substitution **(1)** 55 = 2 + 1/v	
			19 mm **(1)** (18.9 mm)	
		(ii)	substitution	(1)
			57 D	(1)
		(iii)	substitution e.g 57 – 55	(1)
			+ 2 D	(1)
3			one mark for each up to a maximum of 6, eg	
			low intensity light give perception of warmth / calm / quiet	(1)
			high intensity light give the perception of active / exciting / cold	(1)
			red light is a warm colour	(1)
			blue light is a cold colour	(1)
			advertising situation with appropriate colour and intensity	(1)
			eg fast food restaurant	(1)
			uses combination of red and yellow as these are busy colours	(1)
			second different situation	(1)
			extra detail	(1)

4 one mark each up to a maximum of 5, eg
laser boils water content (of cell)
cell shrivels / dies
advantages:
heat cauterises wound
so less bleeding (than conventional surgery)
sterile surgery compared with….
as no direct contact with tissue
finer cut than
shorter recovery time
keyhole surgery / minimal intrusion / shorter hospitalisation

5 **(a)** minimum intensity at which sound is just detected **(1)**

(b) substitution 63 = 10 lg 5 / 10-12 **(1)**
1.995 x 10-6 W m-2 **(1)**

(c) **(i)** substitution / I = k / d2 **(1)**
or k = 3.2 x 10-5
3.1 x 10-8 W m-2 **(1)**

(ii) substitution I.L. = 10 lg (3.1 x 10-8 / 1.0 x 10-12) **(1) ecf (i)**
45 dB **(1)**

(iii) only just detected / just at the threshold **(1)**
comparison with 10-8 W m-2 **(1)**
relevant response eg
would not be heard if any background sound / reflections would increase I.L / ref.
to how to cater for impaired hearing / sound of wind / **(1)**

6 **(a)** (electrostatic) potential **(1)**
kinetic **(1)**
thermal **(1)**

(b) 3.75 x 1017 x 1.4 x 10-14 **(1)**
5250 W **(1)**

(c) ref. to very large quantities of heat generated **(1)**
sensible comment eg target needs high melting point **(1)**
anode made of good conductor **(1)**
oil surrounding target to remove heat **(1)**
rotating anode **(1)**
anode large mass **(1) etc to max. 2**

(d) I = Io e -μx **(1)**
0.5 = e-μx 3.0 **(1)**
μ= 0.23 **(1)** 230
mm –1 **(1)** m-1

(e) eg X-ray is cheaper **(1)**
quicker **(1)**
relatively portable / MRI larger **(1)**
MRI cannot be used if metal implants **(1)**
to max. 2

7 **(a)** direct:
atoms / molecules in DNA are ionised **(1)**
by direct interaction / 'collision' **(1)**
indirect:
free radicals formed / H and OH formed / H_2O_2 formed **(1)**
which then damage the DNA (in chromosomes in the nuclei of cells) **(1)**

(b) kill cell / cancer develops / mutation **(1)**

8 **(a)** **(i)** D = f x X / 60 x 0.050 **(1)**
D = 3.0 **(1)**
J kg^{-1} / Gy **(1)**

(ii) D = (41 to 45) x 0.050 = 2.05 to 2.25 J kg^{-1} / Gy **(1)**

(b) lower energy could reduce absorbed dose for soft tissue / increase dose for bone **(1)**
More absorption in bone so better contrast, (so exposure time could be reduced) **(1)**
Film would have higher efficiency for lower energy, (so exposure time could be reduced further) **(1)**

For mark scheme for the common question see unit 2825/05.

Mark Scheme 2825/03
January 2007

1 **(a)** **(i)** single crystal example; **(1)**
application: eg silicon in integrated circuit / quartz in watch. **(1)**

(ii) amorphous example; **(1)**
application: eg glass as optic fibre: metallic glass as transformer core. **(1)**

[4]

(b) **(i)** each atom/ bubble is surrounded by / in contact with 6 atoms / bubbles. **[1]**

(ii) fault at H or I / f or g OR L or M / h or I **(1)**
Impurity atom / substitution (defect) / interstitial (defect). **(1)**
fault at L or M / h or i OR E or F / f or g; **(1)**
dislocation. **(1)**

[4]

(c) **(i)** ball model shows 3 dimensions / bubble raft only shows 2 dimensions; **(1)**
(ii) bubble raft can show imperfections / ball model cannot show imperfections. **(1)**

[2]

2 **(a)** **(i)** R = V / I = 6.0 / 8.2 x 10-6 = 7.32 x 105 Ω **(1)**
σ = 1 / ρ stated or implied **(1)**
= L / RA **(1)**
= 0.018 / (7.32 x 105 x 0.0075 x 0.0075) = 4.37 x 10-4 Ω-1m-1 **(1)**

[4]

(ii) v = I / nAe = 8.2 x 10-6 / (2.1 x 1016 x 0.0075 x 0.0075 x 1.6 x 10-19) **(1)**
= 43.4 m s-1 **(1)**

[2]

(b) **(i)** Charge carriers / electrons in the valence band are given more thermal energy; **(1)**
so more are able to cross the energy gap (into the conduction band). **(1)**

[2]

(ii) $\ln \frac{n2}{2.1 \times 1016} = 1.28 \times 104 \left(\frac{1}{298} - \frac{1}{303} \right)$ (= 0.709) **(1)**

$\frac{n2}{2.1 \times 1016} = 2.03$ **(1)**

n2 = 4.27 x 1016 m-1 **(1)**

[3]

(iii) (From I = nAve), with no change in drift velocity current would be 4.27 / 2.1 = 2.03 times bigger; **(1)**
For same current p.d. needs to be 6 / 2.03 = 2.95 V. **(1)**

[2]

3 **(a)** **(i)** (At equilibrium separation) attractive force (between atoms); **(1)**
equals repulsive force (between atoms). **(1)**

[2]

(Resultant force is zero - allow 1 mark)

(ii) (Separation varies) because atoms vibrate (about a mean position). **[1]**

(b) **(i)** 1 (Resultant force is attractive) from 0.4 nm to 0.9 nm / above 0.4 nm. **[1]**
2. 0.4 nm. **[1]**

(ii) The energy required is the work done in overcoming the attractive force; **(1)**
Work done = force x displacement (in direction of the force); **(1)**
The shaded area represents this work. **(1) max**

[2]

(iii) 2 mm square represents 1.0 x 10-23 J / cm square represents 2.5 x 10-22 J; **(1)**
Area under graph = 170 - 210 2 mm squares / 7.5 - 8.5 cm squares; **(1)**
Energy in range 1.7 x 10-21 J - 2.1 x 10-21 J **(1)**
[3]

OR equivalent based on triangle approximation)

(iv) Specific latent heat of sublimation is energy calculated in (iii); **(1)**
times the total number of bonds between all the atoms in 1 kg. **(1)**

[2]

4 **(a)** The temperature at which the resistance suddenly drops to zero. **[1]**

(b) **(i)** Completion of table and one point correctly plotted; **(1)**
3 further points correctly plotted; **(1)**
All points correctly plotted with suitable line. **(1)**
[3]

(ii) 1 (Intercept at T2 = zero) Bo in range 0.190 T to 0.198 T; **(1)**
2 (Intercept at B = zero) Tc2 in range 84 (K2) to 90 (K2); **(1)**
Tc in range 9.1 K to 9.5 K. **(1)**

[3]

(c) **(i)** High temperature superconductors have transition temperatures above 50 K / alternative sensible description); **(1)**
Liquid nitrogen needed for cooling to transition temperature. **(1)**
Liquid nitrogen for cooling is cheaper to produce than liquid helium; **(1)**
Cost of maintaining a higher low temperature is less. **(1) max**

[3]

5 **(a)** Sketch to include: Variable frequency A.C source to primary, core, coils; **(1)**
resistor connected to secondary; **(1)**
appropriate meters in primary and secondary circuits; **(1)**
Quantities kept constant: Voltage of source; **(1)**
Primary current / power; **(1)**
Resistance of secondary circuit resistor; **(1)**
Number of turns in both coils; **(1)**
Procedure: Use several frequencies over a wide range / the range available; **(1)**
At each frequency read meters; **(1)**
Table headings to show: meter readings; **(1)**
primary power, secondary power, efficiency. **(1)**
Graph of efficiency against drawn; **(1)**
Details of calculations of power (may use meter readings and value of resistor); **(1)**
Expression for efficiency / % efficiency. **(1) max**

[10]

(b) Energy / heat is lost in core due to hysteresis; **(1)**
Energy / heat loss in 1 cycle is proportional to area of hysteresis loop; **(1)**
Frequency increase reduces efficiency because energy loss (per second) = frequency x area enclosed by hysteresis loop. **(1)**
Energy loss takes place due to heat generated in core by induced / eddy currents; **(1)**
Induced voltage in core increases with frequency / is proportional to frequency; **(1)**
(so) induced current in core increases with frequency / is proportional to frequency. **(1) max**

[4]

6 **(a)** Polar / interatomic bonds in glass absorb photons; **(1)**
This process is a major factor above 1.5 μm; **(1)**
Hydroxyl ions / impurities in glass absorb photons; **(1)**
This process is only significant around 1.4 μm; **(1)**
Photons scattered by Rayleigh scattering / random fluctuations in the density / composition of glass; **(1)**
This process decreases with increasing wavelength. **(1)**
1.5 μm is the wavelength which minimises absorption and scattering processes; **(1)**

[7]

(Accept labelled and annotated graph providing some / all above information.)

(b) (Amount of) scattering is proportional to 1/ λ4 **(1)**

$$\frac{\text{\% of A scattered}}{\text{\% of B scattered}} = \frac{\lambda 4B}{\lambda 4A}$$ **(1)**

$$\lambda 4B = \frac{1.54 \times 5}{10} \quad \lambda = 1.26\ \mu m$$ **(1)**

[3]

For mark scheme for the common question see unit 2825/05.

Mark Scheme 2825/04
January 2007

ADVICE TO EXAMINERS ON THE ANNOTATION OF SCRIPTS

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

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. <u>No comments should be written on scripts unless they relate directly to the mark scheme. Remember that scripts may be returned to Centres.</u>

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, (eg '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.

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)	general shape: crosses axis, reaches turning point; then hits distance axis (not asymptotic);	**1** **1 [2]**
(ii)	marks sections as 'repulsive' and 'attractive', consistent with graph;	**1 [1]**
(iii)	marks crossing point 'X'	**1 [1]**
(b)	at smaller separation / to left of X, force is repulsive; at larger separation / to right of X, force is attractive; either so force always returns neutrons to original separation / is a restoring force **or** at equilibrium separation strong force is zero;	**1** **1** **1 [3]**
(c)	acts only on nearest neighbour / when nuclei are 1 diameter apart; **either** so force holding nucleons/ neutrons together independent of size of nucleus **or** reference to b so distance apart (of nucleons) must be constant; so density of nucleus is independent of size;	**1** 1 **1 [3]** **10**

2 (a)	23992U -> 23993Np + 0-1β / 0-1e + $\bar{\nu}$ allow 23892U + 10n on LHS 23993Np -> 23994Pu + 0-1β / 0-1e + + $\bar{\nu}$ allow neutrino instead of antineutrino omits neutrino altogether - gets 1/2	**1** **1 [2]**
(b)	straight line starts from zero and reaches 1.08 x 1013 at t = 6.0 x 105 s or equivalent	**1 [1]**
(c) (i) **(ii)** **(iii)** **(iv)**	rate of decay increases with time; because rate of decay increases with / is proportional to number of nuclei; (eventually) rate of decay (of $^{239}_{93}Np$) = rate of formation $dN/dt = (-)\lambda N$ equation $\lambda = 0.693 / T_{½}$ so $N = (dN/dt) / \lambda = 1.8 \times 10^7 / (0.693 / [2.04 \times 10^5])$ subs. $= 5.3 \times 10^{12}$ ans. calculation of λ gets 1/3 correctly curved from zero to (5.3×10^{12}) or less	**1** **1 [2]** **1 [1]** **1** **1** **1 [3]** **1 [1]**
(d) (i) **(ii)**	24 000 year remembers $= 24000 \times 3.16 \times 10^7 = 7.58 \times 10^{11}$ s answer starts from origin with zero gradient; approaches line parallel with Np production line, X;	**1** **1 [2]** **1** **1 [2]** **14**

3 (a) (i)	to come to rest simultaneously, total mtm. = 0 *or* AW (but initial mtm. not zero)	1	[1]
(ii)	initial mtm. = $3mu - 2mu = mu$ when closest, mtm. = $(3m + 2m)v$ so $5mv = mu$ (and $v = u/5$)	1 1	 [2]
(b) (i)	initial k.e. = final k.e. + (gain of) p.e.	1	[1]
(ii)	k.e. = $\frac{1}{2}mv^2$ total k.e. = $\frac{1}{2} \times 3mu^2 + \frac{1}{2} \times 2mu^2$ (= $2.5mu^2$) = $2.5 \times 1.67 \times 10^{-27} u^2$ (= $4.18 \times 10^{-27} u^2$) allow $m = 1.66 \times 10^{-27}$ kg for full credit	1 1 1	 [3]
(iii)	gain of p.e. = initial k.e. - final k.e. $\frac{(1.6 \times 10^{-19})^2}{(4\pi \times 8.85 \times 10^{-12} \times 1.5 \times 10^{-15})} = 4.18 \times 10^{-27} u^2 - 4.18 \times 10^{-27} (u/5)^2$ $1.53 \times 10^{-13} = 4.01 \times 10^{-27} u^2$ algebra $u = 6.18 \times 10^6$ m s^{-1} omits $- 4.18 \times 10^{-27} (u/5)^2$, gets $u = 6.06 \times 10^6$ m s^{-1} : 1/2, 1, 1 = 3/4	 2 1 1	 [4] 11

4 (a)	*Either* equation $^{2}_{1}H + ^{3}_{1}H \rightarrow ^{4}_{2}He + ^{1}_{0}n$ (+ energy) (2) *or* $^{2}_{1}H$ fuses with $^{3}_{1}H$ (1) *and* detail eg why the deuterium-tritium reaction was chosen D-T reaction works at lower temperature D-T reaction releases more energy; (1) confinement: by magnetic field(s) (<u>not</u> inertial or gravitational); detail: *either* what produces magnetic field - field coils/ current in plasma *or* ions / nuclei spiral along magnetic field lines; (1) energy supply: pass high current through plasma (1*) causes (ohmic) heating effect (1) radio frequency / RF heating by electromagnetic / radio waves (1*) at (approx.) same frequency as rotation of ions round *B* lines (1) injection of high energy particles: (1*) detail: neutral particles / atoms (*allow* ions) which collide with plasma ions, transferring energy; (1) self-heating of plasma by He nuclei: (1*) (He nuclei have energy from reaction) and transfer it by collision with nuclei (1) high temperatures: (to give nuclei enough kinetic energy) to overcome coulomb barrier / mutual repulsion; to get nuclei close enough for strong force to act; (1) (high temperature) gives nuclei much k.e.; (1) any 2 * marks any (3) other marks	**1** **1** **1** **2** **3**	**[8]**

(b)	(much) greater energy per unit mass of fuel 1* detail: greater change of binding energy / nucleon for fusion than fission (1) no / little radioactive waste 1* detail: by-product is (stable) helium (1) materials in JET structure will not become radioactive over long period (1) tritium has short half-life (and is used anyway) (1) fuel / reactants (virtually) limitless 1* detail: deuterium available from water (1) deuterium easily separated from normal hydrogen (1) lithium is a common material (1) but <u>not</u> tritium is widely available no chance of runaway / meltdown 1* detail: only minute quantities of reactants (in vessel) (1) reaction ceases immediately (temperature falls) (1) any two reasons * @ 1mark+corresponding detail @ 1mark = 2+2 accept other valid answers	4 [4] 12

5 (a)	½ $m v^2$ = $V e$ ½ x 1.67 x 10^{-27} v^2 = 750 x 1000 x 1.6 x 10^{-19} so v = 1.20 x 10^7 m s^{-1} uses electron mass - gives 5.13 × 10^8 m s^{-1} gets 1,0,1 = 2/3 ½ x 1.67 x 10^{-27} v^2 = 750 gets 1,0,0 = 1/3	1 1 1	 [3]
(b)	time interval = $\pi r / v$ = π x 0.382 / (1.20 x 10^7) (= 1.00 x 10^{-7} s)	1 1	 [2]
(c)	no. of times = 750 / 15 = 50	1	[1]
(d)	horizontal steps from 60 correct ΔE steps at each 10^{-7} s, starting at 1.0x10^{-7} s straight line through points gets 0,1,0 = 1/3	1 1 1	 [3]
(e)	Δv increments would decrease with increasing time; *either* because v^2 increases with ΔE or AW; (1) *or* v would increase linearly between steps; (1) any 1	1 1	 [2] 11

6 (a)	$^{236}_{92}U \rightarrow {}^{100}_{40}Zr + {}^{131}_{52}Te + 5\,{}^{1}_{0}n$	**1**	**[1]**
(b) (i)	nucleon number: no change proton number: increases by 1	**1**	**[1]**
(ii)	nucleon number: 100 proton number: 44	**1**	**[1]**
(iii)	5 correct points 4 correct arrows	**1** **1**	**[2]**
(iv)	straight line through / close to 56 / 44 of $1 \le$ gradient < 2 if curved, correct sense	**1**	**[1]**
(c) (i)	reactant mass = 99.895 808 u product mass = 99.891 679 + 0.000 549 (= 99.892 228 u) mass defect = 0.003 580 u	 **1** **1**	**[2]**
(ii)	Δm = 0.003 580 x 1.66 x 10^{-27} (= 5.943 x 10^{-30} kg) $E = (\Delta)mc^2$ = 5.943 x 10^{-30} x $(3.0 \times 10^8)^2$ (= 5.35 x 10^{-13} J) *or* uses 1u = 931 MeV so 0.00358 = 931 × 0.00358 (= 3.33 MeV) (1) = 3.33 × 1.6 × 10^{-13} (= 5.33 × 10^{-12} J) (1)	**1** **1**	**[2]**
(iii)	(anti-)neutrino is also emitted (1) (anti-)neutrino has (some) energy (1) recoiling (niobium) nucleus has (kinetic) energy (1) any 2	**2**	**[2]** **12**

For mark scheme for the common question see unit 2825/05.

Mark Scheme 2825/05
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1 **(a)** Analogue-to-Digital Converter (1) (do not accept ADC)

(b)

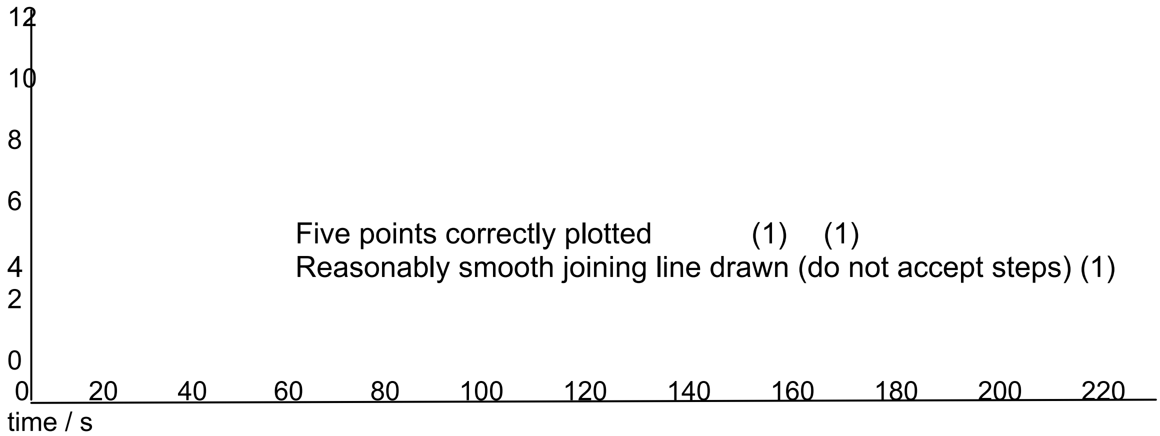
(1)	(1)	(1)	(1)	(1)
0010	1000	1011	1011	1011
time 0	time 60	time 120	time 180	time 240

msb clearly indicated (1)

(1 mark each for first three samples then 1 mark in total for last two)

(c) Digital-to-Analogue Converter (1) (do not accept DAC)

(d)



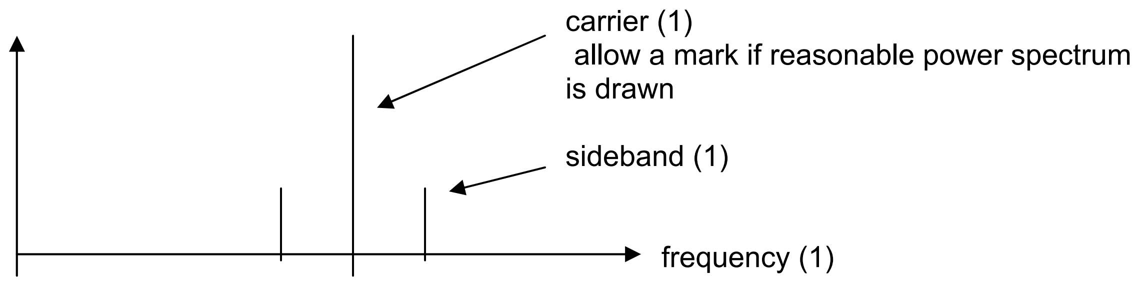
Five points correctly plotted (1) (1)
Reasonably smooth joining line drawn (do not accept steps) (1)

(e) Fig.2.1 shows a temperature rising more slowly than actually (1)
Fig.2.1 shows a rise in temperature from time 0 not from time 40 (1)
Fig.2.1 fails to catch the drop in temperature when the door is opened at 140s (1)
This is because the sampling frequency (1/60 Hz) is far too low to resolve the detail (1)

(f) To catch the rapid drop in temperature at 140 s there should be no longer than 1 or 2 seconds between samples.
So sampling frequency should be about 1 Hz (allow 1Hz to 0.5Hz)
for explanation (1) for frequency (1)

(g) Total number of bits = Number of samples x number of bits per sample
= 241 x 4964
= 964 (1)

2 (a)



Any sensible explanation of carrier (eg RF wave being modulated/controlled/broadcast) (1)
Sidebands are limits in frequency space of modulated carrier (or wtte) (1)

(b) Bandwidth = 2 x 4 = 8 (1) kHz (1) (for unit)

(c) Maximum number of stations = (280 - 140) / 8 (1)

= 17 (1)

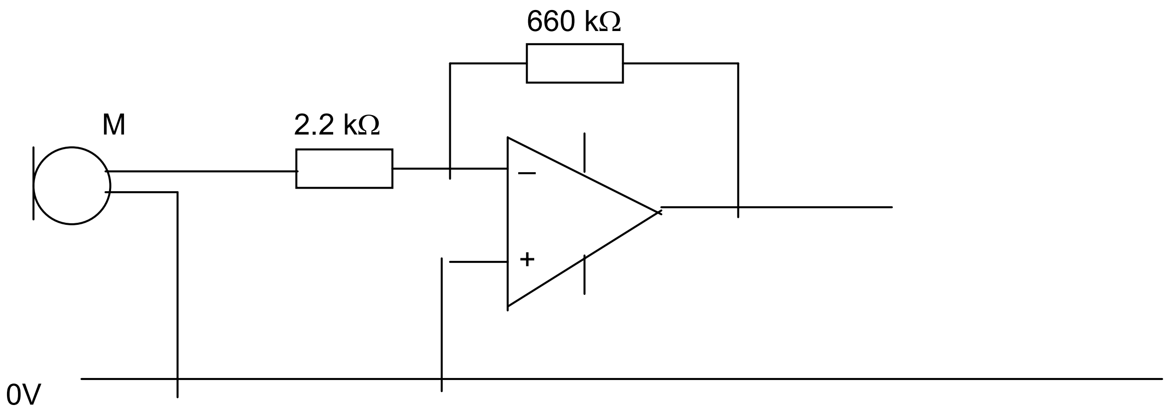
(d) Broadcast quality FM requires a bandwidth of about 180 kHz per station (1)
The available frequency space (140 kHz) would not even accommodate one station (1)

(e) Normal broadcast TV requires an information / signal bandwidth of over 5 MHz (1)
There is thus no way to provide for such frequencies on a carrier much lower than this (1)

3 **(a)** Microphone correctly labelled (1)

(b) Maximum output voltage = ± 14 V (1) (allow ± 13 V to ± 15 V)

(c)



Non-inverting input (+) connected to 0V line	(1)
Input resistor connected to inverting input (-)	(1)
Feedback resistor correctly wired up	(1)
One microphone pin connected to 2.2 kΩ resistor Other microphone pin connected to 0V line	(1)

(d) Voltage gain = 10.5 / 0.035 (1)
= 300 (1)

(e) Feedback resistor = 300 x 2.2 kΩ (1)
= 660 kΩ (1)

Both 660 kΩ feedback resistor and 2.2 kΩ input resistor correctly labelled (1)

4	(a)	p.d. across electromagnet	=	0.2 x 48	(1)
			=	9.6 V (1) < 1% of 1200 V	
	(b)	Cable resistance	≈	1200 / 0.2	(1)
			≈	6000 Ω	
		(more precisely R	=	[1200 - 9.6] / 0.2 = 5952 Ω)	
	(c)	Area of copper	=	ρ L / R	(1)
			=	$1.7 \times 10^{-8} \times 3000 \times 10^{3} / 6000$	(1)
			=	8.5×10^{-6} m^2	(1)
		Diameter	=	$\sqrt{(4 \times 8.5 \times 10^{-6} / \pi)}$	(1)
			=	3.3 mm	
	(d)	Mass of copper	=	$8930 \times 3000 \times 10^{3} \times 8.5 \times 10^{-6}$	(1)
			=	2.28×10^{5} kg (1) (allow ecf using dia.. 3.5mm)	
	(e)	power ratio	=	$10 \lg P_1 / P_2$	
			=	$10 \times \lg (9.6 \times 0.2 / 1200 \times 0.2)$	(1)
			=	- 21 dB	(1)

(ignore absence of negative sign)
(If ratio is given as a power ratio 0.008 then allow 1 mark)

(f) To save on the cost of a return cable / copper was/is expensive
or
Sea water is a very good conductor so no need for return cable (1)

5	(a)		The central core has a higher refractive index than the outer cladding	
			Rays travel slower in core	(1)
			Rays propagate by total internal reflection	(1)
			Along the core	(1)
			As long as angle of incidence of ray is greater than critical angle	(1)
				(any four points)
	(b)	(i)	Ray A at angle in core makes multiple reflections	(1)
			Ray B moves directly parallel without reflecting along core	(1)
		(ii)	Ray C into cladding will gradually lose energy and be lost	(1)
	(c)	(i)	Different rays with different angles of incidence travel by different paths Some path lengths are longer than others All rays travel at same speed Rays take different times to propagate through the core Any pulse is composed of many rays each taking a different time Any pulse input becomes stretched in time on output Thus high frequency pulses will eventually smear into one another And coded information / signal will be lost Any sensible comment on material dispersion	
				(any five points)
		(ii)	Monomode fibre has a tiny diameter core (in order of 10 μm) Only direct rays can travel along core No multipath dispersion occurs Pulses keep in time and do not smear into each other	
			Monomode fibres allow much higher frequency of pulse transmission Higher frequency means greater bandwidth / information carrying capacity Higher bandwidth means greater scope for time-division multiplexing This reduces the cost per user So telephone system is affordable by all	
				(any four points)

6 **(a)** Mean time of flight = (14.8 + 17.2 + 15.6) / 3 = 15.87 s (1)
Maximum speed = 240 / 15.87 = 15.12 m s^{-1} (1)

(b) **(i)** To produce a vector at 45^o the horizontal and vertical components must be equal
And the 15 ms^{-1} horizontal component does not change with time (1)

(ii) Vertically, the time of flight is given by 15 = 0 + 9.81 x t
Thus t = 1.53 s (1)

Vertical fall y = ut + ½ at^2

= 0 + ½ 9.81 $(1.53)^2$ = 11.47 m (1)

(Allow 1 mark for correct substitution in any appropriate formula and allow 1 mark for correct calculation of 11.47m)

(iii) Horizontal jump x = ut + ½ at^2
= 15 x 1.53 + 0 = 22.95 m (1)

(iv) Resultant velocity = 15 / Cos 45 = 15 x √2 = 21.2 ms^{-1}
(1)

Kinetic Energy = ½ mv^2 = ½ x 86 x 21.2^2
(1)
= 19350 J (1)

or KE at ramp = KE on take off + PE lost through fall of 11.47m = 19350J

(Allow 1 mark for KE = ½ mv2 1 mark for correct use of 15m s-1 and 1 mark for correct calculation of KE)

(c) **(i)** At top of loop, the centripetal force = mv^2 / r (1)
= mg (1)

Thus speed at top v = √gr

= √9.81 x 9.17 / 2
(1)
= 6.7 ms^{-1}

or use an energy argument KE on entry = PE gained + KE at top

(1 mark for idea, 1 mark for correct substitution in appropriate formula and 1 mark for correct calculation of 6.7 ms^{-1})

(NOTE The unexplained use of $v^2=u^2$ + 2gs can only score a maximum of 1 mark)

(ii) Kinetic Energy at top = ½ x 86 x 6.7^2 (1)
= 1935 J (1)
Potential Energy at top = 86 x 9.81 x 9.17 (1)
= 7740 J (1)

(iii) Kinetic Energy on entry = ½ x 86 x 15^2
= 9675 J (1)
Sum of energies at top = 1935 + 7740
= 9675 J .... QED (1)

(iv) Any reference to loss of contact / centripetal force or wtte (1)
Comment on the consequences of taking off vertically or wtte (1)

Enacting the suggestion could result in disaster
At the point A in the loop, the velocity vector is purely vertical
Therefore there is no horizontal component of velocity
So no matter how fast the cyclist is travelling he will only be projected vertically
And come (crashing?) down on the same point where he left off
The best that could happen (with some skill) is to return back along same path

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1 (a) (i) V = πr2l = x 202 x15 **[1]**
= 18 800 m3 (75 400 allow ½) **[1]{2}**

(ii) mass = 18 800 x 1.3 = 24 500 kg **[1]{1}**

(iii) ½mv2 with m from (ii) and v = 15 m s-1 **[1]**
= 2.76 x 106 (J) **[1]{2}**

(iv) recognises that this is 60% of previous figure **[1]**
= 0.6 x 2.76 x 106 = 1.65 x 106 W **[1]{2}(7)**

(b) (i) 30% of (a)(iv) = 0.3 x 1.65 x 106 W = 4.95 x 105 W (500 000) **[1]{1}**

(ii) 1000 /½ = 2000 **[1]{1}(2)**

(c) (i) eg no production of CO2 **[1]{1}**

(ii) eg there may be days when there is little wind **[1]**
relate demand to supply eg on a (cold) day when there is high demand **[1]{2}(3)**

(d) (i) eg lower efficiency
more air is 'lost' between the blades
more K.E. of wind after passing blades
more vibration of blades
MAXIMUM 2 for one idea well explained **[2]{2}**

(ii) danger of breaking up **[1]{1}**

(iii) huge numbers of turbines would be required
conventional stations still required for base load
environmental problems
longer supply lines needed as wind turbines will be in out of the way places
(2) for main argument and explanation (1) for extra different detail **[3]{3}(6)**

TOTAL (18)

2 (a) (i) Q = It with knowledge of what the symbols mean **[1]**
= 0.050 x 4.0 x 3600 **[1]**
= 720 (C) **[1]{3}**

(ii) E = QV with knowledge of what the symbols mean **[1]**
= 720 x 6.0 = 4320 (J) **[1]{2}(5)**

(b) chemical (potential) (energy) **[1]{1}(1)**

(c) (i) I = 4.0/48 = 0.5/r (ie by proportion or by finding current) **[1]**
r = 24/4 = 6 (Ω) **[1]{2}**

(ii) E = V2t/R with knowledge of what the symbols mean **[1]**
= 4.02 x 2700 / 48 **[1]**
= 900 (J) **[1]{3}**

(iii) 900/4320 = 5/24 = (0.208) **[1]{1}(6)**

(d) because the p.d. across it (4.5 – 4.0) is known only to 1 sig.fig. **[1]{1}(1)**

TOTAL 13

3 (a) tyre pushes backwards on the road **[1]**
Newton's third law therefore gives an equal and opposite force on a different body **[1]**
this is the force the road exerts on the tyre **[1]**
motion here could be no relative motion between tyre and road **[1]**
larger forward force than drag therefore acceleration takes place **[1]{3}(3)**

MAXIMUM (3)

(b) the equal forces act on different objects **[1]**
example and/or clarification eg when an apple is falling the force the Earth exerts on the apple equals the force the apple exerts on the Earth **[1]**
this force causes an appreciable acceleration of the apple but negligible acceleration of the Earth **[1]{3}(3)**

(c) diagram does not show the movement of particles (in direction across tube) **[1]**
distance across tube is a measure of the displacement of particles along tube **[1]{2}(2)**

(d) on open circuit (infinite resistance so) current zero so V x I = 0 **[1]**
when shorted, resistance is zero so I2R is zero **[1]{2}(2)**

(e) the astronaut is accelerating / has centripetal acceleration **[1]**
and the space station has the same acceleration **[1]**
a person does not feel gravity **[1]**
only feels forces applied by contact with the walls of the space station **[1]**
no support force from the space station (as they have the same acceleration) **[1]{4}(4)**

MAXIMUM (4)
TOTAL 14

4 **(a)** speed = 3.00 x 108 (m s-1) **[1]{1}(1)**

(b) **(i)** wavelength = eg 0.124(±0.002)/3 = 0.041 (m) **[1]{1}**

(ii) frequency = c/λ = 3.00 x 108 / 0.041 **[1]**
= 7.3(2) x 109 Hertz or Hz **[1]{2}**

(iii) allow microwaves or radio waves **[1]{1}(4)**

(c) **(i)** both 49 cm **[1]{1}**

(ii) phase difference will be zero **[1]**
so amplitude of resultant wave will be a maximum **[1]{2}**

(iii) DABC = 80 cm, DC = 18 cm **[1]{1}**

(iv) path difference = 62 cm, which is 15½ wavelengths **[1]**
so waves arrive (π radians) out of phase **[1]**
so cancellation (may) take(s) place **[1]{3}**

(v) large signal from transmitter would swamp (reflected) weak signals **[1]**
unless they arrived at different times **[1]**
this cancels out the strong signal **[1]**
but allows the weak signal through **[1]**
strong signal could damage the receiver **[1]{3}(10)**

MAXIMUM 3
TOTAL 15

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1 (b) (ii) Extension

Reading for y_0. One mark. **[2]**
$y - y_0$ calculated correctly. One mark.

(c) Readings **[3/2/1/0]**
Write the number of readings as a ringed total by the results table.
6 sets of values for m and x ($x \neq 0$) scores one mark.
Check a value for lg(m/g) and a value for lg(x/cm). Underline checked values.
Ignore small rounding errors. Tick if correct and score one mark.
If incorrect then write in correct values; ln values will not score this mark.
Readings should include raw values for length y; tick head of column and score one mark.
If help is given then –1.
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.

(c) Quality of results. **[2]**
Judge by scatter of points about the line of best fit.
Five or six good trend plots, with little or no scatter. Two marks.
Some scatter, within a couple of small squares for a full size graph. One mark.
Large scatter/no trend scores zero.
These marks cannot be scored if lg m or lg x values have been miscalculated (but accept ln values).

(c) Column headings. One mark for m, one mark for x and/or y. **[2]**
The columns for m and y (and/or x) must be headed with a quantity and a unit.
There must be some distinguishing mark between the quantity and its unit.
eg 'm/g' or 'm(g)' or 'm in g' or 'mass in grams' are all allowable;
'm g' or '(m) g' or 'mg' or 'g' (on its own) are not allowable.
Please tick each correct column heading to show that it has been seen.
Ignore the column headings for lg(m/g) and lg(x/cm).

(c) Consistency of raw readings in the table of results. **2/1/0]**
Apply to m and y (and/or x) only. One mark for m, one mark for x and/or y.
All raw readings of a particular quantity must be given to the same number of decimal places. Do not allow an unreasonable degree of precision to be given which is inconsistent with the apparatus used.
Indicate using ✓C at the foot of each column of raw readings if correct.
m must be to the nearest gram; y and x must be to the nearest mm.

(d) (i) Axes **[2/1/0]**
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 (eg 3:10, 6:10, 7:10, 8:10 etc).
One mark for each correct axis.
Axes inverted, lose a mark.

(d) (i) Plotting of points. **[1]**
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 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 plot should have been.
Allow errors up to and including half a small square for this mark.

(d) (i) Line of best fit. **[1]**
There must be a reasonable balance of points about the line of best fit.
If one of the plots is a long way from the trend of the other plots then allow this plot to be ignored when the line is drawn.
This mark can only be awarded if a straight line is drawn through a linear trend.
Do not credit thick (≥ 1 mm) or “hairy” lines.

(d) (ii) Measurement of gradient. **[2]**
The hypotenuse of the triangle must be greater than half the length of the drawn line. One mark.
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 by labelling with Δ.
If the triangle is of an appropriate size then ✓Δ.

(e) lg m = lg k + n lg **x** **[1]**
(Allow ln m = ln k + n ln x)

(e) Value of n (from gradient) **[1]**

(f) (i) Use of micrometer **[1]**
Micrometer screw gauge readings for b and d.
Both must be within ±0.20 mm of SV
Raw values must be given to 2 d.p. , ie to 0.01 mm.

(f) (ii) Calculation of A **[2]**
Correct calculation 4 (b x d), to be checked. One mark.
Conversion of units, ie x 10-6. One mark. This mark is only to be awarded if the physics is correct ie b x d is in the calculation.

(f) (iii) Largest percentage uncertainty in b. **[2/1/0]**
One mark for sensible Δb (0.05 or 0.1 mm)
One mark for correct ratio idea, and x100. No need to check calculation.
If repeats done then Δb can be half the range.

(f) (iv) Use of correct formula, stress = mg/A and calculation correct, to be checked. One mark. **[4/3/2/1/0]**
(Do not allow g = 10N kg-1 since g = 9.8 N kg-1 is given at start)
ecf for incorrect values of A.
Correct units, Pa or N m-2. One mark.
Answer to 2 or 3 sf. One mark
Assumption that cross-sectional area hasn’t changed, one mark

28 marks in total.

2

(b)	Recording of times.	**1**
(c)	Determination of time interval and correct method for calculation of rate. (rate = $5/\Delta t$)	**1**
(d)	Justification of number of sf in R_1 ie same sf as $\Delta\theta$ (allow "raw data" ideas). Do not allow dp ideas. Answers must be consistent with c(ii).	**1**
(e)	Calculation of R_2, which must be less than R_1. Check calculation.	**1**
(f)	One mark for correct calculation of both average excess temperatures. One mark for calculation of k's, or using ratios. One mark for conclusion that $d\theta/dt$ is proportional to θ_{excess} with explanation (only if k values are within about 10% of each other). OR, if k values are not within 10%, conclusion that $d\theta/dt$ is not prop. to θ_{excess}. One mark.	**3/2/1/0**
(g)	Evaluation of procedure. Relevant points must be underlined and ticked. Some of these might be: [P = problem S = solution] P. Difficult to read thermometer accurately when temperature is changing/difficult to read time and temperature simultaneously P. Difficult to read stop clock without stopping it/human error S. Use a helper/clamp stand for thermometer/use of video S. Time individual temperature drops separately. S. Repeat set of readings, and <u>average</u>. S. Sensor attached to thermometer bulb + data logger P. Results affected by draughts. S. Close doors and windows / use some sort of shielding. P. Two readings are not enough to draw a conclusion. S1. Several/many sets of values of t and $\Delta\theta$ are needed, to draw a <u>graph</u> of R against $\Delta\theta$ S2. Plot a graph of temperature against time, measure the gradient at various temps, (then plot gradients against θ_{excess}). P. At higher/lower temps 5°C difference is too small/large. S. Have larger/smaller values for temperature difference. Allow other relevant points (7 maximum)	**7**
	2 marks are reserved for quality of written communication. **16 marks** maximum to be awarded.	**2**

	Planning Exercise	
A1	Diagram showing workable arrangement of apparatus, eg plastic strip clamped at each end (not tied).	1
A2	Labelled load and how extension is measured. Penalise incorrect measurement of extension here, not in A1.	1
A3	Workable method. Measure m and x, change m and repeat.	1
B1	Labelled sketch graph of load/extension (or stress/strain), with correct shape for plastic, ie elastic region briefly linear then slightly curved, no clear yield point.	1
B2	Failure labelled on graph.	1
C1	Measure thickness, with a micrometer.	1
C2	Area A = width x thickness, and load F = mg (or use newton weights).	1
C3	Young modulus = (load/A) / (x/l) - usual meanings. Must be obtained from gradient of linear part of stress / strain graph or load / extension graph	1
D1	Ideal properties looked for by manufacturers might be : large failure stress (or large failure load together with being as thin as possible) biodegradeable. YM not too small, so that the plastic doesn't stretch too much. toughness/ ability to resist tearing. (not 'inexpensive', not just 'strong', not just 'not brittle'	2/1/0
D2	Any further relevant detail, eg Evidence of preliminary experiment. Measure thickness of several layers of plastic. Care to cut out the sample accurately with parallel sides. Safety, eg secure clamp stand to bench / something to catch falling masses after failure. Not goggles. Discussion of 'grain' structure of the plastic. Direction of stretch important. Other good points	2/1/0
R	Evidence of research of material. ie at least two detailed references have been given (i.e chapter and/or page numbers must be given). Allow internet pages to be sourced. Two or more vague references (ie no chapter or page reference) score one mark One detailed reference scores one mark. One vague reference scores zero.	2/1/0
	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 (eg ✓A1).	
Q	Quality of written communication (organisation) Rambling and poorly presented material cannot score both marks.	2

Total 16

Advanced GCE Physics A 3883/7883
January 2007 Assessment Series

Unit Threshold Marks

Unit		Maximum Mark	a	b	c	d	e	u
2821	Raw	90	43	38	33	28	24	0
	UMS	90	72	63	54	45	36	0
2822	Raw	90	49	44	39	34	29	0
	UMS	90	72	63	54	45	36	0
2823A	Raw	120	96	85	74	64	54	0
	UMS	120	96	84	72	60	48	0
2823B	Raw	120	96	85	74	64	54	0
	UMS	120	96	84	72	60	48	0
2823C	Raw	120	93	84	75	66	57	0
	UMS	120	96	84	72	60	48	0
2824	Raw	90	62	55	48	41	35	0
	UMS	90	72	63	54	45	36	0
2825A	Raw	90	66	59	52	46	40	0
	UMS	90	72	63	54	45	36	0
2825B	Raw	90	66	59	52	46	40	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	64	56	48	41	34	0
	UMS	90	72	63	54	45	36	0
2825E	Raw	90	64	57	50	44	38	0
	UMS	90	72	63	54	45	36	0
2826A	Raw	120	89	80	71	62	53	0
	UMS	120	96	84	72	60	48	0
2826B	Raw	120	89	80	71	62	53	0
	UMS	120	96	84	72	60	48	0
2826C	Raw	120	86	79	72	65	59	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	18.9	36.6	58.1	77.0	94.0	100.0	278
7883	21.7	45.7	69.6	87.0	95.7	100.0	54

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

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