

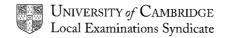
GCE ADVANCED SUBSIDIARY LEVEL AND ADVANCED LEVEL

MARK SCHEME

MAXIMUM MARK: 40

SYLLABUS/COMPONENT: 9702/01

PHYSICS
Paper 1 (Multiple Choice (AS))



Page 1	Mark Scheme	Syllabus	Paper
	A/AS LEVEL EXAMINATIONS - JUNE 2003	9702	01

Question Number	Key	Question Number	Key
1	В	21	В
2	В	22	D
3	В	23	В
4	Α	24	D
5	С	25	С
6	В	26	В
7	С	27	С
8	С	28	С
9	D	29	В
10	D	30	С
11	В	31	Α
12	Α	32	В
13	D	33	В
14	В	34	В
15	Α	35	С
16	С	36	D
17	С	37	В
18	D	38	С
19	В	39	В
20	Α	40	D



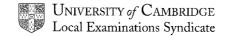
GCE ADVANCED SUBSIDIARY LEVEL AND ADVANCED LEVEL

MARK SCHEME

MAXIMUM MARK: 60

SYLLABUS/COMPONENT: 9702/02

PHYSICS
Paper 2 (Structured Questions (AS))



Page 1	Mark Scheme	Syllabus	Paper
	A/AS LEVEL EXAMINATIONS - JUNE 2003	9702	02

Categorisation of marks

The marking scheme categorises marks on the MACB scheme.

B marks: These are awarded as <u>independent</u> 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 answer.

M marks: These are <u>method</u> 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 answer. If a candidate fails to score a particular M-mark, then none of the dependent A-marks can be scored.

C marks: These are <u>compensatory</u> 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 he/she knew the equation, then the C-mark is awarded.

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

Conventions within the marking scheme

BRACKETS

Where brackets are shown in the marking scheme, the candidate is not required to give the bracketed information in order to earn the available marks.

UNDERLINING

In the marking scheme, underlining indicates information that is essential for marks to be awarded.

Page 2	Mark Scheme	Syllabus	Paper
•	A/AS LEVEL EXAMINATIONS - JUNE 2003	9702	02

1		kg m ⁻³ B1 frequency or count rate or activity or decay constant B1 NC ⁻¹ or V m ⁻¹ or kg m s ⁻² C ⁻¹ etc. B1 momentum or impulse. B1 (Allow solidus notation and non SI units)	[4]
2 (a)	(i)	distance from a (fixed) point	
	(ii)	(displacement from start is zero if) car at its starting position B1	[3]
(b)	(i)1	$v^2 = u^2 + 2as$ $28^2 = 2 \times a \times 450$ (use of component of 450 scores no marks)C1 $a = 0.87 \text{ m s}^{-2}$	[2]
	(i)2	v = u + at or any appropriate equation 28 = 0.87 t or appropriate substitution	[2]
	(i)3	$E_k = \frac{1}{2}mv^2$	[2]
	(i)4	$E_p = mgh$	[3]
	(ii)	power = energy/time	[3]
	(iii)	some work also done against friction forces	[2]
3 (a)	(i)	ductileB1	
	(ii)1	L shown at end of straight lineB1	
	(ii)2	reciprocal of gradient of straight line region B1	[3]
(b)	(i)1	circumference = 3π cm or arc = $r\theta$	
	(i)2	strain = extension/length	[4]
	(ii)	stress = force/area	[3]

Page 3		3	Mark Scheme	Syllabus	Paper
			A/AS LEVEL EXAMINATIONS - JUNE 2003	9702	02
		(iii)	Young modulus = stress/strain = $(7.44 \times 10^7)/(6.8 \times 10^{-4})$ = $1.1 \times 10^{11} \text{ Pa}$		[2]
		(iv)	remove extra load and see if pointer returns to original wire returns to original length	-	[1]
4 ((a)		e.g. both transverse/longitudinal/same type meet at a point, same direction of polarisation, etc1 each, max 3 (allow 1 mark for any condition for observable interfer		[3]
((b)	(i)1	allow 0.3 mm \rightarrow 3 mm	B1	
		(i)2	$\lambda = ax/D$ (allow any subject)	B1	
		(ii)1	separation increasedless bright		
		(ii)2	separation increasedless bright		
		(ii)3	separation unchangedfringes brighterfurther detail, i.e quantitive aspect in (ii)1 or (ii)2(in (b), do not allow e.c.f. from (b)(i)2)	B1	[7]
5 ((a)	(i)	resistance = V/I = $6.0/(40 \times 10^{-3})$ = 150Ω (no marks for use of gradient)		
		(ii)	at 8.0 V, resistance = 8.0/(50 x 10^{-3}) = 160 Ω		[4]
((b)	(i)	straight line through originpasses through $I = 40 \text{ mA}$, $V = 8.0V$		
		(ii)	current in both must be 40 mA e.m.f. = 8.0 + 6.0 = 14.0 V		[4]
6 ((a)	(i)	curve is not smooth, fluctuations, etc	B1	
		(ii)	curve is same shape or same half-life, not affected by etc		[2]
((b)	(i)	134	B1	[1]
		(ii)	α -particle shown as 4_2 He or as ${}^4_2\alpha$	B1	

[3]



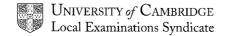
GCE ADVANCED SUBSIDIARY LEVEL AND ADVANCED LEVEL

MARK SCHEME

MAXIMUM MARK: 25

SYLLABUS/COMPONENT: 9702/03

PHYSICS Paper 3 (Practical (AS))



			AAS LEVEL EARININATIONS - SOINE 2003 5702	UJ
1	(a)	(iv)	% uncertainty in $ heta$	2/1/0
			Accept $\Delta \theta$ to $\pm 1^{\circ} \pm 2^{\circ}$ (1 mark)	
			Ratio and percentage ideas correct (1 mark)	
	(d)	(i)	Measurements	3/2/1/0
	` ,	•	Expect to see at least 6 sets of results (1 mark)	
			Less than 6 sets does not score this mark Check a value of T^4 . Underline checked value and tick if correct	
			(1 mark)	
			Ignore small rounding errors. This mark cannot be awarded if there	
			are no raw times, number of oscillations measured in a fixed time, or	
			the stopwatch has been misread. If there is no record of the number of oscillations then this mark cannot be scored	
			It may be necessary to refer to page 3 of script for a value of n	
			Check a value for $\cos \theta$. Underline checked value and tick if correct	
			(1 mark)	
			Ignore small rounding errors. Expect to see a correct sign If either incorrect, write in correct value and -1 eeoo	
			Minor help given by Supervisor, -1. Major help, then -2	
	(d)	(i)	Repeated readings	1
	()	(-)	For each value of θ there must be at least two values of t	-
			An average value does not have to be calculate	
	(al\	<i>(</i> :)	At least 10° between the readings of θ	1
	(d)	(i)	•	
	(d)	(i)	Quality of results	2/1/0
			Judge by scatter of points about Examiner line of best fit 6 reasonable trend plots with little scatter (2 marks)	
			5 trend plots, or some scatter of plots (1 mark)	
			Large scatter/no trend/wrong quantities plotted (zero)	
	(d)	(i)	Column headings	1
			Check the 1/T ⁴ column heading only Quantity and unit (s ⁻⁴) must be correct	
			Quantity and unit (\$) must be correct	
	(d)	(i)	Consistency	2/1/0
			Apply to raw values of θ and t only (one mark each)	
			Values of $ heta$ must all be given to the nearest degree. Do not allow	
			tenths of a degree Values of <i>t</i> must all be given to the nearest 0.1 s or 0.01 s	
			Do not apply to average values	
	(d)	(ii)	Justification of number of sf in $\cos \theta$	1
	()	(/	Answer must relate sf in θ to sf in $\cos \theta$	·
			Do not allow answers in terms of decimal places	
			Do not allow vague answers that are given in terms of 'raw data'	
	(e)	(i)	Axes	1
			Scales must be such that the plotted points occupy at least half the graph grid in both the x and y directions (i.e. 4 x 6 in portrait or 6 x 4	
			in landscape)	
			Axes must be labelled with the <u>quantity</u> plotted. Ignore units. Do not	
			allow awkward scales or gaps of more than three large squares between the scale markings	
			2025	

Syllabus 9702 Paper 03

Page 2		Mark Scheme	Syllabus	Paper
		A/AS LEVEL EXAMINATIONS - JUNE 2003	9702	03
(e)	(i)	Plotting of points Check a suspect plot. Circle and tick if correct. If incorrect correct position with arrow, and -1. Work to half a small subservations must be plotted		1
(e)	(i)	Line of best fit There must be a reasonable balance of points about the fit There must be at least 5 plots on the grid for this mark to Do not allow a straight line to be drawn through a distinct Allow an acceptable curve through a curved trend of point	be awarded curve trend	1
(e)	(ii)	Determination of gradient Hypotenuse of Δ used must be greater than half the leng drawn line Check the read-offs and ratio. Read-offs must be accura small square Do not allow this mark if a curve has been drawn		1
(e)	(ii)	y-intercept The value must be read to half a small square Do not allow this mark if a curve has been drawn		1
(f)		A = candidate's value of gradient		1
(f)		B = candidate's value of intercept		1
(f)		Unit of A and B both correct (s ⁻⁴)		1
(g)		Measurement of L The value should be in the range 40 cm \pm 2 cm. Can be the working It may be necessary to refer to the Supervisor's Report	implied in	1
(g)		Correct method of working to give a value for g in range g 11.0 m s ⁻² A POT error anywhere in the working will not score this n		1
(g)		Sf in g Allow 2 or 3 sf only. Apply to any value given A bald value with no working cannot score this mark		1
(g)		Unit of g correct (and consistent with other measurement. There must be a numerical value of g for this mark to be A bald value with no working cannot score this mark.		1
		25 marks in total		





GCE ADVANCED SUBSIDIARY LEVEL AND ADVANCED LEVEL

MARK SCHEME

MAXIMUM MARK: 60

SYLLABUS/COMPONENT: 9702/04

PHYSICS
Paper 4 (Structured Questions (A2 Core))

Page 1	Mark Scheme	Syllabus	Paper
	A/AS LEVEL EXAMINATIONS - JUNE 2003	9702	04

Categorisation of marks

The marking scheme categorises marks on the MACB scheme.

B marks: These are awarded as <u>independent</u> 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 answer.

M marks: These are <u>method</u> 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 answer. If a candidate fails to score a particular M-mark, then none of the dependent A-marks can be scored.

C marks: These are <u>compensatory</u> 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 he/she knew the equation, then the C-mark is awarded.

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

Conventions within the marking scheme

BRACKETS

Where brackets are shown in the marking scheme, the candidate is not required to give the bracketed information in order to earn the available marks.

UNDERLINING

In the marking scheme, underlining indicates information that is essential for marks to be awarded.

			A/AO LLYLL LAAMINA HONO - JOHL 2003	3102	7 T
1	(a)		work done in bringing/moving unit massfrom infinity to the point(use of 1 kg in the definition – max 1/2)		[2]
	(b)		potential at infinity defined as being zero	B1	[3]
	(c)	(i)	φ = -GM/R change = 6.67 x 10 ⁻¹¹ x 6.0 x 10 ²⁴ x({6.4 x 10 ⁶ } ⁻¹ - {1.94 x 1 change = 4.19 x 10 ⁷ J kg ⁻¹ (ignore sign)	C2	
		(ii)	$\frac{1}{2}mv^2 = m\Delta\varphi$		[6]
					[5]
2	(d) (a)		acceleration is not constant	B1	[1]
			(-1 for each error or omission)	B2	[2]
	(b)		heat lost by liquid gold = $0.95m \times 129 \times \Delta T$ heat gained (silver) = $0.05m \times 235 \times (1340 - 300) + 0.05m \times 1050 \times 122.5m \Delta T = 17.470m$	5 000C1, C1	
			Δ <i>T</i> = 143 Ktemperature = 143 + 1340 = 1483 K		[5]
	(c)		e.g. thermocouple/resistance thermometer	B1	[1]
3	(a)		f_0 is at natural frequency of spring (system)		[2]
	(b)		line: amplitude less at all frequencies peak flatter peak at f_0 or slightly below f_0	B1	[3]
	(c)		(aluminium) sheet cuts the magnetic flux/field	B1 M1	
			less energy available for the oscillations	A0	[4]
4	(a)		field causes forces on the electrons	A1	[3]
	(b)	(i)	$E = Q/4\pi\epsilon_0 r^2$	C1 C1 A1	[3]

Syllabus 9702 Paper 04

Page 3	Mark Scheme	Syllabus	Paper
	A/AS LEVEL EXAMINATIONS - JUNE 2003	9702	04

		(ii)	$V = Q/4\pi\varepsilon_0 r$		
		()	= $(9.8 \times 10^{-6})/(4\pi \times 8.85 \times 10^{-12} \times 0.21)$	C1 \1	[2]
	(c)		e.g. sphere not smooth, humid air, etc	31	[1]
5	(a)		centripetal force = mv^2/r	31 31	[3]
	(b)		$r_{\alpha}/r_{\beta} = (m_{\alpha}/m_{\beta}) \times (q_{\beta}/q_{\alpha})$	C1 A2	[3]
	(c)	(i)	r_{α} = (4 x 1.66 x 10 ⁻²⁷ x 1.5 x 10 ⁶)/(1.2 x 10 ⁻³ x 2 x 1.6 x 10 ⁻¹⁹) = 25.9 m	\ 2	
		(ii)	r_{β} = 25.9 x 3.64 x 10 ³ = 7.13 x 10 ⁻³ m	\1	[3]
	(d)	(i)	deflected upwards		
		(ii)	opposite direction to α -particle and 'through side'	31	[3]
6	(a)		greater binding energy gives rise to release of energy		[2]
	(b)		probability of decay		[2]
	(c)	(i)1	A = λ N	21	[3]
		(i)2	mass = $0.09 \times (4.67 \times 10^{15})/(6.02 \times 10^{23})$	C1 A1	[2]
		(ii)	$A = A_0 e^{-\lambda t}$ $A/A_0 = e^{-0.025t}$ = 0.88	C1 A1	[2]



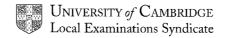
GCE ADVANCED SUBSIDIARY LEVEL AND ADVANCED LEVEL

MARK SCHEME

MAXIMUM MARK: 30

SYLLABUS/COMPONENT: 9702/05

PHYSICS Paper 5 (Practical (A2))



1	(a)	(v)	Measurements	3
			6 sets of readings (<i>I</i> ≠ 0) scores 1 mark Allow more than 6 sets without penalty Write the number of readings as a ringed total by the table	
			Choose a row in the table Check a value for tan <i>θ</i> . Tick if correct and score 1 mark	
			If incorrect, write in correct value and do not award the mark	
			Ignore small rounding errors	
			All values of θ < 90° score 1 mark	
			Minor help from the Supervisor -1. Major help, then -2 If help has been given then write SR at the top of the front page of the script, and give a brief explanation of the type of help that has been given by the table of results	
	(a)	(v)	Repeats	1
	(-,	()	Expect to see at least two sets of readings for θ , with an average	
			calculated	
			Do not award this mark if all the results are the same	
	(a)	(v)	Quality of results	2/1/0
			Judge by scatter of points about the line of best fit 6 trend points with little scatter scores 2 marks	
			5 trend points with little scatter scores 1 mark	
			Shallow curve can score 1 mark	
			4 trend points only scores zero Wrong trend or 'impossible results' cannot score these marks	
	(a)	(v)	Column headings	1
	()	()	Apply to the current column only There must be some distinguishing mark between the quantity and the unit	
			Allow I/A , $I(A)$ or I in A	
	(a)	(v)	Consistency	2/1/0
			Apply to both θ and I All values of θ must be given to the same number of d.p.	
			Allow θ to be given to the nearest half degree or nearest degree	
			All values of <i>I</i> must be given to the same number of d.p. (0.1 A or 0.01 A)	
			Do not accept values to the nearest Ampere or milliampere	
	(a)	(vi)	Justification of sf in tan $ heta$	2/1/0
			Answer must relate the number of sf in $ heta$ to the number of sf in $ heta$	
			Do not allow answers in terms of decimal places 'Raw data' ideas can score 1 mark	
	(b)	(i)	Axes	1
			The axes must be labelled with the quantities plotted Ignore units on the axes	
			The plotted points must occupy at least half the graph grid in both	
			the <i>x</i> and <i>y</i> directions (i.e. 4 large squares in the <i>x</i> -direction and 6	
			large squares in the <i>y</i> -direction) Do not allow more than 3 large squares between the labels on an axis	
			Do not allow awkward scales (e.g. 3:10, 6:10, etc.)	

Syllabus 9702 Paper 05

		7.7.10 == 1 == 2.0	
(b)	(i)	Plotting of points All the observations must be plotted Count the number of plots and ring this total on the grid Do not allow plots in the margin area Check one suspect plot. Circle this plot. Tick if correct. If incorrect, mark the correct position with a small cross and use an arrow to indicate where the plot should have been, and -1. Allow errors up to and including half a small square	1
(b)	(i)	Line of best fit Only a drawn straight line through a linear trend is allowable for this mark This mark can only be awarded for 5 or more plots on the grid There must be a reasonable balance of points about the drawn line Do not allow a line of thickness greater than half a small square	1
(b)	(ii)	Gradient Ignore any units given with the value Hypotenuse of Δ must be > half the length of line drawn Check the read-offs. Work to half a small square. $\Delta x/\Delta y$ gets zero Values taken from the table that lie on the line to within half a small square are acceptable Do not award this mark if a curve has been drawn	1
(c)		k = candidate's gradient	1
(c)		Unit of k (i.e. A^{-1})	1
(c)		SF in k Allow 2 or 3 sf only	1
(d)	(i)	Value of θ when I = 15 A Method of working must be checked. Ignore unit and small rounding errors	1
(d)	(ii)	Reasons for not being able to verify experimentally Heating problems with the wires Fuse may blow on psu/max. output current on psu exceeded Do not allow vague answers such as 'It is dangerous'	1
		20 marks in total	

Syllabus 9702 Paper 05

Page 3	Mark Scheme	Syllabus	Paper
	A/AS LEVEL EXAMINATIONS - JUNE 2003	9702	05

2 A1	Sensible choice of equipment and procedure OK (i.e. measure count rate and p.d.; change p.d. and measure new count rate) Unworkable methods/inappropriate choice of apparatus cannot score this mark	1
A2	Voltmeter shown in parallel with the GM tube or the supply	1
А3	Ratemeter/scalar/datalogger connected to terminals A and B of GM tube	1
B1	Radium or Cobalt source used	1
B2	Reason for choice Answer must relate to half-life. This mark cannot be scored if B1 = 0	1
В3	Method of removing α or β radiation (depending on source used) Appropriate absorber is expected. Accept 'aluminium' or <u>thin</u> lead Could be shown on the diagram. Allow electric or magnetic deflection	1
C1/2	Any two safety precautions e.g. use source handling tool store source in lead lined box when not in use do not point source at people/do not look directly at source Do not allow 'protective clothing', 'lead suits', 'lead gloves', 'goggles', etc.	2
D1/2	Any good/further detail Examples of creditworthy points might be: Repeat readings (to allow for randomness of activity) or scalar + long time Sensible value of p.d. applied to GM tube (i.e. 50 V to 1000 V) Keep distance from source to GM tube constant/fixed/same, etc. Subtract count rate due to background radiation Aluminium sheets must be mm or cm thickness Allow other valid points. Any two, one mark each	2

10 marks in total



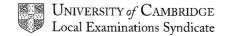
GCE ADVANCED SUBSIDIARY LEVEL AND ADVANCED LEVEL

MARK SCHEME

MAXIMUM MARK: 40

SYLLABUS/COMPONENT: 9702/06

PHYSICS Paper 6 (Options (A2))



Page 1	Mark Scheme	Syllabus	Paper
	A/AS LEVEL EXAMINATIONS - JUNE 2003	9702	06

Categorisation of marks

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C marks: These are <u>compensatory</u> 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 he/she knew the equation, then the C-mark is awarded.

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

Conventions within the marking scheme

BRACKETS

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UNDERLINING

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Option A – Astrophysics and Cosmology

1	(a)		large mass of gas (allow H and He)giving off e.m. radiation (allow light)held together by gravitational forces, or other good physics	. B1	[3]
	(b)		group of (many) starsany further detail e.g. some dimension, shape, etc		[2]
	(c)		rocky or gaseous object orbiting a star seen by reflected light	. B1	[3]
2			measure wavelength of light received from galaxymeasure wavelength of light in laboratory/on Earth(fractional) change in wavelength related to speed		
			or Doppler shift gives speed	. B1	[3]
3	(a)		$v = H_0 d$ $H_0 = (1.8 \times 10^4)/430$ = 42 km s ⁻¹ Mpc ⁻¹	. C1 . A1	[2]
	(b)	(i)	1 pc = 3.1×10^{16} mage = $1/H_0$		
			$= (3.1 \times 10^{22})/(42 \times 10^{3})$ $= 7.4 \times 10^{17} \text{ s}$. C1 . A1	
		(ii)	Earth-Moon distance = 3.8×10^5 km (allow $2 - 7 \times 10^5$ km)speed = $(3.8 \times 10^8)/(7.4 \times 10^{17})$ = 5.1×10^{-10} m s ⁻¹	. C1	[5]
	(c)		This is local gravitational attraction On wider scale, galaxies are receding	. B1	[2]
O	ption	F – The	e Physics of Fluids		
4	(a)	(i)	equal	. B1	
		(ii)	density of ice is less	. B1	[2]
	(b)		mass of ice becomes equal mass of water (allow weight)	.M1	[0]
_			so level does not change	. A1	[3]
5	(a)		e.g. streamline, incompressible non-viscous, horizontal flow(1 each, max 3)	. B3	[3]
	(b)		air close to train moves at the speed of the train/air dragged alo by train	. B1 . B1 . M1	[4]
6	(a)	(i)	random/irregular movement (of fluid)any other detail, e.g. eddies, pattern always changing		

	(ii)	kinetic energy given to air to cause turbulence or work needed to overcome drag force	[4]
(b) (i)	drag coefficient/drag constant	
	(ii)	power = Fv and hence	
	(iii)	120 x 10 ³ - $\frac{1}{2}$ x 0.3 x 1.2 x 2.5 x v^3	[4]
01	: NA B		[4]
Opt	ion IVI — I	Medical Physics	
7 (a)	electrons fired at metal target	[5]
(b) (i)	increase cathode/tube current B1	
	(ii)	increase anode voltageB1	
	(iii)	use aluminium filter (allow metal filter)	[3]
(c)	$I = I_0 e^{-\mu x}$	[3]
o /	a)		[0]
8 (a)	produces greater intensity (at focus) limits region of cell damage allows for accurate guidance	[2]
(b)	laser beam cauterises tissue can produce coagulation vaporisation of water in cells	[2]
	a) b)	ability to detect (small) changes in loudness/intensity	[2] [3]

Syllabus 9702 Paper 06

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	A/AS LEVEL EXAMINATIONS - JUNE 2003	9702	06

Option P – Environmental Physics

10	(a)		source of (useful) energy B1 derived from (incomplete) decay of organic matter B1	[2]
	(b)		resources: total deposits of fossil fuels	[2]
11	(a)		heavy nucleus/heavy atom/U-235, etc B1 bombarded by neutron B1 produces two fragments of about equal mass B1 plus neutrons and energy B1	[4]
	(b)	(i)	slows down neutronsB1	
		(ii)	absorbs neutronsB1	
		(iii)	maintains coolant around reactor core	[4]
12	(a)		$E_{\text{MAX}} = (1 - T_{\text{L}}/T_{\text{H}}).$ C1 = $(1 - 313/813)$ C1 = 0.61 A1	[3]
	(b)	(i)	e.g. heat loss in exhaust gases/cooling towersB1	
		(ii)	e.g. pre-heat water entering boiler, <u>either</u> increase T_H or decrease T_L re-heat steam in multistage turbine, CHP system(1 each, max 2) B2	[3]
	(c)		e.g. thermal, visual, etc(1 each, max 2)B2	[2]
Op	tion T	– Tel	lecommunications	
13	(a)		correct signal voltages(-1 each error or omission)B2 corresponding binary numbers(-1 each error or omission)B2	[4]
	(b)		signal changes at correct positions	[2]
	(c)		(use ADC and DAC with) larger number of bits M1 makes smaller 'step height' A1 sample more frequently M1 makes smaller 'step depth' A1	[4]
14	(a)		central conductor with outer screening	[2]
	(b)		e.g. greater bandwidth immune to e.m. interference radiates less e.m. power less cross-talk lower noise levels (1 each, max 3)	[3]
15			$10 \text{ m} \rightarrow 100 \text{ m}$ worldwide more than 100 m 1000 km less than 10 m line of sight <u>or</u> worldwide using satellites (-1 each error or omission)	[5]