OCR

RECOGNISING ACHIEVEMENT

Mark Scheme 2825/05
January 2002

Advice to examiners on the annotation of scripts

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

2 Please mark all post-standardisation scripts in red ink. A tick (✓) should be used for each answer judged worthy of a mark. Ticks should be placed as close as possible to the point in the answer where the mark has been awarded. The number of ticks should be the same as the number of marks awarded. If two (or more) responses are required for one mark, use only one tick. Half marks (1/2) should never be used.

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

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

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

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

6 Correct answers to calculations should gain full credit even if no working is shown, unless otherwise indicated in the mark scheme. (An instruction on the paper to 'Show your working' is to help candidates, who may 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/Principle 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 1	Expected Answers	Marks
(a) (i)	Analogue signal	1
	Either, because there is a continuous variation in voltage (AW) Or , because the voltage variation is analagous to displacement of air molecules (AW)	1
(ii)	Microphone frequency = 1 / period	1
	= 1 / 0.4ms = 2.5 kHz	1
(iii)	Single vertical line drawn At 2.5 kHz	1
(iv)	Sine wave bandwidth = 0	1
(b)	Carrier frequency = 1 / period = 1 / 0.02 ms = 50kHz	1
(c) (i)	Any AM shape	1
	20 cycles of carrier in 0.4 ms	1
	1 cycle of audio in 0.4 ms	1
	carrier wobbles between 7V and 3V	1
(ii)	3 equally spaced vertical lines drawn	1
	central large carrier between two smaller sidebands	1
	carrier marked 50 kHz and sidebands marked 47.5 kHz and 52.5 kHz	1
(iii)	Bandwidth of AM signal = 5 kHz	1

Question 2	Expected Answers	Mark
(a)	Analogue-to-digital converter (do not accept ADC)	1
(b)	0010 1000 1110 0110 0010 (-1 mark each error)	2
(c)	4 bits must be slotted into 5 ms, so each bit cannot last any longer than 1.25 ms	1
(d)	Five samples correctly positioned on graph 2V 8V 14V 6V 2V Smooth line drawn between points (or stepped line)	1 1
(e)	The recovered signal of Fig. 2.2 is an alias which bears no relation to the amplitude/frequency of the original signal (AW) Frequencies in original are much higher than the sampling frequency (It has arisen because the sampling frequency has been far too low)	1 1
(f)	The sampling frequency must be increased to more than twice the highest frequency component in the original signal the highest frequency component is about 2kHz Thus sampling frequency should be greater than 4kHz Also the 4 bit conversion is far too few bits The fine detail is lost with a quantisation error of 1V Need 5 or 6 bit conversion in order to recover all the information	1 1 1 1

Question 3	Expected Answers	Marks
(a)	Light Dependant Resistor (do not accept LDR)	1
(b)	Operational amplifier (accept op-amp)	1
(c)	Voltage at A = (3 / 3 + 7) x 15	1
	= 4.5 V	1
(d) (i)	As light intensity changes from darkness to brightness, resistance of LDR changes from high to low resistance.	1
(ii)	In darkness, the voltage at B will be greater than the 4.5 at A	1
	thus output of X is in positive saturation (of about +13V)	1
	Getting lighter, at some point, the LDR resistance will have decreased sufficiently	
	for the voltage at B to become less than 4.5V	1
	at which point the op-amp switches into negative saturation	1
(e) (i)	If the diode were not in the circuit the lamp would always be operating	1
	because a lamp can be operated by either direction or current	
	or the diode only allows current to flow in one direction	1
(ii)	When the op-amp output is positive the diode conducts	1
	thus the lamp only operates when the LDR is in darkness	1

Question 4				
Waveband	full name	frequency range	propagation	typical use
LF	Low Frequency	30 kHz – 300 kHz	Diffraction over curved Earth	Long wave AM radio broadcasting (1 mark)
HF	High Frequency (1 mark)	3 MHz = 30MHz (1 mark)	Multiple reflections between Earth surface and ionosphere (1 mark)	Short wave AM broadcasting Amateur radio (1 mark)
UHF	Ultra High frequency (1 mark)	300MHz – 3 GHz (1 mark)	Line of sight (1 mark)	TV broadcasting

Question 5	Expected Answers	Marks
1	Glass is an extremely common substance So is much cheaper than copper	
2	Optic fibre is much thinner and lighter than coaxial cable So is easier for technicians to handle	
3	Optic fibre has a much lower attenuation than coaxial cable So has a much greater distance of uninterrupted transmission	
4	Optic fibre has a much higher bandwidth than coaxial cable So has much greater information carrying capacity	
5	Optic fibres are immune to electromagnet interference So can be used in electrically noisy environments	
6	Optic fibres do not radiate energy So there is no crosstalk between adjacent fibres	
7	Optic fibres cannot be trapped So they are more secure than coaxial cable	
8	Optic fibres are ideally suited to light pulses So are ideally suited to time-division multiplexing	Any three for 2 each

Question 6	Expected Answers	Marks
(a)	1. Period of orbit must be 24 hours (or some indication of fixed radius of orbit) 2. Satellite must rotate above equator 3. Satellite must rotate in same sense as Earth rotates	1 1
(b)	Using $\frac{G M_E m_s}{r^2} = \frac{m_s v^2}{r}$ we see that the satellite mass m_s cancels so conditions for v in terms of r (and constant G and M_E) do not depend on m_s	1 1 1
(c)	Using equations in part (b) above $r = G M_E / v^2$ and $v = 2\pi r / T$ so $r^3 = G M_E T^2 / 4\pi^2$ thus $r = \sqrt[3]{(6.7 \times 10^{-11} \times 6.0 \times 10^{24} \times [24 \times 3600]^2) / 4\pi^2}$ $= 4.2 \times 10^7$ m.	 1 1 1 1
(d)	Batteries cannot last forever and so need to be recharged Solar cells are not always in sunlight and therefore some storage is necessary	1 1
(e)	Area of solar cells required = (600 / 1500) ÷ 5% = 8 m^2	1 1
(f)	Maximum power received = ($\pi 0.75^2$ / 4 ÷ π 700000^2 /4) x 350 = 4.0×10^{-19}W	1 1
(g)	The frequency received is extremely low power If the frequency transmitted were the same the outgoing signal would swamp the incoming signal (and positive feedback would result) (AW)	 1

Question 7	Expected Answers	Marks
(a)	cable has resistance	1
	hence there is a pd across cable (itself)	1
	this is not available to user	1
	(energy dissipated in cable could get ½ of last two marks)	
(b)	air emerging from aerogenerator is moving	1
	hence it has ke/eddies	1
	work/energy used against friction	1
	(ohmic) heating in generator	1
	any 2	2 max
(c) (i)	$m = \pi R^2 l \rho$	1
	$= \pi (0.75)^2 \times 8 \times 1.3$	1
	(= 18.4 kg)	
(ii)	ke = ½ $m v^2$	1
	= ½ x 18 x 8^2 = 576 J (allow 588 J from ½ x 18.4 x 8^2)	1
(iii)	average power output = (40/100) x 576 = 230 W	1
	(Allow 235W from 0.4 x 588)	
(d)	$W = P t$ $7 \times 10^6 = 230 t$	1
	t = 3.0(4) x 10^4 s (= 8.45 h) (allow 2.98 x 10^4 from 7 x 10^6 = 235 t)	1
(e) (i)	chemical (not potential or electrical)	1
(ii)	energy dissipated/ wasted as heat inside battery/wires	1
(f) (i)	$E = P t$	1
	= 160 x 40 x 3600 = 2.3 x 10^7 J	1
(ii)	total stored energy = 2.3 x 10^7 x 100 / 80	1
	= 2.88 x 10^7 J	1
(iii)	no. of batteries = 2.88 x 10^7 / (7 x 10^6)	1
	(= 4.1) i.e 5	1