

TELECOMMUNICATIONS

Mark Scheme 2825/05 January 2003

2825/05			Mark Scheme	January 20	003	
1. (a)	Silence	Spectro	um B		(1)	
	The power s	pectrum	is of an unmodulated carrier (wtte)		(1)	
	Pilot Tone	Spectro	ım C		(1)	
	The carrier is	s modul	ated by a single frequency		(1)	
	Music	Spectro	am A		(1)	
The sidebands contain a spectrum/range of			ain a spectrum/range of audio frequencies		(1)	
(b)(i)	200kHz				(1)	
(ii)	2kHz				(1)	
(iii)	8kHz				(1)	
(iv)	Long Wave (Low Frequency)			(1)		
(v)	Maximum nu	ımber	= (300 - 30) kHz / 8kHz		(1)	
			≈ 33 stations		(1)	
(c)			produces a large bandwidth (180kHz) y one station could operate within the waveba	and (wtte)	(1) (1)	[14]

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2. (a)(i)	Voltage at X = 0V	(1)	
(ii)	Current is $2 k\Omega = pd / 2 k\Omega$	(1)	
	= $(40 \text{ mV} - 0) / 2 \text{ k}\Omega$ = $20 \mu\text{A}$	(1)	
(iii)	Current in 160 k $\Omega$ = 20 $\mu$ A	(1)	
	because no current enters the input of the op-amp or, the op-amp has an infinite input impedance	(1)	
(iv)	$V_{out} = -20 \mu A \times 160 k\Omega$ or $V_{out} = -80 \times 0.04 = -3.2 V$	(1)	
	= - 3.2 V	(1)	
(v)	Maximum input voltage = saturation voltage (accept 13 – 15V) / voltage	gain	
	= ± 14 / 80	(1)	
	= ± 0.175 V	(1)	
(b)	Overall voltage gain = -480 / 12 x - 68 / 3.4 x -1 / 10 formula = -80 formula three gains multiply together	(1) (1) (1)	
(c)(i)	Both amplifiers are inverting amplifiers So both have output which is 180° out of phase with input	(1)	
(ii)	The input impedance of Fig.2.1 is 2 $k\Omega$		
	the input impedance of Fig.2.2 is 12 $k\Omega$	(1)	
(iii)	The bandwidth of Fig.2.2 is greater than that of Fig.2.1		
	Because the bandwidth is limited by the maximum gain in any stage		
	And Fig.2.1 has the greatest gain (x 80) of all the stages shown	(1)	
(iv)	The maximum input voltage before saturation for Fig.2.1 is 0.175 V (as above	ve)	
	The maximum input for Fig.2.2 is limited by the first two op-amp gains	(1)	
	And this is $\pm 14V / (40 \times 20) = \pm 0.0175 V$	(1)	[17]

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3. (a) 	Suitable drawing of analogue signal Suitable drawing of a digital signal An analogue signal is analagous to the physical property It varies continuously in time It can have any value between two limits Digital signal is a coded representation of a piece of infor It does not vary continuously in time It can only have one of two values.	_	
(b)	At the local exchange the analogue voltage (ie call) is sai ADC	mpled (8000 Hz) by (1)	
	Each sample in converted into a parallel 8-bit word.	(1)	
	Each bit in the 8-bit word is transmitted serially	(1)	
(c)	The serial digital signal is applied to a serial to parallel co	onverter (1)	
	Each 8-bit word is applied to a DAC	(1)	
	DAC output becomes the analogue signal to the receiving	g telephone (1)	
(d)	Advantages of pcm are all the advantages of digital signs	als.	
	Elimination of noise Computer control Storage in memories Error correct codes Encryption Time-division multiplexing	(any two valid points) (1) (1)	[14]

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4. (a)	Refractive index	of core must be greater than th	at of cladding	(1)	
	To allow total inf	ternal reflection in core		(1)	
(b)	Speed of light in	core = $3 \times 10^8 / 1.5$		(1)	
		$= 2 \times 10^8 \text{ ms}^{-1}$	(deduct mark if wrong unit)	(1)	
(c)	Shortest time	= distance / speed			
		= 4000 / 2 x 10 <sup>8</sup>		(1)	
		= 20 µs		(1)	
(d)	Longest time	= $(4000 / Sin 65.4) / 2 \times 10^8$ (1) (1)	Expansion of answer with explanation or drawing	(1)	
		= 22 μs			
(e)	Emerging pulse	should have the following chara	acteristics.		
	Any curved sha	pe of duration longer than 1 μs		(1)	
	Duration of puls	e is 3 μs (ie 1 μs actual pulse +	2 μs extra time)	(1)	
	Starts at 21 μs (ie 1 μs start time plus 20 μs minimum)			(1)	
	Ends at 24 μs			(1)	
	Area of emerging	ng pulse is same as area of inpu	it pulse	(1)	
			An	y (4)	
(e)	Pulses would ha	ave to be separated by approxir	nately 3 μs		
	So maximum fro	equency ≈ 1 / 3 μs		(1)	
		≈ 333 kHz		(1)	
(g)	Smearing			(1)	[16]

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5.				
Space waves	VHF UHF SHF EHF (allow, a	any waveband where f>30 MHz	z) (1)	
	Propagates by line of sight		(1)	
	Maximum terrestrial range a	llow 20km to 100km	(1)	
Surface waves	VLF LF MF (allow, any wave	eband where f<3 MHz)	(1)	
	Propagates by long wavelen	gths bending round curvature of	of Earth (1)	
	Maximum terrestrial range	1000 km (in MF) (but can be world wide in LF)	(1)	
Sky waves	HF (allow, waveband where	30 MHz>f>3 MHz)	(1)	
	Propagates by reflections be	etween Earth's surface and ion	osphere (1)	
	Maximum terrestrial range world wide			[9]

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(ii) 130 N (accept 125-135) both correct 1 [1]  (b) F = ma (1015-130) = 1100a so a = 0.80 ms² (accept 0.80-0.81) 1 [3]  (c) 18 ms³ (accept 15-21) find largest difference between force graphs and note speed or clear from graph 1 [2]  (d) 49.7 ms³ (accept 49.5 - 50.0) speed is max. when driving force equals/balanced by drag force 1 [2]  (e) 220 N	6 (a) (i)	1015 N (accept 1010-1020)	<del></del> _	
(b) F = ma (1015-130) = 1100a so a = 0.80 ms² (accept 0.80-0.81) 1   1   [3]  (c) 18 ms³ (accept 15-21) find largest difference between force graphs and note speed or clear from graph 1   1   [2]  (d) 49.7 ms³ (accept 49.5 - 50.0) speed is max. when driving force equals/balanced by drag force 1   [2]  (e) 220 N		, ,	1	[1]
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(d) 49.7 ms <sup>-1</sup> (accept 49.5 - 50.0) speed is max. when driving force equals/balanced by drag force  (e) 220 N  work done = force x distance = 220x1000 (=2.2x10 <sup>5</sup> J)  (f) work done = 3.5(2)x1000 = 3.5(2)x10 <sup>5</sup> J accept (3.5 - 3.6)x10 <sup>5</sup> 1 [1]  (g) distance travelled on 1 litre at 31 ms <sup>-1</sup> = 2.2x16/3.5(2) = 10.0 km (9.8 - 10.1)  (h) ke = ½mw² = ½x 1100x31² (= 5.29x10 <sup>5</sup> J)  (i) (ke lost =) heat gained = mc(θ₂ - θ₁) 5.3x10⁵ = 8x460 Δθ Δθ = 144 K so θ₂ = 144 + 15 = 159 °C assumption: brakes initially at 15 °C (1) allheat is dissipated in brakes Or other valid assumption (not Law of Energy)  (j) W = Fd 5.3x10⁵ = 9300d so d = 57 m assumption: no work done against (other) drag forces car is on horizontal road	}		Í	ļ
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(h) $ ke = \frac{1}{2}mv^2 $ $= \frac{1}{2} \times 1100 \times 31^2 \ (= 5.29 \times 10^5 \ J) $ (i) $ (ke lost =) heat gained = mc(\theta_2 - \theta_1) $ $5.3 \times 10^5 = 8 \times 460 \ \Delta \theta $ $\Delta \theta = 144 \ K \text{ so } \theta_2 = 144 + 15 = 159 \ ^{\circ}\text{C} $ assumption: brakes initially at 15 \(^{\circ}\text{C} $= \frac{1}{2} \text{ allheat is dissipated in brakes} $ (not Law of Energy) (not Law of Energy) $ (mot \ Law \ of \ Energy) $ any 1 1 [3] (j) $ W = Fd $ $5.3 \times 10^5 = 9300d $ so $d = 57 \ m$ assumption: no work done against (other) drag forces $ car \ is \ on \ horizontal \ road $				
(h) $ke = \frac{1}{2}mv^2$ $= \frac{1}{2} \times 1100 \times 31^2 \ (= 5.29 \times 10^5 \ J)$ (i) $(ke \log t = ) \text{ heat gained} = mc(\theta_2 - \theta_1)$ $5.3 \times 10^5 = 8 \times 460 \ \Delta\theta$ $\Delta\theta = 144 \ K \text{ so } \theta_2 = 144 + 15 = 159 \ ^{\circ}\text{C}$ assumption: brakes initially at 15 \ ^{\circ}\text{C} all heat is dissipated in brakes or other valid assumption (not Law of Energy)  (not Law of Energy)  any 1  (i) $W = Fd$ $5.3 \times 10^5 = 9300d$ so $d = 57 \text{ m}$ assumption: no work done against (other) drag forces car is on horizontal road	(g)	, ,	1	
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(i)	(h)	ke = ½mv²	1	
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5.3x10 <sup>5</sup> =8x460 $\Delta\theta$ $\Delta\theta$ = 144 K so $\theta_2$ = 144 + 15 = 159 °C  assumption: brakes initially at 15 °C  allheat is dissipated in brakes  or other valid assumption  (not Law of Energy)  (i) $W = Fd$ 5.3x10 <sup>5</sup> = 9300 $d$ so $d = 57$ m  assumption: no work done against (other) drag forces  car is on horizontal road	1	}		r.1
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so d = 57 m assumption: no work done against (other) drag forces car is on horizontal road  1 [2]	( )			
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car is on horizontal road	}		1	121
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or other valid assumption   1201	-	or other valid assumption		[20]