Mark schemes

Q1.

(a) *L* ✓

1

(b) Evidence of 0.707 OR 0.71 OR 0.7 used ✓ (V_{out} = 3.6 mV)

use of *Q* = their f_0 ÷ their f_B ✓

Expect to see
f_0 = (779 - 769) kHz;
f_B = 10 kHz (± 1 kHz)

Q = 774 ÷ 10 = 77.4 ✓ Accept range (*Q* = 70 - 86)

Alternative for 2 marks max if ~50% point is used (V_{out} ≈ 2.6 mV)

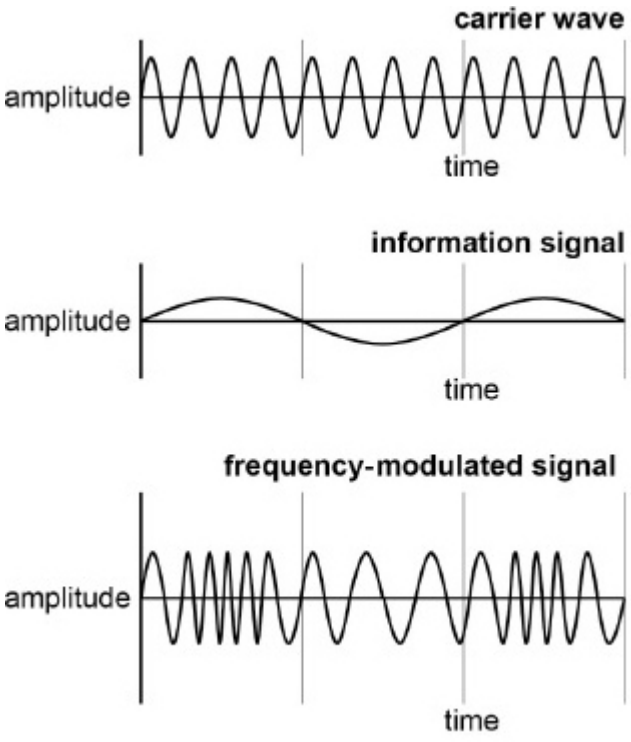
leading to f_B = 12 kHz (± 1 kHz) ✓

Q = 65 ✓

Accept that rounds in range (Q = 60 -70)

3

(c)



✓✓

1st mark - constant amplitude
2nd mark - correct frequency variation

2

(d) f_m = 18 ✓ (kHz)

Expect to see bandwidth = 2(Δf + f_m)

1

[7]

Q2.

The mark scheme gives some guidance as to what statements are expected to be seen in a 1 or 2-mark (L1), 3 or 4-mark (L2) and 5 or 6-mark (L3) answer. Guidance provided in section 3.10 of the 'Mark Scheme Instructions' document should be used to assist in marking this question.

Mark	Criteria
6	All three areas covered with at least two aspects covered in some detail. 6 marks can be awarded even if there is an error and/or parts of one aspect missing.
5	A fair attempt to analyse all three areas. If there are several errors or missing parts, then 5 marks should be awarded.
4	Two areas successfully discussed, or one discussed and two others covered partially. Whilst there will be gaps, there should only be an occasional error.
3	One area discussed and one discussed partially, or all three covered partially. There are likely to be several errors and omissions in the discussion.
2	Only one area discussed or makes a partial attempt at two areas.
1	None of the three areas covered without significant error.
0	No relevant analysis.

The following statements are likely to be present.

Analogue to Digital conversion Sample rate

- Appreciation of speech being at lower end of audio spectrum (eg 3-4 kHz bandwidth)
- Minimum is 2 × highest frequency
- If too low, then aliasing can occur
- If too high, then forces redundant data to be generated

Resolution

- Determined by number of bits (*n*) used to code each sample
- Number of levels available is 2^n
- If too low - leads to poor quality signal retrieval
- If too high - may exceed data rate capability of system

Transmission technique

- Name the technique 'Time Division Multiplexing'
- Data from each source transmitted in successive time slots using synchronized switches
- Time slots are of equal length
- Time slots present to each source in a cyclical way giving availability to each source at regular intervals
- Efficient / low-cost solution for heavy use transmission channel

[6]

Q3.

(a) modulator amplifier receiver demodulator ✓

1

(b) The up-link and down-link frequencies were made different. ✓

1

(c) Evidence of travel time calculation using:

distance travelled in single/return journey ÷ speed of e-m wave (in free space) ✓

Single journey time

= 80 × 10^6 m ÷ 3 × 10^8 m s^{-1} = 267 ms

OR

Return journey time

= 160 × 10^6 m ÷3 × 10^8 m s^{-1} = 533 ms (accept 534 ms)

Do not allow use of 40 × 10^6 m

Processing time = time delay - travel time ✓

Must be a round-trip calculation for second mark.

E.g. Processing time = 900 ms - 533 ms = 367 ms

*Accept their **return** journey travel time as ecf in MP2*

2

(d) **USA** - Geostationary satellite provides permanent link ✓

UK - idea that the satellite is in communication with UK and USA (only) for (short) periods of time. ✓

Accept reference to additional time delay for live events in UK due to extra distance travelled by e-m wave.

2

(e) any two from ✓✓

- more secure - need to break into the cable to read data in transition.
- continuous communication as link is always connected.
- larger bandwidth.
- reduced time delay between signal transmission and reception due to shorter distance travelled (even allowing for slower signal speed in cable).
- reduced interference - e-m noise will not interfere with optical transmission.

Allow other correct answers.

2

[8]

Q4.

(a) ($f = 1 / T$; $f = 1 / 5\ \mu s$)

200 ✓ (kHz)

1

(b) Measurement from the graph of the half wavelength of signal

$T = 2 \times 42\ \mu s$ ✓

First mark for factor 2 in calculation

Allow range 2 × (40 – 44) μs

Calculation of frequency ($f = 1 / T$) using their T

11.9 kHz (± 0.6 kHz) ✓

Second mark – allow ecf only if their T is clearly derived form analysis of the graph

2

(c) Any one from: ✓

- Immune to any noise in amplitude. (since information stored in the frequency variation)
- Quality of an FM signal remains high even when the transmitter power is low.
- (since most of power is in sidebands / information).
- Carries more information
- (since the FM bandwidth is much wider than that of AM)

Max 1 mark

1

(d)

= 100 stations ✓

$$\frac{(108\ \text{MHz} - 88\ \text{MHz})}{200\ \text{kHz}}$$

1

(e) Bandwidth = $2(\Delta f + f_m)$ = 2 × (75 kHz + 15 kHz) = 180 kHz ✓

This fits in allocated 200 kHz band ✓

Second mark – allow ecf if conclusion is consistent with their calc.

2

[7]

Q5.

The mark scheme gives some guidance as to what statements are expected to be seen in a 1 or 2 mark (L1), 3 or 4 mark (L2) and 5 or 6 mark (L3) answer. Guidance provided in section 3.10 of the '*Mark Scheme Instructions*' document should be used to assist in marking this question.

Level	Criteria
L3 **6 marks**	The candidate shows a good understanding of the way **both** systems operate. They propose a valid and reasoned solution for both Island **B** and Oil rig **C**. They use technical terms correctly, the answer has structure and clearly conveys the information required.
L3 **5 marks**	The candidate shows a good understanding of the way **both** systems operate. They propose a valid and reasoned solution for both Island **B** and Oil rig **C**. However, there may be minor gaps in knowledge OR the style / structure may lead to a lack of clarity in some of the information being presented.
L2 **4 marks**	The candidate shows a general understanding of the material but one of the systems or supported solutions will be treated superficially. Structure and technical language used is generally good.
L2 **3 marks**	The candidate shows a general understanding of the material but one of the systems or supported solutions will be treated superficially. There may be some lack of clarity either through the structure or in use of technical terms.
L1 **2 marks**	The candidate shows a basic understanding of the way **one** system operates. They propose a supported valid solution for either Island **B** or Oil rig **C**. There may be some lack of clarity in structure, there is good use of technical terms.
L1 **1 marks**	The candidate shows a basic understanding of the way **one** system operates. They propose an unsupported but valid solution for either Island **B** or Oil rig **C**. There may be some lack of clarity either through the structure or in use of technical terms.
L1 **0 marks**	The work contains no significant analysis of the question asked.

Proposed solution:

Island B

Initial phase – use of satellite link

- Quick and easy to set up mobile sat unit(s).
- Initial usage and platform range likely to be low, hence lower bandwidth / data rates not an issue.
- Some difficulties with two-way conversations due to signal delay.
- Higher maintenance costs and possible interference problems due to EM noise and security issues.

Later phase – install submarine cable

- More forward planning / expense needed to put this in – cable ship / terminations / internal network
  Heavier usage as development proceeds and wider platform support – hence more bandwidth / larger data rate required.
- More reliable link
- Low security issues and immune to EM interference.

Oil rig C

Satellite link

- Fibre optic cable not an option due to mobile nature of the rig.
- Satellite link is a low-cost short-term solution.
- Light use and limited platform requirement so reduced bandwidth / lower data rate not critical.
- Some difficulties with two-way conversations due to signal delay.
- Reliability issues.

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