Communication

Mark Scheme 5

Level	International A Level
Subject	Physics
Exam Board	CIE
Topic	Communication
Sub Topic	
Paper Type	Theory
Booklet	Mark Scheme 5

Time Allowed: **60 minutes**

Score: **/50**

Percentage: **/100**

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

1 **(a) (i)** ratio / dB = $10 \lg(P_1 / P_2)$ C1
$24 = 10 \lg(P_1 / \{5.6 \times 10^{-19}\})$ C1
$P_1 = 1.4 \times 10^{-16}$ W A1 [3]

(ii) attenuation per unit length = $1 / L \times 10 \lg(P_1 / P_2)$ C1
$1.9 = 1 / L \times 10 \lg(\{3.5 \times 10^{-3}\}/\{1.4 \times 10^{-16}\})$ C1
$L = 1$ km A1 [3]
or
attenuation = $10 \lg(\{3.5 \times 10^{-3}\}/\{5.6 \times 10^{-19}\})$ (C1)
= 158 dB
attenuation along fibre = (158 – 24) (C1)
L = (158 – 24) / 1.9 = 71 km (A1)

(b) less attenuation (per unit length) / longer uninterrupted length of fibre B1 [1]

2 **(a) (i)** unwanted random power / signal / energy B1 [1]

(ii) loss of (signal) power / energy B1 [1]

(b) (i) *either* signal-to-noise ratio at mic. = $10 \lg (P_2 / P_1)$ C
= $10 \lg (\{2.9 \times 10^{-6}\} / \{3.4 \times 10^{-9}\})$
= 29 dB A1
maximum length = (29 – 24) / 12 C1
= 0.42 km = 420 m A1 [4]

or signal-to-noise ratio at receiver = $10 \lg (P_2 / P_1)$ (C1)
at receiver, $24 = 10 \lg(P / \{3.4 \times 10^{-9}\})$
$P = 8.54 \times 10^{-7}$ W (A1)
power loss in cables = $10 \lg(\{2.9 \times 10^{-6}\} / \{8.54 \times 10^{-7}\})$ (C1)
= 5.3 dB
length = 5.3 / 12 km
= 440 m (A1)

(ii) use an amplifier M1
coupled to the microphone A1 [2]
(*repeater amplifiers scores no mark*)

3 **(a)** (carrier wave) transmitted from Earth to satellite (1)
satellite receives greatly attenuated signal (1)
signal amplified and transmitted back to Earth B1
at a different (carrier) frequency B1
different frequencies prevent swamping of uplink signal (1)
e.g. of frequencies used (6/4 GHz, 14/11 GHz, 30/20 GHz)
(*two B1 marks plus any two other for additional physics*) B2 [4]

(b) advantage: e.g. much shorter time delay M1
because orbits are much lower A1
e.g. whole Earth may be covered (M1)
in several orbits / with network (A1)
disadvantage: e.g. *either* must be tracked
or limited use in any one orbit M1
more satellites required for continuous operation A1 [4]

4 **(a) (i) 1.** signal has same variation (with time) as the data B1
2. consists of (a series of) 'highs' and 'lows' B1
either analogue is continuously variable (between limits)
or digital has no intermediate values B1 [3]

(ii) e.g. can be regenerated / noise can be eliminated
extra data can be added to check / correct transmitted signal
(*any two reasonable suggestions, 1 each*) B2 [2]

(b) (i) analogue signal is sampled at (regular time) intervals B1
sampled signal is converted into a binary number B1 [2]

(ii) one channel is required for each bit (of the digital number) B1 [1]

5 **(a)** frequency of carrier wave varies (in synchrony) with signal — M1
(in synchrony) with displacement of signal — A1 [2]

(b) advantages e.g. less noise / less interference
greater bandwidth / better quality
(1 each, max 2)
disadvantages e.g. short range / more transmitters / line of sight
more complex circuitry
greater expense
(1 each, max 2) — B4 [4]

6 **(a)** gain / loss/dB = 10 lg(P_1/P_2)
190 = 10 lg($18 \times 10^3 / P_2$) — C1
or –190 = 10 lg P_2 / 18×10^3) — C1
power = 1.8×10^{-15} W — A1 [3]

(b) 11 GHz / 12 GHz — B1 [1]

(ii) e.g. so that input signal to satellite will not be 'swamped'
to avoid interference of uplink with / by downlink — B1 [1]

7 **(a)** signal becomes distorted / noisy — B1
signal loses power / energy / intensity / is attenuated — B1 [2]

(b) (i) *either* numbers involved are smaller / more manageable / cover wider range
or calculations involve addition & subtraction rather than multiplication and division
B1 [1]

(ii) 25 = 10 lg(P_{min} / (6.1×10^{-19}))
minimum signal power = 1.93×10^{-16} W — C1
signal loss = 10 lg(6.5×10^{-3})/(1.93×10^{-16})
= 135 dB — C1
maximum cable length = 135 / 1.6 — C1
= 85 km so no repeaters necessary — A1 [5]