A-Level Physics

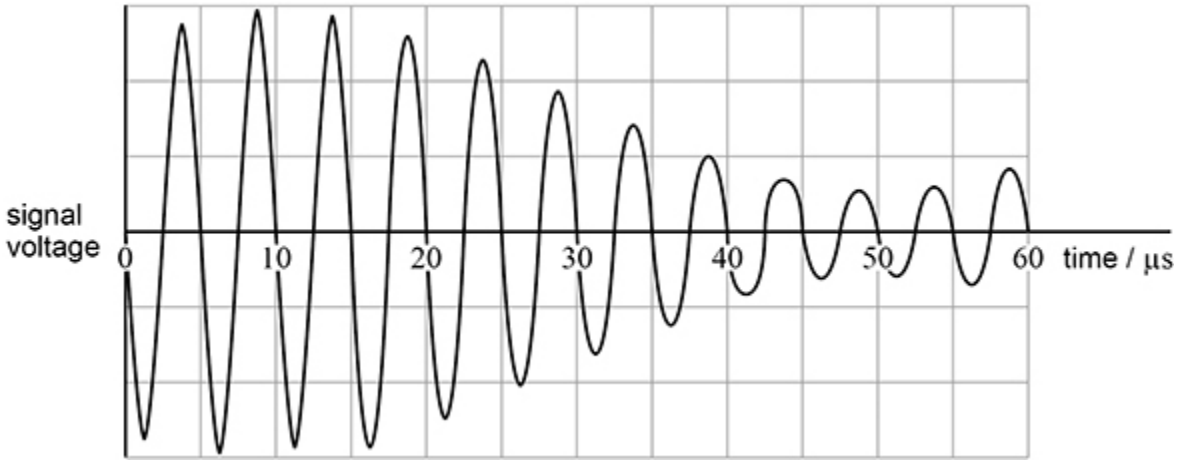
Data Communication Systems

Question Paper

Time available: 77 minutes
Marks available: 48 marks

1. The figure below shows the output signal from the tuner circuit of a radio receiver.

The radio carrier wave is amplitude modulated by a single-frequency test tone.



(a) Determine the frequency, in kHz, of the carrier wave.

frequency of carrier wave = _____ kHz

(1)

(b) Determine the frequency, in kHz, of the test tone.

frequency of test tone = _____ kHz

(2)

(c) State **one** advantage of using frequency modulation (FM) rather than amplitude modulation (AM).

_____

_____

(1)

(d) The frequency range of the FM radio band in the UK is 88 to 108 MHz.

The FM stations are allocated centre frequencies that start at 88.100 MHz and are separated by 200 kHz.

Calculate the maximum number of stations allowed within the range.

maximum number of stations = _____

(1)

(e) A radio station broadcasting on FM transmits a maximum audio frequency of 15 kHz and has a frequency deviation of $\pm$ 75 kHz.

Deduce whether the radio station fits the FM bandwidth allocation in the UK.

_____

_____

_____

(2)

(Total 7 marks)

2. The table below shows some communication applications that transmit using different regions of the electromagnetic spectrum.

Application	Spectrum region	Typical transmission frequency / MHz
national radio station	longwave	0.198
amateur radio	shortwave	28.2
satellite TV link	microwave	10 700

Explain why each transmission takes the pathway it does from the transmitter to the receiver.

For each of the spectrum regions, you should:

- indicate a frequency range
- refer to the properties of the wave
- name the pathway and outline its properties.

You may use diagrams to help explain your answer.

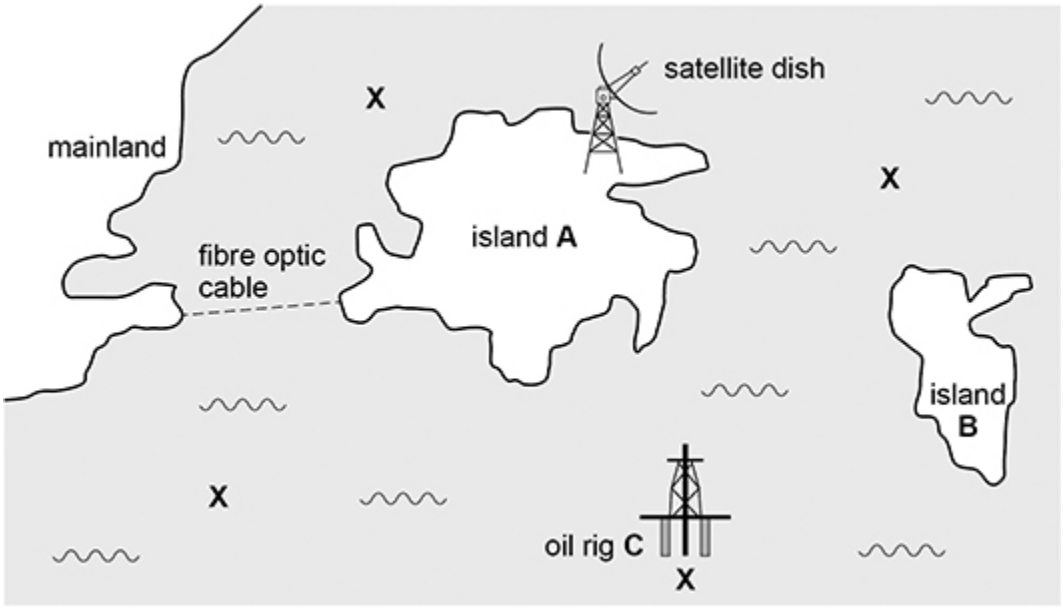
Space for diagrams

(Total 6 marks)

3. The figure below shows island **A**, a fully developed island off the mainland coast. The island is connected to the mainland by a fibre optic cable lying along the seabed and it also has a satellite link.

Nobody lives on island **B**, but it is due to be developed as a major holiday resort over the next 5 years.

Moveable oil rig **C** is due to explore the four sites marked '**X**' for oil and gas over a 9-month period.



A communications company has been asked to provide solutions for island **B** which will allow the development to begin immediately and then later to support a fully developed holiday resort.

A communications solution is also required for oil rig **C** during the 9-month exploration period.

Describe appropriate solutions involving fibre optic cabling and satellite communication systems for each of the two clients, island **B** and oil rig **C**.

In your answer you should:

- outline the way each communications system operates
- suggest, with reasons, your choice of system for each solution.

(Total 6 marks)

4. British embassies in Europe are to be connected to a new long-distance communication link. The link, in the form of a land-based cable, will support multiple simultaneous video conferencing as well as the transmission of sensitive government data.

The company installing the link has to consider the choice between using optic fibre or copper wire in the cables.

Compare the advantages and disadvantages of the two options for use in these cables. State which option you would advise the company to use.

For both types of cable refer to their:

- physical properties
- ability to reject external interference
- signal-carrying properties.

(Total 6 marks)

5. Discuss how longwave (LW), shortwave (SW) and microwave links can be used to communicate beyond the visible horizon.

For each link, you should give:

- a typical carrier frequency that is used
- an explanation of how the signals travel from the transmitter to the receiver
- a typical use.

You may use a diagram to help make clear aspects of your answer.

(Total 6 marks)

6. (a) Describe what is meant by amplitude modulation (am).

(1)

(b) A radio wave has an unmodulated frequency of 120 kHz. It is amplitude modulated by a signal from an audio transducer of frequency 2.2 kHz.

Calculate the bandwidth of the modulated wave.

bandwidth = _____ kHz

(1)

(c) Explain why frequency modulation (fm) is not used for commercial radio transmissions in the medium and long wave bands.

_____

_____

(1)

(d) State and explain **one** advantage of transmitting digital signals using frequency modulation (fm) rather than amplitude modulation (am).

_____

_____

_____

_____

(2)

(Total 5 marks)

7. Part of a communication system has the following subsystems:

carrier generator **input transducer** **modulator** **transmitter**

(a) Draw a labelled block diagram to show how these subsystems are connected.

(3)

(b) Describe the operation of each of the subsystems in part (a), stating for each one its action on its input signal(s) and the form taken by its output signal.

(i) carrier generator _____

_____

_____

(2)

(ii) input transducer _____

_____

_____

(2)

(iii) modulator _____

_____

_____

(3)

(iv) transmitter _____

_____

_____

(2)

(Total 12 marks)