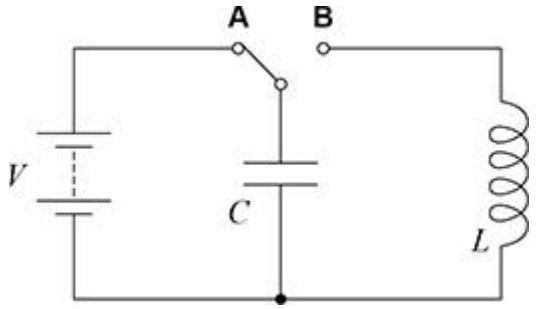
Q1.

Figure 1 shows an LC circuit that produces electrical oscillations when the switch is moved from position **A** to position **B**.

Figure 1



(a) Which quantity in the LC circuit is analogous to the mass in a mass–spring system?

Tick (✓) **one** box.

C ☐

$\frac{1}{C}$ ☐

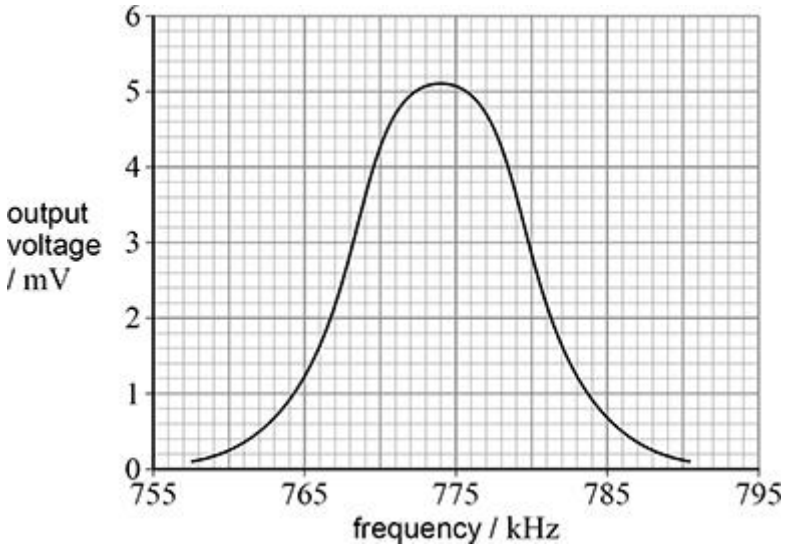
L ☐

$\frac{1}{L}$ ☐

(1)

(b) A radio receiver uses a parallel LC tuned circuit to select a radio station. **Figure 2** shows the response of the tuned circuit.

Figure 2



Calculate the quality factor Q of the tuned circuit.

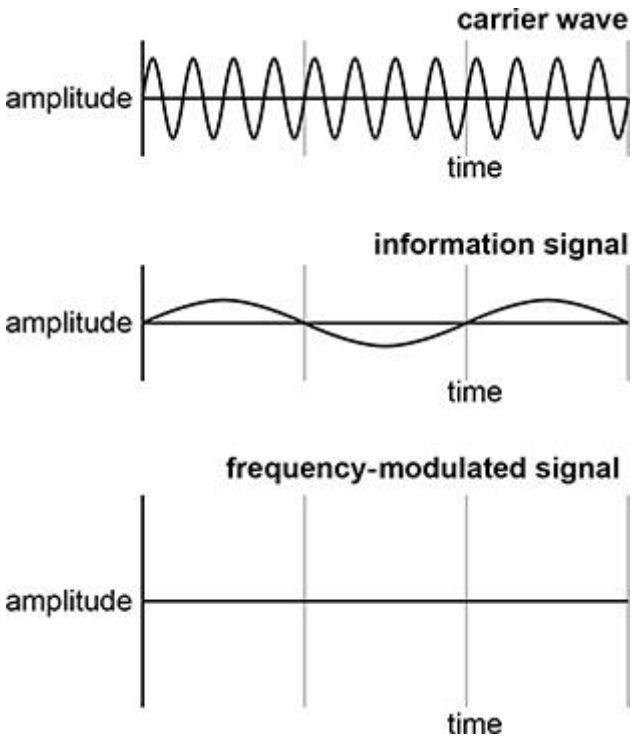
Q = _____

(3)

Another radio receiver is used to detect frequency-modulated (FM) radio waves.

Figure 3 shows the variation of amplitude with time for a carrier wave and an information signal.

Figure 3



(c) Sketch, on **Figure 3**, the graph that represents the frequency-modulated (FM) signal.

(2)

(d) An audio signal is transmitted on an FM music station. The transmission has a bandwidth of 186 kHz. The carrier wave has a maximum frequency deviation of 75 kHz.

Calculate the maximum frequency in the information signal.

maximum frequency = _____ kHz

(1)

(Total 7 marks)

Q2.

Several telephone conversations need to be transmitted simultaneously between two locations.

Describe the process that allows these conversations to be carried by the same optical fibre.

In your answer you should explain:

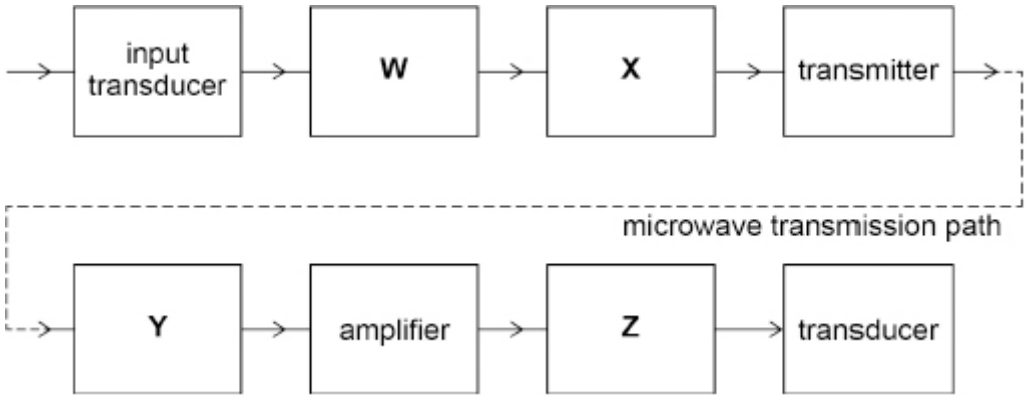
- the importance of the sampling rate in the analogue-to-digital conversion
- the effect of resolution in this conversion
- the technique that is used to enable several conversations to be transmitted simultaneously.

You may use diagrams to help with your explanation.

(Total 6 marks)

Q3.

(a) The figure below shows a block diagram for part of a communication system that transmits control information from Earth to a satellite.



Which row gives the functions of the boxes **W**, **X**, **Y** and **Z** in the figure above?

Tick ✓ **one** box.

W	X	Y	Z	
amplifier	modulator	demodulator	receiver	☐
modulator	amplifier	receiver	demodulator	☐
demodulator	amplifier	modulator	receiver	☐
amplifier	demodulator	receiver	modulator	☐

(1)

(b) Syncom 3 was the first geostationary communication satellite.
The satellite was used to broadcast television signals of the 1964 Olympic Games from Tokyo in Japan to Los Angeles in the USA.

State what is required so that de-sensing does not occur in a radio receiver such as that on Syncom 3.

_____

_____

_____

(1)

Commentators in Los Angeles interviewed athletes in Tokyo using Syncom 3.

The commentators found that there was a significant time delay between the end of each question and the arrival of its reply.

This time delay was made up of:

- the total time that the signals spent travelling
- the total processing time.

(c) The distance of the geostationary satellite from both Tokyo and Los Angeles was 40 000 km.

The time delay was 900 ms.

Calculate, in ms, the total processing time.

total processing time = _____ ms

(2)

(d) The television signals received in the USA were relayed to the UK using a satellite in low Earth orbit.
The availability of live coverage was different for viewers in the USA and viewers in the UK.

Explain why.

_____

_____

_____

_____

_____

_____

(2)

(e) For the 2020 Olympics, digital TV signals between Tokyo and Los Angeles used a fibre-optic cable. The cable lies on the seabed.

Explain why a fibre-optic cable rather than a satellite link is now preferred for intercontinental communication.

_____

_____

_____

_____

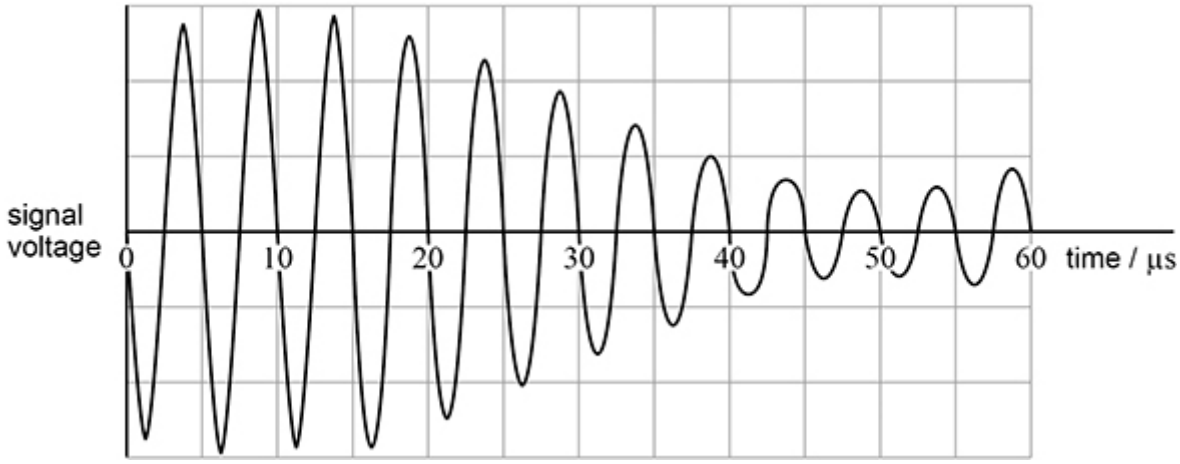
(2)

(Total 8 marks)

Q4.

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)

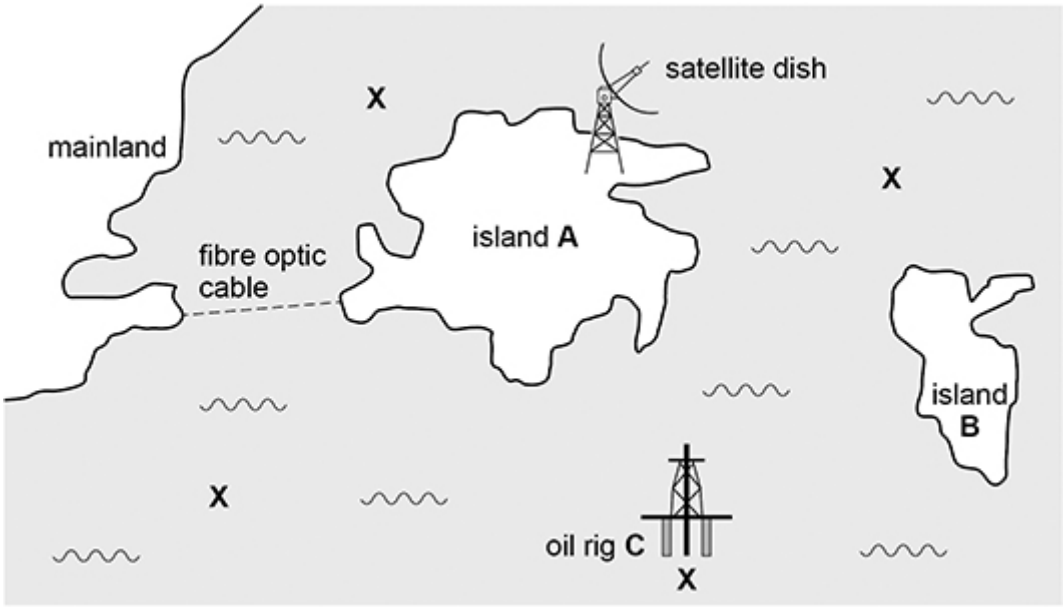
(Total 7 marks)

Q5.

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)