AQA A-LEVEL PHYSICS · 7408

PHYSICS



EXAM QUESTION PACK

3.13.6 DATA COMMUNICATION SYSTEMS

SCORE	PERCENTAGE
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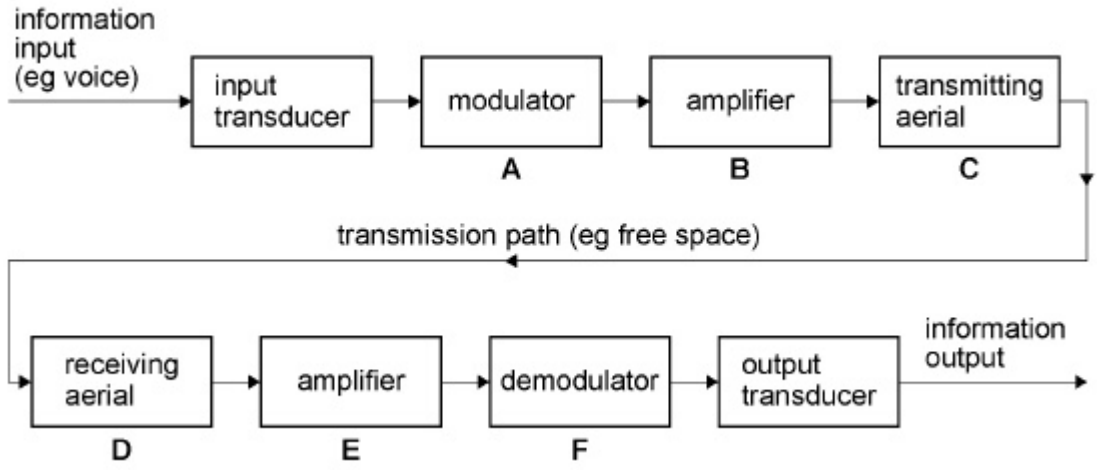
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Q1.

Figure 1 shows a block (subsystem) diagram for a radio communication system.

Figure 1



(a) State the letter representing the subsystem in which you might find an induced emf being generated.

(1)

(b) State the letter representing the subsystem where the audio and radio waves are combined.

(1)

(c) The signal strength at stage **D** must be amplified.

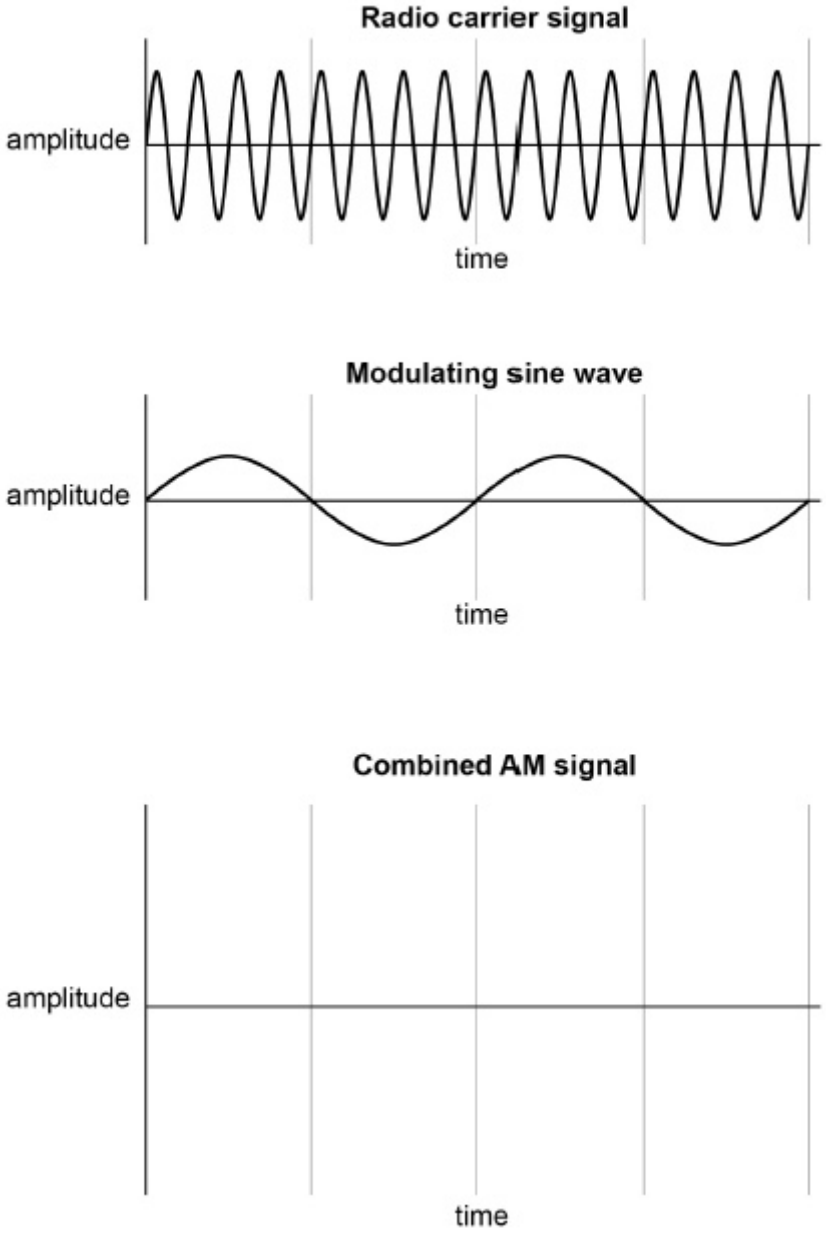
Explain why the signal strength at stage **D** is weak.

(1)

(d) **Figure 2** shows graphs of a radio carrier signal and a modulating sine wave.

Figure 2

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Complete the graph in **Figure 2** to represent the combined amplitude modulated (AM) signal.

(1)

(e) Approximately 20 radio stations use amplitude modulation (AM) to broadcast to people living in the London area. Another 35 AM stations broadcast to people outside the London area. However, these broadcasts can still be received in London.

The allocated frequency spectrum for all these broadcasts is in the range 540 kHz to 1600 kHz

Suggest whether all these stations can broadcast hi-fi music using the full audio frequency of 20 kHz

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(3)

(Total 7 marks)

Q2.

In a recording studio the output from a microphone is an analogue signal.
The equipment in the studio converts this analogue signal into a digital signal before storing it.

Discuss aspects of the analogue-to-digital conversion in this context.

In your answer you should include:

- what is meant by quantisation
- factors that affect the quality of the digital version of the analogue signal
- the advantages and disadvantages of digitising the analogue signal.

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

(Total 6 marks)

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Q3.

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)

Q4.

A student needs to monitor the temperature of a pond using a remote link. To provide the link the student decides to use radio transmitter and receiver modules.

The radio modules available to the student are available with either amplitude modulation (AM) or with frequency modulation (FM).

(a) Describe what is meant by amplitude-modulated and by frequency-modulated radio waves.

In your answer you should:

- indicate the principal features of each of these two types of modulation
- explain the differences between them
- refer to the advantages and disadvantages of using each type of modulation.

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(6)

(b) The radio modules chosen by the student transmit a signal that is amplitude modulated having a carrier frequency of 434 MHz. The data sheet for the modules specifies quarter-wave aerials for both the transmitter and receiver.

Calculate the length of a quarter-wave aerial.

length of aerial = _____ m

(2)

(c) The output from the temperature sensor in the pond is connected to an astable oscillator. The frequency f (in Hz) of the astable varies with temperature θ (in $^{\circ}\mathrm{C}$) according to the equation

$$f = 7.3(6\theta + 273)$$

During the course of the year the temperature of the pond varies between 4$^{\circ}\mathrm{C}$ and 22$^{\circ}\mathrm{C}$. The highest frequency produced by the astable is 3.0 kHz.

Calculate the lowest frequency in kHz produced by the astable.

lowest frequency = _____ kHz

(1)

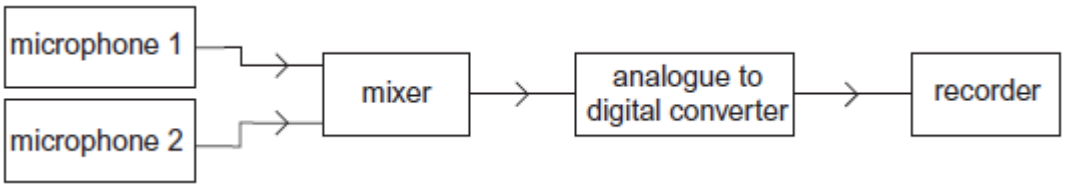
(d) Deduce the maximum bandwidth required by the AM carrier wave produced by the radio transmitter as the signal from the astable is transmitted.

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(2)
(Total 11 marks)

Q7.

The diagram shows a block diagram of an audio recording system.



(a) Explain the purpose of the mixer in this system.

_____

_____

(1)

(b) Suggest a type of recorder that may be used in this system.
Give **one** reason for your answer.

_____

_____

_____

_____

(2)

(c) Explain **one** advantage of including the analogue to digital converter in the system.

_____

_____

_____

_____

(2)
(Total 5 marks)

Q9.

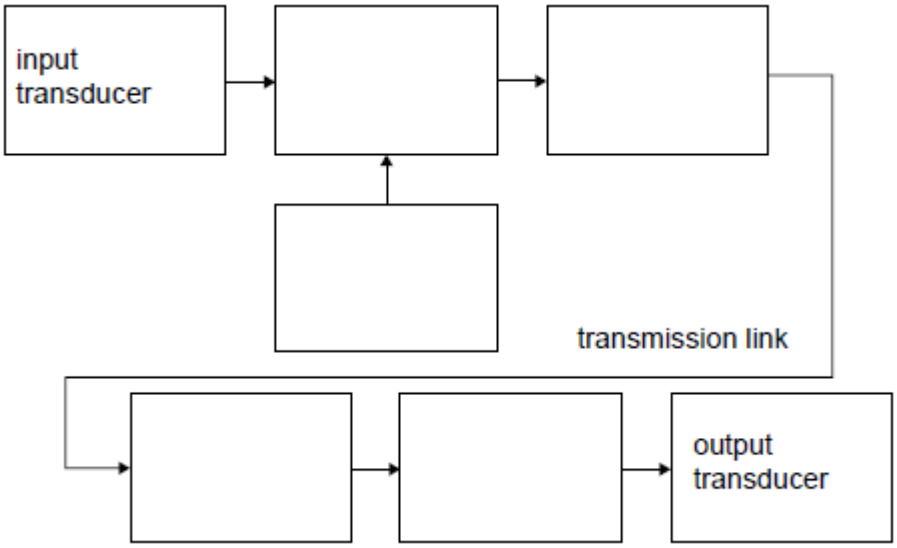
Figure 1 shows a block diagram of a generalised communications system.

(a) Complete the labelling of the block diagram, using the following terms:

carrier wave generator **demodulator** **modulator** **receiver** **transmitter**

Figure 1

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(2)

(b) Name **three** different media suitable for the transmission link.

1. _____

2. _____

3. _____

(3)

(c) (i) State the function of the modulator.

_____

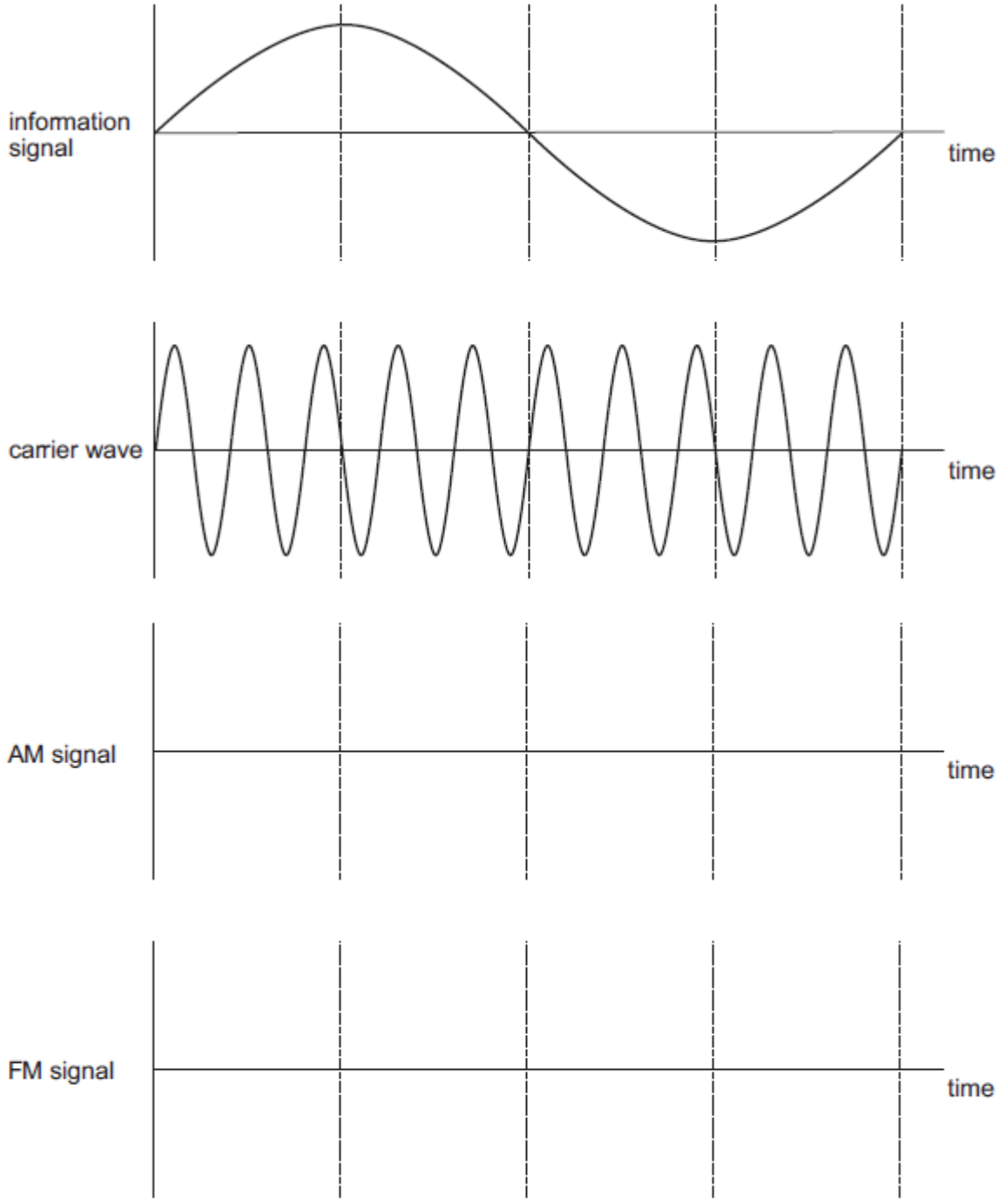
(1)

(ii) AM and FM are two types of modulation.
An information signal and a carrier wave are shown on the upper axes of **Figure 2**.

Draw on the lower axes the AM signal and the FM signal that these would produce.

Figure 2

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(4)

(Total 10 marks)

Q10.

The audio signals on an audio CD are digitally encoded. Part of the audio CD specification describes the encoding as:

'PCM with 16-bit values sampled at 44.1 kHz'.

(a) Explain why 44.1 kHz is a suitable sampling frequency for high quality audio recording.

_____

_____

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_____

_____

(3)

(b) Calculate the number of different voltage levels which can be detected in each sample.

_____

(1)

(c) The **quantisation error** is the voltage step difference between each level. The peak-to-peak signal voltage is 5 V.

Calculate the quantisation error for an audio CD.

_____

_____

(2)

(d) A call centre uses an audio CD to play music to callers while they are waiting for their calls to be answered. The telephone system operates in the frequency range 300 Hz to 3 kHz.

Describe **two** different effects this will have on the quality of the music the callers hear.

_____

_____

_____

_____

(2)

(Total 8 marks)

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