Standard Grade Physics

Number :

Name:

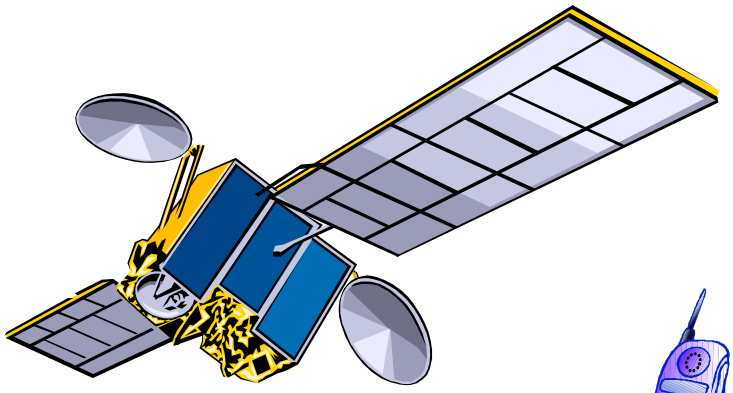
Thurso High School

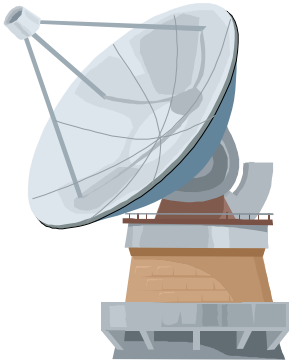
Physics Department

UNIT 1

TELECOMMUNICATIONS

PUPIL PACK





Study Guides
Summary Notes
Homework Sheets

TELECOMMUNICATIONS
Working at Home

TO THE PUPIL

Each day you have physics at school, you should set aside time for work at home. By this stage you should be accepting more responsibility for your own learning and should undertake the following tasks on a regular basis:

- Tackle the supplied homework sheets as each section of work is completed in class.
- Check your own progress in the homework sheets by referring to the homework answer files available in class. Discuss any difficulties that arise with your class teacher.
- Complete any formal homework tasks that your teacher may issue from time to time and hand them in on the due date for marking.
- Revise the work you have covered in class activities by referring to your classwork jotters.
- Complete the supplied summary notes as the coursework allows you to, then use the summary notes to help you in your revision of the course content.
- Make your own short notes to cover each learning outcome in the supplied study guides.

TO THE PARENT

Your co-operation would be appreciated in ensuring that pupils are encouraged to complete homework. It would be helpful if you could talk over the work given for homework and sign the homework record sheet on this page after they have completed each exercise.

The physics department hopes that this record of your child's achievement will be of interest to you, and we would welcome any comments on this or other areas related to the work of the department.

Please sign here to confirm that you have seen the homework record sheet: _____

HOMEWORK RECORD SHEET

HOMEWORK	SECTION OF WORK	MARK	CHECK	PARENTAL SIGNATURE
1.1	Communication Using Waves 1			
1.2	Communication Using Waves 2			
1.3	Communication Using Cables 1			
1.4	Communication Using Cables 2			
1.5	Radio and Television 1			
1.6	Radio and Television 2			
1.7	Transmission of Radio Waves 1			
1.8	Transmission of Radio Waves 2			

Some questions in the pack are marked with symbols to give you specific information. Here is the key:

Credit Level question. This relates directly to the Credit Level learning outcomes.

Problem Solving question. This puts the knowledge you have gained into new contexts.

TELECOMMUNICATIONS
Study Guide

Section 1 – Communication Using Waves

Since the earliest times, humans have tried to communicate with each other. The ability to communicate effectively is at the heart of civilisation. All of the early attempts at telecommunications relied on two types of waves: light and sound.

In this section, you will find out about communicating using sound and other waves, and you will also find out more about waves themselves.

At General level, by the end of this section you should be able to:

- ❑ 1. Give an example that shows the speed of sound in air is very much less than the speed of light in air.
- ❑ 2. Describe an experimental method for measuring the speed of sound in air.
- ❑ 3. Carry out calculations involving $speed = \frac{distance}{time}$ in problems on sound.
- ❑ 4. State that waves are one way of carrying signals.
- ❑ 5. Use each of these terms correctly with respect to sound: *wave*; *frequency*; *wavelength*; *speed*; *energy, energy transfer*; *amplitude*.
- ❑ 6. Carry out calculations involving $speed = \frac{distance}{time}$ in problems on water waves.
- ❑ 7. Carry out calculations involving *wavespeed = frequency x wavelength* in problems on both water and sound waves.

Additionally, at Credit level you should also be able to:

- ❍ 8. Explain why wavespeed can be calculated using either *frequency x wavelength* or $\frac{distance}{time}$.

Section 2 – Communication Using Cables

In some modern telecommunications systems, the messages are carried along cables. This could be electrical cables, such as in telegraph and telephone systems, or optical fibres. Optical fibres are lighter, cheaper and less prone to tapping or crossed lines, and so most telecommunications companies are adopting them nowadays.

As the information age takes off, we are going to rely heavily on optical fibres to bring the TV channels, phone messages, closed video captioning and Internet services that we will come to expect from our communications services.

At General level, by the end of this section you should be able to:

- ❑ 1. Describe how a message can be sent using a code – for example, Morse Code.
- ❑ 2. State the function of: *(a)* a transmitter; and *(b)* a receiver.
- ❑ 3. State that the telephone is an example of long range communication between a transmitter and receiver.
- ❑ 4. State the energy changes in: *(a)* a microphone; and *(b)* a loudspeaker.
- ❑ 5. State which device can be found in a telephone's: *(a)* earpiece; and *(b)* mouthpiece.
- ❑ 6. State that electrical signals can be transmitted along wires during a telephone call.
- ❑ 7. State that the speed of a telephone signal is very much greater than the speed of sound.
- ❑ 8. Describe the effect on a C.R.O. signal pattern due to a change in a sound's: *(a)* loudness; and *(b)* frequency.
- ❑ 9. Describe how these terms relate to sound signals: *frequency*; *amplitude*.
- ❑ 10. State what is meant by the term '*optical fibre'*.
- ❑ 11. Describe one practical use of optical fibres in telecommunications.
- ❑ 12. State that both electrical cable and optical fibres can be used in telecommunication systems.
- ❑ 13. State that light can be reflected.
- ❑ 14. Describe how a ray of light is reflected from a flat mirror with the help of the *Law of Reflection*.
- ❑ 15. State that light signals pass along an optical fibre at very high speeds.

Additionally, at Credit level you should also be able to:

- ❍ 16. Explain how changes in the loudness and frequency of a sound signal affect the corresponding electrical signal pattern.
- ❍ 17. Compare the properties of electrical cables and optical fibres.
- ❍ 18. Explain what is meant by *reversibility of light*.
- ❍ 19. Describe how an optical fibre transmission system works.
- ❍ 20. Carry out calculations using $speed = \frac{distance}{time}$ in problems on light travelling through optical fibres.

Section 3 – Radio and Television

Radio communication is used by millions of people for entertainment and for information. Radio is very important to the emergency services, and to the military. Most people use the television a lot, usually for entertainment, and often for news and other information. Television has become such an important part of society that it is often a person's main window on the world.

In this section, you will discover how a radio and a television work.

At General level, by the end of this section you should be able to:

- ❑ 1. Name the main parts of a radio receiver.
- ❑ 2. Identify these parts on a block diagram of a radio receiver.
- ❑ 3. Describe the function of each of these parts of a radio receiver.
- ❑ 4. Name the main parts of a television receiver.
- ❑ 5. Identify these parts on a block diagram of a television receiver.
- ❑ 6. Describe the function of each of these parts of a television receiver.
- ❑ 7. Describe how a picture is produced on a television screen in terms of line build-up.
- ❑ 8. Explain how colour pictures can be produced on a television screen using red, green and blue light.

Additionally, at Credit level you should also be able to:

- ❍ 9. Explain how radio transmission works using these terms: *transmitter*; *carrier wave*; *amplitude modulation*; *receiver*.
- ❍ 10. Explain how television transmission works using these terms: *transmitter*; *carrier wave*; *amplitude modulation*; *video and audio receivers*.
- ❍ 11. Describe how a moving picture is seen on a television screen using these terms: *line build-up*; *image retention*; *brightness variation*.
- ❍ 12. Describe the effects of mixing red, green and/or blue light.

Section 4 – Transmission of Radio Waves

A lot of the modern telecommunications systems use radio waves or microwaves to carry the information between the transmitter and receiver. To understand how these systems work, we have to first understand how the waves that carry the information behave. You will find out about the behaviour of waves in this section.

The first man-made satellite, "Sputnik I", was launched in 1957. Nowadays, several satellites are used to transmit thousands of phone calls and many television channels around the world (and all at the same time!)

In this section you will find out about the use of satellites to enable communication with all parts of the world, and about the aerials used to send and receive signals over long distances.

At General level, by the end of this section you should be able to:

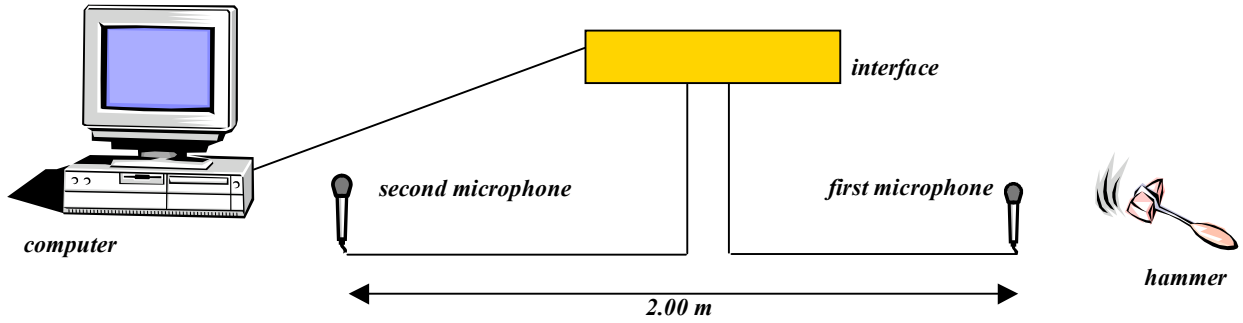
- ❑ 1. State that mobile telephones, radio and television are examples of long range communication which do not need cables between the transmitter and receiver.
- ❑ 2. State that microwaves, radio and television signals are waves that carry energy.
- ❑ 3. State that microwaves, television and radio signals travel at very high speeds.
- ❑ 4. State the speed of microwaves, television and radio signals through air.
- ❑ 5. State that a radio transmitter can be identified by wavelength or frequency values.
- ❑ 6. State the purpose of the curved reflector on certain aerials.
- ❑ 7. Explain the effect the curved reflector has on the received signal.
- ❑ 8. Describe one use of curved reflectors in telecommunications.
- ❑ 9. Say how a satellite's height affects the time it takes to complete an orbit around the earth.
- ❑ 10. Explain the meaning of the word *period*.
- ❑ 11. State the meaning of a *geostationary satellite*.
- ❑ 12. Describe how geostationary satellites and dish aerials can be used to allow satellite television broadcasting.
- ❑ 13. Describe how geostationary satellites and ground stations make intercontinental communications possible.

Additionally, at Credit level you should also be able to:

- ❍ 14. Carry out calculations involving the relationship between speed (v), distance (d) and time (t) in problems on microwaves, television and radio waves.
- ❍ 15. Carry out calculations involving the relationship between speed (v), wavelength (λ) and frequency (f) for microwaves, television and radio waves.
- ❍ 16. Explain some of the differences between radio bands in terms of source strength, ability to diffract, reflection, etc.
- ❍ 17. Explain how wavelength affects radio reception in terms of *diffraction*.
- ❍ 18. In addition to ***6*** above, explain the action of curved reflectors on certain transmitters.

Homework 1.1 - Communication Using Waves I

PS 1. A pupil reads about an experiment that can be carried out to measure the speed of sound in air. When the hammer hits the metal block a sound wave is produced. The computer is used to measure the time it takes for the sound wave to travel from one microphone to the other. The computer will display the time taken for the sound to travel this distance or it can be used to calculate the speed of sound directly.



The pupil carried out the experiment, and the time measured was 0.006 s.

(a) What other information does the computer need to calculate the speed of sound for her? (1)
(b) Find the speed of sound using the pupil's results. (1)
(c) The pupil found that the speed was not calculated properly when the experiment was done close to a wall. Suggest a reason for this. (1)

2. You see a flash of lightning, and then hear the thunder 6 seconds later. How far away (roughly!) is the thunderstorm? Take the speed of sound to be 340 m/s. (1)

PS 3. A person at the mouth of a cave shouts, and hears an echo from the back wall of the cave. Using a stopwatch, she times 1 second between shouting and hearing the echo. Calculate how far away the back wall of the cave is. Take the speed of sound to be 340 m/s. (3)

4. Copy and complete the following table. You **must** show all your working for each answer. (3)

SPEED	DISTANCE	TIME
10 m/s	100 m	
	3000 m	150 s
1.2 m/s		30 s

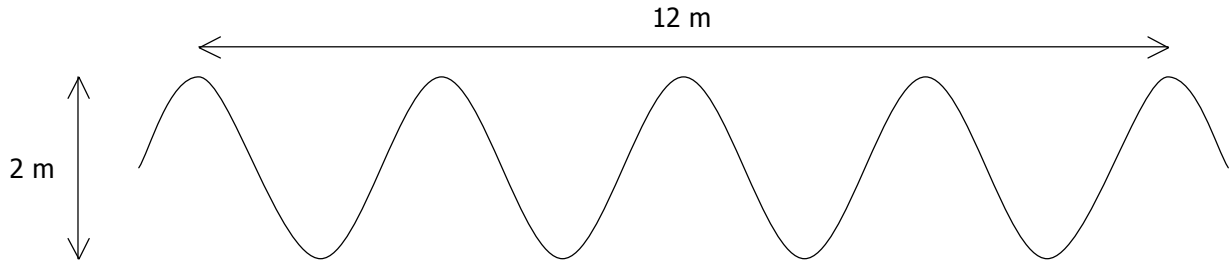
Total 10 marks

Homework 1.2 - Communication Using Waves II

1. Copy the table below and fill in the symbol, unit and definition for each term. (3)

WAVE TERM	SYMBOL	UNIT	DEFINITION
frequency			
wavelength			
speed			

2. The questions below refer to this diagram.



(a) Calculate the wavelength of the waves shown. (1)
PS (b) If the waves took 6 seconds to travel this distance, what is their frequency? (1)
(c) What is the amplitude of these waves? (1)
PS (d) Use the **wave equation** to calculate the speed of the waves. (2)

3. A wave of frequency 8 Hz has a wavespeed of 16 m/s.
What is its wavelength? (2)

Total 10 marks

Homework 1.3 - Communication Using Cables I

1. Messages can be sent down copper cables by code. Name one code that has been used for this. (1)

2. Copy the diagram of a telephone handset, and label these parts: (2)

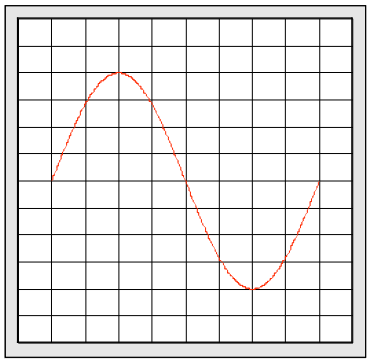
   transmitter; receiver; loudspeaker; microphone.

3. Write the main energy changes in:

   (a) a loudspeaker. (½)
   (b) a microphone. (½)

4. (a) What is the approximate speed of a telephone signal in a copper cable? (1)
   (b) What is the speed of the light signal in an optical fibre? (1)

5. Look at this diagram of a sound signal pattern displayed on an oscilloscope. Describe what would happen to its **frequency** *and* **amplitude** in each of the following situations:



   (a) The volume of the sound is increased. (1)
   (b) The pitch is increased, but the volume isn't changed. (1)
   (c) The pitch is decreased and the volume is decreased. (1)

6. What type of signal is used to carry telephone messages along a copper cable? (1)

Total 10 marks

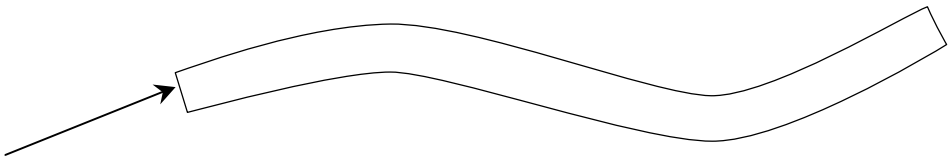
Homework 1.4 - Communication Using Cables II

1. (a) What is the law of reflection? (1)
   (b) Illustrate your answer to part *(a)* with a neat, labelled diagram. (2)

2. (a) What is an optical fibre? (1)
   (b) Give one example of a use for optical fibres in a **telecommunications system**. (1)

CR 3. Give two advantages of optical fibres over electrical cable. (1)

4. Copy the diagram, and complete it to show the path taken by the ray of light.
   Include normals and mark all angles. (2)



CR 5. An optical fibre is used to carry a telephone message to the USA from Scotland. It travels 5000 km. The light signals travel at a speed of 2×10^8 m/s. How long will this take? (2)

Total 10 marks

Homework 1.5 - Radio and Television I

1. (a) Copy the table below, and fill in the correct definition for each term: (3)

PART	FUNCTION
Aerial	
Tuner	
Decoder	
Amplifier	
Loudspeaker	
Electricity supply	

(b) Draw a block diagram to show how these parts of a radio receiver are connected together. (3)

CR 2. (a) Explain what is meant by amplitude modulation of a wave. (2)
(b) Draw a diagram to show an amplitude-modulated wave. (1)
PS (c) The radio frequency of the modulated wave is called the *carrier wave*. Why do you think it gets this name? (1)

Total 10 marks

Homework 1.6 - Radio and Television II

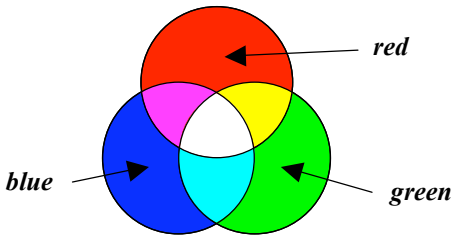
1. Describe how the electron gun in a cathode ray tube can produce a complete picture on a television screen. (2)

2. A colour television can produce millions of different colours on screen.

   (a) How many colours of paint are on a colour television's screen? (1)
   (b) Name these colours. (1)
   (c) How are these colours used to produce the millions of colours seen on screen? (1)

CR 3. How does a television show moving pictures? (2)

CR 4. (a) Copy and complete this diagram to show how red, green and blue light mix. You don't need to use coloured pencils – labels will do! (2)



PS (b) How is a black area produced on a television screen? (1)

Total 10 marks

Homework 1.7 - Transmission of Radio Waves I

1. (a) Name three forms of long range communication that don't use cables to carry the signals. (1)
   (b) How are signals transferred from transmitter to receiver for these systems? (1)

2. (a) Virgin Radio broadcasts on a frequency of 1215 kHz. What is the wavelength of these radio waves? (2)
   (b) Name two quantities that can be different for different radio signals. (1)

PS 3. The table below gives information about the main radio and television waves:

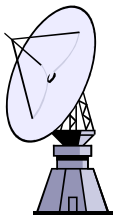
Frequency Range	Frequency	Wavelength Spread	Waveband	Range	Main Uses
30 Hz - 3 kHz	ELF	>100 000 m	---	---	Links to submarines
3 kHz - 30 kHz	VLF	100 000 - 10 000 m	---	>1500 km	long range navy & army use
30 kHz - 300 kHz	LF	10 000 – 1000 m	long wave	>1500 km	long range navy & army use
300 kHz - 3 MHz	MF	1000 – 100 m	medium wave	<1500 km	sound broadcasts
3 MHz - 30 MHz	HF	100 – 10 m	short wave	world wide	sound broadcasts
30 MHz - 300 MHz	VHF	10 – 1 m	ultra short	just beyond horizon	high quality sound
300 MHz - 3000 MHz	UHF	1 - 0.1 m	---	horizon	television or mobile link

   (a) What are ELF radio waves used for? (½)
   (b) Northsound Radio uses a frequency of 96.9 MHz. Which waveband does Northsound use? (½)
   (c) Calculate the wavelength of Northsound Radio waves. (2)

CR 4. A house in a hilly region can't get a good reception on the television, but radio reception is perfect. Explain why this is. (2)

Total 10 marks

Homework 1.8 - Transmission of Radio Waves II



1. Aerials picking up signals from a long distance away often have a curved reflector attached to them.

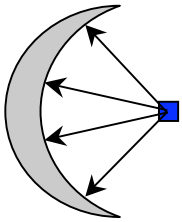
   (a) What is the purpose of the curved reflector? (1)
   (b) How does it do this? Include a diagram with your answer. (2)

2. The period of a geostationary satellite is 24 hours.

   (a) Explain what a geostationary satellite is. (1)
   (b) What is meant by the word *period*? (1)
   (c) How is a satellite's period affected by its height above the Earth? (1)

3. Draw a diagram to show how a telephone signal could be sent to America from Britain without the use of undersea cables. (2)

CR 4. Copy this diagram and complete it to show how the curved reflector helps produce a parallel beam of microwaves: (2)



Total 10 marks