Standard Grade Physics

Number :

Name:

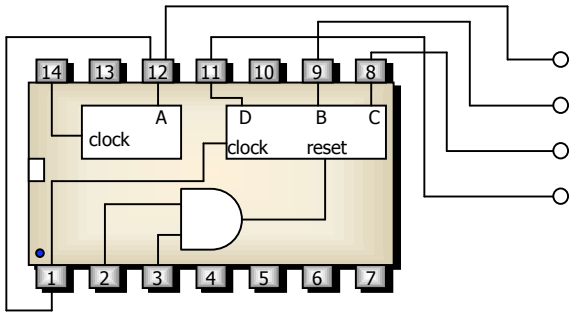
Thurso High School

Physics Department

UNIT 4

ELECTRONICS

PUPIL PACK



Study Guides
Summary Notes
Homework Sheets

ELECTRONICS
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
4.1	Overview 1			
4.2	Overview 2			
4.3	Output Devices 1			
4.4	Output Devices 2			
4.5	Input Devices 1			
4.6	Input Devices 2			
4.7	Digital Processes 1			
4.8	Digital Processes 2			
4.9	Analogue Processes 1			
4.10	Analogue Processes 2			

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

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

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

ELECTRONICS
Study Guide

Section 1 - Overview

The modern world is full of things that use electronics. Radios, televisions, calculators, computers, telephones, washing machines, autobanks and microwave ovens are just a few examples. In this unit, you will find out about some of the bits and pieces that are used in electronic devices. You will also be given the opportunity to design and build electronic circuits.

Some electronic systems are very complex, but you can get a very good idea of how the system works by thinking about it in three parts - INPUT, PROCESS and OUTPUT.

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

- ❑ 1. State that an electronic system can be described by three parts: *input*; *process*; *output*.
- ❑ 2. Distinguish between *digital* and *analogue* outputs.
- ❑ 3. Identify analogue and digital signals from oscilloscope traces.

Section 2 - Output Devices

There are many different types of output devices. Some turn information from an electronic system into a form we can easily understand. Often this involves an energy change. Other output devices allow electronic systems to control pieces of equipment.

In this section you will use a number of output devices.

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

- ❑ 1. Give examples of output devices, and state the energy changes involved.
- ❑ 2. Give examples of digital output devices and analogue output devices.
- ❑ 3. Draw and identify the symbol for an LED.
- ❑ 4. State that an LED will only light when it is connected one way round.
- ❑ 5. Explain why you need to connect a resistor in series with an LED.
- ❑ 6. State that different numbers can be produced by lighting up segments of a 7-segment display.

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

- ❍ 7. Choose the most appropriate output device for a given application.
- ❍ 8. Use a circuit diagram to show the correct way to connect up an LED to allow it to light.
- ❍ 9. Calculate the value of series resistor needed to protect an LED.
- ❍ 10. Calculate the decimal equivalent of a binary number in the range 0000 (*0*) to 1001 (*9*).

Section 3 - Input Devices

Any electronic system must be fed information in some way. This is the job of the input device. In this section, you will examine a number of input devices and use them in sensor circuits.

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

- ❑ 1. Describe the energy transformations in these devices:
  microphone;
  thermocouple;
  solar cell.
- ❑ 2. State how the resistance of a thermistor changes as the temperature changes.
- ❑ 3. State how the resistance of an LDR changes as the light intensity changes.
- ❑ 4. Carry out calculations using $V = IR$ for a thermistor and an LDR.
- ❑ 5. State that the voltage across a capacitor increases as time goes on whilst it is charging.
- ❑ 6. Choose an appropriate input device for an application from a list.

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

- ❍ 7. Carry out calculations involving voltages and resistances in a voltage divider.
- ❍ 8. State that the time taken to charge a capacitor depends on 2 things:
  resistance of the circuit;
  the value of the capacitor.
- ❍ 9. Choose the most appropriate input device for a given application.

Section 4 - Digital Processes

In sections 2 and 3 you found out about input and output devices. To make a useful electronic system, these have to be connected by a process device.

In this section, the first process device you will meet is the transistor. You will use it to make systems which can switch on lights or heaters automatically. Later, you will investigate the use of more complex process devices called gates.

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

- ❑ 1. State that the transistor may be conducting (*ON*) or non-conducting (*OFF*).
- ❑ 2. State that a transistor can be used as a voltage-controlled switch.
- ❑ 3. Draw and identify the circuit symbol for a transistor.
- ❑ 4. Work out, from a circuit diagram, the purpose of a simple transistor switching circuit.
- ❑ 5. Draw and identify the symbol for the following gates: *AND; OR; NOT*.
- ❑ 6. State what a truth table is.
- ❑ 7. State that:
  logic '1' = high voltage (usually 5V)
  logic '0' = low voltage (usually 0V)
- ❑ 8. Draw the truth table for the following gates: *AND; OR; NOT*.
- ❑ 9. Explain how to use combinations of these gates for simple control circuits.
- ❑ 10. State that a digital circuit can produce a series of clock pulses.
- ❑ 11. State that there are digital circuits which can count clock pulses.
- ❑ 12. State that the output of a counter circuit is in binary.
- ❑ 13. State that the output of a counter circuit can be converted to decimal.
- ❑ 14. Give an example of a device which contains a counter circuit.

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

- ❍ 15. In addition to ***4*** above, explain the operation of a transistor switching circuit.
- ❍ 16. Identify the following gates from truth tables: *AND*; *OR*; *NOT*.
- ❍ 17. Draw a truth table for a simple circuit containing a combination of gates.
- ❍ 18. Explain how a simple oscillator produces clock pulses.
- ❍ 19. Describe how to change the frequency of the clock.

Section 5 - Analogue Processes

The process devices in section 4 were digital devices. In those, the voltage changed in steps (OFF or ON). In analogue devices, the voltage changes smoothly.

In this section you will discuss the function of amplifiers.

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

- ❑ 1. Pick out some devices which amplifiers are an important part of from a list.
- ❑ 2. State the function of an amplifier in devices such as radios, intercoms and music centres.
- ❑ 3. State that an audio amplifier increases the amplitude of a signal but does not affect its frequency.
- ❑ 4. Carry out calculations involving input voltage (V_{in}), output voltage (V_{out}) and voltage gain of an amplifier.

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

- ❍ 5. Describe a method of measuring the voltage gain of an amplifier.
- ❍ 6. State that power can be calculated from V^2/R, where V is the voltage and R is the resistance of the circuit.
- ❍ 7. State that the power gain of an amplifier is the ratio of power output to power input.
- ❍ 8. Carry out calculations involving the power gain of an amplifier.

Homework 4.1 - Overview I

1. (a) Name the three parts of an electronic system. (1)
   (b) Draw a diagram to show how these parts are linked. (1)

PS 2. (a) Street lights come on automatically when it gets dark. A light sensor detects the light level, and a voltage controlled switch turns on a lamp when it gets dark enough.
   Show this system in a block diagram. (3)
   (b) A burglar alarm consists of a pressure pad to detect when someone treads on it connected to a bell. A voltage divider decides when the pressure is great enough to set off the alarm (this avoids small animals setting it off).
   Show this system in a block diagram. (3)

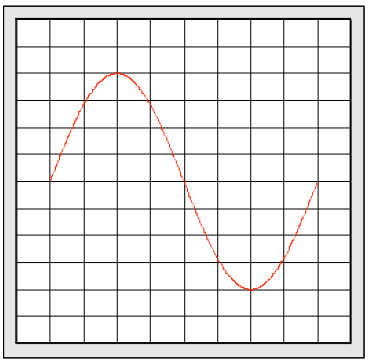
PS 3. (a) Name the process in a radio which makes the signal stronger before the loudspeaker changes it to a sound signal. (1)
   (b) What part of a radio is the input? (1)

Total 10 marks

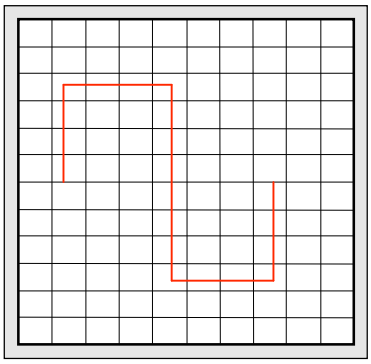
Homework 4.2 - Overview II

1. Study these two oscilloscope screens.

A



B



(a) State which one represents an analogue output and which a digital output. (1)
(b) Explain your answer to part *(a)*. (2)

2. Make a table with two columns headed **Analogue** and **Digital**. Place the following electronic devices into one of the two columns: (4)

mercury thermometer; electronic thermometer; computer; cassette recorder; radio; clockwork watch; moving-coil meter; video timer.

PS 3. What is the difference between an analogue watch and a digital watch? (2)

PS 4. CD players, hi-fi units and televisions all have amplifiers in them. The amplifier is a process device used to add energy to the input signal before it is output as sound.

Is an amplifier an analogue or a digital process? (1)

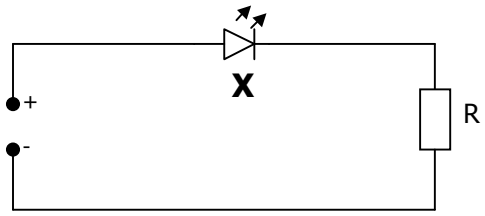
Total 10 marks

Homework 4.3 – Output Devices I

1. Copy and complete the following table: (5)

OUTPUT DEVICE	ENERGY CHANGE	SYMBOL
	Electrical →	
Motor	Electrical →	
	Electrical →	
Solenoid	Electrical →	
	Electrical →	

2. For each of the devices mentioned in the table above, state whether it is an analogue output or a digital output. (2½)

3. 

(a) Name the component marked **X** in the circuit. (½)
(b) What would happen in the circuit if component **X** was connected the opposite way around? (1)
(c) Why must there always be a resistor in series with this component? (1)

Total 10 marks

Homework 4.4 – Output Devices II

CR 1. An LED is attached to a 6 V supply. An excerpt from its data sheet is given below:

Maximum forward voltage: *2.7 V*
Maximum forward current: *110 mA*

(a) Draw a circuit diagram that will allow this LED to light safely. (3)
(b) Calculate the value of the resistor needed. (3)

2. (a) Why is a seven-segment display so-called? (1)
(b) Draw the numbers (i) 3; (ii) 9 as they'd appear on a seven-segment display. (1)
(c) What range of numbers can be displayed on a single seven-segment display? (1)

CR 3. What is the decimal equivalent of the binary number *0110*? (1)

Total 10 marks

Homework 4.5 – Input Devices I

1. Copy and complete the following table: (2)

INPUT DEVICE	ENERGY CHANGE
solar cell	→
	heat → electrical
microphone	→

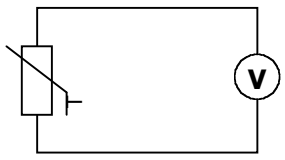
2. Sketch a graph to show how the resistance of an LDR might vary with light intensity. (2)

PS 3. A thermistor is placed in a beaker of water and its resistance measured with an ohmmeter at various temperatures. The following results are obtained:

TEMPERATURE(°C)	RESISTANCE (Ω)
0	980
10	600
20	375
30	300
40	240
50	160
60	108
70	75
80	53

(a) What is the resistance of the thermistor at 30 °C? (1)
(b) If the thermistor was connected to a 6V battery, how much current would flow through it at 30 °C? (2)

PS 4. A girl decides to find out how a thermistor could be used to investigate temperature changes. She sets up the following circuit:

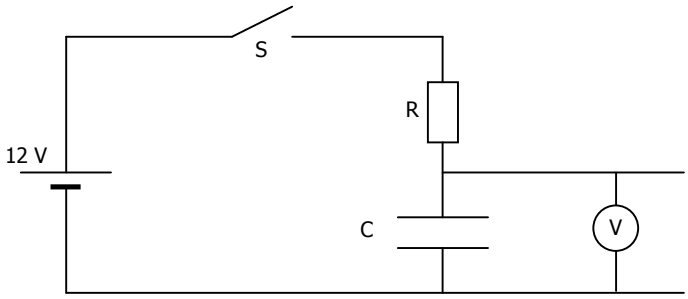


(a) Suggest why this circuit is not suitable for her purpose. (1)
(b) Explain how she could change the circuit, and redraw the amended version. (2)

Total 10 marks

Homework 4.6 – Input Devices II

1. Look at the following circuit. Capacitor **C** is initially discharged. Switch **S** is now closed



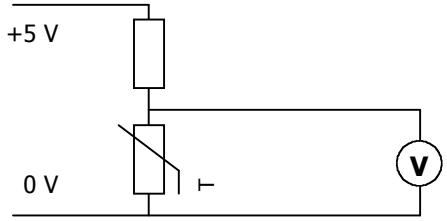
(a) What will the voltmeter read before the switch is closed? (1)
(b) What happens to the voltage as time goes on after the switch is closed? (1)
(c) State two changes that could be made to this circuit which would decrease the time taken for the capacitor to fully charge up. (1)

2. Use the following list of input devices to choose the most appropriate input for the following systems: (2)

microphone; thermocouple; solar cell; LDR; switch; voltage divider; capacitor; thermistor.

(a) Karaoke machine
(b) Automatic camera flash
(c) Temperature control in a fish tank
(d) Time delay switch on a burglar alarm

3. The circuit shown below was set up. The thermistor used has its resistance vary with temperature as show in the table. The fixed resistor has a value of 1000 Ω.



TEMPERATURE (°C)	RESISTANCE (Ω)
20	1000
50	700
100	100

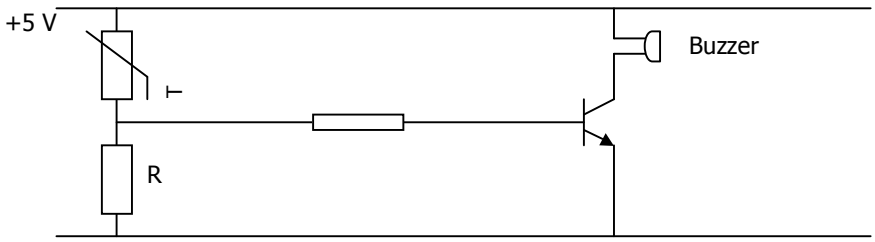
(a) What is the reading on the voltmeter at room temperature (20 °C)? (3)
(b) The thermistor is now heated to 100 °C. Calculate the new reading on the voltmeter. (2)

Total 10 marks

Homework 4.7 – Digital Processes I

1. (a) Draw the circuit symbol for a transistor. (1)
   (b) Give one use for a transistor in an electronic circuit. (1)

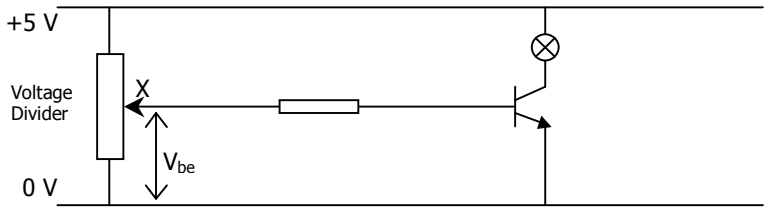
2. The circuit shown below is used as an alarm.



   (a) The thermistor is positioned in a car engine. At normal engine temperatures, the transistor is OFF. What will happen if the engine overheats? (1)

CR (b) Explain how the circuit works. (2)

PS 3. A transistor will switch on when a voltage is applied between the base and the emitter. An experiment is set up to investigate this as shown.



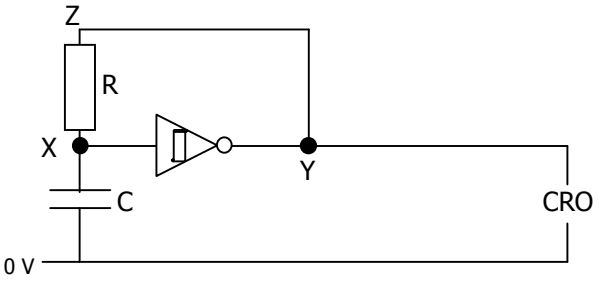
   If the transistor is just at the point of switching on, in which direction will the sliding contact X have to be moved in order to switch it on? Explain your answer. (2)

4. (a) Draw the circuit symbols for an **AND** gate, an **OR** gate, and a **NOT** gate. (1½)
   (b) Draw the truth table for each of these - remember to mark which is which! (1½)

Total 10 marks

Homework 4.8 – Digital Processes II

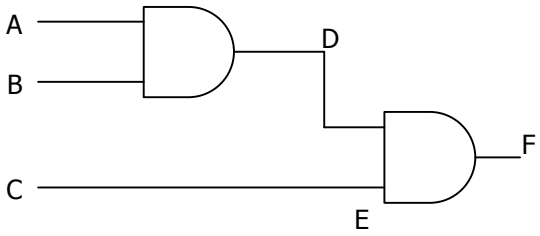
The circuit shown below is used to produce a series of pulses. Questions 1 and 2 both refer to it.



1. (a) Draw what will be seen on the oscilloscope screen (no numbers are necessary!) (1)
   (b) On the same diagram, use a different colour to draw what would be seen if there were more pulses produced each second. (1)

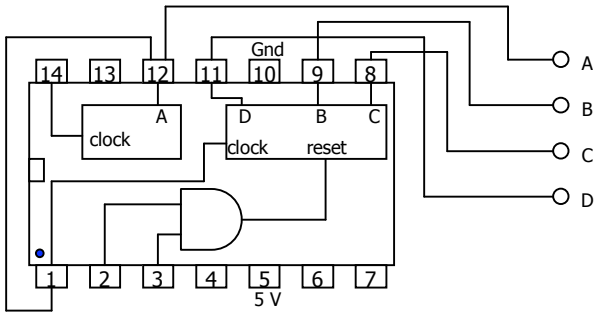
CR 2. (a) If you wanted more pulses each second, what two things could be altered in the circuit? (1)
   (b) If the capacitor is initially discharged, what is the voltage at **X**? (½)
   (c) What logic level does this represent? (½)
   (d) What will the logic level at **Y** be? (½)
   (e) What voltage does this produce at **Z**? (½)

CR 3. Look at the following circuit and then complete its truth table: (2)



A	B	C	D	E	F
0	0	0			
0	1	0			
1	0	0			
1	1	0			
0	0	1			
0	1	1			
1	0	1			
1	1	1			

PS 4. The diagram to the right shows the pin configuration for a 7493 integrated circuit, which is the basis for many counting circuits. Its outputs D, C, B and A will represent a binary number provided pin 12 is connected to pin 1 (as shown). No other connection should be made to pin 1.



   (a) To which two pins should a reset signal be applied? (1)
   (b) If the counter resets every 5th pulse, which two pins have been connected to the reset pins? Explain your answer. (2)

Total 10 marks

Homework 4.9 – Analogue Processes I

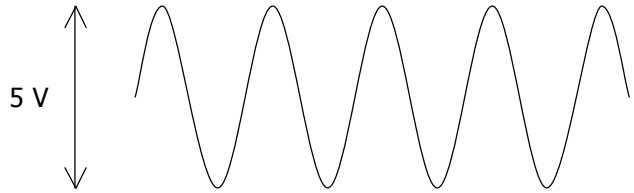
1. Using the list below, choose the devices that contain an amplifier: (2)

   television; radio; microwave oven; compact disc player; baby alarm; fridge; kettle; lamp.

2. (a) In a stereo, what does an amplifier do to the electrical signal? (1)
   (b) Where does the amplifier get the energy to do this? (1)
   (c) What wave property must the amplifier not affect? (1)

3. (a) What are the units of voltage gain? (careful!) (1)
   (b) State the equation used to calculate voltage gain. (1)
   (c) A baby alarm inputs a 0.01V voltage to an amplifier when a baby is crying, and the output voltage is 1V. Use the above equation to calculate the voltage gain of this amplifier. (1)

PS 4. A small amplifier in a physics lab has a voltage gain of 3. The following wave is fed to the amplifier from a signal generator. Calculate the output voltage from the amplifier, and draw the signal to the same scale. (2)



Total 10 marks

Homework 4.10 – Analogue Processes II

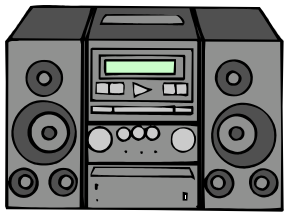
CR 1. Describe a method for measuring the voltage gain of an amplifier. You must name all equipment used, state what measurements are made and explain what calculations would have to be done. (3)

CR 2. Copy and complete the following table. You must do full working for each problem. (4)

VOLTAGE (V)	POWER (W)	RESISTANCE (Ω)
230		2000
12		24
50	25	
	14.4	10

CR 3. A power amplifier boosts a 0.5 W signal to 15 W. Calculate the power gain. (1)

CR 4. A small stereo has a power output of 30W. Its amplifier is rated as having a power gain of 1000. Calculate the size of the input power. (2)



Total 10 marks