basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

ELECTRICAL TECHNOLOGY (DIGITAL ELECTRONICS)

GUIDELINES FOR PRACTICAL ASSESSMENT TASKS

GRADE 12

2020

These guidelines consist of 50 pages.

TABLE OF CONTENT

1. INTRODUCTION

The 17 Curriculum and Assessment Policy Statements subjects which contain a practical component all include a practical assessment task (PAT). These subjects are:

- AGRICULTURE: Agricultural Management Practices, Agricultural Technology
- ARTS: Dance Studies, Design, Dramatic Arts, Music, Visual Arts
- SCIENCES: Computer Applications Technology, Information Technology, Technical Sciences
- SERVICES: Consumer Studies, Hospitality Studies, Tourism
- TECHNOLOGY: Civil Technology, Electrical Technology, Mechanical Technology and Engineering Graphics and Design

A practical assessment task (PAT) mark is a compulsory component of the final promotion mark for all candidates offering subjects that have a practical component and counts 25% (100 marks) of the end-of-the-year examination mark. The PAT is implemented across the first three terms of the school year. This is broken down into different phases or a series of smaller activities that make up the PAT. The PAT allows for learners to be assessed on a regular basis during the school year and it also allows for the assessment of skills that cannot be assessed in a written format, e.g. test or examination. It is therefore important that schools ensure that all learners complete the practical assessment tasks within the stipulated period to ensure that learners are resulted at the end of the school year. The planning and execution of the PAT differs from subject to subject.

Practical assessment tasks are designed to develop and demonstrate a learner's ability to integrate a variety of skills in order to solve a problem. The PAT also makes use of a technological process to inform the learner what steps needs to be followed to derive a solution for the problem.

The PAT consists of four or more simulations and a practical project. The teacher may choose any one of the practical projects and any four simulations available for power systems.

The teacher must apply assessment on an ongoing basis at the same time that the learner is developing the required skills. Four simulations should be completed by the learners, in addition to the manufacturing of a practical project.

The PAT incorporates all the skills the learner has developed throughout the year. The PAT ensures that all the different skills will be acquired by learners on completion of practical work, as well as the correct use of tools and instruments.

Requirements for Presentation

A learner must present the following:

- PAT file with all the evidence of simulations, design and prototyping. A copy of the PAT 2020 cover page. The relevant simulations and assessment sheets should be copied and handed to each learner to include in the file.
- Practical project with:
  - Enclosure:
    - The file must include a design.
    - The enclosure and the design must match.
    - No cardboard boxes are allowed.
    - Plastic and metal enclosures are acceptable.
    - The enclosure should be accessible for scrutiny inside.
    - Lids that are secured with screws are preferred.

- Circuit board:
  - The file should include the PCB design.
  - The PCB must be mounted inside the enclosure in such a manner that it can be removed for scrutiny.
  - Switches, potentiometers, connectors and other items must be mounted.
  - Wiring must be neat and bound/wrapped.
  - Wiring must be long enough to allow for the PCB to be removed and inspected with ease.
- Logo and name:
  - The file should contain the logo and name design.
  - Logo and name must be prominent on the enclosure.

The PAT will have a financial impact on the school's budget and school management teams are required to make provision to accommodate this particular expense.

PAT components and other items must be acquired timeously, for use by the learners, before the end of the first term at the start of the academic year.

It is the responsibility of the HOD to ensure that the teacher is progressing with the PAT from the start of the school year.

Provincial departments are responsible for setting up moderation timetables and consequently PATs should be completed in time for moderation.

2. TEACHER GUIDELINES

2.1 How to Administer PATs

Teachers must ensure that learners complete the simulations required for each term. The project should be started in January in order to ensure its completion by August. In instances where formal assessments take place, the teacher has to assume the responsibility thereof.

The PAT should be completed during the first three terms and must be ready at the start of PAT moderation. Teachers must make copies of the relevant simulations and hand it to learners at the beginning of each term.

The PAT must not be allowed to leave the workshop and must be kept in a safe place at all times when learners are not working on it.

The weightings of the PAT must be adhered to and teachers are not allowed to change weightings for the different sections.

2.2 How to Mark/Assess the PATs

The PAT for Grade 12 will be set and assessed internally, but moderated externally. All formal assessment will be done by the teacher.

The teacher is required to produce a **working model and model answer file** that sets the baseline for assessment at a Highly Competent Level for every project choice exercised by the learners. This file must include all the simulations with answers the teacher has done him/herself. The teacher will use the model answers and project to assess the simulations and projects of the learners.

Once a facet sheet has been completed by the teacher, assessment will be deemed to be complete. **No re-assessment will be done once the facet sheets have been completed** and captured by the teacher. Learners must ensure that the work is done to the required standard before the teacher finally assesses the PAT during each stage of completion.

2.3 PAT Assessment Management Plan

The assessment plan for the PAT is as follows:

TIME FRAME	ACTIVITY	RESPONSIBILITY
	Preparation for PAT 2020	Teacher – Builds the models and works out the model answers for the simulations for 2020. Identifies shortages in tools, equipment and consumable items for simulations that must be procured in 2020 SMT – Receives procurement requests from teachers and processes payments for the acquisition of required items
January–March 2020	Simulations 1 and 2	Teacher – Copies and hands out simulations Learners – Complete simulations Teacher – Assesses simulations HOD – Checks if tasks have been completed and marked by the teacher before the holiday
January 2020	PAT project – procurement	Teacher – Obtains quotations for PAT projects Principal – Approves PAT procurement for PAT projects Teacher – Ensures that PAT projects are ordered and delivered HOD – Checks in on teacher to see if the process is adhered to
February 2020	PAT project – learners commence with project	Teacher – Ensures that there is secure storage for PAT projects Teacher – Hands out and takes in PAT projects Teacher – Includes practical sessions for learners to complete the PAT project every week Learners – Commence with completion of the PAT project HOD – Checks in on teacher to ensure that practical workshop sessions take place on a weekly basis
April–June 2020	Moderation of Simulations 1 and 2	District subject facilitator/subject specialist will visit the school and moderate Simulation 1 and 2 10% of learners' work is moderated
April–June 2020	Simulations 3 and 4	Teacher – Copies and hands out simulations Learners – Complete simulations Teacher – Assesses simulations HOD – Checks if tasks have been completed and marked by the teacher before the holiday
April–June 2020	PAT project – learners continue with project	Teacher – Ensures that there is secure storage for PAT projects Teacher – Hands out and takes in PAT projects Teacher – Includes practical sessions for learners to complete the PAT project every week Learners – Continue with completion of the PAT project HOD – Checks in on teacher to ensure that practical workshop sessions take place on a weekly basis
July holidays 2020	PAT intervention	Learners that are behind on the PAT are required to complete the project during this holiday.
July–August 2020	Moderation of Simulations 3 and 4	District subject facilitator/subject specialist will visit the school and moderate Simulations 3 and 4 – different learners from the previous term 10% of learners' work is moderated
July–August 2020	PAT project – completion	Teacher – Ensures that there is secure storage for PAT projects Teacher – Hands out and takes in PAT projects Teacher – Completes the PAT project with learners and compiles the PAT file Learners – Complete the PAT project and file HOD – Checks to see that 100% of the PAT files and projects are completed and assessed
September–October 2020	PAT moderation	PAT projects are moderated by subject facilitators/subject specialists from the province and learners are available to demonstrate skills 10% of learners are moderated randomly

2.4 Moderation of PATs

Provincial moderation of each term's simulations will start as early as the following term. Simulations 1 and 2 should be moderated as soon as the second term starts. Similarly, Simulations 3 and 4 will be moderated in July. The project will, however, only be moderated on completion.

During moderation of the PAT the learner's file and project must be presented to the moderator.

The moderation process is as follows:

- During moderation, learners are randomly selected to demonstrate the different simulations. All four simulations will be moderated.
- **The teacher is required to build an exemplar model for each project type chosen for the school.**
- **This model must be on display during moderation.**
- **The teacher's model forms the standard of the moderation at Level 4 (Highly Competent).**
- **Level 5 assessments must exceed the model of the teacher in skill and finishing.**
- Learners who are moderated will have access to their files during moderation and may refer to the simulations they completed earlier in the year.
- Learners may NOT ask assistance from other learners during moderation.
- All projects and files must be on display for the moderator.
- **If a learner is unable to repeat the simulation or cannot produce a working circuit during moderation, marks will be deducted and circuits assessed as not being operational.**
- The moderator will randomly select no fewer than **two projects** (not simulations) and the learners involved will have to explain how the project was manufactured.
- Where required, the moderator should be able to call on the learner to explain the function and principles of operation, and request the learner to exhibit the skills acquired through the simulations for moderation purposes.
- On completion the moderator will, if needed, adjust the marks of the group upwards or downwards, depending on the outcome of moderation.
- Normal examination protocols for appeals will be adhered to, if a dispute arises from adjustments made.

2.5 Absence/Non-submission of Tasks

The absence of a PAT mark in Electrical Technology without a valid reason: The learner will be given three weeks before the commencement of the final end-of-year examination to submit outstanding task. Should the learner fail to fulfil the outstanding PAT requirement, such a learner will be awarded a zero (0) for that PAT component.

2.6 Simulations

Simulations are circuits, experiments and tests/tasks which the learner will have to build, test and measure and practically do as part of the development of practical skills. These skills have to be illustrated to the external moderator that visits the school at intervals during the school year.

Teachers who make use of simulation programs on a computer may use it for the learners to practice on. However, it is required that the circuit be built using real components and that measurements be made with actual instruments for the purposes of assessment and moderation.

The correct procedure for completing simulations is outlined below for teachers and school management teams who are responsible for the implementation of the PAT in Electrical Technology.

STEP 1: The teacher will choose simulations from the provided examples.
STEP 2: Compile a list of the components needed for every simulation. Add extra components as these items are very small and you will need extras, as these items get lost/damaged very easily when learners are working with it.
STEP 3: Contact three different electronics component suppliers for comparative quotations.
STEP 4: Submit the quotations to the SMT for approval and procurement of the items.
STEP 5: Place the components in storage. Collate items for each simulation, thus making it easier to distribute and use during practical sessions. Ensure that different values of components do not mix, as this would lead to components being used incorrectly and this could damage the component and in extreme cases, the equipment used.
STEP 6: Copy the relevant simulations and hand them out to learners at the start of the term.

Teachers are allowed to adjust circuits and component values to suit their environment/ resource availability.

Teachers are required to develop a set of model answers in the teacher's file.

Moderators will use the teacher's model answers and artefacts when moderating.

2.7 Projects

The projects are construction projects teachers can choose for their learners. These projects are based on proven circuits provided from schools and subject advisors. The projects are based on working prototypes and require careful construction in order for it to operate correctly.

Projects are varied in cost and teachers must ensure that the projects chosen fall within the scope of the school's budget.

Once the teacher has decided on a circuit, he/she must construct the prototype. Thereafter, copies of the provided circuit can be made and distributed to learners. They MUST redraw these circuits in their file correctly.

The description of the operation of the circuits is NOT complete. It is required of learners to interrogate the function of the components in the provided circuit. They should elaborate on the purpose of components in the circuit. It is recommended that those learners investigate similar circuits available on the internet and in the school library or workshop reference books.

2.8 Working Mark sheet

(A working Excel file is provided with this PAT)

PAT Mark Sheet		Term 1		Term 2		Project		Total = Term1 + Term 2 + Project 250	Mark out of 100	Moderated Mark
No.	Name of Learner	Simulation 1 40	Simulation 2 40	Simulation 3 40	Simulation 4 40	Design and Make Part 1 70	Design and Make Part 2 20			
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										
	Total									
	Average									

Teacher Name: _____ Principal Name: _____ Moderator Name: _____

Signature: _____ Signature: _____ Signature: _____

Date: _____ Date:_____ Date:_____

School Stamp

3. LEARNER GUIDELINES

PAT 2020 cover page (Place this page at the front of the PAT.)

Department of Basic Education
Grade 12
CAPS for Technical High Schools
Practical Assessment Task – Electrical Technology

Time allowed: Terms 1–3 (2020)

Learner Name: _____

Class: _____

School: _____

Specialisation: DIGITAL ELECTRONICS

Complete FOUR simulations.

Project (Write the name of the project): _____

Evidence of moderation:

NOTE:
When the learner evidence (LE) selected has been moderated at school level, the table will contain evidence of moderation. Provincial moderators will sign the provincial moderation and only sign if re-moderation is needed.

Moderation	Signature	Date	Signature	Date
School-based				
Provincial moderation			Re-moderation	

Mark allocation

PAT Component	Maximum Mark	Learner Mark	Moderated Mark
Simulation 1	40		
Simulation 2	40		
Simulation 3	40		
Simulation 4	40		
Design and Make Project – Circuit	70		
Design and Make Project – Enclosure	20		
Total	**250**		

3.1 Instructions to learner

- The practical assessment task counts 25% of your final promotion mark.
- All work produced by you must be your own effort. Group work and co-operative work is not allowed.
- The practical assessment task must be completed over three quarters.
- The PAT file must contain 4 simulations and a practical project.
- Calculations should be clear and include units. Calculations should be rounded off to TWO digits. SI units should be used.
- Circuit diagrams can be hand-drawn or drawn on CAD. No photocopies or scanned files are allowed.
- Photos are allowed and can be in colour or greyscale. Scanned photos and photocopies are allowed.
- This document must be placed inside your PAT file together with the other evidence.
- Learners with identical photos will be penalised and receive zero for that section

3.2 Declaration of Authenticity (COMPULSORY)

Declaration: I _____ herewith declare that the work represented in this evidence is entirely my own effort. I understand that if proven otherwise, my final results may be withheld.

_____ _____
Signature of learner Date

4. SIMULATIONS

4.1 Simulation 1: 741 Op-Amp and 555 IC

Name of learner: _____	
Class: _____ **Date Completed:** _____	**Mark** _____ 40
Date Assessed: _____	Assessor Signature: _____
Date Moderated: _____	Moderator Signature: _____

PURPOSE:

Construct a simple circuit **using the 741 op-amp to build a non-inverting amplifier** and display the input/output waveforms on an oscilloscope

Activity 1A: Construct a circuit using the 741 op-amp.

REQUIRED RESOURCES:

TOOLS/INSTRUMENTS	MATERIALS
Analogue/Digital trainer Analogue/Digital oscilloscope Function generator Variable DC power supply Side cutters Wire stripper	1 x LM741 IC 1 x 1 KΩ resistor 1 x 10 KΩ resistor Connecting wires

PROCEDURE:

1. Construct the circuit as in FIGURE 1.1 on the breadboard.

Learner was able to construct a minimum part of the circuit correctly without assistance	Learner was able to construct a part of the circuit correctly without assistance	Learner was able to construct the circuit correctly without assistance
1	3	4

(4)

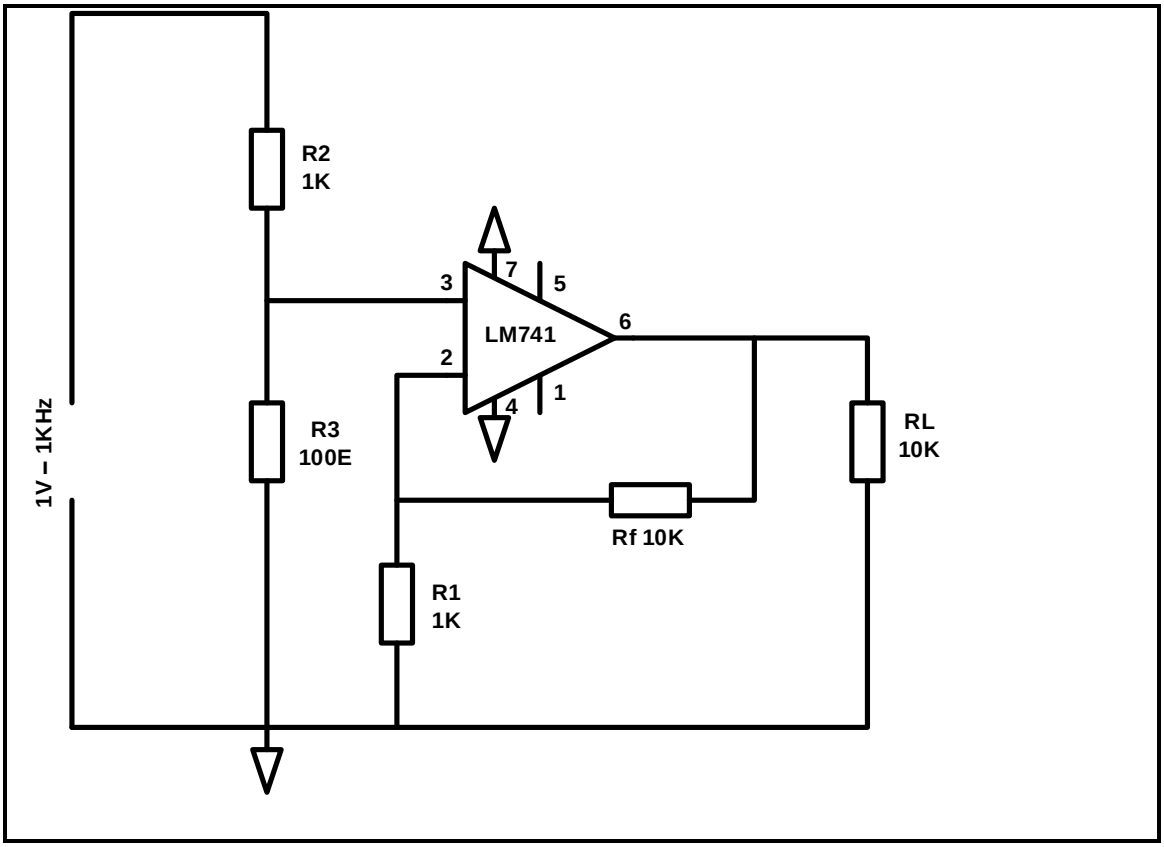


FIGURE 1.1

2. Connect the function generator between ground and Vin. (1)

3. Connect channel 1 to the input and channel 2 to the output.

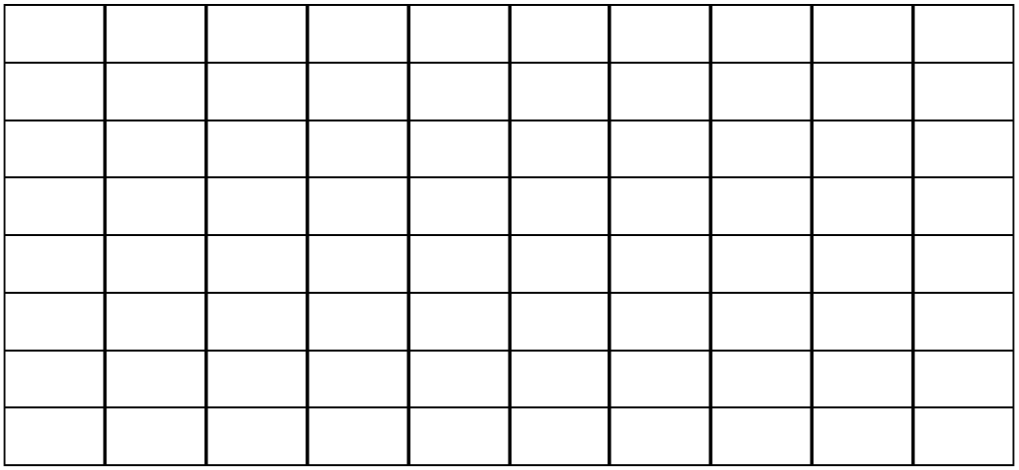
4. Set the function generator to give a sine wave output. (1)

5. Adjust the function generator to 1 000 Hz (1 kHz) at a voltage of 1 V peak. (1)

6. Switch on the power to the circuit and observe the input and output waveforms.

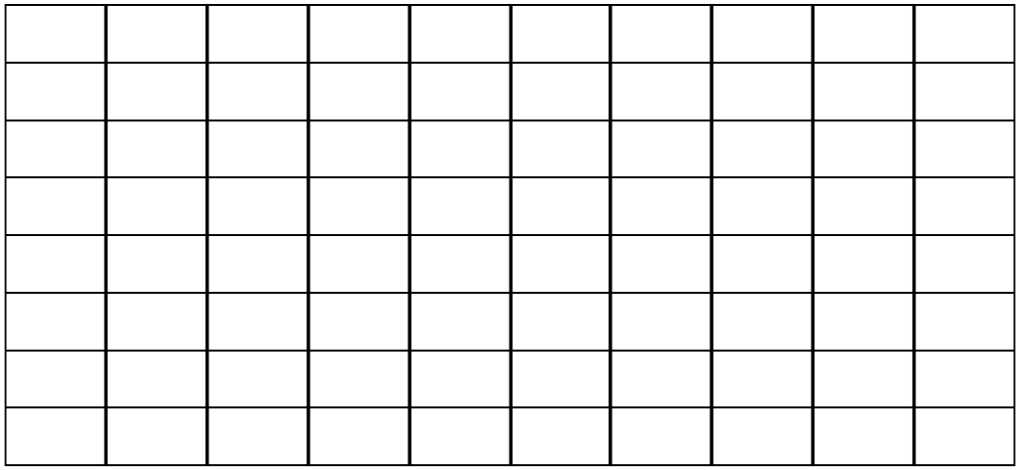
7. Draw the input and output waveforms.

INPUT WAVEFORM



_____V/Div _____µs/Div (3)

OUTPUT WAVEFORM



_____V/Div _____µs/Div (3)

QUESTIONS

1. Calculate the gain of the amplifier with the given resistor values. (3)

2. State how the gain of the amplifier will be affected if the feedback resistor is halved. (2)

Learner did not do any housekeeping duties	Learner did housekeeping after being reminded	Learner did housekeeping without being reminded
1	2	3

(3)

Subtotal – Activity 1A [21]

Activity 1B: Construct a clock pulse circuit using the 555 IC

PURPOSE

Construct a simple circuit using the **555 IC** to build a clock pulse generator **(astable multivibrator)** and display the output waveforms on an oscilloscope.

REQUIRED RESOURCES

TOOLS/INSTRUMENTS	MATERIALS
Analogue/Digital trainer Analogue/Digital oscilloscope Function generator Variable DC power supply Side cutters Wire stripper	1 x 555 timer IC 1 x 220 Ω resistor 1 x LED 1 x 10 KΩ resistor 1 x 100 KΩ pre-set POT 1 x 10 µF (electrolytic capacitor 16 V) Connecting wires

PROCEDURE

1. Construct the circuit, as in FIGURE 1.2, on the breadboard.

Learner was able to construct a minimum part of the circuit correctly without assistance	Learner was able to construct a part of the circuit correctly without assistance	Learner was able to construct the circuit correctly without assistance
1	3	4

(4)

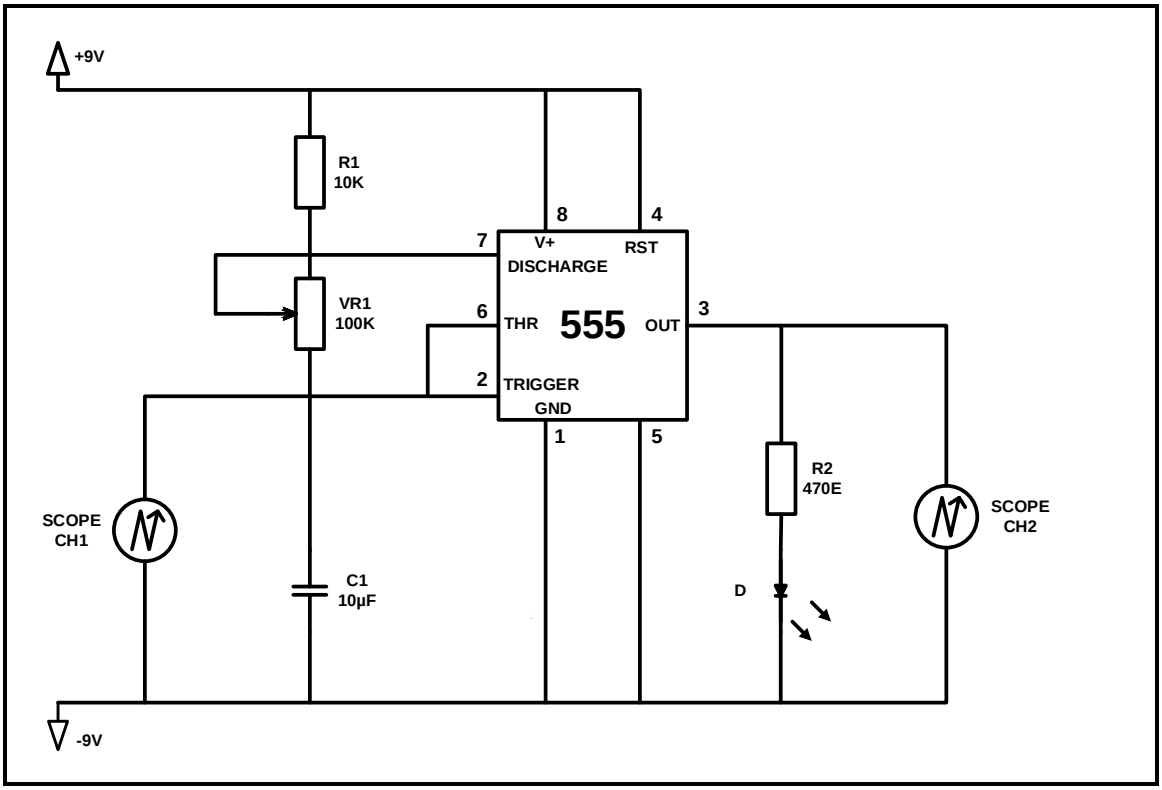


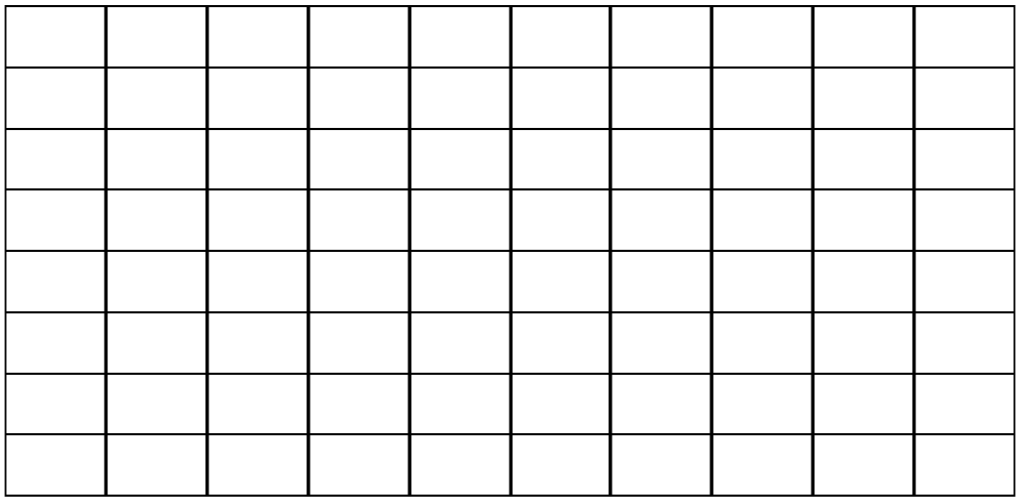
FIGURE 1.2

2. Connect channel 2 of the oscilloscope to the output.

3. Switch the power on to the circuit and observe the output waveform on the oscilloscope as well as the LED.

4. Draw the output waveforms observed on the oscilloscope on the grid provided.

OUTPUT WAVEFORM



(3)

QUESTIONS

1. List the components responsible for the frequency of the output. (3)

2. Calculate the charging time for the circuit using the given components. (3)

1	2	3
Learner did not do any housekeeping duties	Learner did housekeeping after being reminded	Learner did housekeeping without being reminded
The learner failed to get the output wave on the oscilloscope	The learner was able to set the oscilloscope and managed to get the output wave after the assistance from the teacher	The learner was able to set the oscilloscope and managed to get the output wave without the assistance of the teacher

(6)
[19]

Subtotal: Activity 1A (21)
Subtotal: Activity 1B (19)
Total: Simulation 1 (40)

4.2 Simulation 2: 741 op-amp Schmidt trigger and summing amplifier circuit

Name of learner: _____	**Mark:** _____ / 40
Class: _____ **Date completed:** _____	
Date assessed: _____	**Assessor signature:** _____
Date moderated: _____	**Moderator signature:** _____

PURPOSE

Construct a simple circuit using the using a 741 op-amp to build a Schmidt trigger circuit and a summing amplifier circuit and display output waveforms on an oscilloscope.

Activity 2A: Construct a Schmidt trigger circuit using the 741 op-amp.

REQUIRED RESOURCES

TOOLS/INSTRUMENTS	MATERIALS
Analogue/Digital trainer Analogue/Digital oscilloscope Function generator Variable DC power supply Side cutters Wire stripper	1 x LM741 op-amp 2 x 10 KΩ resistors 3 x 1 kΩ resistor 1 x 2k2 Ω resistor (pre-set POT) 1 x 100 kΩ resistor 1 x 1MΩ 1 x LED Connecting wires

PROCEDURE

1. Construct the circuit, as in FIGURE 3.1, on the breadboard.

Learner was able to construct a minimum part of the circuit correctly without assistance	Learner was able to construct a part of the circuit correctly without assistance	Learner was able to construct the circuit correctly without assistance
1	3	4

(4)

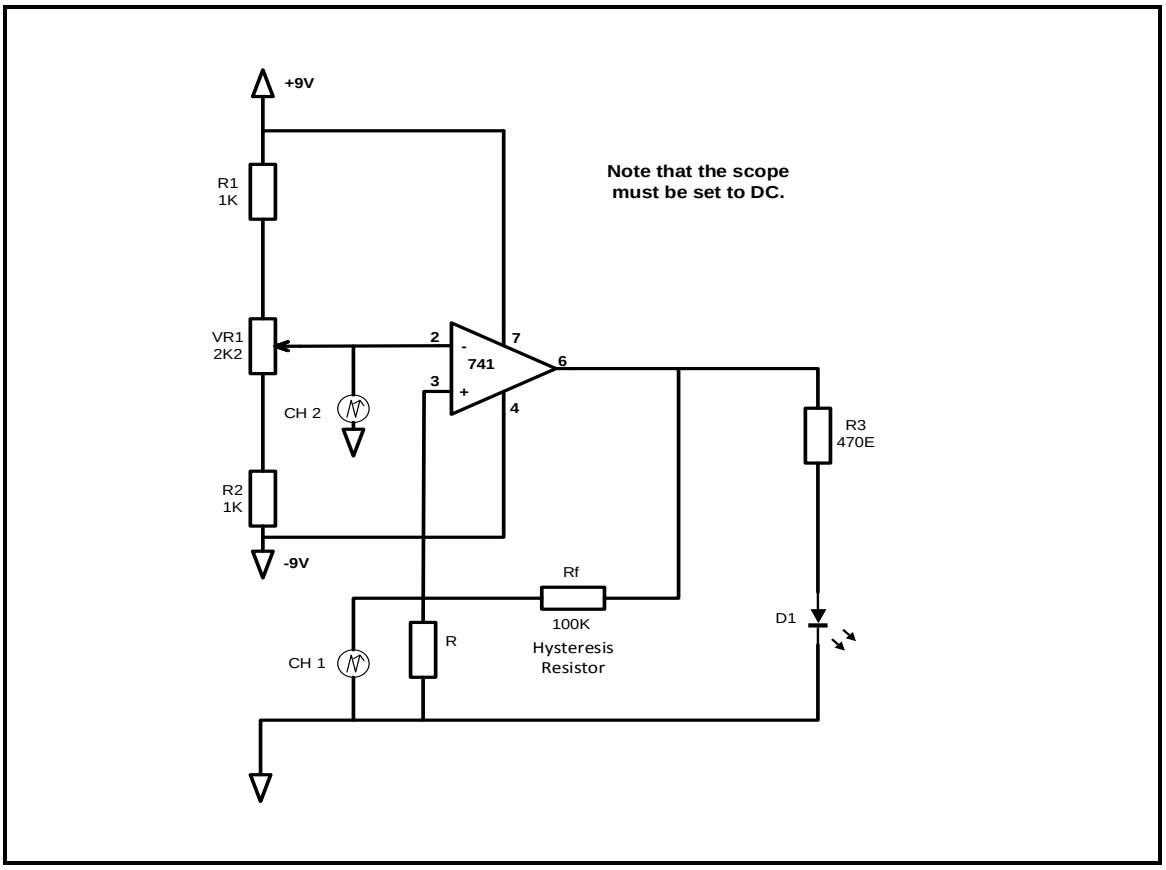


FIGURE 3.1

2. Adjust the potentiometer, while observing the output voltage.
The output switches to a HIGH when V**in** is _____V and to low when V**in** is_____V.
The hysteresis is _____V. (3)

3. Replace the 100k resistor with 10 k. Adjust the input potentiometer slowly.

4. While watching the LED on the output, can you change the output of the comparator to adjust the brightness of the LED? _____. (1)

The output now switches to high when input voltage is _____V and to low at _____V. (1)
The hysteresis is _____V. (2)

5. Replace the hysteresis resistor with 1 M.
The output now switches to a HIGH at _____V and to a LOW at _____ V. (2)
The hysteresis is _____V. (1)
Remove the hysteresis resistor and adjust the potentiometer slowly

_____
_____
_____
_____

6. **CONCLUSION:**

(3)

Learner did not do any housekeeping duties	Learner did housekeeping after being reminded	Learner did housekeeping without being reminded
1	2	4

(4)
[21]

ACTIVITY 2B: Constructing a summing amplifier circuit using the 741 op amp

REQUIRED RESOURCES

TOOLS/INSTRUMENTS	MATERIALS
Analogue/Digital trainer Analogue/Digital oscilloscope Function generator Variable DC power supply Wire-stripper Side cutters	6 x 1k Ω resistors 4 x 10 kΩ resistors 1 x 2k7 Ω resistor 3 x 2k2 Ω variable POTs 1 x LM 741 IC Connecting wires

PROCEDURE

1. Construct the circuit, as in FIGURE 3.2, on the breadboard.

Learner was able to construct a minimum part of the circuit correctly without assistance	Learner was able to construct a part of the circuit correctly without assistance	Learner was able to construct the circuit correctly without assistance
2	3	5

(5)

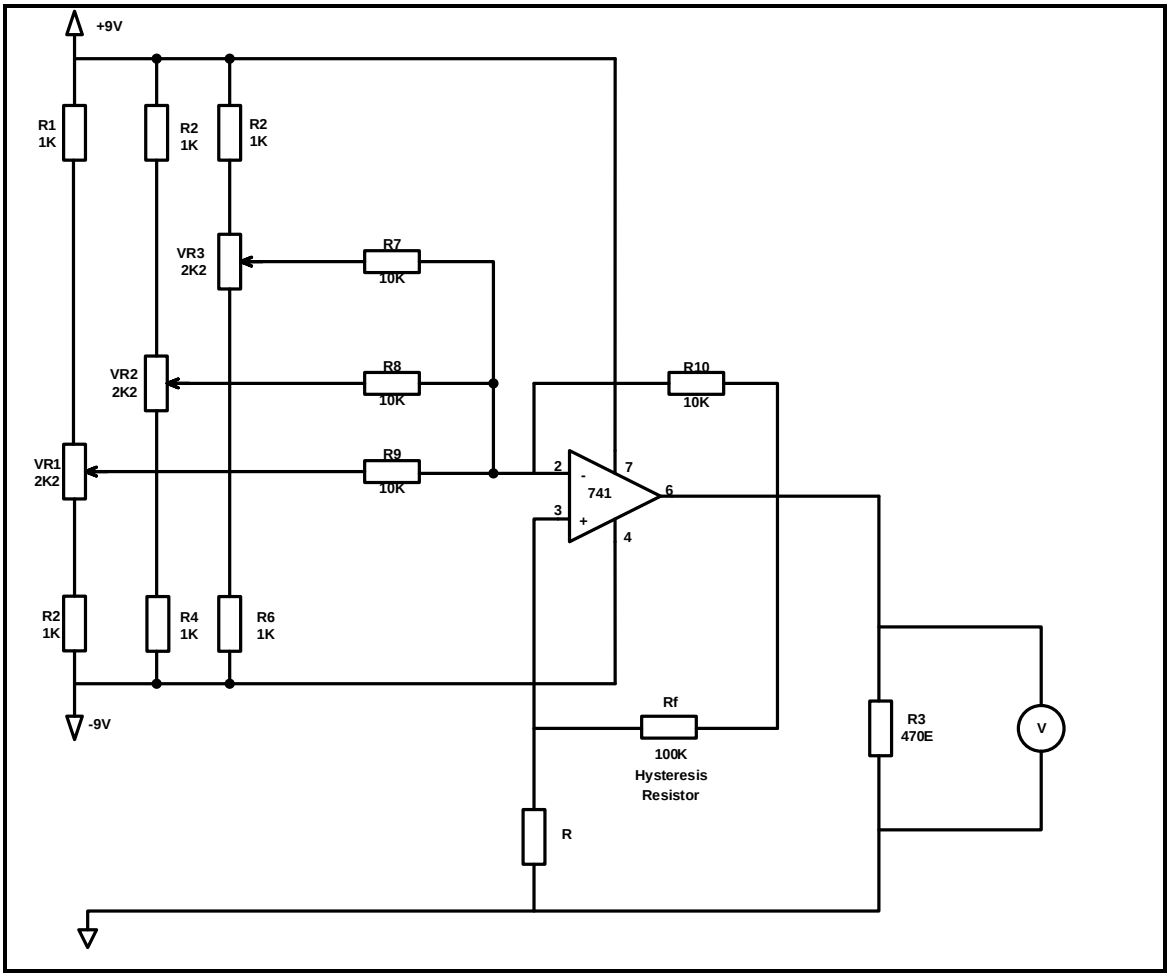


FIGURE 3.2

2. Use the 2k2 Ω POTs to set V1, V2 and V3 to the voltages as indicated in the table below. Measure the output values and populate the table below.

3.

V_1	+	V_2	+	V_3	=	V_{out}
3	+	2.5	+	1.75	=	
1.5	+	-4	+	2.2	=	
5	+	-4.5	+	1	=	
-4	+	1.5	+	2.5	=	
-1.5	+	-2.25	+	-3.25	=	

(5)

4 **CONCLUSION:**

_____
_____
_____
_____
_____

(5)

Learner did not do any housekeeping duties	Learner did housekeeping after being reminded	Learner did housekeeping without being reminded
1	2	4

(4)
[19]

Subtotal: Activity 2A (21)
Subtotal: Activity 2B (19)
Total: Simulation 2 [40]

4.3 Simulation 3: 741 bi-stable multivibrator

Name of learner: _____	**Mark:** _____ / 40
Class: _____ **Date completed:** _____	
Date assessed: _____	**Assessor signature:** _____
Date moderated: _____	**Moderator signature:** _____

PURPOSE

- To study the 741 bi-stable multivibrator as a practical circuit.
- To build a bi-stable multivibrator with the 741 op-amp.
- To compare the theory learned in class with the actual circuit.

RESOURCES

TOOLS/INSTRUMENTS	MATERIALS
Experiment board Voltmeter Dual power supply 9 V 0–9 V Side cutters Long-nose pliers Wire stripper	1 x 741 op-amp dip8 1 x 560 Ω resistor 3 x 1 kΩ resistors 2 x 470 Ω resistors 1 x 10 µF capacitor 1 x red LED 1 x green LED 2 x push button/tactile switches Connecting wires

PROCEDURE

1. Build the circuit diagram in FIGURE 3.1 on your experiment board. After you switch on the circuit press switch (SW1).
   Connect channel 1 of the oscilloscope to pin2 of the 741 IC.
   Connect channel 2 of the oscilloscope to pin 6 of the 741 IC.
   Set the T/div setting to 1s/div and answer the questions that follow.
   Take note of the polarity of the input pulses, output signal and which LED is ON.

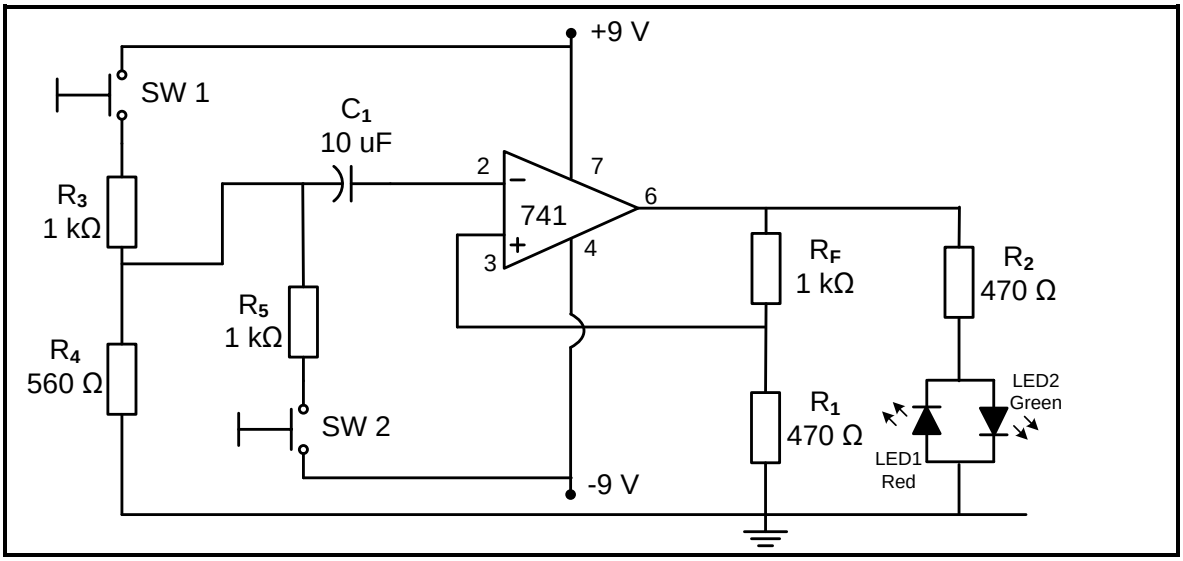


FIGURE 3.1: 741 BISTABLE MULTIVIBRATOR

OBSERVATIONS

2. Press switches S_1 and S_2 respectively. Write down the polarity of the input pulses and output when the switches are pressed. (4)

	Polarity of input pulse	**Polarity of output signal**
S_1		
S_2		

3. Which LED is ON when S_1 is pressed? Motivate why. (3)

4. Which LED is ON when S_2 is pressed? Motivate why. (3)

5. Explain why this circuit is known as a bi-stable multivibrator. Refer to the input signals, its polarity, the output signal, its polarity and the time that the circuit remains in each state. (5)

Subtotal: Activity 3A [15]

Facet sheet 3A: 741 Bi-stable multivibrator

	FACET 1	FACET 2	FACET 3	FACET 4	MAXIMUM POSSIBLE MARKS	LEARNER MARK
Prepare for the Simulation	ID components correctly (1)	Collect PSU/Mini Trainer (1)	Collect instruments – multimeter (1)	Collect hand tools (1)	4/2 = 2	
Hand Tools	Use side cutters correctly (1)	Use long-nose pliers correctly (1)	Use wire stripper correctly (1)		3/3 = 1	
Preparation for Insertion of Components into Breadboard.	Check the pinout of the 741 IC (1)	Set supply voltage correctly at +9V 0V -9V (1)			2/2=1	
Correct Connection on Breadboard – Nodes and Polarity	Correct connection of 741 IC to supply (2)	Polarity and connection of switches - correct (2)	Polarity of both LEDs – correct (2)		6/2=3	
Circuit Is Working Correct	S1 is pressed – LED 1 (red) ON (1)	S2 is pressed - LED 2 (green) ON (1)			2/2=1	
Housekeeping	Cleaning the working area after the experiment (1)	Replace tools in correct places after work (1)			2/2 = 1	
Safety	Observing safety before being reminded (2)	Observing safety after being reminded (1)			2/2 = 1	
				SUBTOTAL FACET 3A	**10**	

SIMULATION 3B: 555 IC Astable multivibrator

PURPOSE:

Construct a simple circuit using the **555 IC** to build a clock pulse generator **(astable multivibrator)** and display output waveforms on an oscilloscope

REQUIRED RESOURCES:

TOOLS/INSTRUMENTS	MATERIALS
Analogue/Digital trainer Analogue/Digital oscilloscope Function generator Variable DC power supply Side cutters Wire stripper	1 x 555 timer IC 1 x 220 Ω resistor 1 x LED 1 X 10 nF capacitor 1 x 10 KΩ resistor 1 x 100 KΩ pre-set POT 1 x 10 µF (electrolytic capacitor 16 V) Connecting wires

PROCEDURE

1. Construct the circuit on the breadboard as in FIGURE 3.2.
   Connect channel 1 of the oscilloscope across C_1.
   Connect channel 2 of the oscilloscope to pin 3 of the 555 IC.
   Switch ON the circuit and observe.
   Answer the questions that follow.

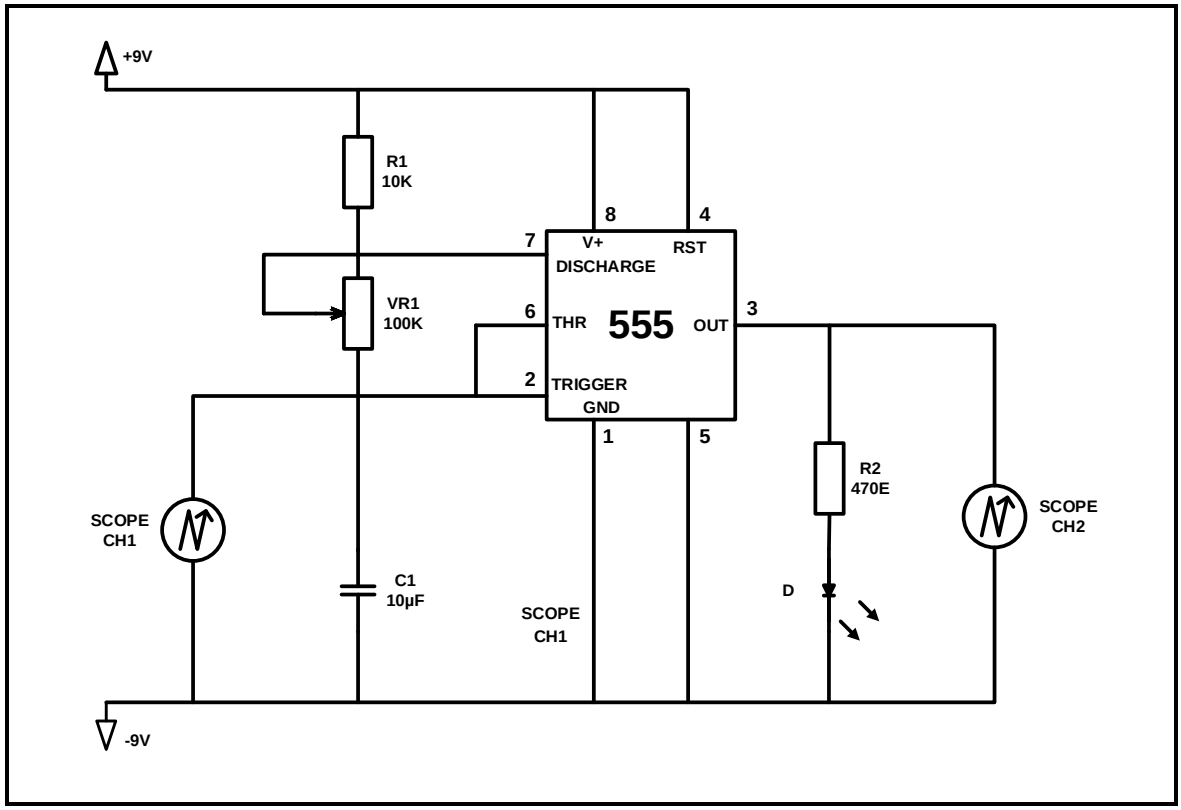
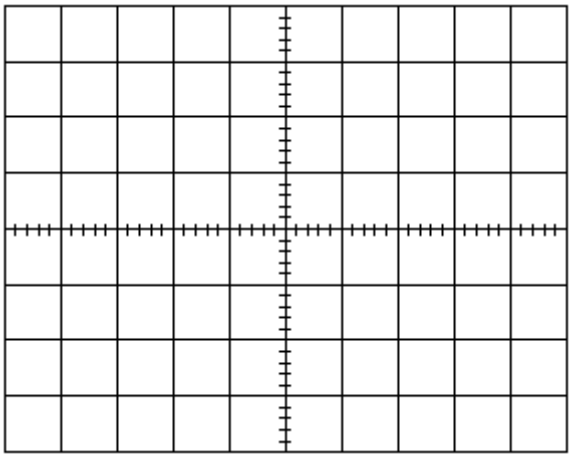


FIGURE 3.2

2. Draw the output waveform observed on the oscilloscope on the grid provided.



V/Div:_____ (Ch 1)

V/Div:_____ (Ch 2)

T/Div: _____

NOTE:
1 mark for each correctly drawn waveform.
1 mark for the oscilloscope settings**.**

(3)

QUESTIONS:

3. List the components responsible for the frequency of the output. (3)

_____

_____

_____

1	2	3
Learner was able to construct a minimum part of the circuit correctly with assistance	Learner was able to construct a part of the circuit correctly without assistance	Learner was able to construct the whole circuit correctly without assistance
The learner failed to get the output wave on the oscilloscope	The learner was able to set the oscilloscope and managed to get the output wave after the assistance from the teacher	The learner was able to set the oscilloscope and managed to get the output wave without the assistance of the teacher
Learner did not do any housekeeping duties	Learner did housekeeping after being reminded	Learner did housekeeping without being reminded

(9)
[15]

Subtotal: Activity 3A _____ (15)
Subtotal: Facet sheet 3A _____ (10)
Subtotal: Activity 3B _____ (15)
TOTAL SIMULATION 3 _____ **[40]**

This simulation is an OPTION to do in the place of simulation 3A.

SIMULATION 3C: 741 op-amp as a non-inverting amplifier

PURPOSE

Construct a simple circuit **using the 741 op-amp to build a non-inverting amplifier** and display the input/output waveforms on an oscilloscope

Activity 1A: Construct a circuit using the 741 op-amp.

REQUIRED RESOURCES

TOOLS/INSTRUMENTS	MATERIALS
Analogue/Digital trainer Analogue/Digital oscilloscope Function generator Dual power supply 9V 0 -9V Side cutters Wire stripper	1 x LM741 IC 2 x 1 kΩ resistor 2 x 10 kΩ resistor 1 x 5 kΩ resistor Connecting wires

PROCEDURE:

1. Construct the circuit, as in FIGURE 1.1, on the breadboard.

   Set the function generator to give a sine wave output of 1 V peak at a frequency of 1 000 Hz (1 kHz).
   Connect channel 1 of the oscilloscope to pin 3 of the 741 IC.
   Connect channel 2 of the oscilloscope across RL (pin 6).
   Switch on the power to the circuit and observe the input and output waveforms.
   Draw the input and output waveforms.

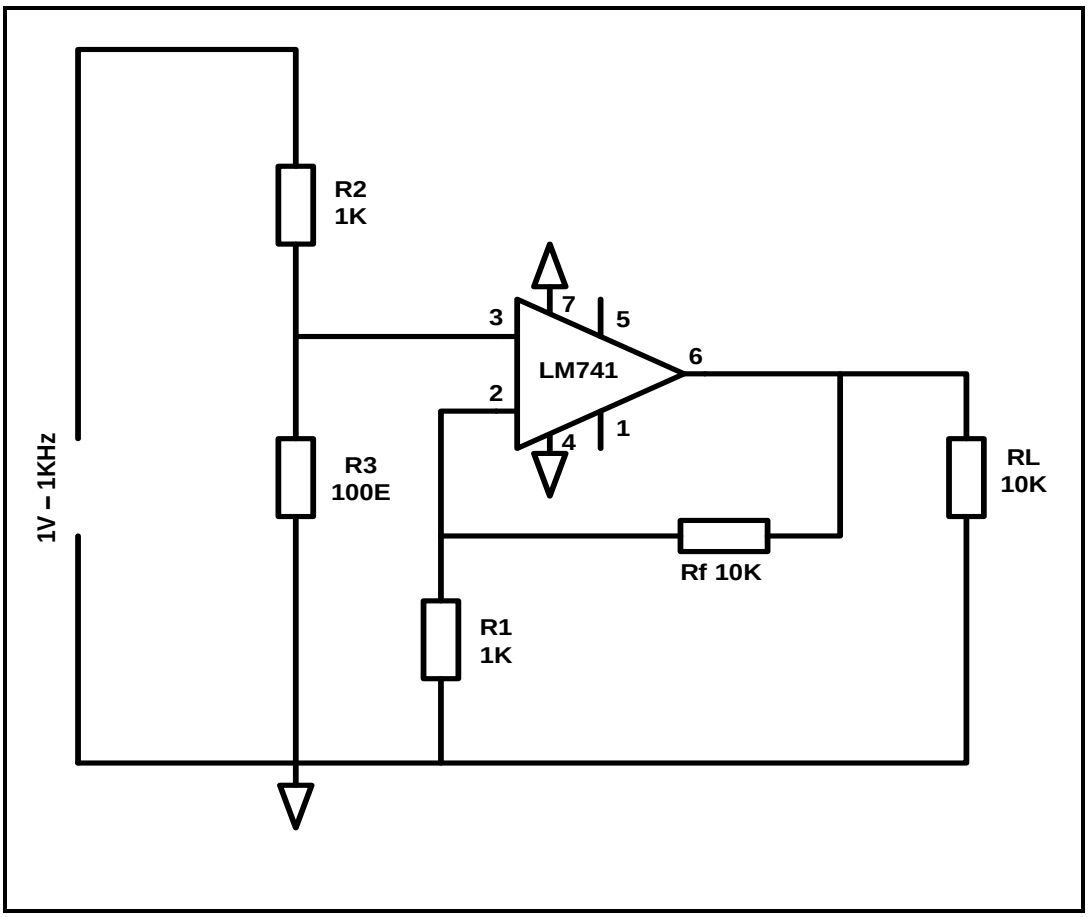
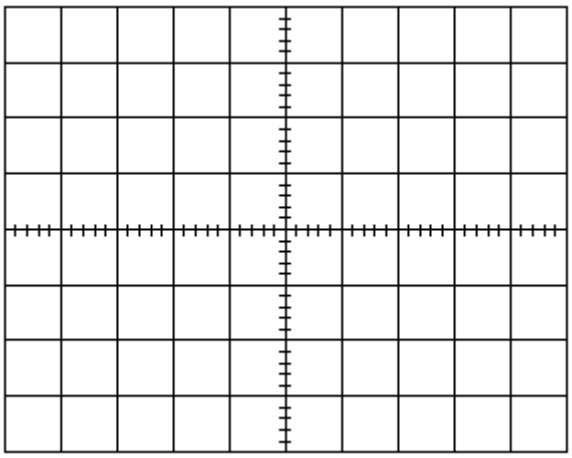


FIGURE 2.1: NON INVERTING AMPLIFIER

2. Draw the output waveform observed on the oscilloscope on the grid provided.



V/Div:_____ (Ch 1)

V/Div:_____ (Ch 2)

T/Div: _____

NOTE:
1 mark for each correctly drawn waveform.
1 mark for the oscilloscope settings.

(3)

QUESTIONS:

1. Calculate the gain of the amplifier with the given resistor values. (3)

2. Measure the voltages across R_1, R_F and R_L: (3)

   V_{R1} _____
   V_{RF} _____
   V_{RL} _____

3. Replace RF with a 5 kΩ resistor. (3)

   V_{R1} _____
   V_{RF} _____
   V_{RL} _____

4. How did this change affect the output of the amplifier? Motivate your answer. (3)

Facet sheet 3C: 741 non-inverting op-amp

	FACET 1	FACET 2	FACET 3	FACET 4	MAXIMUM POSSIBLE MARKS	LEARNER MARK
Prepare for the Simulation	ID components correctly (1)	Collect PSU/Mini Trainer (1)	Collect instruments – multimeter (1)	Collect Hand Tools (1)	4/2 = 2	
Hand Tools	Use side cutters correctly (1)	Use long-nose pliers correctly (1)	Use wire stripper correctly (1)		3/3 = 1	
Preparation for Insertion of Components into Breadboard.	Check the pinout of the 741 IC (1)	Set supply voltage correctly at +9V 0V -9V (1)			2/2=1	
Correct Connection on Breadboard – Nodes and Polarity	Correct connection of 741 IC to supply (2)	Measurement across R1, RF and RL (1)			3	
Circuit Is Working Correct	Vout is not inverted with RF= 10 kΩ (1)	Vout is not inverted with RF= 5 kΩ (1)			2/2=1	
Housekeeping	Cleaning the working area after the experiment (1)	Replacing tools after work (1)			2/2 = 1	
Safety	Observing safety before being reminded (2)	Observing safety after being reminded (1)			2/2 = 1	
TOTAL					**10**	

Subtotal: Activity 3C _____ (15)
Subtotal: Facet sheet 3C _____ (10)
Subtotal: Activity 3B _____ (15)
TOTAL Simulation 3 _____ **[40]**

4.4 Simulation 4: Connect a 7-segment display to a 4-bit BCD 7-segment driver

Name of learner: _____	**Mark:** _____ / 40
Class: _____ **Date completed:** _____	
Date assessed: _____	**Assessor signature:** _____
Date moderated: _____	**Moderator signature:** _____

PURPOSE:

Construct a simple circuit **to connect a 7-segment display to a 4-bit BCD 7-segment display driver**.

Activity 4A : Connect a 7-segment display to a 4-bit BCD 7-segment driver.

RESOURCES:

TOOLS/INSTRUMENTS	MATERIALS
Analogue/Digital trainer Breadboard Variable DC power supply Side cutters Breadboard Wire	4 x LEDs 4 x 390 Ω resistors 7 x 1k resistors CD4511 IC CD4518B IC 5 x SPST switches 7-segment display

PROCEDURE

Construct the circuit as in FIGURE 4.1 below:

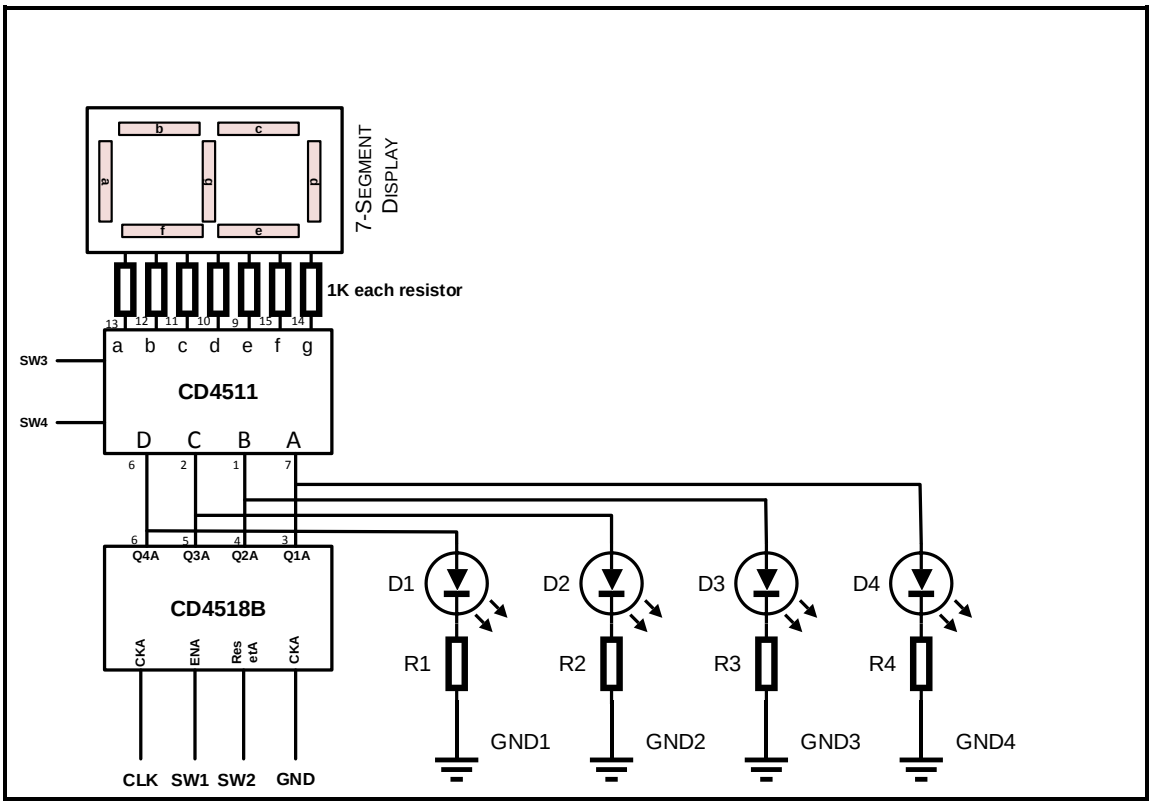


FIGURE 4.1

An alternative circuit can be used.

FACET SHEET 8: Connect a 7-segment display to a 4-bit BCD 7-segment driver

	FACET 1	FACET 2	FACET 3	FACET 4	MAXIMUM POSSIBLE MARKS	LEARNER MARK
Prepare for the Simulation	Identify components correctly (1)	Collect PSU/MiniTrainer	Collect instruments – oscilloscope	Collect hand tools	4	
Hand Tools	Use side cutters correctly	Use wire stripper correctly			2/2 = 1	
Preparation for Insertion of Components into Breadboard.	Check the datasheet on the ICs (1)	Set supply voltage correct at +9 V (1)			2	
Correct Connection on Breadboard – Nodes and Polarity	8 nodes for correct connection of CB4518B IC (8/2 = 4)	20 nodes for correct connection of CD4511 IC and the 7-segment display (20/2 = 10)			14	
Housekeeping	Cleaning the working area after the experiment (1)	Replace tools in the correct places after work (1)			2	
Safety	Observing safety before being reminded (2)	Observing safety after being reminded (1)			2	
Total					**25**	

Activity 4B
Conduct the following steps and answer the questions in the space provided.

	IC CD4185 GIVEN CODE	7-SEGMENT DISPLAY	
a	Which number is displayed on 7-segment display if the binary number 0111 is illuminated on the output LED's of the counter?		(3)
b	Which number is displayed on 7-segment display if the binary number 1000 is illuminated on the output LED's of the counter?		(3)
c	Which number is displayed on 7-segment display if the binary number 1001 is illuminated on the output LED's of the counter?		(3)
d	Which number is displayed on 7-segment display if the binary number 0011 is illuminated on the output LED's of the counter?		(3)
e	Which number is displayed on 7-segment display if the binary number 0101 is illuminated on the output LED's of the counter?		(3)
			(15)

Subtotal: Activity 4A 25
Subtotal: Activity 4B 15
Total: Simulation 4 40

4.5 Simulation 5: RS latch and PICAXE flow diagram

Name of learner: _____	
Class: _____ **Date Completed:** _____	**Mark** _____ **40**
Date Assessed: _____ **Assessor Signature:** _____	
Date Moderated: _____ **Moderator Signature:** _____	

PURPOSE
To study the RS latch as a practical circuit.
To compare the theory learned in class with the actual circuit.
To build a RS latch.

Activity 5 A: Construction of the RS latch.

REQUIRED RESOURCES

TOOLS/INSTRUMENTS	MATERIALS
Experiment board	74L500 IC
Voltmeter	Toggle switches x 2
Dual power supply 9V-0- 9V	1 kΩ resistor x 2
Dual power supply 5V-0- 5V	220 Ω resistor x 2
Side cutters	1 x red and 1 x green LED
Wire stripper	Connecting wires

CIRCUIT DIAGRAM

Construct the circuit, as in FIGURE 6.1, on the breadboard. After you switch on the circuit, press the set switch. You will be assessed with the rubric below

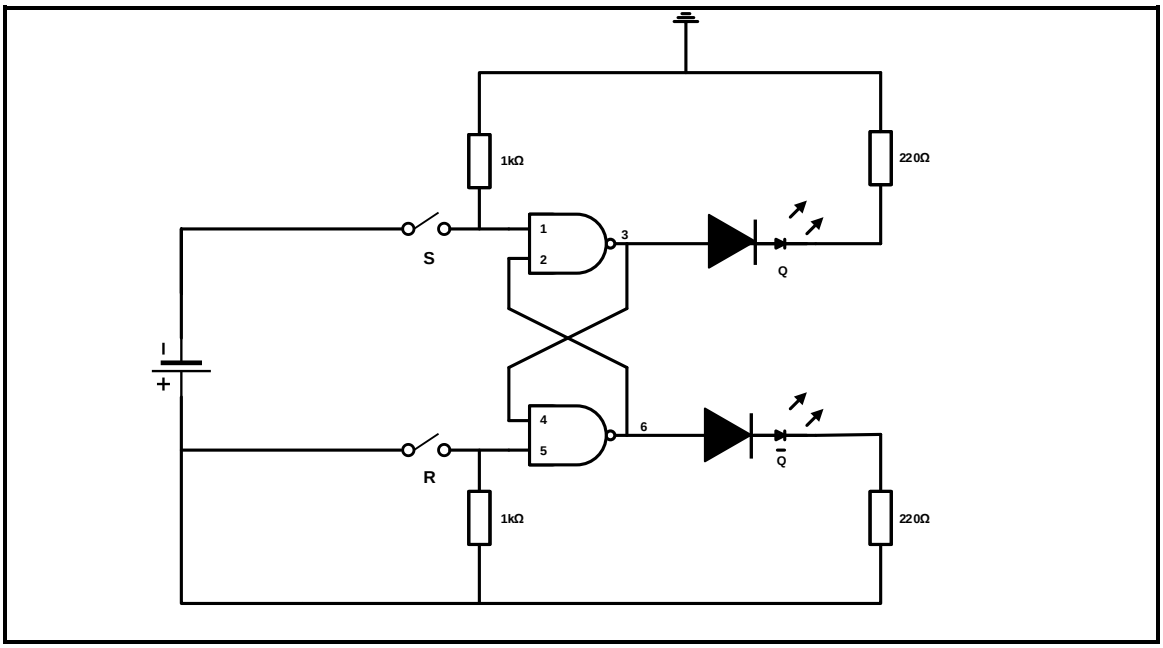


FIGURE 6.1: CIRCUIT DIAGRAM OF A RS LATCH

RUBRIC

Level descriptor				Mark obtained
1	**2**	**3**	**5**	
The learner could not identify the correct components	The learner identified the correct components but could not build the circuit on the breadboard	The learner did build the circuit after the assistance of the teacher	The leaner managed to identify the correct components and build the circuit without the assistance of the teacher	
The learner could not use the measuring instruments	The learner managed to calibrate instruments after the assistance of the teacher	The learner managed to use the instruments and managed to get ONE reading required after the assistance of the teacher	The learner managed to use the instruments and managed to get all the readings required without the assistance of the teacher	

(10)

OBSERVATIONS:

1. Press the reset and set switches. Write down your observations. (3)

2. Press both reset and set switches simultaneously. Write down your observation (3)

3. Complete the truth table based on the operation of the circuit you have constructed

INPUTS		OUTPUTS	
S	**R**	**Q**	**Q**
0	**0**		
0	**1**		
1	**0**		
1	**1**		

(4)

HOUSEKEEPING

When you have obtained all the measurements and the teacher has validated all your answers you must tidy up your workplace as part of the safety in the workshop. You will be assessed on housekeeping with the rubric below.

Level descriptor				Mark obtained
0	**2**	**3**	**5**	
The candidate did not do any house-keeping.	The candidate did do house-keeping after the teacher reminded the candidate.	The candidate did do housekeeping, but only tidy up his/her own workplace and did not help in cleaning the rest of the workshop.	The candidate did house-keeping on his/her own and help to tidy up the entire workshop.	

(5)

PICAXE

PURPOSE

To test knowledge of flow diagrams and PICAXE.

Activity 6B: Using PICAXE draw a flowchart of a control system for counting cars entering and leaving a car park using two digital sensors. (15)

5. SECTION B – DESIGN AND MAKE

Design and Make Project

Time: January to August 2020

Learner Name: _____

School: _____

Class: _____

Title/Type of Project: _____

INSTRUCTIONS

- This section is COMPULSORY for all learners.
- The teacher will choose a circuit for the project.
- Any project constructed must include at least (but is not limited to):
  - Seven components
  - A variety of components (both active and passive)
  - PCB making in some form
  - Soldering
  - An enclosure with a switch and protection
- The checklist below must be used to ensure that all the required tasks for the PAT have been completed.

PAT CHECKLIST

The learner MUST fill in this checklist for the teacher BEFORE marking of that section takes place!

NO.	DESCRIPTION	TICK (☑)	
		NO	YES
Design and Make: Part 1			
1.	Circuit diagram drawn	☐	☐
2.	Circuit description filled in	☐	☐
3.	Component list completed	☐	☐
4.	Tools list for circuitry populated	☐	☐
5.	Measuring instrument list filled in	☐	☐
6.	Evidence of prototyping printed and pasted into the file	☐	☐
7.	Learner's own Veroboard/PCB planning/design printed and included in file	☐	☐
Design and Make: Part 2			
1.	Enclosure design completed and included in the file	☐	☐
2.	Unique name written down and on the enclosure	☐	☐
3.	Logo designed and on the enclosure	☐	☐
Miscellaneous			
1.	Enclosure included in the project	☐	☐
2.	Enclosure prepared and drilled according to the design	☐	☐
3.	Enclosure finished off and completed with name and logo	☐	☐
4.	PCB securely mounted in the enclosure using acceptable techniques	☐	☐
5.	Circuit inside the enclosure accessible	☐	☐
6.	Internal wiring neat and ready for inspection	☐	☐
7.	File and project completed and ready for moderation at the workshop/room	☐	☐

5.1 Design and Make: Part 1

5.1.1 Circuit diagram

Draw a circuit diagram of your project and add it after this page.

5.1.2 Project: Description of operation

Use the space below to provide an overview of how the project functions. Use your own words and do some research of your own.

5.1.3 Component list

Draw up a list of components you will need from the circuit diagram.

LABEL	DESCRIPTION AND VALUE	QUANTITY

5.1.4 Tools/Instrument List

Draw up a list of tools you will need to complete the PAT circuitry. You may add to the list as you proceed through the PAT.

DESCRIPTION	PURPOSE

5.1.5 Evidence of prototyping

Take photographs of the working prototype on the breadboard using a digital camera or cellphone and insert it here. Add your name on the photograph.

Add the pictures after this page.

5.1.6 PCB design

Design a printed circuit board layout for the circuit you are going to build.

Print it out and attach after this page.

5.2 Assessment of the Design and Make Phase: Part 1

NO.	FACET DESCRIPTION	Mark	Achieved = 1 Not achieved = ✗
	Circuit Diagram		
1.	The circuit diagram was drawn using EGD equipment.	1	
2.	The circuit diagram was drawn using CAD/any electronic design software.	1	
3.	The circuit diagram was drawn using correct symbols.	1	
4.	The circuit diagram has all labels – R1, C1, Tr1, etc.	1	
5.	The circuit diagram has all component values –100 Ω, 220 µF, etc.	1	
6.	The circuit diagram has a name / title.	1	
7.	The circuit diagram has a frame and title block. (EGD approach).	1	
	Component List		
8.	Labels correlate with circuit diagram.	1	
9.	Description and values correlate with circuit diagram.	1	
10.	Quantities are correct.	1	
	Description of Operation		
11.	Basic function of the circuit is described correctly.	1	
12.	All sub circuits in the circuit diagram and component list are included in the description.	1	
13.	Purposes of sub circuits in the circuit diagram are described correctly.	1	
14.	Learner used own interpretation and did not copy from another source verbatim.	1	
15.	Sources are acknowledged.	1	
	Tools/Instrument List		
16.	The tools/instrument list has been completed.	1	
17.	The tools/instruments listed all have a purpose for being used.	1	
	Evidence of Prototyping on Breadboard		
18.	Unique, original photos of the prototyping are included.	1	
19.	Unique, original photos include the learner name.	1	
20.	Photos are clear and in focus: All components are clearly identifiable.	1	
21.	Prototype is operational. No photo, no mark.	2	
	PCB Design		
22.	Printed Circuit Board design is included in the PAT file.	1	
23.	PCB Design is made using a CAD approach.	3	
24.	Component overlay showing placement is included.	1	
25.	Components are labelled the same as in the circuit diagram.	1	
26.	The design is original and does not match any other learner's design.	1	
27.	Board layout (tracks/current flow) is functional and matches the original circuit diagram.	1	
	Circuit Board Manufacturing		
28.	Circuit board is etched neatly according to the PCB design.	5	
29.	The learner's name is etched onto the circuit design.	1	
30.	The PCB is tinned neatly.	1	
31.	The soldered PCB, solder side, is covered with a clear protective coating (Plastic 70/clear lacquer).	1	
32.	Holes are drilled neatly and are aligned in the middle of the pads on the PCB.	1	

NO.	FACET DESCRIPTION	Mark	Achieved = 1 Not achieved = ✗
33.	Mounting holes of the PCB are drilled symmetrically.	1	
34.	All burrs are removed.	1	
35.	The PCB is cut neatly/squarely and edges are filed neatly.	1	
36.	Axial and radial components are placed neatly and flush with the board.	1	
37.	Component orientation are aligned between similar components (e.g. the gold band of all resistors are placed on the same side).	1	
38.	Soldered components – leads are cut off, flush and neat on the solder side.	2	
39.	More than 60% of the solder joints are shiny (not dry joints).	2	
40.	Wire insulation is stripped to the correct length (no extra copper showing).	2	
41.	Wiring is long enough to allow for dismantling and inspection.	1	
42.	Wiring is wrapped neatly.	1	
43.	A power switch is included and fitted to the enclosure.	2	
44.	A fuse/protection is included and fitted correctly where applicable.	2	
45.	Wiring entering/exiting the enclosure is provided with a grommet/applicable fittings/sockets where applicable.	2	
46.	Batteries are mounted using a battery housing/mounting bracket and battery clip (NO double-sided tape).	1	
47.	The project has a pilot light/LED installed in the enclosure showing when the circuit is operational. (Switch is on – must go out when fuse is blown.)	1	
48.	The project is fully operational and commissioned/installed in the enclosure.	10	

TOTAL (PART 1 = 70 marks)	

NOTE: In projects where facets 43 and 44 are not applicable, the projects should be marked out of 66, and the totals adjusted accordingly.

5.3 Design and Make: Part 2

5.3.1 Enclosure design

- Design an enclosure for your project.
- NO FREEHAND DRAWINGS.
- Draw using EGD equipment **OR** use a CAD program.
- Draw in first-angle orthographic projection.
- Add your drawings after this page.
- Use colour to enhance your drawing.

5.3.2 Manufacture the enclosure neatly according to your design.
You may use pre-cut panels from metal, wood and or perspex/ plexiglass. You must, however, construct/assemble these parts.
Injection moulded enclosures are also acceptable. It is important that your enclosure and the placement of the parts align with your design.

5.3.3 Choose a name for your device.
Write down the name of the device below.

_____

5.3.4 Design a unique logo for your device, as well as a specification plate and attach it after this page. **[20]**

5.4 Assessment of the Design-and-Make-Phase: Part 2

NO.	FACET DESCRIPTION	Mark	Achieved = 1 Not achieved = ✗
	Enclosure Design		
1.	Enclosure design is included in first-angle orthographic projection.	1	
2.	Drawn design includes a title box and page border.	1	
3.	Isometric drawing included additionally.	1	
4.	Dimensions are included.	1	
5.	The name of the device is written in the PAT document.	1	
6.	The logo design and specification plate design is in the PAT document.	2	
	Subtotal (7 marks max.)		
	Enclosure Manufacturing		
7.	Enclosure matches the design. – Dimensions and placement correlate.	1	
8.	Name of the device is attached on the enclosure.	1	
9.	The logo design is attached on the enclosure.	1	
10.	The logo design on the enclosure is durable and not merely a paper pasted on the enclosure (painted/used decoupage/screen printed/sublimation printed).	1	
11.	The enclosure is manufactured from scratch/pre-cut parts. **Does NOT include:** cardboard, paper, margarine container **Does include:** sheet metal, Perspex, Plexiglas, wood, glass and other raw materials, injection-moulded plastic boxes	3	
12.	Holes/Cut-outs in the enclosure are made with the appropriate tools.	2	
13.	Specification plate with the learner's name, operating voltage, fuse rating and additional information on the project.	1	
14.	Enclosure is neatly prepped, painted and aesthetically pleasing.	2	
15.	The circuit board is mounted using appropriate methods inside the enclosure. (NO double-sided tape, Prestik, glue, chewing gum, masking tape, etc.)	1	
	Subtotal (13 marks max.)		

TOTAL (PART 2 = 20 marks)	

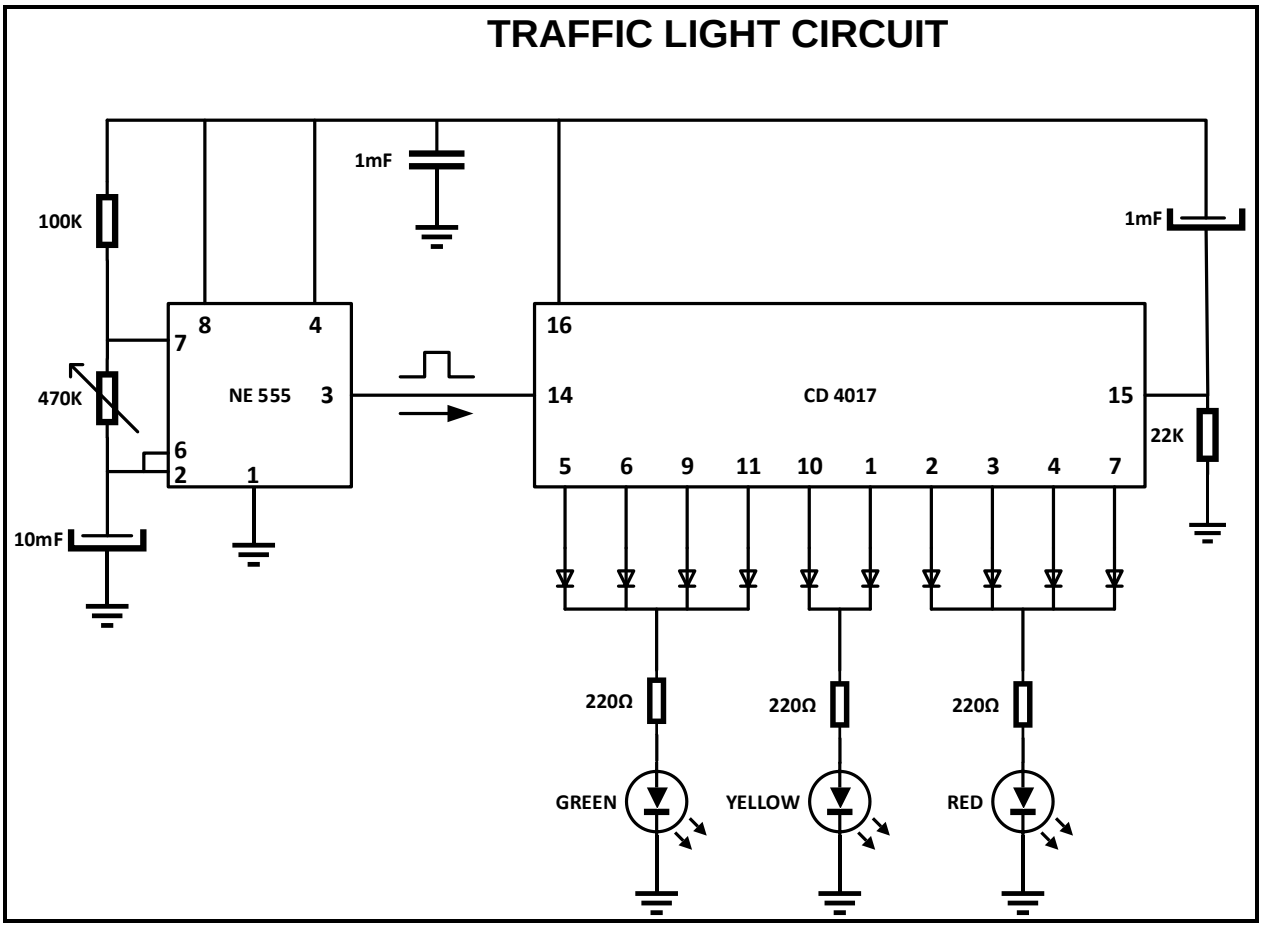
6. PROJECTS

6.1 Practical Project (Electronics):Traffic Light

RESOURCES

TOOLS/INSTRUMENTS	MATERIALS
• Oscilloscope (analogue/digital) • Analogue/Digital trainer with dual power supply • Electronics multimeter • Soldering iron • Helping hands • PCB etching tank or similar • Solder sucker • Wire-stripper • Side cutters	• 100 kΩ resistor • 220 Ω resistor x 3 • 22 kΩ resistor x 1 • LED green x 1 • LED yellow x 1 • LED red x 1 • 1 µF capacitor x 2 • 10 µF capacitor x 1 • 470 kΩ variable resistor x 1 • IC NE555 • IC CD 4017 • 1N4007 diode x 6 • PCB 150 x 100 mm • Solder • PCB etching chemicals

CIRCUIT DIAGRAM



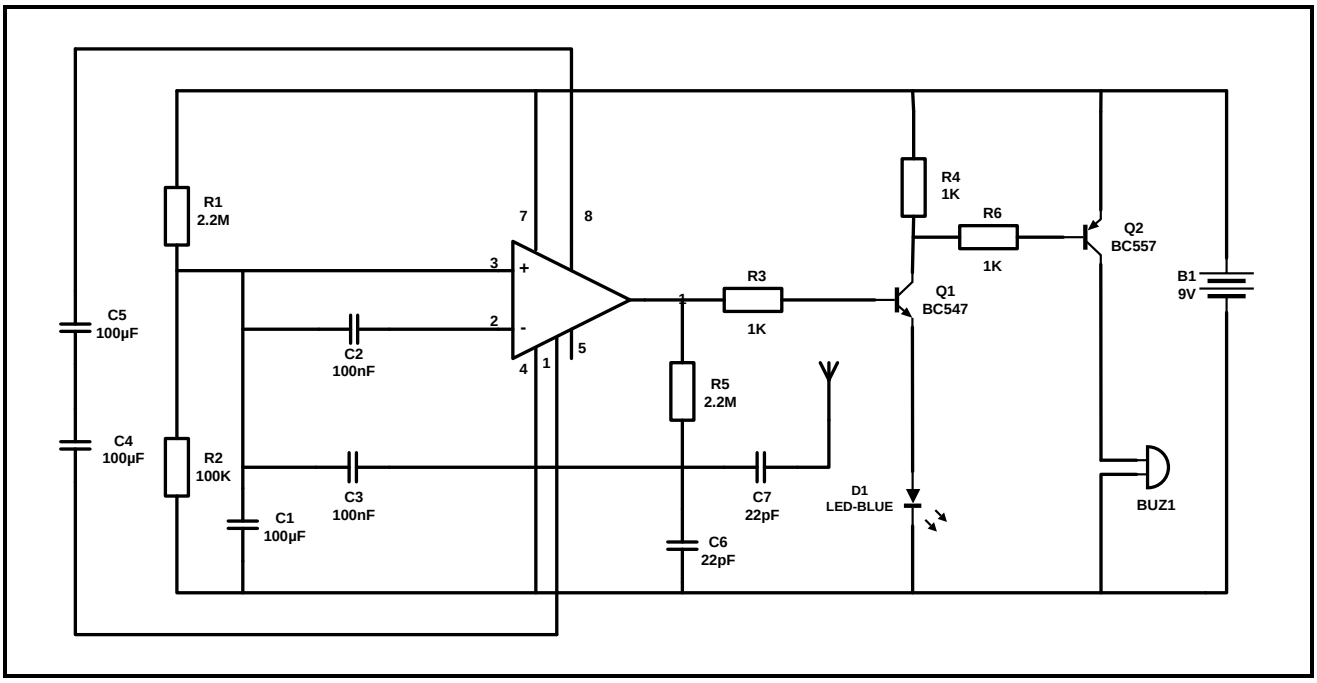
6.2 Practical Project (Digital Electronics): Cellphone detector

Cellphones are widely used in the world. While people have to be connected to one another, there are situations or places where the usage has to be prohibited, either due to security reasons or because it may be a health hazard. Cellphone detection has been under investigation for a long time. There are techniques that have been formulated or proposed on how to detect cellphones. Most of them use features such as the audio system, RF system and common materials of the cellphone to try and look into how it can be used to detect mobile phones. This project utilises the RF system of the cellphone as the feature to detect its presence. A circuit that detects signals of the range 0,9 GHz to 3 GHz is used to detect a cellphone when in use. When the signal is detected, an LED blinks to indicate the usage of a cellphone within a radius of 1,5 metres.

It is therefore a reality that mobile usage in some places must be prohibited. Due to the privacy laws that limit the use of cellphone jammers, cellphone detectors must be designed and installed so that in case a person gets into such places with a cellphone, they can be notified and either be told to switch it off or to remove it. The effectiveness of cellphone detectors is that they continually scan for the presence and usage of cellphones and sound an alarm to notify the user or security personnel.

This project is limited to the detection of a cellphone that is in use: on call, communication via SMS and internet access. The detection of cellphones that are on standby mode, switched off or on airplane mode will not be included in this project.

TOOLS/INSTRUMENTS	MATERIALS
• Oscilloscope (analogue/digital) • Analogue/Digital trainer with dual power supply • Electronics multimeter • Soldering iron • Helping hands • PCB etching tank or similar • Solder sucker • Wire-stripper • Side cutters	• Op amp CA3130 • 2,2 M resistor (2) • 100 K resistor (1) • 1 K resistor (3) • 100 nF capacitor (4) • 22 pF capacitor (2) • 100 uF capacitor • Breadboard • 9 volt battery • Battery connector • LED • Transistor BC547 • Transistor BC557 • Connecting wires • Buzzer • Antenna

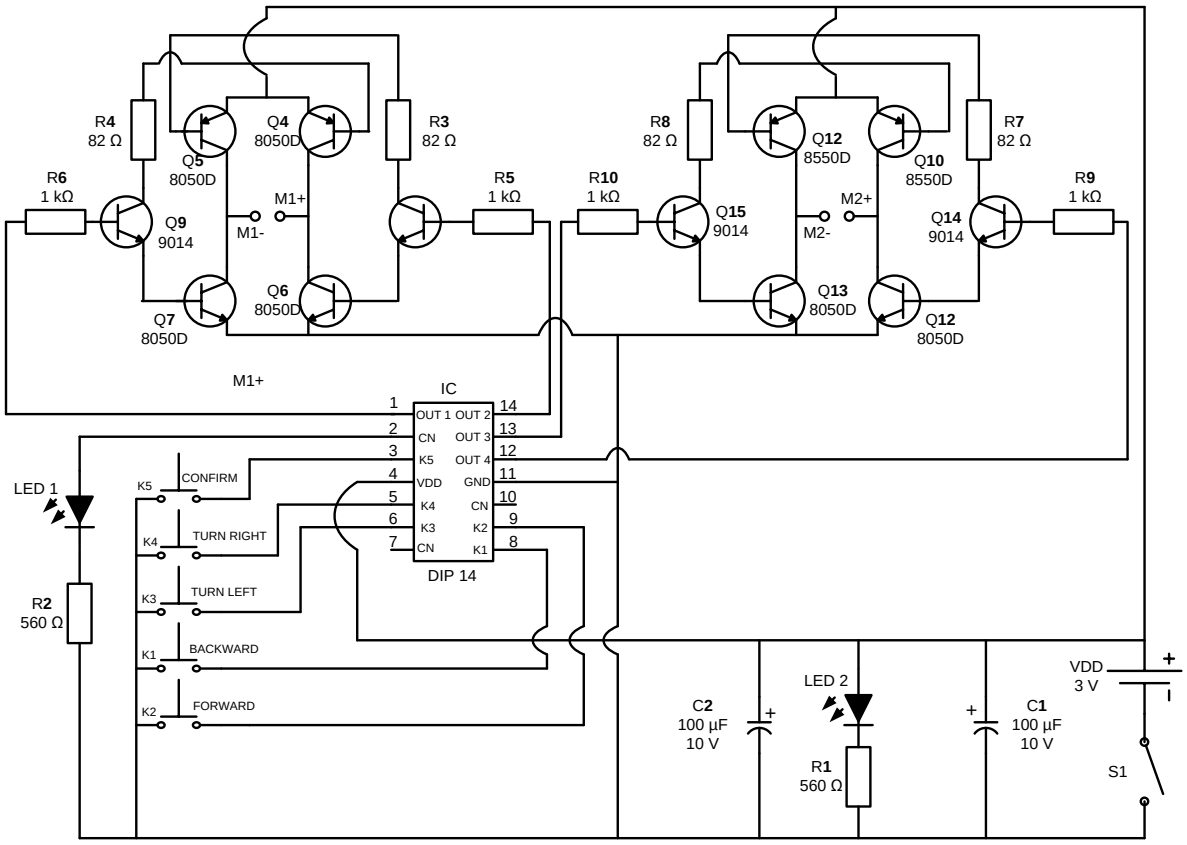


CELLPHONE DETECTOR CIRCUIT

6.3 Programmable Buggy

K1-K4 is responsible for inputs for forward and backward movement of the buggy. K5 is the OK button. When the buggy is switched on, The red LED will be on and the buggy is ready to be programmed.
(K1 = Turn right, K2 = Turn left, K3 = Reverse, K4 = Forward) When the buggy is ready, the green LED will flash. This means the instructions entered are valid. After the program is set, press K5 = OK button to execute all instructions. The buggy can accept up to 30 input commands at a time. When the commands are executed, the green and red LEDs will emit simultaneously.

CIRCUIT



RESOURCES

NO.	POSITION	ITEM	DESCRIPTION	QTY
1	IC	IC	LGW-17368-SCH02 /NY8A053BP14	1
2	C1,C2	Capacitor	100 µF 10 V (size 5X7 mm)	2
3	R5,R6,R9,R10	Resistor	1 kΩ - ¼ W	4
4	R3,R4,R7,R8	Resistor	82 Ω - ¼ W	4
5	R1,R2	Resistor	560 Ω - ¼ W	2
6	Q8,Q9,Q14,Q15	Transistor	9014C	4
7	Q4,Q5,Q10,Q11	Transistor	8550D	4
8	Q6,Q7,Q12,Q13	Transistor	8050D	4
9	LED1	LED	5 mm YELLOW COLOR	1
10	LED2	LED	5 mm RED COLOR	1
11	K1,K2,K3,K4,K5	Tact Switch	6 x 6 x 5 mm	5
12	S1	On/Off Switch	8 mm	1
13	MOT 1, MOT 2	Gear Box	Sped rate: 1/120 Straight Shape	2
14	BH-3V	Battery holder	AA x 2 : 58 x 34 mm.	1
15	M+	Wire	3+50+3 red	2
16	M-	Wire	3+50+3 black	2
17	W1	Univ. Wheel	37x17x10 mm	1
18		Plast. Wheel	37x15 mm	2
19	Gear box	Screw	Round head PM 3x25 mm	4
20	Battery Holder	Screw	Flat head KM 3x6 mm	2
21	Univ. Wheel	Screw	Round head PB 2 3x6x D=4	4
22		Screw	Meson Head PWA 7x5 mm W5	1
23	M3	Screw nut	M3	6
24	Gear Box Support	Plastic A	26 x 10 x 10 mm	2
25	Gear Box Support	Plastic B	26 x 10 x 7 mm	2

7. CONCLUSION

On completion of the practical assessment task learners should be able to demonstrate their understanding of the industry, enhance their knowledge, skills, values and reasoning abilities as well as establish connections to life outside the classroom and address real-world challenges. The PAT furthermore develops learners' life skills and provides opportunities for learners to engage in their own learning.