

SEPTA-O-LEVEL PHYSICS SEMINAR SLATED FOR 23RD JUNE 2024 AT
ST. JOSEPH OF NAZARETH HIGH SCHOOL KAVULE-KATENDE

ELEMENTS OF CONSTRUCT AND THEIR CHAPTER BREAK DOWN

1. Physics 535/1 (Theory paper)

Construct: Appreciates physics in everyday life

Item	Element of construct	Topics covered
SECTION A: Compulsory		
Item one	Understands how waves are generated, propagated and their application in every day life	<input type="checkbox"/> Nature of light; reflection of light at plane surfaces
		<input type="checkbox"/> Reflection of light at curved surfaces
		<input type="checkbox"/> Refraction, dispersion, and colour
		<input type="checkbox"/> Lenses and optical instruments
		<input type="checkbox"/> General wave properties
		<input type="checkbox"/> Sound waves
Item Two	Understands the structure of atoms, nuclear processes and their application in every day life.	<input type="checkbox"/> Atomic models
		<input type="checkbox"/> Nuclear processes
Item Three	Understands solar system ,galaxies, stars, satellites & digital communication in everyday life	<input type="checkbox"/> The solar system
		<input type="checkbox"/> Stars and galaxies
		<input type="checkbox"/> Satellites and communication
		<input type="checkbox"/> Digital electronics
SECTION B		
PART I		
Item four and five	Understands effect of force and heat on properties of matter	<input type="checkbox"/> Measurements in Physics
		<input type="checkbox"/> States of matter
		<input type="checkbox"/> Effects of forces
		<input type="checkbox"/> Work, energy, and power

		<input type="checkbox"/> Turning effect of forces, centre of gravity, and stability
		<input type="checkbox"/> Pressure in solids and fluids
		<input type="checkbox"/> Mechanical properties of Materials and Hooke's law
		<input type="checkbox"/> Linear and non-linear motion
		<input type="checkbox"/> Temperature measurements
		<input type="checkbox"/> Heat transfer
		<input type="checkbox"/> Expansion of solids, liquids, and gases
		<input type="checkbox"/> Heat quantities and vapours

Item Six and Seven	Appreciates electricity and magnetism in every day life	PART II
		<input type="checkbox"/> Magnets and magnetic fields
		<input type="checkbox"/> Electromagnetic effects
		<input type="checkbox"/> Electrostatics
		<input type="checkbox"/> Introduction to current electricity
		<input type="checkbox"/> Voltage, resistance and Ohm's law
		<input type="checkbox"/> Electric energy distribution and consumption

NOTE:

- Section A will comprise of three compulsory items
- Section B comprises of Part I and Part II each having two questions and a learner answers one question from each part.
- In total five questions must be attempted by the learner.
- The paper is for 2 hours 30 minutes

2. Physics practical 535/2/3

Construct: Appreciates scientific investigation in physics

Item	Element of Construct	Sections
Item One or Two	Appreciates Scientific	<input type="checkbox"/> Mechanics
		<input type="checkbox"/> Optics

	Investigation in Physics	<input type="checkbox"/> Electricity
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NOTE:

- The exam duration is 2 hours.
- There are two examination items in this paper.
- Students select one item from the options provided.
- The two items can cover either Mechanics and Electricity, Electricity and Optics or Mechanics and Optics.
- Learners are encouraged to practice all three sections: Mechanics, Heat, Electricity, and Optics.
- Avoid focusing solely on specific themes as any item may come from any where

SEMINAR ITEMS

WAVES AND LIGHT

Item 1

In a certain music concert that took place at night, a man played a guitar on a floating stage surrounded by disco lights flashing red, blue and green in the middle of the lake. The audience on the boats and shores were wearing yellow clothes with black spots on them. The audience was surprised about the new appearance of the colours of their clothes. The sound waves from the guitar travel through the air with a frequency of **440Hz**. The organizers also projected laser light, that travels through air with a frequency of **$4.7 \times 10^8 \text{MHz}$** **illuminating** waves on the lake surface to aid visibility. The shores of the lake were **15m** away from a tall storage building. Boys A and B standing in the same direction and in line with the playing music from the lake heard the sound at different intervals of time which attracted them to go and observe what was taking place at the lake. Boy A heard the sound after **3s** and boy B heard the sound after **4s**.

Hint: Speed of sound in air = **330ms^{-1}** , Speed of light in air = **$3.0 \times 10^8 \text{ms}^{-1}$**

Task:

As a physics student;

- (a) Help the two boys to understand why they heard the sound at different intervals.
- (b) Clearly explain why the colour of the clothes of the audience kept on changing when coloured lights flashed on them.
- (c) Why was laser source of light preferred to provide laser light that enhanced visibility late in the late hours of the night.

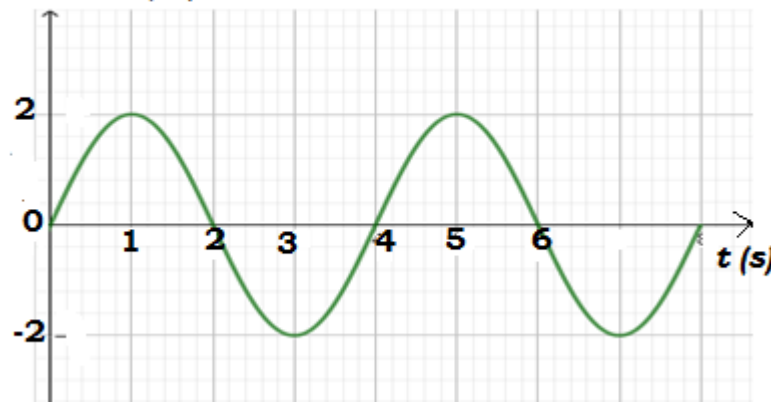
- (d) Compare the wave length of the sound waves and laser light waves in air medium.

Item 2

A war erupted in a certain mountainous areas surrounded by small water bodies where soldiers only communicated by throwing a stone in water to alert their colleagues of danger ahead. Instead, this alerted their enemies. One of the soldiers had small sizable plane mirrors and torn paper box in his bag. Their leader sent spies to peep behind hills to see if the enemies were hiding there but many were captured and killed. They totally lacked knowledge on how to solve this problem. The enemy troops had a radio call that was used for communication and wave forms of wave length were produced on the receiver's computer clearly indicating the amplitude, period and time taken for the wave to reach the receiver at the headquarter. One afternoon, it threatened to rain and bright colours of different kind spread in the skies. This scared the soldiers even more.

Hint;

A graph obtained from the receiver's computer
amplitude (m)



Task:

As a physics student, help the soldiers to;

- Understand why the throwing of the stone in water always alerted their enemies
- Know the best way they could reduce the rate at which their spies were being killed and captured.
- Understand the strange appearance of the skies that sent them to hide outs.
- Determine frequency at which the waves reached the receiver at the home base of the army.

STARS, GALAXIES, (EARTH AND SPACE PHYSICS) DIGITAL ELECTRONICS.

Item 3

On a certain day at around 1:30pm while in the dining hall, learners watched heavy fog-rains and floods being experienced in a certain outside country on an international T.V live channel. To worsen matters, the floods were happening at night and this risked many natives as many of them were ambushed while asleep. Learners wondered how it would be night and seriously raining in an area yet it was day and the Sun was highly shining at that time in their school.

Task:

As a physics learner help the learners clear their queries about;

- Occurrence of the floods in one area yet it was shining in their school at same time.
- Why it was night in that outside country yet it was day-time in their area?
- How T.V signals broadcast from where the floods were happening reached them.

Item 4

A child went out of the house at around 8:30pm and realized that security lights were off. The child saw glittering substances in the space and wondered why the clouds were so much glittering. While still wondering, the child heard a person tip-toe and rushed to the corridor with light switches to switch on. Unfortunately, the corridor was closed by parents who had mistakenly gone with the keys and was not yet back. The person knocked on the gate but the child was challenged whether the parent had come and had to open or the person knocking was a thief. Later the parent came, and when the child narrated, the parent said the glittering substances were artificial satellites in the international Space Station (ISS).

Task:

As a physics learner, using the knowledge of space physics and digital electronics, help the child and parent:

- Understand more types of those identified satellites and why they exist there without falling.
- Solve the problem of operation of security lights.

Item 5

In every year, there are various seasons which all people rely on to carry out different activities. At the beginning of a year here in Uganda, many people complain about too much sunshine wondering where the sun gets such too much energy from. Such people even wished the sun to die to have peace during the day and others prefer endless nights so that they don't have to deal with the sun. However, some people attributed the sun as the major source of energy on the earth.

Task:

As a physics student explain to the people;

- (a) Where the sun sources its much energy from.
- (b) Why some people attribute the sun as the major source of energy on the earth.
- (c) About occurrence of various seasons and the likely stages that an average star like the sun may undergo to satisfy the wish of some people.

NUCLEAR PROCESSES, ATOMIC MODELS

Item 6

A group of students visited the nuclear power plant and they were blocked from entrance due to an accident that had occurred and several operators were exposed to radiation. Only emergency cars were allowed to enter to transport the operators to the hospital to undergo medical examination, including x-ray scans to assess any potential radiation related injuries. Students wondered how harmful radiations were. It became hard for them to understand even how the power plant could generate electricity after being told at the entrance that the plant was the only source of electricity in that area. If the plant's radiation monitoring system detects a background radiation level of **30** counts per minute, and when the radioactive source is placed in front of the radiation detector, the reading on the detector is **550** counts per minute and the source has a half-life of **25** minutes.

Hint: The power plant will be safe for use if the detector reads 95 counts per minute.

Task

As a student of physics;

- (a) Advise the Power plant team leader on how long they had to wait for the power plant to be safe for use.
- (b) Help the students to understand;
 - (i) the relevant nuclear process at the power plant
 - (ii) Understand type of radiations emitted at the power plant and their properties.

- (c) How are the emitted radiations different from x-rays?
- (d) Assist learners to appreciate that indeed the guide was right to stop them and explain how the operators managed to be there always.

Item 7

In a certain hospital, a patient has come in with suspected broken bone in their arm, and another patient is scheduled for a dental examination. Your x-ray machine produces electromagnetic waves with a frequency of $6 \times 10^{18} \text{ Hz}$. Your supervisor asks you to;

- Take an x-ray image of the patient's arm to confirm the bone fracture diagnosis
- Take a dental x-ray to examine the patient's teeth and jaw alignment

Hint;

Wavelength of x-rays	$5 \times 10^{-11} \text{ m}$	$5 \times 10^{-10} \text{ m}$	$5 \times 10^{-9} \text{ m}$
Image resolution	High	Medium	low

Task: As a learner of physics;

- Comment on the resolution of the image of patients arm and bone fracture.
- Explain how the frequency and wavelength relate to the penetrating power of the x-rays and how this affects your choice of settings for the arm and dental exams
- Suggest possible precautions taken while dealing with x-ray machines.

Item 8

A certain town experienced an atomic bomb blast, many people were killed in the incidence and others survived with severe injuries, the government advised those survived to re-locate to other places of the country because this village was not safe for them. The scientist carried out a scientific investigation using detectors of radiations and found out that the environment was still radioactive as shown in the table below.

Time (days)	0	22	42	62	82	102	122	142	162
Count rate (min^{-1})	106	83	66	56	47	36	31	26	15

The scientists recommended that the environment will be safe for use again when obtained half-life value is less than 60 days and they will need like 1 year (365 days) for the environment to be free from radioactive wastes and materials.

Task: As a student of physics, use your knowledge to:

- Help the people to know the value of half-life and advise them accordingly.
- Sensitize the people about the risk associated with radioactive materials and how they should be handled
- Help the people to understand the value of number of neutrons of a nuclide Y formed when a radioactive substance X of mass number 208 and atomic number 104 decays by emitting 3 alpha particles, 4 beta particles and gamma rays to form a nuclide Y.

HEAT AND MECHANICS

Item 9

During holidays, a boy of mass **50 kg** went to a play resort near the lake shores on a certain beach and sat on one side of a see-saw at a distance of **2.4 m** from its pivot. It was very hot that day and the diurnal temperatures that were above **42°C** after afterwards he decided to enter the lake and swim to cool himself. He was wearing heavy black shorts and white vest. After swimming, he was left puzzled and wondering why his heavy black shorts dried quicker than the white vest and beach cottages (semi-houses) roofed with grass instead of iron sheets were cooler than those with iron sheets.

Hint:

Specific heat capacity of the boy (human body) = **3.5 kJkg⁻¹K⁻¹**

Task:

As a physics student;

- Help the guide at the play resort to determine if another boy of mass **40 kg** will restore equilibrium in the see-saw if he sits at a distance of **3m** from the pivot.
- Assist the boy to understand what has made him puzzled and keep wondering.

- (c) Determine the quantity of heat lost by the boy if his temperature in the lake was **22°C**.

Item 10

A pump is used to fill a tank by drawing water from underground well to be used at school power house. In order to minimize on power consumption its use for limited time, the pump works at a constant rate of **$2.4 \times 10^2 \text{W}$** and it's able to raise **0.188 m^3** of water every minute through a height of **6m**. The cooks complain that it is slow at work. At the power house the cook is always surprised because water pumped in the morning is always above the normal temperature at **30°C** when measured using a thermometer which the cook checks before making morning tea. The pump is said to be efficient if the ratio of its work out put to work input is above **0.75** and the cook boils **9.5l** of water for morning tea and **500g** evaporated.

Support materials

Density of water is 1000kgm^{-3}

Specific heat capacity of water = $4200 \text{Jkg}^{-1}\text{K}^{-1}$

Specific latent heat of vaporization of water $2.56 \times 10^6 \text{Jkg}^{-1}$

Task.

- Obtain the rate at which the pump works in raising the water and comment on its efficiency.
- Explain to the cooks why water pumped in the morning has such temperature.
- How much heat is necessary to turn the lost volume of water into vapour.

Item 11

On a construction site a builder uses an electric lifter to transfer the mortar from the ground to a height of **17.0m** on the building. When power went off and work has to continue, the builders got a rope, a pail of negligible mass with a handle that lift a maximum of **20kg** of mortar. They want to design a simple machine with a help of a grooved rim which can enable them resume work. Given that the rope has a maximum thermal strength of **3.8kJ**.

Hint;

Assume all the potential energy is converted to heat energy

Task.

- Help the builders to design the machine and guide the on how it works.

- (b) Advise whether the rope will withstand the heat generated or it will break.
- (c) Suggest the necessary factor to consider that enable the rope to successfully execute the work.

Item 12

A steel and tube industries company limited was contacted by the school to make a number of new items to restock their kitchen. Among the items on the invoice are; saucepan, strainer, saucepan covers (lids), ladles, cups and plates for students. The school did not specify the type of materials these items should be made of and therefore, the procurement officer of the company their raw materials supplier and the following was supplied following the invoice.

- Plain sheets of copper
- Plain sheets of aluminum
- Melamine resin powder
- Clay
- Wood

For the production team to come up with the items requested by the school, they have to subject these raw materials to either heat or force however these materials behave differently under these two factors.

Support knowledge.

Heat capacity of copper is $400 \text{ J kg}^{-1} \text{ K}^{-1}$

Heat capacity of aluminum is $900 \text{ J kg}^{-1} \text{ K}^{-1}$

Task

- a) As a physics learner, with reason(s) help the production team to select the raw material suitable for each item to be produced.
- b) Explain at particle level how these materials behave when subjected to either heat or when a force is applied.

ELECTRICITY & MAGNETISM

Item 13

In a certain place, a house was connected to a **240V** mains voltage supply and the owner wished to connect a TV set rated **120V, 75W**, a flat iron rated **120V, 600W**, an electric bell of resistance **5 ohms** that would instantly produce sound to alert the house owner about the visitors at the gate when a switch was pressed, and **4** bulbs rated **120V, 60W** either in series or parallel connection for lighting purposes. The house owner also bought a Power King extension with a fuse rated **5A**, where he plugged in his TV set and Flat iron. The T.V set is operated for **5** hours per day.

Task:

- Comment on the effectiveness of the fuse in the extension if it would support the above electrical appliances when plugged in the extension altogether.
- Assist the house owner to know in which way to connect his bulbs in the house and explain why?
- Explain how sound was produced when a switch was pressed.
- Determine the amount of money required to keep the T.V operating the whole day, if the electricity rate is Ugsh. **680 per kWh**.

Item 14

In a certain school, students visited a hydroelectric power plant and received information that electricity at a dam is generated in form of alternating current (a.c) at **12kV** but transmitted at **400kV** using aluminum transmission cables yet in the physics laboratory electricity can be generated as direct current (d.c) using dilute sulphuric acid and two electrodes of copper and zinc where a filament is connected and after sometime its brightness fades. However, learners are confused about how voltage is increased and have questions how a.c is used to charge a mobile phone yet it is only d.c that can be used to charge mobile phones.

Task:

- Explain how voltage is changed from 12 kV to 400 kV
- Explain how a.c from the dam is used to charge a mobile phone.
- Determine the current in the transmission cables, if 10% of its energy lost in changing its voltage, if the current before the change is 20 A
- Explain why the brightness of the bulb faded and how it can be restored.

Item 15

A factory produces small metallic tanks for storing paint and uses a magnetic lifting device to move tanks around the factory and packing them in lorries for delivery. One construction company ordered for large size tanks. However, after manufacturing them, the magnetic lifting device failed to lift the tanks due to their increased weight. Even the packed tanks were found attracted to the

other. The same day the factory engineer wasn't available which left the attendants puzzled on how to ensure delivery is made in time.

Support material: A strong electric battery, copper wires, iron rods, current controllers (variable resistors)

As a physics student;

- Advise the attendants on how and which device they can design to effectively load them on lorries for timely delivery.
- Explain how the strength of the device used for loading can be improved.
- Explain why is that the tanks were found attracted to each other upon delivery
- Advise the construction company on how they will be able to separate the tanks that are in contact.

Item 16

The welders in a certain workshop are troubled with their tools being shocked by electricity from a generator of **240V**. When they visited a technician, they were advised to wind a copper wire to **3000** turns around a soft iron ring on the receiving part so as to output **120V** suitable for their work shop operations fixed in a box. However, the welders seem bothered of how this will be of help.

Task

As a learner of physics,

- Explain to the welders how the above design will produce power corresponding to their consumption.
- Help the welder to determine the number of turns to be wound on the output part of the device
- Comment on how efficient the device is if the ratio of current output to current input is **1.5**
- Advise the welders on how to improve the efficiency of the device.

PRACTICAL PHYSICS P535/2 SEMINAR QUESTIONS

ITEM 1 (Mechanics)

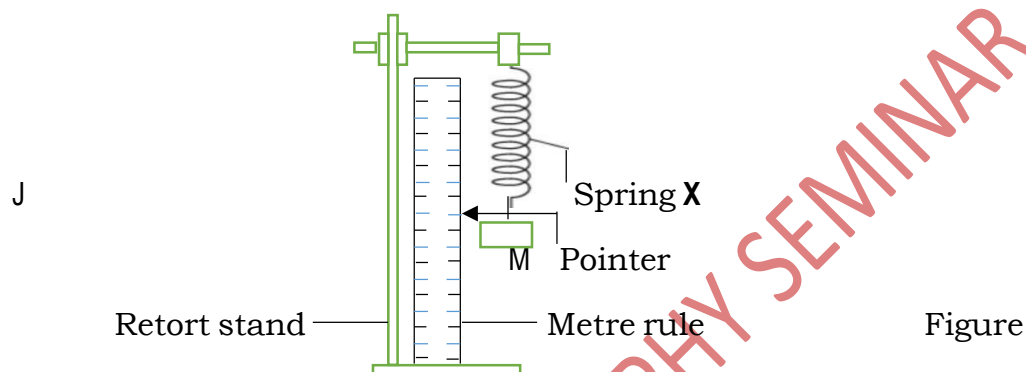
A mobile money operator working along one of the busy streets in Kampala faced a challenge one day when the Umbrella she was seated under got blown away by a violent wind. She picked the broken umbrella a few metres away from her work station but discovered that its springs were completely

destroyed. When she took the umbrella for repair, the mechanic requested her to buy new springs of force constant 25 Nm^{-1} , which she did. There was, however, no label on the springs she bought indicating the value of the spring constant.

Task:

You are provided with a spring **X** having the same properties as those of the spring bought by the mobile money operator. Carry out a scientific investigation to determine the force constant of the spring.

Hint:



- M is a standard (known) mass.
- Other experimental setups may be used.
- Hooke's law: $F = ke$.

ITEM 2 (Light)

In most of Uganda's homes, charcoal is the main source of heat energy for cooking. Because there is high demand for charcoal, many trees have been felled, leading to deforestation and an increase in global warming. To mitigate the ever increasing effects of global warming, experts running a Non – Governmental Organization (NGO) advised people to turn to alternative sources of energy like solar, gas, electricity etc. The NGO donated concave mirrors of

focal lengths in the range 15.0 cm – 20.0 cm to be used to harness solar energy from the sun. The challenge is finding the solar heating points of the mirrors.

Task:

As a student of physics, carry out a scientific investigation to locate the solar heating point of a concave mirror donated to your home.

Hint:

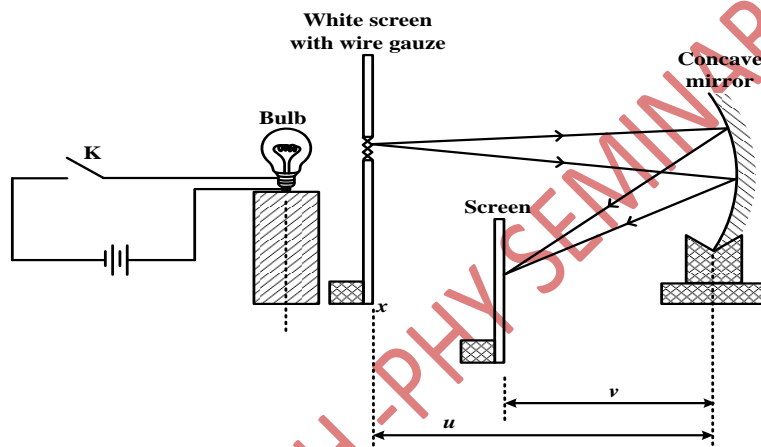


Figure 2.0

- ✓ Other experimental setups may be used.
- ✓ $\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$

ITEM 3 (Electricity)

A box of new torch bulbs was delivered at a school laboratory for use in practical physics investigations. The new bulbs looked identical to an old stock of torch bulbs that had been supplied the previous term. When each of the new bulbs was connected to a new dry cell, the light emitted was not as bright as that obtained from each of the bulbs that were delivered earlier. This led to the suspicion that the resistance of the filament in the new stock of torch bulbs was higher than the recommended value of 1.0Ω .

Hint:

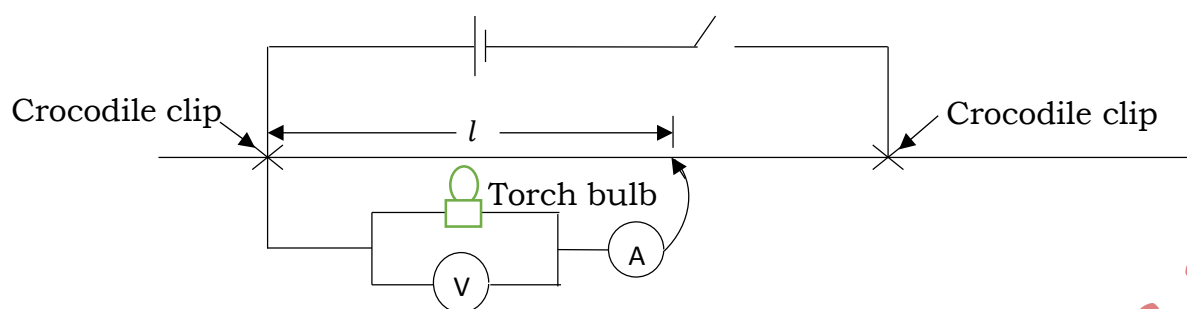


Figure 3.0

Other experimental setups may be used

Task.

As a student of physics working closely with the laboratory technician at your school, carry out a scientific investigation to determine the resistance of one of the new bulbs supplied.

**SECONDARY PHYSICS TEACHERS ASSOCIATION (SEPTA) EXTENDS
GREAT THANKS TO THE FOLLOWING MEMBERS OF PHYSICS
DEPARTMENT OF ST JOSEPH OF NAZARETH HIGH SCHOOL**

SN	NAME	CONTACT
1	MR. ISMA OUMA (H.O.D)	0705-134080
2	Miss. NAKABAZZI ANNETIE	0754-156669
3	MR. LAGANYI AMBROSE	0705-425596
4	MR. EJANG BENARD	0706-466049
5	MR. ARINAITWE JULIUS	0744-588722
6	MR. NANDWA WYCLIFF	0703-329869
7	MR. KIVAINUMA SAMUEL	0752-456368

END