Physics Syllabus, Grade 10

Grade 10 physics objectives

After completing grade 10 physics lessons the students will be able to:

- Understand the motion of objects in horizontal, vertical, and inclined planes, and with reference to the forces acting on the objects; the laws of conservation of energy and of momentum for objects moving in one and two dimensions

- Develop basic manipulative skills in investigate motion in a plane, and solve problems involving the forces acting on an object in linear, projectile, and circular motion, with the aid of vectors, graphs, and free-body diagram,

- Understand the concepts of, electrical, gravitational, and magnetic fields; electromagnetic radiation; electromagnetic induction, and the interface between energy and matter, the common applications of electrical and electronic circuits, and the function and configuration of the components used in circuits
- Develop skills in using measuring instruments and familiar electrical devices ;constructing simple electrical circuits using common tools appropriately and safely
- Appreciate the applications of electrical and electronic technologies to the community

Unit 1: Motion in two dimensions *(22 periods)*

***Unit outcomes*:** Students will be able to:

- describe the motion of objects in horizontal, vertical, and inclined planes, and predict and explain the motion with reference to the forces acting on the objects;
- investigate motion in a plane, through experiments and solve problems involving the forces acting on an object in linear, projectile, and circular motion, with the aid of vectors, graphs, and free-body diagrams;
- analyze ways in which an understanding of the dynamics of motion relates to the development and use of technological devices, including terrestrial and space vehicles, and the enhancement of recreational activities and sports equipment.

Competencies	***Contents***	***Suggested activities***
Students will be able to: • Define the term projectile • Give examples of projectiles • Distinguish between one dimensional and two dimensional motions • Identify that a projectile motion is a two dimensional motion • Define the term angle of projection(angle of elevation and depression) • Describe the effect of gravity in the motion of a projectile • Identify that the horizontal motion part is motion with a constant velocity and the vertical motion part is a uniformly accelerated motion • write an expression for the time required to reach the maximum	***1. motion in two dimension*** **1.1 Projectile motion** *(5 periods)* • Horizontal projection • Vertical projection • Inclined projection	Demonstration: The “aluminium foil cannon ball”. It uses a rubber band to shoot an aluminium cannon ball out of a paper tube. Inclined plane – hitting a target. It shows independence of vertical and horizontal motions. Equipment: the same long “v” track from Newton’s First Law demonstration. It should be at least a meter and a half long. Put a ball in motion down the track. Have a stop at the end. Use a short segment of track at a high angle; say 45 degrees, to impart momentum. Measure the speed of the ball on the track. Measure the height of the end of the track off the floor. Calculate the time it takes to fall. Predict where the ball will land if the stop is removed. Put a cup there to catch the ball. Repeat the demonstration perhaps with the track running over student desks. Invite students to measure and place the cup. Change the velocity of the ball. Re-measure with a different launch angle. Invite a group of students to measure the velocity and make a prediction about where to put the cup. PEER INSTRUCTION on motion in 2 dimensions Group lab – ACTIVE ASSESSMENT: Each row will have paper tube cannon. They will calibrate the cannon’s initial velocity by measuring the force constant of the rubber band. Using the definition of work, and F_{avg} they calculate the work done on the ball by the elastic. This predicts the initial velocity and also the vertical height the ball should reach.

Competencies	Contents	Suggested activities
height of a projectile projected at an angle θ to the horizontal • use an expression to calculate the maximum height attained by a projectile in an inclined projection • Write an expression for the total time of flight of a projectile projected at a given angle • Derive an expression for the range R of a projectile projected at a given angle • Deduce the path (trajectory) of a projectile is parabolic • Show that the range occurs at an angle of 45 degrees • Solve problems involving projectile motion		The launcher is placed in either the front desk or back desk. The instructor gives groups of 6-9 students a small basket 10-20 cm in diameter. The lab challenges student groups to calculate the angle of the launcher so that a launch will hit the basket placed in the middle of their desks. Each group gets three tries. Each group must submit a report showing their calculations and measurements that achieved the result. Individuals must write up the process and explain how to calculate range of a projectile. Activity: Independence of gravity and other forces Position a ruler or other stick on the edge of a table. place a penny on one end of the ruler and place another penny on the edge of a table near the ruler, Quickly pivot the ruler about its other end and one penny will drop straight down while the other will be hit by the ruler and move in a horizontal and vertical direction simultaneously. Listen for the clicks as each penny hits the floor. Do they hit the floor at the same or at different times? Repeat the activity using different sizes of coins and different heights. Does the motion in the vertical direction influence the motion in the horizontal direction? Discuss.
• Define the term centre of mass • Determine the centre of mass of regular and irregular bodies	• Centre of Mass • Definition of centre of mass • Centre of mass theorem	Demonstration: A 2m plank with four low friction wheels such as from roller bearings models a boat in water. The middle of the plank is marked on the plank and on the floor. A student, starting in the middle, walks four steps. The plank moves backwards. Marks are made of finial positions. The instructor guides a calculation of the motion of the centre of mass. Demonstration: two students on platforms with wheels exchange a very heavy ball (sand filled basket ball). They analyze the event in Newtonian fashion. Now one platform has 2 or 3 students. Repeat the demonstration. Record backward motion of each sled.
	• Application problems for CM.	Demonstration of centre of mass (CM) using a tennis racket. Some lights form a band around part of the tennis racket. Use one band at a time. The

Competencies	Contents	Suggested activities
	• Boat on a river with occupant walking. • Satellite separating from an explosion or a rocket.	instructor throws it toward the back of the class. Lights on the ends make loops in the air. Lights placed at one spot make a perfect parabola. The instructor investigates what properties this point has. He suspends the racket by a string at that point. It balances. This demonstration gives support to the CM theorem. The instructor tries again with a stick weighted heavily at one end. The CM is closer to the heavy end Activity: centre of mass of an irregular object How can we find the centre of mass of an irregularly shaped object? Use a nail or pencil to punch three holes in the perimeter of a cardboard. Slightly enlarge these holes so the cardboard can rotate freely. Place a nail or pencil in one hole and hang a weighted piece of string from it. Swing the cardboard and when it comes to rest , draw a line on the cardboard showing the position of the string .the cardboard swing back and forth as a pendulum until the centre of mass comes to rest directly below the point of support . This position represents the state of least energy for the body, and all bodies move toward a position of minimal energy. Repeat the other two holes. Attempt to balance the cardboard at the intersection of the three lines
• Explain the force needed to keep an object moving in a horizontal circle (centripetal force) • Identify that a radial acceleration of a body in a uniform circular motion arises from a change in the direction of a velocity • Calculate the magnitude of the centripetal force that is needed to keep an object moving in a horizontal circle • Describe the rotational motion of a body. • Describe angular displacement and tangential displacement.	• uniform circular motion **1.2 Kinematics** *(5 periods)* • Rotational variables • Angular and tangential displacement	Demonstration: The instructor swings a pail of water horizontally at sufficient speed not to spill the water. Draw out students' ideas about circular motion. What keeps the water from spilling? Use diagrams to pull apart ideas about forces on the water. Why does the instructor lean back a bit? (bring in centre of mass arguments) Bring in Newton's laws. Why the water in the pail accelerated but its speed is not changing? Repeat the experiment with a vertical motion of the pail. Begin with a pendulum like motion then move to full rotation. Do force diagrams at the top, bottom and side points. Demo: Cut a piece of glass tubing about 15 cm in length. Heat one end in a Bunsen burner flame until the walls of the tube are smoothly rounded. Hang one end of a one-metre section of fishing line to two-holed rubber stopper and thread the other end through the tube. Tie approximately 50 grams of metal washer from the line. These washers provide the centripetal force that is exerted through the line to keep the stopper rotating in a circle. Using a stopwatch or other timing device, swing the stopper at a constant rate. Be certain to adjust the line so the distance from the top of the tube to the stopper is equal to the chosen radius, and attach a paperclip to the line above the weights to use as an indicator to check the circular motion is

Competencies	***Contents***	***Suggested activities***
• Express the measure of an angle in terms of revolutions, degrees, and radian. • Define angular velocity and tangential velocity. • Identify that the SI unit of angular velocity is rad/sec. • Define angular and tangential acceleration. • Identify that the SI unit of angular acceleration is rad /s^2 • Show the relationship between angular displacement and tangential displacement. • Show the relationship between angular velocity and tangential velocity. • Show the relationship between angular acceleration and tangential acceleration. • Use the relation |a|=(a2 t +a2r)1/2 to calculate the magnitude of the total acceleration of a body in circular motion. • Solve problems related to angular displacement, angular velocity, and angular acceleration. • Describe rotational motion with constant angular acceleration. • State the equations of	• Angular and tangential velocity • Angular and tangential acceleration • Uniform circular motion • Rotational motion with constant angular acceleration • Equations of motion with constant angular acceleration **1.3. Rotational dynamics** *(7 periods)* **1.3.1. Moment of inertia and rotational kinetic energy** **1.3.2. Torque** • Torque and angular acceleration • Angular momentum • Law of conservation of angular momentum • Conditions of equilibrium in rotational motion • Centre of gravity	steady. If the clip remains stationary, the radius and speed of rotation is constant. The velocity can be computed by dividing the circumference of the circle by the period of rotation. It is easier to determine the period of rotation by measuring the time required for ten rotations and dividing by ten. Calculate the centripetal acceleration acting on the stopper. Repeat using a larger radius Demonstration: The tool is a bicycle wheel that is filled with sand, or better, some sand mixed with metal shot. The axels have handles to hold the wheel as it rotates. The instructor gets the wheel going as fast as possible. He invites students to come up and hold the handles and attempt to twist the wheel in a vertical direction. They describe a resistance. He stops the wheel and invites others to twist in a vertical direction. Why is there no resistance when the wheel is stopped? The instructor wraps more masses onto the wheel (bicycle tire segments filled with sand, sealed at the ends.) These are taped symmetrically on the wheel. He makes the wheel spin again and invites students to try to twist it. Is it harder or easier than before? Alternately, the understanding with a demonstration of angular momentum using a weighted bicycle wheel. Have the wheel accelerated by spinning it. Connect angular momentum with linear momentum by accelerating the mounted wheel by having a weight drop and exert a torque. Demonstration: angular momentum, torque and stability Hold a coin horizontally, using thumb and first finger of one hand. Slowly move your fingers apart until the object falls. Unless you are agile enough to release both fingers from the coin at precisely the same instant the coin will flip as it falls because the last finger touching the coin acts as pivot and gravity acting at the coin's centre of mass provides an external torque to rotate the coin about this axis .As the coin falls it rotates around its centre of mass The demonstration motivates a qualitative understanding of the moment of inertia, a quantity a lot like mass but now only applicable with rotation.

Competencies	***Contents***	***Suggested activities***
motion with constant angular acceleration. • Show the analogous relation between equations of uniformly accelerated rectilinear motion and rotational motion • Use equations of motion with constant angular acceleration to solve simple related problems • Define the moment of inertia of a point mass • Define rotational kinetic energy of a body. • Solve simple problems related to moment of inertia and rotational kinetic energy • Define the term torque • Identify the SI unit of torque is Nm,which is not the same as Joule • Express torque in terms of moment of inertia and angular acceleration • Derive an expression for the work done by the torque • Use the formula $W=\tau\theta$ to solve problems related to work done by torque • Define the angular momentum of a particle of mass m • Write the SI unit of angular momentum		Demonstration: To demonstrate distribution of mass and rotational inertia. Tape cans of soup or other similar objects an equal and short distance from the centre of a meter stick, leaving room for your hand to grasp the stick at its center.Apply torque to the stick by twisting it back and forth and note the effort required. Move the objects to the ends of the metre stick and tape them. Is it easier or more difficult to rotate the stick? Activity: to demonstrate rotational inertia Place two different sized rolls of adding machine tape or other rolled paper on the dowel. Attach heavy clips to the rolls and hold so they cannot unwind .release the rolls at the same time and note which unrolls most rapidly. Which roll has the greatest rotational inertia? Define angular momentum using the right hand rule. Show its representation as an arrow from the centre of the axis. "reality of the unseen". Angular momentum is real but it is not, itself, visible. Trying to change the direction of rotation meant applying forces to the angular momentum vector. Inquire students how angular momentum helps riding a bicycle. Restate Newton's 1st law for rotation. Restate Newton's 2nd law for rotation. Define torque. Inquire why there is a distance in the definition? Define kinetic rotational energy. Show the correspondence of terms. $KE_{linear} = ½ mv^2 = 1/2\ I\omega^2 = KE_{rot}$ Demonstration: Use a mounted, weighted bicycle wheel and a small, light wooden pulley to supply torque to show conversion of Potential Energy into rotational Kinetic Energy. A weight suspended on a string attached to a pulley disk forces the weighted wheel to accelerate. Activity: Obtain three cans of similar size, one filled with a liquid, one filled with a solid or semi-solid, and an empty can with the ends cut out. Which can will reach the bottom first when released on a ramp at the same time?Last?Test your predictions. PEER Instruction:

Competencies	***Contents***	***Suggested activities***
• State the law of conservation of angular momentum • Solve problems using the law of conservation of angular momentum • State the first and second conditions of equilibrium. • Solve problems related to conditions of equilibrium. • Define the term centre of mass (centre of gravity) of a solid body. • Determine the centre of gravity of a body using a plumb –line method. • Define the terms: stable, unstable and neutral equilibrium.		What happens if the mass of the wheel is increased? Why? What happens if the mass is doubled? Increase the mass of the wheel by adding sand filled segments taped on. Demonstration: Converting rotational kinetic energy into electrical energy: Get the weighted wheels going to a good speed? Use a small DC electric motor with a 5-10 cm disk attached to the shaft. Have a small mirror segment attached to the disk and a light shining on the mirror to make rotations visible. Demonstrate attaching a battery to the motor. Remove the battery; attach a bulb to the output of the motor. Bring the weighted wheel to maximum speed. Touch the motor's wheel to the tire. The light bulb will light for a while, as the wheel slows down. When it runs in reverse way, a motor is also a generators.
• State the Newton's law of universal gravitation • Determine the magnitude of the force of attraction between two masses separated by a distance r • Calculate the value of g at any distance above the surface of the earth • State Kepler's law of planetary motion • Use kepler's law of planetary motion to determine the period of any planet • Differentiate between	**1.4 Newton's law of universal gravitation** *(5 periods)* • Variation of g with altitude • Kepler's law of planetary motion • Motion of artificial satellites(orbital and escape velocities) • Geostationary satellites	PEER Instruction: What kinds of energy transformations are involved? If the light bulb were not screwed in, what would the interaction with the motor and tire? Do the experiment. Collect literature satellites from news papers, libraries and catalogues. inquire students to write an essay about the history of satellites, dates for the launching of the satellites into space and time spent into space.

Competencies	***Contents***	***Suggested activities***
orbital and escape velocity of a satellite • Determine the period of a satellite around a planet • Calculate the orbital and escape velocity of a satellite • Describe the period, position and function of a geostationary satellite	**Engineering Project**	The Mousetrap car. Using power from one mousetrap students design a mousetrap car to go the furthest distance. They can choose any number of wheels and any size of the wheels. The world record is 180m

Assessment

The teacher should assess each students work continuously over the whole unit and compare it with the following description, based on the competencies, to determine whether the student has achieved the minimum required level.

Students at minimum requirement level

A student working at the minimum requirement level will be able to: analyze and predict, in quantitative terms, and explain the motion of objects in horizontal, vertical, and inclined projections; analyze and predict, in quantitative terms, and explain the motion of a projectile with respect to the horizontal and vertical components of its motion; analyze and predict, in quantitative terms, and explain uniform circular motion in the horizontal and vertical planes with reference to the forces involved ;describe Newton's law of universal gravitation, apply it quantitatively, and use it to explain planetary and satellite motion.

Students above minimum requirement level

Students working above the minimum requirement level should be praised and their achievements recognized. They should be encouraged to continue working hard and not become complacent.

Students below minimum requirement level

Students working below the minimum requirement level will require extra help if they are to catch up with rest of the class. They should be given extra attention in class and additional lesson time during breaks or at the end of the day.

Unit 2: Electrostatics *(19 periods)*

Unit outcomes**:** Students will be able to:

- Demonstrate the principles of static electricity;
- Gain knowledge and understandings in static electric charge, electric field and force, electric potential capacitors and energy stored in capacitors
- Develop skills in performing electrostatic experiments, and solving problems related to charges at rest
- Appreciate the workings of some equipments which operate on the basis of electrostatic charges
- Describe and apply models of static electricity.

Competencies	***Contents***	***Suggested activities***
Students will be able to: • State the law of conservation of charge. • Describe and explain the charging processes: charging by rubbing, conduction, and induction. • Perform an experiment to charge an electroscope by conduction, induction. • Describe the distribution of charge on a conductor of variable shape. • Explain how lightning is formed. • Describe the use of lightning rod. • Describe the working principle of some equipments which operate on the principles of electrostatic charge. • Describe the electrostatic hazards and useful application of electrostatics. • State coulomb's law.	***2.Electrostatics*** **2.1 Electric charge** *(6 period)* • electric charge and law of conservation of charge • charging processes (rubbing, conduction, and induction) • charge distribution on a conductor • lightning and lightning rod • applications of electrostatics (paint, spray, electrostatic photocopier) • electrostatics danger	Demonstration :Electrostatic Attraction of water Adjust the faucet so it releases the smallest continuous stream of water possible. Bring the charged comb near the stream and note that it shifts the flow by means of electrostatic attraction. ACTIVITY: Hanging balloons with electrostatic force Inflate a balloon and then briskly rub one side of it on your hair. Place this surface of the balloon toward a wall or door and release it when it appears to be sticking. What can you conclude about the nature of the surfaces to which the balloon sticks? Demonstration: Induction Tear a sheet of news paper into small bits approximately one half cm in diameter .Place the paper bits under a glass plate supported by two books. Rub the glass vigorously with silk and notice how the paper jumps up to the glass. What attracts the paper to the glass? Why does not it stay attached to the glass? Discuss with the group. Demonstration: A typical 25 cm –diameter Van de graaf generator is capable of generating a 200,000-volt potential difference that can cause gasses in a fluorescent tube to glow. Darken the room, turn on the generator, and slowly move a fluorescent tube toward the generator and observe that it starts to glow. Why does the portion between the tube and your hand and the generator glow?

Competencies	***Contents***	***Suggested activities***
• Compare coulomb's law and Newton's law of universal gravitation. • Compute the force acting on a charge due to two other charges placed on the same plane (line of action). • Calculate the force between three charges placed collinearly. • Define an electric field. • Represent diagrammatically the electric field lines around and between two point charges. • Calculate the electric field strength at a point due to charges placed collinearly and at right angles. • Distinguish between electric field between inside and outside a spherical metallic conductor.	**2.2 electric forces and fields** *(5 periods)* • Coulomb's law • Force between charges. • Electric field strength. • Electric field lines. • Electric field due to a point charge. • Electric field inside and outside a spherical metallic conductor.	
• Define electric potential and it's SI unit. • Distinguish between absolute potential and potential difference. • Show that 1N/C=1V/m. • Explain about equipotential lines and surfaces. • Draw equipotential lines and surfaces in an	**2.3. Electric potential** *(4 periods)* • Absolute potential and potential difference. • Equipotential lines and surfaces. • Electric potential energy. • Conversion of mechanical to electrical and electrical to	

Competencies	*Contents*	*Suggested activities*
electric field. • Define the term electric potential energy. • Define what is meant by a dielectric material. • Describe the structure of a simple capacitor. • Define the term capacitance and it's SI unit. • Use the circuit symbol to represent a capacitor. • Apply the definition of capacitance to solve numerical problems. • Explain the charging and discharging of capacitor. • Identify combination of capacitors in series, parallel, and series-parallel. • Define the term dielectric. • Explain the effect of inserting dielectric in the gap between the plates of a parallel plate capacitor. • Derive an expression for the effective capacitance of capacitors connected in series and parallel. • Compare the effective capacitance of combination of capacitors in series and parallel.	mechanical. **2.4. Capacitors and capacitances** *(4 periods)* • Definition of a capacitor • Charging and discharging processes • Combination of capacitors in series. • Combination of capacitors in parallel. • Combination of capacitors in series-parallel. • Parallel-plate capacitor. • Capacitance of a parallel plate capacitor with and without dielectric. • Energy stored in a capacitor. • Applications of capacitors.	Demonstration: Obtain large capacitors 350+mf from dead TV power supplies. They look like small beer cans. Charge the capacitor for a few minutes. Let it power a small light. Observe the behaviour of the light's decay. Invite student hypotheses about what happened. What was stored? What drained? If sufficient numbers of capacitors are available let student teams experiment with charging and discharging the capacitor. Invite them to make drawings of light intensity vs. time graph as the capacitor decays. Is the graph linear or not? Experiment with capacitors in series and parallel. Which takes longer to decay? Why? all done qualitatively. There should be much experimentation with capacitors (big ones from dead TV's) They store enough energy to power a bulb for a short time. Capacitors build up the idea of electron flow and the idea of transient currents. This treatment is much too theoretical. Get the big capacitors (like a beer can) or a film canister and let kids experiment with them. Less board work. Much more hands on. Put in a resistor. What happens to the discharge of the large capacitor? Put some in series, in parallel. What happens with the discharge?

Competencies	***Contents***	***Suggested activities***
• Solve problems on combination of capacitors • Define parallel plate capacitor. • Describe the factors that affect the capacitance of a parallel plate capacitor. • Calculate the capacitance of a parallel plate capacitor. • Compare the capacitance of a parallel plate capacitor with and without a dielectric. • Appreciate an expression for the electric potential energy stored in a capacitor. • Calculate the energy stored in a capacitor using one of the three possible formulae. • Draw electric circuit diagram for a simple capacitor, series and parallel connections of two or more capacitors using symbols. • State some uses of capacitors in everyday life.		

Assessment

The teacher should assess each students work continuously over the whole unit and compare it with the following description, based on the competencies, to determine whether the student has achieved the minimum required level.

Students at minimum requirement level

A student working at the minimum requirement level will be able to : demonstrate an understanding of the concepts, principles, and laws related to electric forces and fields, and explain them in qualitative and quantitative terms; state Coulomb's law and compare it with Newton's law of universal gravitation; apply Coulomb's law quantitatively in specific contexts; compare the properties of electric and gravitational fields by describing and illustrating the source and direction of the field in each case; describe and explain, in qualitative terms, the electric field that exists inside and on the surface of a charged conductor;

Students above minimum requirement level

Students working above the minimum requirement level should be praised and their achievements recognized. They should be encouraged to continue working hard and not become complacent.

Students below minimum requirement level

Students working below the minimum requirement level will require extra help if they are to catch up with rest of the class. They should be given extra attention in class and additional lesson time during breaks or at the end of the day.

Unit 3: Current electricity *(14 periods)*

Unit outcomes: Students will be able to:

- Acquire knowledge and understandings in electric current, Ohm's law, combinations of resistors, measuring instruments,emf of a cell, electrical energy and power.
- Conduct investigations and analyze and solve problems related to electric charges, electric circuit.
- Evaluate and describe the social and economic impact of technological developments related to the concept of electricity.
- design and build electrical circuits that perform a specific function.
- Analyze the practical uses of electricity and its impact on everyday life.
- design and conduct investigations into electrical circuits found in everyday life and into the quantitative relationships among current, potential difference, and resistance.
- Evaluate the social, economic, and environmental costs and benefits arising from the methods of electrical energy production used in Ethiopia.

Competencies	*Contents*	*Suggested activities*
Students will be able to : • define electric current and it's SI unit • Explain the flow of electric charges in a metallic conductor. • compute the number of electrons that pass a point at a given length of time when the current in the wire is known.	***3. Current electricity*** **3.1 Electric current** *(2 periods)* • flow of electric charges in a metallic conductor • Electric energy from chemicals	Make it clear that most substances obey ohm's law but it is not a true universal law of physics. Many important substances, like semiconductors and transistors are not Ohmic. Demonstration: Use a compass needle to determine a magnetic North. Wrap approximately 30 turns of thin – gauge insulated copper wire around this compass in a north/south direction, and connect it to a1.5 v light bulb that is connected to a 1.5V battery. Note that when the circuit is closed, a current will flow, the lamp will glow, and the needle will move. This simple galvanoscope can be used whenever you want to detect the presence of small currents. Activity 1: Thermal and electrical conductivity both depend upon the transport of energy by electrons. To test this hypothesis, examine the electrical conductivity of copper, steel, and plastic by observing the deflection of galvanoscope needle when equal- sized pieces of copper, steel, or plastic are substituted for the light bulb. Rank the substances tested from high to low electrical conductivity All electrochemical cells require two electrodes made of two different conductors, an electrolyte solution (a solution that conducts electricity) that reacts with the electrodes, and a conductive wire through which electrons may flow. Activity 2: Roll a lemon, orange grape fruit, or other citrus on a firm surface to break the internal membranes. Cut strips (approximately 4cm×3cm) of copper and zinc sheet metal and insert these in the fruit so they are approximately 1cm apart. Attach the test wires of a volt-ohm-milliammter to the strips and measure the electric potential and current. Will the voltage of your wet cell change if you change the size of the electrodes?

Competencies	***Contents***	***Suggested activities***
	• Electric energy from heat	Try it. Will the voltage change if you construct the cell using different electrodes? Demonstration: the transformation of heat energy directly into electric energy. Thermocouple (seebeck effect) refers to the generation of electricity in a circuit composed of two wires whose junctions are at different temperatures. Create thermocouple junctions at both ends of a section of iron wire by twisting the ends together with copper wires. Place one copper /iron junction in a beaker with ice water while leaving the other junction outside. The two remaining ends of the copper wires should be connected to a sensitive galvanometer. Heat the exposed junction with a Bunsen burner or match and record the current. Does the current increase or decrease if the heat source is removed? Is the change in current immediate? Discuss these questions. Activity 3: Cells in series and parallel. Let the students do these activities in groups. The citric acid in lemons or oranges provides an excellent electrolyte solution for a simple wet cell. After rolling the fruit firmly on a table to rupture its internal membranes, insert two electrodes made of two different metals, making certain the electrodes do not touch. Nails may serve as iron electrodes, stripped electrical wires may serve as copper electrodes, silver jewelleries may serve as silver electrodes. Add a second and then a third similar" fruit cell" in series with the first cell and record the voltages. Continue adding cells until the light is brightly lit .Add a second and then a third similar "fruit cells" in parallel with the first one and record the voltages. What is the advantage of adding cells in series, in parallel? Discuss
• describe factors affecting the resistance of a conductor. • write the relationship between resistance R, resistivity ρ,length l and cross-sectional area A of a conductor. • compute the resistance of a conductor using the formula $R=\rho l/A$ • find the relationship between resistivity and	**3.2 Ohm's law and electrical resistance** *(3 periods)* • resistivity and conductivity electric circuit	Demonstration: Ohm's law A resistor is an electrical component that opposes the flow of current in a circuit. Since pencil "lead' is made of carbon, an element frequently used in resistors, we can use it here. Connect a flash light bulb (1 to 2 v) in series with a pencil lead and a 6v battery. Turn off the room lights and observe the brightness of the bulb. Move one wire contact along the length of the pencil lead and observe the changes in the intensity of light. Repeat the activities with a pencil lead of different diameter. What influence does the diameter of the resistor have upon the net resistance? What effect does the length of the resistive path have upon the total resistance? Discuss these questions. Use a board with 6-8 clips to make circuits.

Competencies	***Contents***	***Suggested activities***
conductivity. • construct and draw electric circuit consisting of source, connecting wires, resistors, switch, bulb, using their symbols. • Explain why an ammeter should be connected in series with a resistor in a circuit. • Explain why a voltmeter should be connected in parallel across a resistor in a circuit. • DO EXPERIMENTS (at least have students touch the equipment) using an ammeter and a voltmeter to investigate the relationship between current and p.d for metallic conductors at constant temperature.		Include capacitors in some circuits. Use big ones. Try to pick non-polar caps to avoid punch through. When students connect them backwards and make a hole in the dielectric film. The work need not have every student group with a meter. Let them build a circuit and have the instructor come over with the meter to measure current and volt.
• identify combinations of resistors in series, parallel, and series-parallel connection. • derive an expression for the effective resistance of resistors connected in series. • derive an expression for the effective resistance of resistors connected in parallel. • Compute the effective resistance of resistors	**3.3 Combinations of resistors** *(3 periods)* • series combination • parallel combination • series-parallel combination	

Competencies	Contents	Suggested activities
connected in series. • Compute the effective resistance of resistors connected in parallel. • Calculate the current through each resistors in a simple series, parallel, and series-parallel combinations. • Calculate the voltage drop across each resistor in a simple series, parallel, and series-parallel connections.		
• Define electromotive force of a cell. • Distinguish between emf and terminal p.d of a cell. • Write the relationship between emf, p.d, current, and internal resistance in a circuit. • Use the equation $V=\varepsilon-Ir$ to solve problems in a circuit. • Identify cells combinations in series and parallel. • Compare the emf of combinations of cells in series and parallel.	**3.4 Emf and internal resistance of a cell** *(3 periods)* • combination of cells in series and parallel	Activity 4: series and parallel circuits. Let the students do these activities in groups. Connect one bulb in series with a battery and note its brightness. Now connect a second and third bulb in series with the bulb. Is there any change in the brightness of the first bulb when the second and third bulbs are added? Once all bulbs are lit, remove one of the bulbs. What happens to the brightness of the others? Confirm their understandings Connect one bulb to a battery and note its brightness. Now connect a second and third bulb in parallel with this bulb. Is there any change in brightness of the first bulb when the second or third ones are added? Once all bulbs are lit, remove one. Is there any change in the brightness of the remaining bulbs? Confirm their understandings. Demonstration: Measuring electromotive force and terminal voltage of a source. Set up a circuit consisting of a dry cell, a bulb, a switch and a voltmeter. Take the reading in the voltmeter while the switch is on. Then another reading while the switch is off. Compare the two readings. Which one is larger? Which reading is the e.m.f? Discuss with the group
• Define electrical energy and power in an electrical circuit.	**3.5 Electric energy and power** *(2 periods)*	Activity 5: Which appliances in your home consume the greatest amount of energy? Is it the refrigerator? The TV set? The electric stove? You can find out by inspecting appliances in your home and determining the number of watts each consumes and multiplying this by the

Competencies	Contents	Suggested activities
• Find the relationship between KWh and joule. • Use P= VI=V2/R=I2R to solve problems in electric circuits. • use W=VIt=I2Rt=V2t/R to compute electric energy dissipated in an electric circuit • perform calculations on cost of electrical energy expressed in KWh	• cost of electric energy **3.6 Electric installation and safety rules** *(1 period)* Engineering project	number of hours operated. By law, each electric device must specify power requirements, and these are generally recorded on a small tag located on the appliance or on the power cable connected to it. Inspect all the appliances in your home and record power requirements in the table. New designs for cars employ hybrid motors. Cars use both electricity and gasoline for power. When going down hill ,instead of standard brakes which converts kinetic energy into heat ,these cars capture energy by using “electric brakes “that recharge the battery or convert the energy into rotational energy in a massive fly wheel . Students design on paper a hybrid car that captures as much energy as possible .Teams may wish to build a model of their design, showing innovative ways to save energy.

Assessment

The teacher should assess each students work continuously over the whole unit and compare it with the following description, based on the competencies, to determine whether the student has achieved the minimum required level.

Students at minimum requirement level

A student working at the minimum requirement level will be able to :define and describe the concepts and units related to electrical systems(e.g., emf, electric potential, resistance, power, energy); compare direct current and alternating current in qualitative terms, and describe situations in which each is used; analyze, in quantitative terms, circuit problems involving potential difference, current, and resistance; use appropriate meters (analog or digital), to measure electric potential difference, current, and resistance in electrical circuits; construct simple electrical circuits using common tools appropriately and safely; draw, by hand schematic diagrams to represent real circuits; analyze, in quantitative terms real circuits using Ohm’s law; describe common applications of simple circuits, and identify the energy transformations that occur (e.g., energy transformations in one of the following appliances or devices: refrigerator, kettle, food mixer, amplifier, television set, light bulb, oscillator, electromagnet, electric motor, garage door opener); identify and describe proper safety procedures to be used when working with electrical circuits, and identify electrical hazards that may occur in the science classroom or at home.

Students above minimum requirement level

Students working above the minimum requirement level should be praised and their achievements recognized. They should be encouraged to continue working hard and not become complacent.

Students below minimum requirement level

Students working below the minimum requirement level will require extra help if they are to catch up with rest of the class. They should be given extra attention in class and additional lesson time during breaks or at the end of the day.

Unit 4: Electromagnetism *(20 periods)*

***Unit outcomes*: Students will be able to:**

- demonstrate an understanding of the properties, physical quantities, principles, and laws related to electricity, magnetic fields, and electromagnetic induction;
- carry out experiments or simulations, to demonstrate characteristic properties of magnetic fields and electromagnetic induction;
- Identify and describe examples of domestic and industrial technologies that were developed on the basis of the scientific understanding of magnetic fields.(e.g. generator, motor, and transformer)
- Appreciate the link between electricity and magnetism, the contributions electricity and magnetism to modern life.

Competencies	***Contents***	***Suggested activities***
Students will be able to : • investigate the domain theory of magnetism	***4. Electro magnetism*** **4.1 Magnetism** *(4 periods)* • Magnetic Domains • Magnetization • Magnetic shielding • Geomagnetism	Activity 1: To investigate magnetic domains, magnetization, demagnetization Fill a test tube two thirds full with iron filings or shredded steel wool and approach the north and then the south end of a compass needle with the end of the tube. Is one end of the needle more attracted than the other? Record the maximum angle to which the needle is deflected. Repeat these observations after stroking the tube 50 times with a permanent magnet and after shaking the test tube vigorously for one minute. In which situation was the test tube more highly magnetised? Why? Let the students' discuss in groups. Demonstration: Magnetization by heating and cooling within a strong magnetic field Use insulated tongs or pliers to heat a nail in the hottest part of the flame until it glows. Remove the nail from the flame and place it lengthwise on a permanent bar magnet. After the nail has cooled, measure its magnetic strength by determining the number of small paper clips that can be suspended in a chain from one end .Compare the magnetic strength of this nail with the strength of one that was not heated, but rested on the permanent bar magnet for an equal length of time. Record your findings in the table. Demonstration: Magnetic shielding Support a bar magnet using a stand on a table, and attach a thread to a paper clip and suspend it below the magnet. Given no disturbances, the paper clip will remain float in space indefinitely due to magnetic lines of force between the magnet and the paper clip. Slide a small sheet of paper in the gap between the paper clip and the magnet, being careful not to touch either. Does paper interfere with the magnetic field? Repeat the process using a sheet of plastic, aluminium foil, and the lid of a "tin "can. Which, if any of the above, interfered with the magnetic field and allowed the paper to fall? Activity 2: Let students do these activities in groups Cut the bottoms from two paper cups of different sizes, two plastic cups of different sizes, two

Competencies	*Contents*	*Suggested activities*
		iron ("tin") cans of different sizes. Place a compass on a table and record the direction of magnetic north. Now place two bar magnets 7 cm to the east and west of the compass so that the N-pole of one magnet faces the S- pole of the other and record the angle of deflection. Remove the magnets, place a tin can over the compass, replace the magnets, and again record the angle of needle deflection. Remove the magnets, place a second can around the first, replace the magnets, and again record the angle of compass-needle deflection. Does the iron interfere with the magnetic field? Repeat the process using paper or plastic cups. Which of the substances best protects or shields the compass from the magnetic field of the bar magnets? Confirm their understanding.
• describe magnetic field • perform and describe an experiment that demonstrate the existence of magnetic field around a current-carrying wire • sketch the resulting magnetic field lines pattern of a current-carrying wire • apply the right –hand rule to tell the direction of magnetic field lines around a straight current- carrying wire • calculate the magnetic field strength at a point due to a straight current carrying wire • sketch the magnetic field lines pattern of a current loop • sketch the magnetic field lines pattern of a solenoid • specify the polarity of a solenoid using a right – hand rule	**4.2 Concepts of magnetic field** *(3 periods)* • Magnetic field around a straight current carrying wire • Magnetic field of a solenoid	Demonstration: Magnetic fields in two dimensions Place a strong bar magnet under a clear sheet of glass. Position the transparent sheet so it is level and then repeatedly tap a beaker filled with iron filings so they fall evenly over the surface. The iron filings should align themselves with the magnetic lines of flux. The points where lines appear to converge represent locations of greatest magnetic flux density. Magnetic flux density is a measure of magnetic force and is defined as the number of flux lines per unit area. Place a number of small compasses around a magnet and draw a diagram showing the orientation of the needles. Demonstration: Magnetic fields in three dimensions Place iron filings in the bottom of a glass jar and fill 90% of the remainder of the jar with salad oil. If you don't have iron filings, you may create iron shreds by rubbing two pieces steel wool together rapidly. Shake the container vigorously until the iron filings are evenly distributed throughout the container and then expose the jar to the magnetic fields of bar magnets outside the jar. Allow time for the iron filings to align with the magnetic field. Let the students draw a diagram of the field lines when the S-pole of one magnet is opposite the N-pole of another.

Competencies	Contents	Suggested activities
• compute the magnetic field strength at the centre of a solenoid • describe the factors on which the force on a moving charge in magnetic field depend		
• Demonstrate the relation B=mv/qR from the fact that the centripetal force is provided by magnetic force • Compute the magnitude of a force acting on a moving charge in a uniform magnetic field • Determine the direction of a force acting on a moving charge using right hand rule • demonstrate the existence of a force on a straight current carrying conductor placed in a magnetic field • Derive the expression F=BIlsinθ from F=qvB sinθ • Apply right hand rule to tell what will happen when current flows perpendicular to a uniform magnetic field • Describe the factors on which the force of a moving charge in the magnetic field depend • Calculate the magnitude	**4.3 Magnetic force** *(6 periods)* • Magnetic force on a moving charge • Magnetic force on a current carrying conductor • Magnetic force between two parallel current carrying conductors • Definition of ampere • Force on a rectangular current carrying wire	

Competencies	***Contents***	***Suggested activities***
of a force on a straight current carrying wire placed perpendicular to a uniform magnetic field • Compute the magnitude and direction of force between two parallel current carrying conductors in a uniform magnetic field • Define the SI unit Ampere • Draw a diagram to show the forces acting on a rectangular current carrying wire in a uniform magnetic field • Draw diagrams to show the action of a force on a simple DC motor and a moving coil galvanometer		
• Define the magnetic flux and its SI unit • State Faraday's law of induction • perform simple experiments that demonstrate an induced emf caused by changing magnetic flux • State Lenz's law • Indicate the direction of induced currents ,given the direction of motion of a conductor and the direction of a magnetic field	**4.4 Electromagnetic induction** *(7 periods)* • Magnetic flux • Faraday's law of induction • Lenz's law • Inductance(self and mutual inductances)	Demonstration: Use the weighted bicycle wheel's rims as the object of the eddy current production. Bring the magnet close to the rim. It must be non-ferrous. The magnet will slow the wheel's spinning noticeably. If one has some background in magnetism and rotational dynamics, one can calculate the deceleration from the induced current. Have a metal disk rotating quickly. Make the disk out of a non-magnetic metal like Aluminum (use thicker metal like used for roofing).Bring a strong magnet near the disk. The magnet will induce a current in the metal by Faraday's law. The magnetic field will oppose that of the magnet. It will act as a break on the wheel; the spinning wheel slows down rapidly. The disk cannot become magnetic - Aluminum is not structurally a magnet. Demonstration: drop a strong small magnet through a non-ferrous tube (without any seams). A thicker copper pipe is fine and better. Make the tubes about one meter long. Have two tubes. Drop a rock through one and the magnet through the other. The magnet will induce an electric current to oppose the motion of the magnet. It will float down the tube quite

Competencies	***Contents***	***Suggested activities***
• Describe the factors that affect the magnitude of induced emf in a conductor • Describe the link between electricity and magnetism • Apply Faraday's law to calculate the magnitude of induced emf • define inductance and it's SI unit • Distinguish between self and mutual inductance • Apply the definition of inductance to solve simple numerical problems • Explain the action of the simple a.c generator • BUILD a simple AC motor. • Explain the action of the simple AC. generator • Compare the actions of d.c and a.c generators • Draw a diagram of a transformer • Give a simple explanation of the principles to operate a transformer • Identify that for an ideal transformer Pout= Pin • Show that for an ideal transformer; Vs/Vp=Ns/Np=Ip/Is	• D.c motor • A.c and d.c generator • Transformer (step up and step down)	slowly. If you put a lot of windings around the tube at one point, say 1,000 turns or more. It will light up a small bulb for a flash. Demonstration: Suspend a non-ferrous ring from two points. Let it swing freely and stop it. Put the magnet on a stick and push it through the ring, then it will pump the ring like a kid pumps height on a swing. Peer instruction on Faraday's law Let the students discuss in a group about the law. Demonstration: The instructor runs a current through two thin wires or pieces of very thin foil (from gum wrappers). The wires or foil bend from the magnetic fields The instructor also uses the Fresnel overhead to project images of Iron filings sprinkled on top of a glass with a magnet beneath Classroom Demonstration: Stored energy in a magnetic field. Use a Fly back (step- up) transformer from an old TV. See http://en.wikipedia.org/wiki/Flyback_transformer These transformers step up voltage drastically. Connect a small bulb in series with a 12V source and a flyback transformer. It will light for an instant then stop. PEER INSTRUCTION: Why does the bulb light and then stop? Check for any heart problems. Invite students to make a human wire complete loop in series with the flyback connected to a 1.5 V battery (not the 12V). Release the connection. A small

Competencies	Contents	Suggested activities
• Apply the transformer formulas to solve simple problems		current will pass through. It will last milliseconds. What is the source? PEER INSTRUCTION Inductance. Lenz and Faraday. Decaying fields. The primary coil of a transformer is connected to a battery, a resistor, and a switch. the secondary coil is connected to an ammeter .When the switch is thrown closed ,the ammeter shows Card 1-zero current Card 2-a non zero current for a short instant Card3- a steady current Let students discuss this question and confirm their understanding Decaying are transient currents.SomeUses for transient currents are: Spark plugs in a car. Heart starting paddles in the hospital. Electric fences for animals. Activity: Make a high number of windings from a broken transformer's wires. Let the magnet fall through the coils. It will cause a transient electric current that can light up a small bulb Project work: Build an AC motor. The cost of materials is very low, next to zero. Build either the toothpick motor or the cork motor: See: http://www.ceressoft.org/Files/emotors.htm This describes how to build an AC motor Student groups build a motor at their desks. They measure the rotation rate. The fastest rotators convert the electrical energy to kinetic energy most efficiently. These get higher grades. Engineering Challenge: Build an AC motor with any design you choose that has the fastest rotation. The motor must have a small piece of reflecting material that bounces back a flashlight beam. That beam hits a simple photo transistor circuit connected to a buzzer. Students count the buzzes in 2 minutes.

Assessment

The teacher should assess each students work continuously over the whole unit and compare it with the following description, based on the competencies, to determine whether the student has achieved the minimum required level.

Students at minimum requirement level

A student working at the minimum requirement level will be able to : describe the terms magnetic domains, magnetization, magnetic shielding; identify the properties of magnetic field interpret and illustrate the magnetic field produced by a current flowing in a long straight conductor and in a coil; identify the factors that affect the magnitude and direction of the electric current induced by a changing magnetic field; describe the properties, including the three-dimensional nature, of magnetic fields; describe and illustrate the magnetic field produced by an electric current in a long straight conductor and in a solenoid; analyze and predict, by applying the right-hand rule, the direction of the magnetic field produced when electric current flows through a long straight conductor and through a solenoid; state the motor principle, explain the factors that affect the force on a current-carrying conductor in a magnetic field, and, using the right-hand rule, illustrate the resulting motion of the conductor; analyze and describe electromagnetic induction in qualitative terms, and apply Lenz's law to explain, predict, and illustrate the direction of the electric current induced by a changing magnetic field, using the right-hand rule; compare direct current (DC) and alternating current (AC) in qualitative terms, and explain the importance of alternating current in the transmission of electrical energy; explain, in terms of the interaction of electricity and magnetism, and analyze in quantitative terms, the operation of transformers (e.g., describe the basic parts and the operation of step-up and step-down transformers; solve problems involving energy, power, potential difference, current, and the number of turns in the primary and secondary coils of a transformer).

Students above minimum requirement level

Students working above the minimum requirement level should be praised and their achievements recognized. They should be encouraged to continue working hard and not become complacent.

Students below minimum requirement level

Students working below the minimum requirement level will require extra help if they are to catch up with rest of the class. They should be given extra attention in class and additional lesson time during breaks or at the end of the day.

Unit 5: Electronics *(11 periods)*

***Unit outcomes*: Students will be able to:**

- Gain elementary knowledge and understandings in vacuum tubes devices, thermionic emission ,CRO, semiconductor diodes, and transistors
- understand common applications of electrical and electronic circuits, and the function and configuration of the components used
- Investigate the development and application of electrical technologies and their impact on local and global economies and the environment.

Competencies	***Contents***	***Suggested activities***
Students will be able to : • Define the term electronics • Mention the importance of electronics in their daily life. Concept map: all items in daily life that use electronics. • State what is meant by thermionic emission • Describe the behaviour of vacuum tubes • describe the function of cathode ray tube • describe the uses of a cathode ray tube • represent both d.cand a.c on current –time or voltage-time graphs • use the current –time or voltage-time graphs to find the period and frequency of alternating currents or voltages • distinguish between conductors, semiconductors, and insulators • give examples of semi-	***5. Introduction to electronics*** **5.1 Vacuum tube devices** *(3 periods)* • thermionic emission • cathode ray oscilloscope (CRO) • using CRO • some uses of oscilloscope • TV picture tube **5.2 Conductors ,semi conductors and insulators** *(1 periods)* **5.3 Semi conductors (impurities, doping)** *(4 periods)* • Semi conductor diode (I-V characteristic) • P-n junction diode as a rectifier(qualitative treatment) • LED • LDR • Thermistor • Photodiode	Use a model of CRO if it is available or use a well labelled diagram of the cathode –ray oscilloscope for your explanation of the structure and function of the CRO Don’t emphasize the CRO. It is a relatively specialize piece of equipment that one doesn’t understand until one uses one. Deeper study of the TV tube is more helpful. Use the Human Wire to explore semiconductors and PN junctions. Students modelling silicon have 4 electron rocks. Those modelling boron have 3 rocks and a basket. It is important to model the 3 dimensional structure of the semiconductor. Use toothpicks and gummy candy to build a tetrahedral lattice (have a marshmallow represent the hole) have an extra gummy piece represent the extra electron from the doped N material, like arsenic. Discuss how a p-n junction can be formed using p-n junction diagrams .Explain the apparent movement of ‘hole’ and ‘electron’ movement and how a potential barrier is set up in the depletion layer Demonstration: demonstrate the current –voltage characteristics of a semiconductor diode. If the materials are not available, discuss the current-voltage characteristics of a semiconductor diode using a typical characteristics curve for a silicon diode. Using a circuit diagram of half wave rectifier circuit, explain the rectification of a diode when an a.c supply is used. Explain briefly how a bridge –rectifier gives a full wave rectification and further smoothing can be made by the use of a capacitor. Demonstration: show the amplification action of a transistor Demonstrate the amplification action of a transistor using transistor amplifier circuit. Ask

Competencies	Contents	Suggested activities
conductor elements • distinguish between intrinsic and extrinsic semiconductors • describe a semi-conductor in terms of charge carriers and resistance • explain doping to produce the two types of semi-conductors • identify semi-conductors as P-type and N-type • describe the mode of conduction by the majority and minority carriers • define the term diode and show it's circuit symbol • draw a current vs voltage characteristics (graph)to show the behaviour of p-n junction • describe how a semi conductor diode can be used in a half –wave rectification • sketch voltage time graphs to compute the variation of voltage with time before and after rectification • distinguish between direct current from batteries and rectified alternating current by consideration of their voltage time graphs	**5.4 Transistors(p-n-p, n-p-n**) *(3 periods)* • Transistor action • Logic gates	students to calculate the current gain Explain briefly how a voltage amplification can be achieved using well drawn simple one transistor amplifier circuit The explanation should all be done qualitatively. The key is "why does the transistor amplify current? Discuss about photo voltaic cells, making electricity directly from the sun Let the students identify a diode, an LED, a transistor, IC, a resistor, and a capacitor from a mixed collection of such items. Project work: Students should know about photovoltaic cells. Current efficiencies are about 7-9%. Higher cost cells produce efficiencies of about 30%. Calculate the number of meters of photovoltaic cells needed to supply all of Ethiopia's energy needs. Ethiopia has potential to generate 30,000MW of power using hydro plants. See http://www.capitalethiopia.com/archive/2007/May/week2/feature.htm Current installations are as large as 160Mwatts, equal to the largest hydro plant in Ethiopia. Ethiopia does have significant hydroelectric potential, unlike many African nations. But it is dependent on rainfall. Solar production is constant, though there must be storage at night.

Competencies	***Contents***	***Suggested activities***
• show the circuit symbols of semi conductor devices such as thermistor, LED, LDR, and transistors • distinguish between p-n-p and n-p-n transistors • identify the base , emitter , and collector of a transistor • use the following terms correctly: forward biased and reverse biased • Describe the behaviour of semi conductor devices such as thermistor, LED, LDR, photodiode, and transistors (all qualitatively) • Use the circuit symbols for the gates • Draw the truth tables for the different logic gates and for a combination of logic gates • Explain the action of logic gates: NOT, OR. AND, NOR, NAND		

Assessment

The teacher should assess each students work continuously over the whole unit and compare it with the following description, based on the competencies, to determine whether the student has achieved the minimum required level.

Students at minimum requirement level

A student working at the minimum requirement level will be able to: describe the function of basic circuit components (e.g., power supplies, resistors, diodes, fuses, circuit breakers, light-emitting diodes [LEDs], capacitors, and switching devices), describe the characteristics of transistors, identify the logic gates and explain their actions.

Students above minimum requirement level

Students working above the minimum requirement level should be praised and their achievements recognized. They should be encouraged to continue working hard and not become complacent.

Students below minimum requirement level

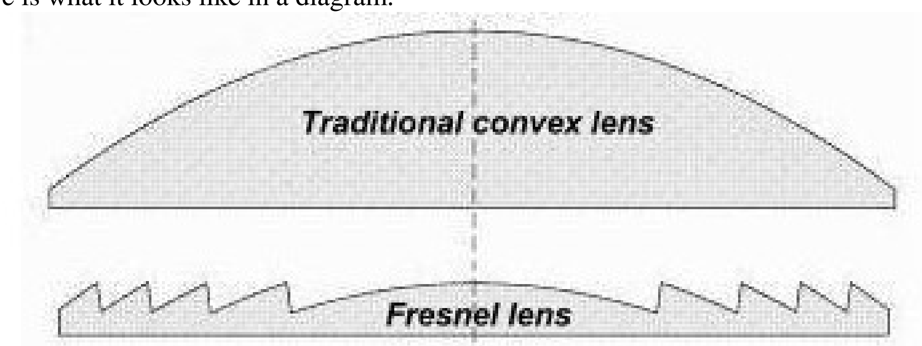
Students working below the minimum requirement level will require extra help if they are to catch up with rest of the class. They should be given extra attention in class and additional lesson time during breaks or at the end of the day.

Unit 6: Electromagnetic waves and geometrical optics *(16 periods)*

Unit outcomes: Students will be able to:

- acquire knowledge and understanding of the properties of light and the principles underlying the transmission of light through a medium and from one medium to another;
- investigate the properties of light through experimentation, and illustrate and predict the behavior of light through the use of ray diagrams and algebraic equations;
- evaluate the contributions to such areas as entertainment, communications, and health made by the development of optical devices and other technologies designed to make use of light.

Competencies	***Contents***	***Suggested activities***
Students will be able to : • Explain how electromagnetic waves are produced • Describe the nature of electromagnetic waves • Compare mechanical and electromagnetic waves • draw diagrams to represent transverse waves • use straight lines to represent the direction of energy flow(rays) • identify that electromagnetic waves emitted by the sun have a very wide continuous range of frequencies s (and wave lengths) • explain some uses electromagnetic radiation • explain what is meant by the rectilinear propagation of light • state the laws of reflection	***6. Electromagnetic waves and geometrical optics*** **6.1 Electromagnetic waves** *(3 periods)* • transverse nature of electromagnetic waves • speed of electromagnetic waves • electromagnetic spectrum (elementary facts about their uses)	Use the "human wave" for transverse forms. In one row, one set of students uses hands to model the electric field. The student sitting beside them models the magnetic field. The students apply Faraday's law that increasing E fields induce a B field. Decreasing E fields induce a B field in the opposite direction. The rows of students hold a rope to model the increasing and decreasing E and B fields. Or alternately, The instructor uses a large ball to model the motion of a charge. Its E field changes with motion. The change in the E field propagates with the speed of light. Use just one wave length at first. Start with just the E field wiggle. Add the B field later when the students understand the mechanics of the emulation process. What is moving? Make it clear that it is the electric field at that point in space, it is not a "thing" that is moving. Add in the B field at 90 degrees. Use cylindrical lenses if possible. VERY IMPORTANT: use multiple rays. Do not rely on the 3 ray model. Students do not understand it. They think that the light is an arrow. The arrow only indicates direction, not the wave itself. Demonstration: MIRROR lab. Student groups: flashlight, comb, paper and mirror. Send light into a reflecting mirror using a comb. Send multiple rays in. Match to the paper it is on the "say left edge" of the light passing through the comb and bouncing off the mirror. Construct the rays that appear to be coming from the virtual image. Break every other tooth of the comb if the image is too faint. Do the experiments first before any equations. Concept first, equations later. Demonstration: Lens Lab

Competencies	*Contents*	*Suggested activities*
• perform experiments to test these laws using plane mirror • use the laws of reflection to explain how images are formed in a plane mirror • find the position of a virtual image produced by a plane mirror using a ray tracing method • use the laws of reflection to solve problems • give examples of the uses of plane mirrors • distinguish between concave and convex mirrors	**6.2. Reflection of light** *(6 periods)* • laws of reflection • image formation by a plane mirror • image formation by curved mirrors • mirror equation	Send light into a lens using a comb. Send in multiple rays. Notice that one ray comes through unchanged. Select a ray on the periphery. That one goes through the focus. Note traditional text drawings that show only 3 rays, there are countless numbers of them. Do not use pins. This confuses students. What does a pin have to do with light? Use the light wave itself to investigate behaviour. On all experiments use the comb to make multiple rays of light. Repeat the Human Medium experiment with the piece of wood "light wave" entering the student body as the "medium" It bends as it goes slower. Use the "Human Optical Bench" and the Fresnel lens to perform investigations of Two slit diffraction: . You will need the Fresnel lens to make a simple overhead projector to put the pattern on the ceiling. The key to the optics experiments is a Fresnel Lens.
• identify the meanings of terms in relation to concave and convex mirrors: principal axis, principal focus, radius of curvature, magnification, • distinguish between real and virtual image • apply the appropriate sign convention when using mirror equations		Here is what it looks like in a diagram. 
• find the position and nature of the image formed by a concave and a convex mirrors using mirror equation and a ray tracing method • use the relation magnification=Si/So=hi/	**6.3 Refraction of light** *(7 periods)* • laws of refraction (refractive index, real and apparent depth) • total internal reflection and it's uses	All the glass is sheared away with the lens replaced by concentric prisms. This is huge light gathering power. It works in daylight easily. It will do great solar cooker experiments as well. Activity: Light is not observed to diffract under normal circumstances because its wavelengths are much smaller than openings of obstructions with which we are familiar. To observe the diffraction of light it is there fore necessary to create an opening with a diameter

Competencies	***Contents***	***Suggested activities***
o to solve problems • give examples of the uses of curved mirrors(concave and convex mirrors) • define the term refraction • state the conditions in which refraction occurs • perform experiments to test the laws of refraction • draw a diagram representing the passage of light rays through a rectangular glass block • give examples of observations that indicate light can be refracted • identify that the passage of a ray of light through a parallel –sided transparent medium result in the lateral displacement of a ray • define the refractive index of a material • use Snell's law to solve simple problems • use the formula refractive index=real depth/apparent depth to find the refractive index of a liquid and a solid in the form of rectangular glass block • define the critical angle θc • explain with the aid of a diagram ,what is meant	• refraction through thin lenses • thin lens formula • magnification • power of a lens • combination of thin lenses • optical instruments(human eye ,microscope, telescope) • Optics of the human eye: far and near sightedness and corrections. • Diffraction of light. • Two slit diffraction • Diffraction by reflection grating • dispersion of light • Looking at spectra using a spectroscope. • refraction through a prism • dispersion of light and colour mixing	of approximately the same dimension as wavelength of light. Use two pencils or other straight edges. Place apiece of tape or around the shaft of one pencil to provide a spacer between them and then place them side by side. Darken the room, peer through the slit between the pencils, and observe a candle flame at a distance of 2m.The students should be able to observe an interference pattern. Rotate the pencils and describe the changes in the interference pattern. Increase and decrease the pressure on the shafts to alter the width of the gap and describe the changes in the interference pattern Activity: Model diffraction with a liquid in the Fresnel plate. "Bound by clay dikes" It will project on the ceiling. Use colored water to emphasize the pattern. Use a small electric motor with an eccentric cam to make water waves to go through the double slit. Observe the interference. Perform some experiments to model different ways to correct human vision. Add a lens to increase the focal length. Add a lens to decrease the focal length. Fresnel lens. Put a paper over 1/2 of it. Does it make ½ an image? Use the Fresnel lens to quantitatively explore the lens equations. Use the Human Optical bench model. Have a bright source (one red flashlight, one green or white one. Have students draw in the rays on a lab sheet. Demonstration: the visible spectrum, let the students do it in groups. To disperse white light into the spectrum requires one prism, and to recombine the spectrum requires a second prism. If there is no access to prisms students can make glass/water prisms with microscope slides, tape, and modelling clay. After filling the triangular container with water, seal the other end with clay. Spectral displays are best observed under very dark conditions. Place cardboard or other material over the windows of your room. If light is shining upon a window, you may use it as a light source simply by cutting a hole in the cardboard on that window. Position the prisms with respect to the light source. Adjust the positions of both prisms so the light dispersed from the first prism is recombined to produce white light by the second. Trace and identify the positions of the prisms and the positions of the various bands of colours on a piece of white paper.

Competencies	***Contents***	***Suggested activities***
by critical angle and total internal reflection • identify the conditions necessary for total internal reflection to occur • perform calculations involving critical angle and total internal reflection • describe how total internal reflection is used in optical fibres • distinguish between convex and concave lenses • identify the meaning of the following terms in relation to converging and diverging lenses: principal focus, principal; axis, focal point, radius of curvature magnification • apply the appropriate sign convention when using thin lens equations • find the position nature of the image formed by a convex and a concave lens using the thin lens formula and a ray tracing method • define the power of a lens • explain how image is formed due to		Activity: The CD spectroscope. Students build a group spectroscope using a cracked CD. They observe spectra of a flashlight, a regular bulb, an infra red bulb, a flashlight with a colored filter, sunlight, a fluorescent bulb. Let them take it home and look at other spectra such as a street light, or the moon. Students observe sunsets. They can see some absorption lines with the instrument. Why do the grooves of the CD function to break light apart into colours? It is like a multiple double slit. The CD must be at an angle so that light bounces off the reflective surface but each groove bounces light off a bit later than the neighbour slit. There is interference which makes the light add along some angles and cancel along others. Demonstration: Measuring the solar constant. Use the Fresnel lens to measure the heat input from the sun. It should be about1, 366 watts per square meter, but the atmosphere filters out many wavelengths. The Fresnel will not pass IR(infrared). They calculate the efficiency of the class demonstration. Project work: Students design a collector that will concentrate and capture the heat of the sun the most effectively. One should be able to get a kilowatt per square meter. The challenge is to find the best design that will heat up 50cc of water to the highest temperature in 10 minutes. Students may employ a Fresnel lens (borrowed from the class for their demo) or some other reflective surface, such as mirrors or reflective aluminium. The limit is that the area of the reflector must be less than 1 square meter

Competencies	***Contents***	***Suggested activities***
combination of thin lenses • draw a ray diagram showing how images are formed by lenses used in a simple microscope and simple telescope • compare and contrast the structure and functions the human eye and camera • describe how human eye forms an image on the retina for different object distances • identify some defects of the eye and their corrections with lenses • explain what is meant by the dispersion white of light to produce a spectrum • identify that the passage of a ray of light through a triangular transparent prism result in a deviation of a ray		

Assessment

The teacher should assess each students work continuously over the whole unit and compare it with the following description, based on the competencies, to determine whether the student has achieved the minimum required level.

Students at minimum requirement level

A student working at the minimum requirement level will be able to **:** define and explain the concepts and units related to communications technology (e.g., frequency, period, cycle, wavelength, amplitude, longitudinal and transverse waves, electromagnetic waves, reflection, refraction, total internal reflection, interference, transmission, absorption); describe the characteristics of waves, and analyze, in quantitative terms, the relationships among velocity, frequency, and wavelength to explain the behavior of waves in different media; predict, in qualitative and quantitative terms, the refraction of light as it passes from one medium to another, using Snell's law; explain the conditions required for total internal reflection. using light-ray diagrams, and analyze and describe situations in which these conditions occur; describe and explain, with the aid of light-ray diagrams, the characteristics and positions of the images formed by lenses: describe the effects of converging and diverging lenses on light, and explain why each type of lens is used in specific optical devices; analyze, in quantitative terms, the characteristics and positions of images formed by lenses**;** demonstrate and illustrate, using light-ray diagrams, the refraction, partial refraction and reflection, critical angle, and total internal reflection of light at the interface of a variety of media; predict, using ray diagrams and algebraic equations, the image position and characteristics of a converging lens.

Students above minimum requirement level

Students working above the minimum requirement level should be praised and their achievements recognized. They should be encouraged to continue working hard and not become complacent.

Students below minimum requirement level

Students working below the minimum requirement level will require extra help if they are to catch up with rest of the class. They should be given extra attention in class and additional lesson time during breaks or at the end of the day.