Physics Syllabus, Grade 7

Grade 7 physics objectives

After completing grade 7 physics lessons students will be able to:

- Understand basic concepts of measurements, static's, force, motion, mechanical energy, power, heat, temperature, sound and electricity;
- Develop basic manipulative skills related to measurements, force, motion, mechanical energy, power, heat, temperature, sound and electricity;
- Develop basic skills of performing practical activities in physics;
- Develop skills of applying physical principles in the production and evaluation of an engineering design project;
- Develop positive interest and attitude for physics.

Unit 1: Physics and measurement *(7 periods)*

Unit outcomes: students will be able to:

- Appreciate the interrelatedness of all things
- Search for patterns or relationships in experimental data
- Use a wide range of possibilities for developing knowledge of the major concepts within physics.

Competencies	***Contents***	***Suggested Activities***
Students will be able to: • Define physics	***1. Physics and measurement*** **1.1 Definition of Physics** *(2periods)* **a. Meaning of physics**	• The instructor invites students to share what they think physics is. He lists them on the board. He gives the meaning of physics from the Greek "Physics" meaning "nature" or "ability to change". Physics is the general study of change. The instructor invites students to give studies or occupations that they believe are not related to physics. These are placed on the board and grouped as students offer them. The studies may or may not be related to physics. Goat tending may not, but farming may be, as engineers using physics design the plows and farming machines. Medicine is related to physics as engineers and physicists design and build the machines doctor's use including microscopes and X-Ray equipment.
• State the other disciplines related to physics • Describe the purpose of studying physics	**b. Object of study of physics** **c. Areas of study physics does not approach**	Students must appreciate that physics is the general study of change. This includes motion as well as the change of one form of energy to another. Physics is the most general of sciences. The instructor invites the students to share when they have seen energy change its form. The instructor writes these down, and after enough have been offered circles the ones directly related to physics. The changing of form should be broadly interpreted. Further study will make the ideas crisper. Students should offer ideas about what they think physics does not study or approach. Gambling, chicken cooking (though the study of heat and stoves is physics), politics, giving birth (though parts of medicine or biology relate to physics), religion and many others are not directly related to physics. Mathematics is not one of the fields studied by physics. It is very true that physics uses a great deal of mathematics, but physics is not mathematics. The goals of study of mathematics and physics are very different. Students should be able to articulate the difference between mathematics and physics.
	d. The core goal of the study of physics – finding physical laws	The core of the study of physics is discovery of scientific truth in the form of physical laws. Students are asked to define what they interpret as "scientific truth" and "scientific law". The instructor records examples from the students, including what they believe to be physical laws. He sorts them as he writes, as they are offered. Most importantly physics seeks laws which are generally true, but all physical laws must be thought of as open to falsification. Newton's Law of Gravity has been found to be true from the size of atoms all the way to the size of galaxies. No contradictions have been found. There are no contradictions found to the

Competencies	*Contents*	*Suggested Activities*
• Describe the relationship of physics to other sciences	**e. Relationship to other sciences and disciplines**	Conservation of Energy Law. There are other laws that are about Universal Truth with a capital T. These laws are the subject of the study of either religion or mathematics. These laws are thought to be absolutely true with no possibility of contradiction. If you seek Truth with a capital T, study these disciplines. Students should be able to articulate the difference between physical law and a law in mathematics or religion. They should be able to give examples of Truths that are not physical truths. The study of physics will not contradict these other kinds of truths. They are in very different kinds of study. The instructor should draw a big oval on the board and label it physics. The class will construct a Venn diagram showing how many disciplines overlap with physics The instructor should invite students to name sciences that may or may not be related or part of physics Chemistry is really physics at an atomic level. Biology overlaps Chemistry by about 1/3. The instructor writes in these disciplines in a Venn diagram to show relationships. Chemistry is a circle inside physics drawn so it touches one side Biology and physics overlap with chemistry as part of physics. Biology overlaps both physics and chemistry. There is a small overlap with physics and biology that is not chemistry in the study of joints, bones and muscles and how they move. Geology overlaps with physics by about ½ - the part dealing with kinds of minerals, earthquakes and volcanoes as these are either chemistry or motion. Part of geology is not in physics – history of the earth. Looking for oil uses physics but is not pure physics. Medicine overlaps with both physics and biology. Making artificial limbs is really physics. Psychology, economics, and other social sciences do not overlap.
• list some branches of physics	**f. Branches of physics**	Students should discuss both main branches of physics, such as astronomy, electronics and optics, and also areas where physics is used in combination with other science disciplines such as bio-physics and physical geography. Students should be asked to write down five examples from everyday life where physics content and skills are in evidence. For example they may choose: • Electricity – lighting and appliances • Mechanics – machines that make our lives easier • Optics – spectacles and optical instruments • Communication – radio, television, telephone • Motion – speed and acceleration Use the students' ideas to construct a large spider diagram showing the many different fields in which physics plays an important role.
• mention the relationship of physics to engineering	**g. Relationship to engineering**	Understanding the relationship to engineering is very important. Students must appreciate that engineering uses a very large amount of physics, but the purpose of engineering is very different. The goal of physics is the discovery of scientific truth. A physical law is either true or false. The method of physics is inquiry. The goal of engineering is the production of

Competencies	***Contents***	***Suggested Activities***
• mention the six criteria for evaluation of good design in engineering		products or processes that benefit mankind. Engineering proceeds by a process of design, not by inquiry. A very efficient automobile or a strong inexpensive bicycle is a fine product of engineering. The bicycle or the automobile is neither true nor false. Engineers apply all the physics and mathematics they can to produce a very good design. Design products are not judged by its truth. Students must clearly articulate the different goals of engineering and physics. They must articulate clearly the goals of inquiry and the goals of design. They must be able to articulate the six criteria for a good design. Products of engineering are judged on six criteria: 1. Is the design functioning as it should? A cheese cutter is not a bridge. 2. Is the design effective? Is it durable? A toy plane is not a jet airliner. 3. Is the design cost effective? For the money put it, is it affordable to the audience compared to other designs. Moon rockets are more expensive than bicycles. Do you need a moon rocket? 4. How does the design affect the individual? Is it comfortable, appealing, light or heavy, compared to similar designs? 5. How does the design affect the society it functions in? Does the design benefit only a few people or a general group? It may be disruptive to a society. Some damns or bridges impact people negatively. 6. How does the design impact the environment? Huge power plants may supply electricity but may bring pollution and strain resources. Students must understand that though out this course they will have to do an engineering project for major units to assess your understanding. The project will generally be a model you will build; you will write about your model to develop scientific literacy. The project will employ many or all of the ideas from physics in the unit to justify the choices you made in your project. Your project will be judged on how well it responds to each of the six criteria for a good engineering design. These projects will make the study of physics relevant to you, your family and your country.
• Define physical quantities as quantities which can be measured and expressed in numbers	**1.2 Standardization and measurement** *(2 periods)* • Physical quantities	Students should appreciate that physical quantities can be measured and in physics a number of different quantities are measured using different units. Students must appreciate that it is very important to used a standardized system of units. In the past there were several systems. Now scientists use the SI system based on the kilogram/meter/second. It is possible that some results in literature will be reported in the gram/cm/second system. Students could be asked to name some common quantities with which they are already familiar e.g. • Length • Area • Volume

Competencies	*Contents*	*Suggested Activities*
• Distinguish between fundamental and derived physical quantities • List the fundamental physical quantities with their SI units • List some derived physical quantities	• Fundamental and derived physical quantities	• Mass • Time • Temperature Point out to students that each of these quantities is measured in a particular unit. Ask students to identify the units of the quantities they have already mentioned e.g. • Metre • Square metre • Cubic metre • Kilogram/gram • Hour/minute/second • Degree centigrade Students should appreciate that in physics there are a very small number of fundamental quantities and a great number of other quantities derived from them. Students should be shown some simple examples of how fundamental quantities combine to give a derived quantity e.g. • Fundamental quantities - distance (metres), time (seconds) and mass (kilograms) • Derived quantity – speed (metres per second) • Force – Newton (kg m/second^2) Students should be able to recall all fundamental quantities and the common derived quantities. Explain to students that during the historical development of physics different groups of scientists used different units to express the same physical quantity. For example pressure: • Meteorologists expressed pressure in bars and mill bars • Engineers expressed pressure in pounds force per square inch • Chemical engineers expressed pressure in atmospheres • Physicists expressed pressure in Newton's per square metre or Pascal's Students should discuss the likely problems that arose as a result of having several different units in use to express the same quantity. Students should appreciate that SI units were established by scientists across the world to provide a set of common quantities and units that could be used by all branches of science. Students should be given the SI unit for both the fundamental quantities and the derived quantities. Students should be practice at finding the units for derived quantities. Students should appreciate that some of the quantities measured have only size or magnitude while others also have direction. In physics these are divided into scalar quantities and vector quantities.

Competencies	***Contents***	***Suggested Activities***
		Physics uses a very important distinction; vectors vs. scalar. Students should be given examples of both scalar and vector quantities e.g. • Scalars – length, mass, time, current • Vectors – force, velocity, acceleration The instructor asks, "Can you give some measurements in common experience where it does not matter which direction it is made in?" The instructor makes a list on the board. He asks a similar question, "What quantities in common usage needs a direction with them to make any sense?" The instructor lists responses from students. These are vector quantities; normal language does not make the distinction. The science of physics must be very clear about which a vector is and which a scalar is. Students should discuss the difference between them in terms of magnitude vs magnitude and direction. Explain to students the difference between speed and velocity. Speed is a scalar quantity and therefore has magnitude only. "I travelled 20 km/hour." Makes now sense. Where did you go? Velocity is a vector quantity and therefore has both magnitude and direction. Velocity is speed in a particular direction.'
• Define vector and scalar quantities • List some examples of vector and scalar quantities	• Vectors and scalars	Class Activity: Vector treasure hunt. Groups of students are given a set of instructions written in vector displacement form. From a starting point on a paper pairs of students interpret. "Go 10 boxes north, then 15 boxes west etc. "There should be about four or five directions in the instructions. Each displacement must be drawn in arrow format, start to arrow at the end. Students should use a ruler and a compass to express the final position. The instructor models solution of one puzzle on the board. The instructor should make the treasure hunt puzzles, even though they start at different places, and have different instructions; all have the same final displacement. The displacement vector may be in a different place on the paper but it has the same magnitude and direction for all puzzles. This is vector addition; it always goes "tip to tail" with the last tip the end point. Student should be clear that the puzzles were fixed to have the same displacement vector. Not all additions are identical as this one is.
• Name the measuring device of length • Perform measurement of length	**1.3. Measuring length, mass, and time** *(3 periods)*	Students should appreciate that we use a variety of different instruments to measure different lengths/distances. These include: • Measure tape – long distances • Metre rule – smaller lengths • Micrometer or Vernier calliper– very small lengths Students should discuss why y there is a need for these different instruments. Students should proactive measuring large and small distances accurately using the appropriate instrument.

Competencies	***Contents***	***Suggested Activities***
• Express the relationship between: meter and millimetre, centimetre, kilometre units and vice versa • Convert meter in to centimetre, millimetre, and kilometre	• Length	Students should appreciate that, just as there are a number of different instruments needed to measure different distances accurately, so there are a number of different units which are derived from the metre. Students should be given the units and their relationship to the metre e.g. • Kilometre = 1000 metres • Metre • Centimetre = $^{1}/_{100}{}^{th}$ of a metre • Millimetre = $^{1}/_{1000}{}^{th}$ of a metre Students should discuss the need to use the appropriate unit e.g. • Why isn't the distance between two towns expressed in millimetres? • Why isn't the thickness of a wire expressed in metres? Students should practice converting between the units of length.
• Define mass as the amount of matter contained in a body • Name some measuring devices of mass • Measure the mass of a body using a beam balance • Convert kilogram in to gram, milligram, Quintal and tonne and vice versa	• Mass	Students should be able to define mass as the quantity of matter in a body. A better definition based on inertia can be given later in the course. Students should measure the masses of a variety of objects using devices such as: • Simple balance • Top pan balance • Spring balance Students should appreciate that in the same way as there are a number of related units for length, there are a group of related units for mass. Students should be given the units and their relationship to the metre e.g. • Tonnes = 1000 kilograms • Kilogram • Gram = $^{1}/_{1000}{}^{th}$ of a kilogram • Milligram = $^{1}/_{1000}{}^{th}$ of a gram Students should discuss the need to use the appropriate unit e.g. • Why isn't the mass of a person expressed in milligrams? • Why isn't the amount of a drug given to a patient in hospital not expressed in kilograms? Students should practice converting between the units of mass.
• Define time as a duration of physical phenomena or process • Mention the measuring devices of time • Measure the pulse rate of his/her friend	• Time	Students should measure time using devices such as: • Clock • Watch • Stopwatch • One earth orbit (a year)

Competencies	***Contents***	***Suggested Activities***
• Convert second to minute, hour, day, week, month and to year • Discuss the wise use of time in their daily life		Students should appreciate that a stopwatch will provide a more accurate measurement than a clock on the classroom wall. Students should discuss circumstances where it is appropriate to measure time in each of the common units: • Year • Month and week • Day • Hour • Minute • Second Students should practice converting between the units of time.

Assessment

The teacher should assess each student's work continuously over the whole unit and compare it with the following description, based on the specific objectives, 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 terms and concepts like physics, physical quantities and mass; give examples of fundamental and derived, scalar and vector quantities and names of measuring devices of length, mass and time; convert different units of length, mass and time

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 the 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: Motion *(8 Periods)*

Unit outcomes: Students will be able to:

- Understand concepts related to motion
- Develop skill of manipulating numerical problems related to motion.
- Appreciate the interrelatedness of all things.
- Use a wide range of possibilities for developing knowledge of the major concepts within physics.

Competencies	*Contents*	*Suggested Activities*
Students will be able to: • Define motion as a change of position of a body in respect with other bodies	**2. *Motion*** **2.1. Definition of motion** *(1 period)*	Students should appreciate that a body is in motion when it changes position with respect to a fixed point or with respect to other bodies. Students should discuss some simple examples of motion from their everyday experience.
• Describe the types of motion: rectilinear, curvilinear, rotary oscillation	• Types of motion	Students should appreciate that motion may be divided into different types. Students should understand the meaning of the following types of motion: • Rectilinear – constant velocity • Curvilinear - constant velocity • Rotation – constant angular velocity • Oscillation - never a constant velocity
• Give examples for each type of motion		Students should be shown examples of each and discuss the differences between them. Rectilinear: a toy wind-up car Curvilinear: a toy wind-up car bound by a curved barrier Rotation: a rock swung around on the end of a rope either horizontally or hung vertically. A bicycle tire spinning on an axis. Oscillation: A pendulum or a bicycle tire with a dot on it viewed at 90 degrees. This motion does not have constant velocity. Where is the object speeding up, when is it slowing down. When is it stopped for an instant? Students should appreciate that all rotations are a kind of oscillation. They are periodic motions. Periodic motions can have constant or non-constant velocities. Class Activity: The instructor invites student groups to give more examples in each of the four categories. If students put out a linear accelerated example the teacher puts that in a 5th category to be discussed later. Human or animal examples should be encouraged. Students should be focused on rectilinear motion at a constant velocity or motion in a straight line at a constant velocity.

Competencies	*Contents*	*Suggested Activities*
• Define the terms average speed, velocity, acceleration, uniform motion ,uniformly acceleration motion	**2.2. Motion along a straight line** *(2 periods)* • Distance • displacement	Remind students of the work carried out in the previous unit on the difference between a scalar quantity and a vector quantity. Introduce the term 'distance' to mean how far a body has moved and 'displacement' as how far a body has moved in a particular direction. From these definitions students should be able to deduce that distance is a scalar quantity while displacement is a vector quantity. Remind students about the difference between speed, a scalar quantity, and velocity, a vector quantity. Both speed and velocity tell the rate at which a body moves but the latter term also tells the direction. Using these definitions, students should be able to deduce a simple equation linking speed, time and distance; and a simple equation linking velocity, time and displacement. • Speed = distance / time • Velocity = displacement / time Students should be able to derive the SI unit of speed (and velocity) by looking at the equation i.e. metre / second = metre per second. Students should appreciate that this unit can be written in two different ways: m/s or ms^{-1} (but not m/s^{-1} a common error)
	• average speed	Students should appreciate that when they calculate the speed of a body by dividing the distance travelled by the time taken, this gives an average speed. The body may travel faster for part of the distance and slower for the other part.
	• velocity	Group Activity: the student invites one student to start at one end of the room and walk toward the other in any strange way he or she wishes. The two rules are that the student must end up standing by the teacher after 30 seconds and the student must be stopped there. The instructor reminds the student about 5 seconds before the time is up. Remind students of the simple experiment they carried out in Unit 1. If they divide the distance run by the time taken this gives their average speed over that distance. This doesn't mean that they travelled at the same speed throughout the whole distance. $V_{average} = \frac{distance}{time}$
	• measuring average velocity	Four or five more students should repeat this motion. A student should record on the board a qualitative Velocity vs. time graph. If the student is going forward V should be positive at that time. If the student is stopped, there is no velocity. If the student goes backwards, the velocity is negative. The class discusses similarities in several of the V vs. t graphs. Students should note that v=0 means start or stop. Students should note that the displacement is the same and the time is the same, so the average velocity is the same for all these different motions, including ones that went backwards or stopped.

Competencies	***Contents***	***Suggested Activities***
		The instructor poses the question: "Did the students travel the same distance?" Groups of students meet to answer the question. The teacher highlights several groups' answers. "Did they have the same displacement?" Students vote using cards: 1 for "yes" and 2 for "no". The instructor invites several students to explain why displacement is different from distance travelled.
• Demonstrate the understanding of uniform motion using 'the human line '	**2.3. Qualitative Exploration of Constant Velocity and Accelerated Motion** *(4 periods)* **2.3.1. Uniform motion** • Dot plot representation of constant velocity	Opening Activity: Whole class does "The Human Measuring Line" to explore qualitatively constant motion and accelerated motion. See the attached description of this whole class laboratory. The lab design incorporates "Teaching by Bridging Metaphors. Students set up "The Human Measuring Line" and make dot plots of motions of people walking or riding on a bicycle. Using the "Human Measuring Line" lab students construct many different dot plots of constant motion of people walking or riding on carts at a constant rate.
• Identify average velocity as the slope of distance vs time graph	• Average speed on any interval	Ex. A dot plot of constant motion would look like: • • • • • • • • • • • • • Where a dot is placed at a position every 2 seconds, for example. The dot plot is a conceptual bridge to understanding the nature of motion. Each dot is like a stop action of the motion at that time period. The time interval should be relatively large like 1 or 2 seconds. The timer is a simple pendulum or a pendulum that triggers a 6v buzzer. Students take data of distance vs. time for at least 4 objects moving at different speeds. Humans can simply count paces per second. Students represent the motion in a second way: a data table of Dist. Vs. Time. Students make copies of the dot plots on a paper at their desks from the D vs. T data.
• Interpret graphs by associating the slope with the velocity	• Average velocity is the slope of a distance vs time plot. • Steeper lines have higher velocities. • More horizontal lines have lower velocities.	Students should plot the data on a D Vs. T graph and connect dots to show a velocity vs. time graph. Students must demonstrate knowledge of good graphing technique by: 1. labelling the axes 2. putting units clearly on both axes 3. labelling each line so that the motions are not confused 4. putting their names on the papers 5. Calculating the slope of the line both from end to end as well as the average velocity for several intervals. Students should demonstrate understanding of reading graphs by associating the slope of the line with the velocity of the object. Students should
	• Segmented graphs. Constant velocity with	Segmented motions: Students should try additional experiments in which a person walks at a constant velocity, then stops for some 3-5 seconds, and then goes on. Some students might want to walk backwards for some time. Students should demonstrate understanding that

Competencies	*Contents*	*Suggested Activities*
• Define accelerated motion • Distinguish between velocity and acceleration • Distinguish between uniform and accelerated motion • Represent uniform and accelerated motion graphically	stopping. **2.3.2 uniformly accelerated motion** • Accelerated motion **2.3.3 Representation of uniform motion and accelerated motion qualitatively using dot plots and quantitatively using tables.**	positive motion forward is associated with a positive slope. Standing still is associated with a horizontal line or zero slope. Negative slope is associated with going backwards. Motion that is accelerated means that the velocity is constantly increasing or decreasing. There is a force on the object making it go faster or go slower. Students make another "Human Measuring Line" but now have a bicycle that starts from zero velocity and speeds up. Students should predict qualitatively what this Dot Plot will look like as d vst. T. Student should demonstrate that accelerated motion means that the average velocity over intervals is getting larger. They should recognize that the spacing will not be constant. They should do the experiment and then construct the graph from the data of D vs. t. Ex. A dot plot of accelerated motion would look like: • • • • • • • The students should make dot plots on the large tape in the "Human Measuring Line and transfer that to copies at their seats. They construct a table of time, distance and average speed defined as Distance travelled in the interval divided by time it took. Students record the data in their notebooks. Students in "The Human Measuring Line" create their own qualitative dot plot representation of accelerated motion in their notebooks. Using the tables generated from quantitative measurements, students generate values for average velocity in an interval. Students characterize acceleration or deceleration as changing velocity over time. From any dot plot students should demonstrate understanding that the object is: • in constant motion forward • is stopped at some point • has segmented motion or constant motion • for segmented motion has a larger velocity on one interval compared with another • has negative velocity for some interval • shows accelerated motion. Students should understand that the average speed of a body is given by the equation and calculate average speed for an interval by this method: $\text{Average speed} = \frac{\text{distance moved}}{\text{time taken}}$ and the S.I. unit of speed is the metre per second or m/s. Velocity is speed in a given direction so velocity is defined by the equation

Competencies	*Contents*	*Suggested Activities*
• define the term acceleration • State the SI unit of acceleration • Apply the definition of acceleration to solve numerical problems • Describe the motion of a freely falling body	• units of acceleration	$\text{Velocity} = \frac{\text{displacement}}{\text{time taken}}$ and has the same unit as speed. Students should appreciate the difference between speed and velocity – velocity is the speed in a particular direction and between distance and displacement – displacement is how far something has travelled in a particular direction. Students should understand that the acceleration of a body is, qualitatively the rate of change of the speed of an object over time. As velocity is length/time, rate of change of velocity is length/time/time or Lengthy/t^2. Peer Instruction: The instructor poses Graphs of D vst t or V vs t. Students work in groups to suggest narratives for the motion. Graph Jeopardy: The Jeopardy board contains graphs. The questions students must respond for a Dist vs. time graph should be "What is constant motion forward, then stopping for a while then going much faster" The same response would fit a segmented graph of vel vs t.

Assessment

The teacher should assess each student's work continuously over the whole unit and compare it with the following description, based on the specific objectives, 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 terms and concepts like motion distance, displacement, speed, velocity, acceleration; give examples for each types of motion; explain why the difference between distance and displacement , speed and velocity; use simple formulae to solve numerical problems related to average speed and acceleration.

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 the 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: Force and Newton's laws of motion *(10 Periods)*

Unit outcomes: Students will be able to:

- Developing a qualitative understanding of Newton's law of motion and forces in static situations
- Develop introductory skill of manipulating numerical problems related to Newton's law of motion and force
- Appreciate the interrelatedness of all things.
- Use a wide range of possibilities for developing knowledge of the major concepts within physics.

Competencies	***Contents***	***Suggested Activities***
Students will be able to: • Define force as a push or pull • Mention some types of force s in nature • Name the measuring device of a force and its SI units	***3. Force and Newton's laws of motion*** **3.1. Force** *(3 periods)* • Definition of force • Kinds of forces	Students should appreciate that a force as a push or a pull. The instructor should inquiry of students what they think "force" means by asking them for examples of force. The instructor writes them on the board, sorting as he goes. It is important to be completely non-judgemental about the responses. Do not discourage any responses that seem non-physical. Students must build an understanding that "force" in physics is a technical term that is not always directly related to common uses of the word "Force" Students may respond: mental force, forceful personality, political force, athletic force (meaning a team), psychological force, and many others. List these together and note these are not "force" as studied in physics. Lightening is not a force it is a current. Sound itself is not a force. It is a wave. The wave can cause a force on your eardrum or body. Some explanations may be needed to clarify "force". Other suggestions may include: gravity, friction, springs, balloons pushing in sports, collisions in automobiles, bicycle force, and possibly magnetic force or electric force (static balloons), or even buoyancy. Note we will study all of these in the course but some will be studied later. It is a good idea to have a balloon and some fur to demonstrate force of electricity by having a balloon stick to a wall or repel another balloon similarly charged. Students should suggest from the list of physical forces they have made the ones that can act on an object without touching it. The instructor writes these in a new list. ACTS at a DISTANCE. These are gravity, magnetic force, and electric force. An instructor might pose a question: are these really the same force but in different appearances? Invite student responses from a group – 3 minutes discussion. Invite them to say why the group thinks they are different or the same.
• Give examples of forces that can act on an object without touching	• Forces that can act at a distance	The instructor highlights that gravity is only attractive, it never pushes away. Magnetic and electrical forces can both attract and repel. Deep laws of physics studied in this course will show that there is a relationship between magnetism and electricity. Magnetic force has poles: N and S. Electric force comes from charges + and -. We will study this later.

Competencies	***Contents***	***Suggested Activities***
		The instructor invites students to look at the list to separate out forces that act only on contact. Which ones, he asks are probably the same thing under different names? Friction and springs are very different, balloons and auto and bike tires are the same. Pushing or collisions in sports or automobiles or bullets are the same. Buoyancy is different, it needs water. We'll study that later. Looked at closely students should recognize that pushing a balloon or a bike tire on a road or a collision in an auto or a bullet or rock hitting something are the same thing, an object colliding fast or slowly with another and making contact. Students should recognize that here are forces between the atoms that act against each other.
• Give examples of forces that act only on contact	• Forces that act only on contact	The student should recognize that contact forces considered, for now, are springs, friction and collisions. They should recognize that the cause of the force may be something at the atomic level but we don't need to know about that for now.
• Describe the effects of force • State the SI unit of force	• Effects of force	The instructor should inquire about what students think the effects of the force would be on any body. What can any of these contact forces do when they are acting? They may have some objects to manipulate, balls, stones, spring, plastic bottles, cans. Group discussion for 3 minutes. The instructor collects responses and puts them in a list. He checks some that are the same response in different words. As a result of their experiments students should appreciate that a force can: • Start a stationary body moving • Stop a moving body • Speed up or slow down a moving body • Change the shape of a body • Or, just bounce off a body changing direction. Students should know that the SI unit of force is the Newton. They should appreciate that, in common with other units which are named in honour of famous scientists, the unit name is written starting with lower case i.e. Newton, but upper case is used for the symbol i.e. N.
• Name the measuring devices of force	• Measuring force	It is a difficult idea but students should begin to differentiate, at least verbally, the idea of mass from force. They should recognize that force is measured in Newtons, not kilograms and use Newtons in dialog whenever referring to force.
	• Spring scales	Force is commonly measured with scales. There are several different kinds of scales. The most common is a spring scale that is vertically positions and uses a pan or a hook to measure the gravitational pull f the earth on the object measured. Students should open up a spring scale and observe its pieces. Students should be able to explain why putting too heavy an object damages a spring scale. Students should be able to make their own simple spring scale with a few coils of slinky. The groups will use tape, a few coils (3-4) of a slinky spring and some

Competencies	***Contents***	***Suggested Activities***
		washers and a hook from a paper clip on the end to make and calibrate a simple scale. One washer stretches it some distance. Students mark it. They continue to about 4 washers. Students then measure the weight of an unknown quantity, a metal nut or a lump of clay. They report their answer in weights of washers. The instructor weighs a mass of 20 washers on a calibrated scale. Students should know how to convert their simple scale calibrated in washers to a simple scale calibrated in grams.
• Measure the mass of a body using a pan balance	• Balancing scales	Pan balances or beam balances are more accurate than spring balances. The instructor models a pan balance and gets the mass of a book or some stone. Pan balances are limited because one side must contain a calibrated collection of masses equal to the mass of the unknown. Students should express clearly why a pan balance cannot find the mass of something like an automobile or elephant.
	• Beam (lever) balances	The instructor demonstrates, if possible, a beam balance that is based on a lever. The weights are fixed to a beam on a long end of a lever. The weighing pan is on a short end of the lever. Moving the weights is like moving a person on a see-saw. Students should demonstrate in a drawing why a beam balance is much like a lever and why it can find weights of heavier objects. All of the above scales operate on finding a balance between two pulls of the earth's gravity on two objects. The instructor inquires of the students what would happen if a pan balance or a spring balance were put exactly in that spot between the earth and the moon where the earth pulls just the same in opposite directions. Peer Instruction: A. Would the scales move or not? 1 for yes, 2 for no. B. Would the mass of the objects disappear? 1 for yes 2 for no The instructor polls the groups by holding up cards. He asks for reasons behind the answers. Students should appreciate that spring and pan balances need gravity. They will read zero if there is no gravity. A zero reading does not mean that there is no mass. Please avoid supporting the idea that there is no gravity in space. There is no gravity only at very special points – where pulls cancel, such as that point between the earth and moon (a bit closer to the moon because the moon is smaller). There is another point like that between the earth and the sun, much closer to the earth than the sun.
	• Inertia balance	The instructor demonstrates an inertia balance. This is a very simple object that consists of two long plastic tubes (1 to 1.5 m) used for plumbing or some other flexible but slightly rigid material. The tubes are screwed into two a small blocks of wood at both ends. One is firmly fixed to a desk with clamps. The end sticking out should be free to vibrate. The students pull back the outer block and count the number of vibrations in one half minute. Students note that all vibrations are horizontal, not affected by gravity. A 1kg mass is placed on the platform. The students pull back the block with the mass on it. They guess if it will vibrate faster or

Competencies	***Contents***	***Suggested Activities***
• Define the term inertia • Relate mass with inertia • State Newton's 1^{st} law • Define inertia as the property of matter that causes it to resist any change of its motion in either direction or speed • Relate mass and inertia	**3.2. Newton's law of motion** *(4 periods)* • Newton's 1^{st} law of motion - Mass and inertia	slower with the added mass. They try counting again. This balance, based on vibration is a measure of the mass of the platform. Peer Instruction: Will this inertia balance work in that point of space with no gravity? 1 for yes 2 for no. Students should be able to explain why the inertia balance is not dependent on gravity. It is a measure of the mass of the object, also called its inertial mass. Whole class demonstration: 1^{st} law of Motion Materials: A large steel ball bearing or a marble (steel is better), a very long "v" shaped track made out of metal. It can be iron (angle iron), or perhaps aluminium (a track for ceilings), but must be very straight and very clean with no bumps or bends. No oil marks or adhesive tape marks are permitted. The track should have some notched blocks under it so that the "V" is pointed down. The ball is launched onto the track from a steep "V" shaped launcher. The instructor describes the track to the students. "It is a very special low friction rolling track. The ball has very low friction too." The instructor places some block, 1 m down the track to stop the ball. He then moves the block .5 m and sends the ball down again. (It is possible to "cheat" a bit by angling the track very slightly, but not visibly, to make up for frictional losses.) He moves the block to the end of the track and lets the ball roll. He then removes the last block and moves the ball to a last launch. This is a bridging strategy for teaching the first law. Peer Instruction: What will happen if you imagine that this track were infinite and the friction of the ball on the track were zero? Vote individually: 1 for "it will stop eventually" 2 for "It will go on forever" The instructor quickly assesses votes and then asks for a group decision. He calls groups to explain the decisions. He lets the ball go, it falls. Students should appreciate that without friction the body will keep on going. Gravity acts only to keep it in the track and to cause a force that makes friction between the two objects. This is Newton's First Law of Motion. He writes on the board. "An object in motion will continue in straight line motion until acted upon by an external force, and an object at rest will continue at rest until acted upon by an external force." The biggest discovery was that both motion and rest are the natural states of matter. Previously people thought that rest was always the end state of motion. Peer Instruction: What keeps the ball moving in a straight line? Vote individually: 1 for "the force that put it motion keeps it going by pushing it" 2 for "the mass of the object must keep going by itself, it has inertia" The instructor quickly assesses votes and then asks for a group decision. He calls groups to explain the decisions. Answer one is very appealing. Many think that the slide gave a special "force" to the ball to

Competencies	Contents	Suggested Activities
		keep it going. The force from the slide ended when the ball hit the track. The students must appreciate that the inertia of the body, its mass, has a tendency to keep on going. It does not need a force to keep going. Students could discuss other examples of rolling or sliding motion stop when the motion of a body changes. They should identify the "external" forces acting on the body making it stop. Students should understand that all objects have a built-in reluctance to start moving, if they are stationary, or to change the speed or direction of their motion. The term inertia should be introduced. Students should carry out experiments of bodies of different masses and deduce a qualitative relationship between mass and inertia. They should push heavier and heavier objects. They should note that friction with the floor also increases. Students should list several ways that friction can be reduced or even eliminated: oils, floating on air cushions, out in space where there is no air. They must be aware of the misconception that gravity causes friction even in space. Friction is a contact force. There is no friction in space to an object moving on a straight line. Gravity on earth causes friction by pressing surfaces together.
• State Newton's 2nd law of motion in words • State the relationship between force, mass, and acceleration • Solve simple numerical problems by applying Newton's law of motion	• Newton's 2nd law - Mass and weight	Remind students about the simplistic definition of mass which they were given in Unit 1. Inertia provides a better definition of mass. Newton's second law is the easiest to state and the most difficult to understand. We will state it here and work to understand it qualitatively and reserve deeper study for later in the physics course. The Second Law is: $F = ma$ The m is the measure of the mass in kg. The 'a' is the acceleration of an object and the F is the force on that object. Acceleration is the most difficult part to understand. Objects dropped on earth accelerate till they hit. The earth's gravity pulls them. They increase speed about 10m/sec every second they fall. To begin to understand acceleration The instructor should make a 2 column table. Time vs velocity downwards of an object dropped from very high about the earth. Start: 0, 1 sec, 10m/sec, 2 sec, 20 m/sec, 3 sec, 30 m/sec, 4 sec, 40 m/sec. It is harder to calculate the distance travelled. We will do that later. Newton's law relates on the left side, a force, a push or a pull, and on the right side, a mass, measured with a scale, and that strange quantity, acceleration, which is related to increase in speed. The quantities in this equation are very different kinds of things. Mass (a kind of measure of stuff), Force (a push or a pull) and acceleration (a measure of changing speed)

Competencies	*Contents*	*Suggested Activities*
• Distinguish between mass and weight • Apply the formula W=mg to calculate the weight of a body		The law is $F = ma$ It is NOT $F = \frac{1}{2}ma$ or $F = \pi * ma$ It is a fundamental law of nature. It is valid from the size of atoms to sizes beyond the distances of galaxies and everything in between. This is why Newton's laws are called Universal. They describe the way the way everything in the universe functions. Peer Instruction: Can you give any other physical law you know that applies universally. 1 yes 2 no Form groups and vote again. The instructor collects answers Students with answer of 1 may say: "Conservation of energy" or conservation of mass, or Newton's 1st law, no other laws are similar. "We will all die." Or other statement is not a physical law. It cannot be proved or disproved in physics. Students should be able to recall Newton's 2nd law of motion. Students should practice applying the equation F=ma for simple examples. It should be approached as a conversion from acceleration to Newtons. They should appreciate that gravitation on the Moon or Mars is different therefore gravitational force or weight is different. Students should appreciate the difference between mass and weight within the context of this law. On a different planet, the mass remains the same, but the weight of an object changes from it's earth weight. The weight of a body is the force with which it acts downwards due to the pull of gravity. Students should appreciate that the acceleration due to gravity on the Earth is 9.8 m/s^2 however, for the purposes of simplifying calculations, it is often taken as 10; a mass of 1 kg has a weight of 10 N. Students should weigh different objects and find their masses and weights. Peer Instruction: mass vs. weight An athlete has gone to the moon and has a space suit to train there. She can now lift 1000 Kg masses but on the earth she could only lift 200 kg masses. She can do this because: 1. the moon has no air friction 2. the moon has no gravity 3. the moon's gravitational pull is less than the earth's 4. the acceleration of gravity on the moon is 1.66 m/sec^2 Both answers 3 and 4 are correct. Students should explain how forces on the same objects can be different on different planets.

Competencies	***Contents***	***Suggested Activities***
• State Newton's third law of motion • Demonstrate their understanding of Newton's third law using 'pushes collision' • Relate some physical phenomena in their daily life activities with Newton's three laws of motion	• Newton's 3rd law - Action and reaction	Group Demonstration: Pushes Collisions Newton's third law: "For every reaction (force) there is an equal and opposite reaction (force)." Is seemingly simple, even obvious, but it is very subtle. Students work in pairs. They push on each other's chairs with their feet till they start to move. Students should pair up so that there is a smaller student paired with a larger one. The larger student then puts some masses on his or her lap such as books or back packs and the pair repeats the experiment. Peer Instruction: As you tried pushing each other please answer: 1. the heavier student could push more on the lighter student 2. The lighter student could push more on the heavier student 3. The push of the heavier student on the lighter one was the same 4. The force of friction from the floor on the heavier student was greater The instructor polls individuals and then asks for groups' responses. Answers 3 and 4 are both correct. They focus on different aspects of the 3rd law. Independent of mass the force of the lighter one on the heavier one is the same. This is counter intuitive. It is not part of ordinary world knowledge. But saying the force is the same does NOT mean the effect is the same. The law states: $F_{ligher\ on\ heavier}=F_{heavier\ on\ ligher}$ But the heavier student has more mass. By Newton's 2nd law they must have different accelerations. F=ma applied to both means, since the forces are the same then $M_{lighter}*a_{smaller}=M_{heavier}a_{heavier}$ This is very strange. Let us say one has twice the mass as the other. $2*M_{ligheer}=M_{heavier}$ $M_l*a_{smaller}=2*M_{lighter}a_{heavier}$ The masses cancel out. This is surprising The equation becomes $a_{smaller}=2*a_{heavier}$ Let's interpret this. In a no friction environment, like on an ice rink. The smaller person goes shooting off at twice the acceleration than the heavier one. Peer Instruction: Why should this happen? The lighter one goes off with a higher acceleration? 1. The lighter one has more force on it. 2. The heavier one has more inertia and is harder to move.

Competencies	*Contents*	*Suggested Activities*
		Discuss this in groups. The answer is 2. #1 is false. The forces are the same, but the EFFECT of the forces is different because of the different mass. Students should discuss the implications of this law in e.g. stepping out of an unmoored boat. What happens with a light boat? Stepping onto or off a platform with wheels. Light platform, heavy platform Students could look for examples of action and reaction in their everyday lives. More Peer Instruction on Newton's laws: See Mazur and Epstein's books. Students should appreciate that Newton's laws of motion are an attempt to explain the behaviour of bodies and they apply to objects in everyday life – not just in the laboratory. Students should use the laws to account for the behaviour of bodies in everyday life.
• Define frictional as a force that resists motion • Give everyday examples of friction forces	**3.3. Frictional force** *(3 periods)*	Remind students of the motion of a freely falling body and the action of air resistance, a form of friction, in acting against the motion of a body. Students should understand that friction is a rather strange force that opposes motion. While a body is stationary there is no friction acting on it. The origin of the friction force is VERY different from gravity, magnetism or any collision. Students should discuss everyday examples of friction e.g. • Friction between parts in an engine • Friction between car tyres and the road • Friction when substances rub against each other.
• Define normal force • Show the relationship between frictional force and normal force		Friction on the road is actually a kind of rubbing and physical geometric interaction between the tire and the very rough surface of the tire. The road is actually ripping small bits of rubber off the tire as the tire pushes on the road. That is why tires wear out. There are other types of friction that can act at the molecular level. If the two objects are very smooth like plates of glass, the individual atoms come close enough to contact and pull together. Atoms in plate one do not know that they are different from the atoms in plate two. They attract just as if it was one substance. Experiment. The instructor gets two very clean plates of glass and puts them together. He and some students try to slide one over the other.
• Identify friction as static and kinetic • Explain static and kinetic (sliding) friction		Students should appreciate that friction force is a very general term covering many different kinds of interactions. It is not a force like gravity, magnets, or forces between charges. In common usage such as friction between surfaces the force of friction that resists motion is directly proportional to the force of gravity pushing the surfaces together. This force is called the Normal Force For an object on a surface friction is express as a coefficient times the force of gravity. It is a simple equation that has many exceptions.

Competencies	***Contents***	***Suggested Activities***
• Apply the formula $f=\mu F_N$ to solve numerical problems • Explain factors affecting friction	• Types of frictional forces - Static friction - Kinetic (moving) friction	F=μ mg Where the symbol μ (pronounced MUE) represents the fraction of the vertical gravitational force that friction will exert in the horizontal direction to oppose motion. μ is almost always less than one. The above equation does not apply in situations like the case of two plates of glass touching closely. There often are two different values for μ in common usage. μ static and μ kinetic. The reason is that once an object gets moving any attractive forces between the objects disappear as the grinding between them puts chips the objects slide on. μ static is larger than μ kinetic. Peer Instruction: Consider this problem "A block pressing with a force 10 N pushing into a surface. The coefficient of static friction is .5 What force is needed to get the block moving? 1. 10.5 N 2. 2 N 3. 5 N 4. 10 N Students work in groups to find the answer. They explain their process. Peer Instruction. If the same object is moved over to a low friction surface like ice with a static friction of about .1, what force would be need to start the object moving on ice? Explain your process Peer Instruction. Consider a larger problem "A block pressing with a force 20 N pushing into a surface. The coefficient of static friction is .5 and the coefficient of kinetic friction is .2 What force is needed to start the block moving, then what force is needed to keep the block moving? 1. 20.5 N then 4 N 2. 4 N then 4 N 3. 10 N then 1 N 4. 10 N then 4 N Explain your answers in groups and share. Peer Instruction: If the object is moving and needs of force of 4 N to keep it going does this violate Newton's first law that says an object should keep going without a force pushing it? 1. Yes 2. No Students should carry out an experiment in which they use a force meter to measure the force required to start dragging and continue to drag an object across a surface, such as a table. From their results students should come to the conclusion that the force needed to start a

Competencies	***Contents***	***Suggested Activities***
		stationary object moving is less than the force needed to keep it moving. The implication is that the friction resisting the motion of a stationary object (static friction) is greater than the friction resisting the motion of a moving object (kinetic friction)
• Describe the advantage and disadvantage of friction	• Advantages and disadvantages of friction	Students should investigate how the mass of the object is linked to the friction acting on it and determine the relationship between friction and the normal force exerted on an object. Students should investigate how different surfaces affect the friction force exerted on an object. Students should understand the meaning of the coefficient of friction and carry out simple calculations using it.
• Describe methods of reducing friction	• Methods of reducing friction	Students should appreciate that friction is sometimes but not always a bad thing. They should discuss examples where friction causes problems; these could include: • Wear of engine parts • Air resistance acting on motor vehicles • Wear on moving parts of devices They should also discuss examples where friction is necessary and important; these could include: • Shoes gripping on the floor as we walk • Tyres of road vehicles gripping the road surface • Hands able to turn door knobs Students could experiment on reducing the friction between a moving object and a surface. They could cover the surface with different substances and measure the effect on friction by pulling the object across using a force meter. Students should appreciate the reason for using oil and grease to reduce the friction between moving parts of engines and appliances. Newton's Jeopardy. Students play a game that has a great variety of situations, even pictures and equations. They provide questions for which the picture, equation, or words are the answer. Ex. 5kg (10 m/sec square) answer" what is the gravitational force from a mass of 5 kg" or "F=μ mg "answer what is the equation for friction?" or "F=μ 5Nt" "what is the friction force on a normal force of 5 Nt.?

Assessment

The teacher should assess each student's work continuously over the whole unit and compare it with the following description, based on the specific objectives, 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 terms and concepts like force, inertia, frictional force, normal force; explain the relation between mass and inertia, force and acceleration, frictional force and normal force mass and weight of the body; give examples form their daily life experience that demonstrate the three Newton's laws of motion solve simple numerical using the formulae F=ma, W=mg and $f=\mu F_N$

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 the 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: Work, energy and power *(8 Periods)*

Unit outcomes: Students will be able to:

- Understand concepts related to work, energy and power;
- Develop skill of manipulating numerical problems related to work, energy and power
- Appreciate the interrelatedness of all things.
- Use a wide range of possibilities for developing knowledge of the major concepts within physics.

Competencies	***Contents***	***Suggested Activities***
Students will be able to: • Define work as the product of force and distance in the direction of force • Express the units of work • Apply the formula Work = Force × Distance to solve numerical problems	***4. Work, energy and power*** **4.1. Work** *(2 periods)* • Definition of work • Work done in the direction of force	The instructor should invite students to define work as they know it. He should make a list separating physical from non-physical examples. Work has a very different meaning in physics. The instructor should be very crisp about including an example in the list that will be "physical work". Picking up a heavy rock is work. Spending time on a job is not physical work. The examples for work must include a change in energy either kinetic or potential. These terms should not yet be used. Students should understand that work has a specific meaning in physics. Work is said to be done when energy is transformed from one form into others. Students should know that the unit of work is the joule, and that the symbol for this is J. Students should appreciate that work is done when a force is applied over a distance. The amount of work done can be calculated using the equation: Work done (J) = force (N) x distance (m) From this equation students should appreciate that one joule of work is done when a force of one Newton acts over a distance of one metre, and that 1 J is equivalent to 1 Nm. It is important to note that friction cannot do any work. Friction is a non-conservative force. One can do work AGAINST friction such as pushing a heavy box Students should use this equation to calculate work done. As far as possible, examples should be related to everyday life experience e.g. lifting a 2 kg bag of tef onto a shelf 1.5 m high. Peer Instruction on work. The instructor asks some questions about work involving the W=Force x distance equation. They should involve both gravitational and friction examples. The questions should include qualitative examples: "If the force is doubled, what happens to the work done?" "If the force is doubled but the distance is halved, what about the work?"
• Define the term energy • Explain how work and energy are related.	**4.2. Energy** *(3 periods)* • Definition of energy	The instructor should invite students to define energy as they know it. If possible the common usage of the term "energy" is even more confusing than the usage of "work". He should make a list separating physical from non-physical examples. Energy has a very precise meaning in physics. The instructor should be very crisp about including an example in the list that will be "physical energy". Picking up a heavy rock is work is changing the energy in the rock. It

Competencies	***Contents***	***Suggested Activities***
		could fall and do some work. . It is not physical energy itself. “Energy of the Ethiopian people” is not physical energy. “Mental energy” is not a physical energy. The examples for inclusion must include a change in energy either kinetic or potential, also electrical energy. Volts is a measure of energy. Gasoline has chemical energy. Students should understand that work has a specific meaning in physics. Work is said to be done when energy is transformed. The definition of energy as the ability to do work should be linked back to the definition of work.
• List the forms of energy	• Forms of energy	Students should appreciate that since energy is the ability to do work, the units for energy and work done are the same, the joule. It is common usage to refer to energy as it source: electrical energy, chemical energy, nuclear energy, energy of motion, potential energy. Students must appreciate that all of this is the same stuff: capacity to do work. If the energy comes from a battery, from gasoline, from splitting atoms, from a rolling rock, or from a rock high on a hill near a cliff, it is the same thing – energy, capacity to do work. We will study at first kinetic and potential energy.
• Define the term kinetic energy		Students should appreciate that kinetic energy is the energy associated with movement. A body in motion has kinetic energy. A car in motion has capacity, if a rope is attached, to run a generator and make electricity, eventually stopping when the motion energy is used up. It a flowing river has kinetic energy. It can run wheels that lift water or perhaps run small generators to make electrical energy. A bullet has kinetic energy to break apart chemical bonds in the target it hits.
	• Kinetic energy	Kinetic energy, in fact all energy is a scalar quantity. It has no direction so speed is used in its calculation. V below really is the speed of the object. Commonly calculations state v instead of s. Students should be given the formula for calculating kinetic energy: Kinetic energy (J) = $^1/_2$ mass (kg) x velocity (m/s) ^{2} The units of KE are the same as Work Joules. Why the ½ appears in the equation can only be explained in later courses. Students should qualitatively appreciate that the kinetic energy of a moving body is determined by both is mass and its velocity. Peer Instruction: “If the mass of a car is doubled then the Kinetic energy is: 1. The same, 2. Doubled, 3. Halved. 4 quadrupled” Groups will discuss the answers’.

Competencies	***Contents***	***Suggested Activities***
• Apply the formula $KE={}^{1}/_{2}mv^{2}$ to solve numerical problems		Peer Instruction: “If the speed of a car is doubled then the Kinetic energy is: 1. The same, 2. Doubled, 3. Halved. 4 quadrupled” Groups will discuss the answers’ Peer Instruction: “If the speed of a car is doubled and the mass of the car is halved, then the Kinetic energy is: 1. The same, 2. Doubled, 3. Halved. 4 quadrupled” Groups will discuss the answers’ Peer Instruction: “A manufacturer of bullets has a new design. The amount of explosive in the bullet is the same but the bullet is ½ the mass. Kinetic energy of the new bullet is: 1. The same, 2. Doubled, 3. Halved. 4 quadrupled” Groups will discuss the answers’ They should discuss examples of moving bodies where kinetic energy is small, and others where it is large. Students should use the formula to calculate the kinetic energy of moving bodies. As far as possible, examples should be related to everyday life experience e.g. the kinetic energy of a car of mass 600 kg moving at 3 m/s etc.
• Define the term potential energy	• Potential energy	Students should appreciate that the term ‘potential’ energy can be applied to several forms of energy. It does not apply to a student’s potential or other references to the future. Students could discuss why chemical energy can be considered a form of potential energy – a chemical reaction in a cell has the potential to produce electrical energy. Similarly, students could discuss why the elastic energy in a catapult can be considered a form of potential energy – when the pouch is released the elastic contracts and fires the stone. There is potential energy in elastic materials like rubber bands or springs.
• Give examples of bodies possessing potential energy		Students should focus on the potential energy possessed by an object held above the ground. This has potential energy because if it is released it will fall to the ground. Students should be given the formula for calculating gravitational potential energy: Potential energy (J) = mass (kg) x acceleration due to gravity (m/s^2) x height (m)
• Apply the formula PE=mgh to solve numerical problems		Students should use the formula to calculate the potential energy of bodies raised above the ground. As far as possible, examples should be related to everyday life experience e.g. the potential energy of a sack of vegetables of mass 25 kg on a table 1 m above the ground etc.

Competencies	***Contents***	***Suggested Activities***
• Explain how energy is transformed from one form to another	**4.3. Transformation and conservation of energy** *(2 periods)*	The whole of physics and engineering is a narrative of the changing of one form of energy to another. Engineers are very interested in efficient ways to make transformations. Power plants transform falling water or burning coal to electricity. They convert potential energy in the falling water or chemical energy in the coal to a new form. Students could carry out experiments with a pendulum to study how energy is transformed between potential energy and kinetic energy as the bob swings back and forth. Students should appreciate that energy is conserved – neither created nor destroyed – during an energy transformation.
• State the law of conservation of energy	• Laws of conservation of energy	Students carrying out experiments with a pendulum will be aware that the pendulum gradually swings less and eventually comes to a stop. Peer Instruction: A pendulum swings, eventually it stops. This violates: 1) Newton's first law 2) the conservation of energy 3) neither Ask them to explain why in this case energy is conserved. Peer Instruction: A pendulum swings but it is put in a vacuum room right on earth. This violates: 1) eventually it stops 2) it keeps on going 3) It might stop eventually because ….(give a reason) 2 and 3 are right. There could be friction in the pivot at the top. It must mean that other energy transformations are taking place. Remind them of the work carried out on friction. Each time energy is transformed between potential energy and kinetic energy, some energy is also transformed into heat and is lost to the surrounding air.
• Explain how energy is obtained from falling water	• Energy of falling water	Use falling water as a natural example of how potential energy is transformed into kinetic energy. Point out to students that if the temperature of water at the top and bottom of a waterfall are carefully measured it is found that the water at the bottom of the water fall should be slightly warmer but the effect is too small to measure in practice. Falling water of rivers is a very large source of energy to drive generators. Invite students to brainstorm about how falling water can make electricity. This will be studied in detail later in the course. Explain that this is the basis of a hydroelectric power station. The potential energy in the falling water is transformed into electricity. Invite students to brainstorm about the limiting factors of a hydroelectric plant. Why cannot it produce all the electricity Ethiopia needs. Challenge more able students to explain the origin of the potential energy in falling water. This should eventually lead back to the Sun as the source of energy which drives the water cycle and hence causes water to evaporate from the sea and fall on high ground as rain.

Competencies	*Contents*	*Suggested Activities*
• Mention some other sources of energy	• Other sources: wind and solar power	There are other sources of power, from wind diving wind turbines or photocells that make electricity from the sun. Brainstorm with students about each source and how it might help Ethiopia's power needs.
• Define power and state its SI unit	**4.4. Power** *(1 periods)* • Definition of power	Explain to students that, as work, the word 'power' has a particular meaning in physics. List common meanings of power. The instructor will keep in one side usages that can properly be called physical power. Political power, personal power, Power of persuasion is all non-physical usages. Power is the rate at which energy is transformed from one form into others.
• Use the definition of power to solve numerical problems.	• Units of power.	Ask students to suggest the unit of power. Since it is the rate of transfer of energy the unit is the joule per second or J/s but is more usually called the watt (W). Power plants are measured in joules per second. Brainstorm about why measuring in joules is not enough to capture the idea of measurement of a capacity of a power plant. Students should calculate the power of some familiar devices e.g. a 40 watt bulb transforms 40 joules of electrical energy into 40 joules of heat and light energy every second. What is the consumption of a 100 watt bulb, a radio, a toaster, a refrigerator?, Remind students of the prefix kilo' and explain that it can also be applied to the watt thus a kilowatt = 1000 watts. Students should calculate the power of some familiar devices e.g. a 1 kilowatt electric heater transforms 1000 joules of electrical energy into 1000 joules of heat and light energy every second. Energy Jeopardy. The board is filled with terms, equation and some numerics. Students must provide the question that fits that answer.
• Demonstrate their understandings of energy transformation using 'Eggs in space project'	• Engineering Project Eggs in Space.	Student teams construct some structure that will enable a raw egg to survive intact a simulation of a space flight. Materials for the launcher: a bicycle tube that has been sliced through at the air hose to make a tube. Then the tube is slit very evenly all away around to make a long rubber band. This band is secured at one end to a small light plastic basket. The end of the other tube is secured to the basket. The launcher will be a giant slingshot. At some point outside about 3-4 m above the ground the students secure the other end of the rubber bands. They can tie with ropes, or use a nail and some very large washers. The rubber band should not break; it will be weakened if not secured evenly. Students pull down the basket of the sling slingshot and try launching vertically something light like a tennis ball. It should go up 10M or more. Tighten the rubber band to adjust tensions for higher flights. Materials for the student: they must construct something that will go all the way around a raw egg. The structure must fit inside a cube 20cm on a side. This is the only engineering design limitation on size. This design limitation means they cannot make a structure with lots of thin sticks sticking out. Smaller sticks are OK. The design must not use a parachute. It must go up

Competencies	*Contents*	*Suggested Activities*
		like a ball and come back down to crash. It is OK to design a bouncing structure. Students may use any material they wish or any design that will absorb the kinetic energy of the launch and also of the crash to keep their egg from breaking. The classroom teacher tests their design outside. The launching must be vertical. The designs are opened right after they land. Winners have raw eggs that did not break. Student teams must submit an analysis of their design, if it failed or not based on the 6 engineering principles. The y must, if their design failed, make a drawing of a revised design for a new launch to try again some later time. They must explain why they changed their design.

Assessment

The teacher should assess each student's work continuously over the whole unit and compare it with the following description, based on the specific objectives, 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 terms and concepts like work, energy , power, kinetic and potential energy; give examples of forms of energy, SI units of energy, work and power; explain how energy mechanical energy is transformed in to kinetic and kinetic to mechanical, work and energy are related. Use the relations $W= FS$, $KE={}^1/_2mv^2$,$PE= mgh$ and $p=W/t$ to solve simple numerical problems.

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 the 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: Simple machines *(7 Periods)*

Unit outcomes: Students will be able to:

- Understand concepts related to Simple machines ;
- Develop skill of manipulating numerical problems related to Simple machines :
- Appreciate the interrelatedness of all things.
- Use a wide range of possibilities for developing knowledge of the major concepts within physics.

Competencies	***Contents***	***Suggested Activities***
Students will be able to: • Define machines as simple devices that help us to do work easily	***5. Simple machines*** **5.1. Definition of machines** *(1 period)*	The instructor asks students to list things they would call machines. The instructor asks them to think about the parts of the machines that make them work. Answers may include belts, gears, perhaps pulleys, cylinders, spark plugs. We will study the absolute simplest of machines. Later study, in engineering will work on these more complex machines. Students should be able to define a machine as a device in which, when a force is applied at one point, gives an output force somewhere else. Students should appreciate that we use machines to make work easier. Students could discuss some familiar machines and the advantages of using them.
• Describe the purpose of simple machines as direction changers, force multipliers and distance or speed multipliers	• Why do we use machines?	Students should appreciate that some machines allow the effort force to be applied in a different direction to that needed to do work e.g. a single pulley allows a person to pull down in order to raise a weight. Students should identify and discuss other examples of direction changers. Students should appreciate that some machines magnify an applied force e.g. a small force exerted at one end of a crow bar is magnified at the other end. Students should appreciate that in a force magnifier the small force is applied over a larger distance than the magnified force and that the work done by the effort is equal to the work done on the load. Students should identify and discuss other examples of force magnifiers. Students should appreciate that some machines magnify the distance over which a force is applied e.g. pushing down a short distance on the pedal of a bin moves the lid a large distance. Students should identify and discuss other examples of distance multipliers.
• Define M.A, V.R and efficiency (η) of a machine • Apply or use the definition of M.A, V.R and efficiency (η) to solve numerical problems	**5.2. Definition of M.A, V.R and efficiency** *(2 periods)*	Students should be able to define the mechanical advantage (or force ratio) of a machine as the ratio of the output force or load to the input force or effort: Mechanical advantage = $\frac{\text{load}}{\text{effort}}$ Students should be able to reason whether the M.A. will be greater than or less than 1 for a force multiplier and a distance multiplier. Students should be able to define the velocity ratio (or distance ratio) of a machine as the ratio of the distance moved by the effort and the distance moved by the load:

Competencies	***Contents***	***Suggested Activities***
• Describe lever and determine its M.A, V.R and efficiency • Determine the velocity ratio of an inclined plane using V.R=l/h • Explain how to determine the V.R of fixed and movable pulley up to two movable pulleys		Velocity ratio = $\frac{\text{distance moved by effort}}{\text{distance moved by load}}$ Students should be able to reason whether the V.R. will be greater than or less than 1 for a force multiplier and a distance multiplier. Students should appreciate that in each case, the ratio has no unit. Students should use these equations to calculate the M.A. and the V.R. of some simple machines both using given data and data obtained by experiment. These results should be kept for the work on efficiency which follows. Students should understand that the efficiency of a machine is the ratio of the useful work output and the work input. Efficiency = $\frac{\text{useful work output}}{\text{work input}}$ As with the M.A and the V.R., efficiency is a ratio and therefore has no unit. Advise students that it can be expressed either as a fraction or a percentage. Remind students of the definition of work as force x distance. Challenge them to combine the equations for M.A. and V.R. to give a definition of efficiency. Efficiency = $\frac{\text{M.A.}}{\text{V.R.}}$ If students were unable to derive this expression for themselves have them verify it. Students should appreciate that all devices have an efficiency of less than 1 because some energy is always lost as unwanted work, most often as heat. Students should calculate the efficiency of some devices using the data on M.A. and V.R. previously given and obtained.
• Define the terms effort, load and fulcrum • List simple machines • Construct some models of simple machines using available materials	**5.3. Types of simple machines** *(4 periods)* • The lever • The pulleys - Fixed pulley - Movable pulley (up to two fixed and two movable pulleys) • Inclined plane	Students should be introduced to a lever. They should be clear that a lever is a simple machines in which there is a place where the effort is applied, a place where the load acts and a turning point, the fulcrum, around which the forces act. Students could be given additional examples of levers and asked to identify the effort, load and fulcrum. Students could be asked to classify levers on the basis of the relative positions of the effort, load and fulcrum. Students should experiment with different ways of using a simple lever and determine in each case whether it is a direction charger and a force or distance magnifier. Students should experiment with different combinations of pulleys, firstly a fixed pulley acting as a direction changer, and a simple movable pulley then with combinations of moveable pulleys acting as force multipliers. Students should experiment with an inclined plane and determine whether it is acting as a force multiplier or a distance multiplier. More able students could extend this work by experimenting with different angles of incline.

Competencies	*Contents*	*Suggested Activities*
		In this section of work students should gather data on the sizes of the load and effort, and the distances moved by the load and effort for use in the next section. Students should construct models of simple machines using common available materials.
• Define the term torque • Identify that torque produces a turning effect	• Torque - The see-saw	Related to the lever is a device called the see saw. It employs a concept called torque. Torque is a vector quantity. It is defined as Force times distance. Torques have both magnitude and direction. There are tendencies to rotate about a fixed point. Demonstration: the teacher has a board, and several masses. He invites the students to balance a heavy one with a light one. The fulcrum is at the centre. The instructor invites students to balance a heavy mass with two or three lighter masses. If an object is in balance, the torques are equal. Torque is a lot like force but it is considered in a rotational setting. If there is no motion about the fulcrum, then the clockwise torque must equal the counter-clockwise torque. Peer Instruction: "In the see saw larger forces balanced smaller ones; This is a violation 1. of Newton's third Law, the forces are not equal and opposite 2. Conservation of energy. 3. neither Students will solve simple torque problems on a see-saw. They will also solve problems of a truck going over a bridge using torques. The bridge is not spinning so the torques must be balanced. SIMPLE MACHINE Jeopardy

Assessment

The teacher should assess each student's work continuously over the whole unit and compare it with the following description, based on the specific objectives, 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 terms and concepts like simple machine, effort, load, fulcrum, mechanical advantage, velocity ratio and efficiency; give examples of simple machines; explain the purposes of simple machines; use formulae of MA, VR, η to calculate simple numerical problems related to lever, pulleys, inclined plane; construct some simple machines using available materials.

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 the 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: Temperature and heat *(9 Periods)*

Unit outcomes: Students will be able to:

- Understand concepts related to Temperature and Heat;
- Develop skill of manipulating numerical problems related to Temperature and Heat:
- Appreciate the interrelatedness of all things.
- Use a wide range of possibilities for developing knowledge of the major concepts within physics.

Competencies	***Contents***	***Suggested Activities***
Students will be able to: • Define temperature as the measure of coldness or hotness of a body • Describe temperature as the measure of average kinetic energy of particles	***6. Temperature and heat*** **6.1. Definition of temperature** *(1 period)* • Intensive vs. extensive	The instructor invites student conceptions about temperature and heat. Where does one see lots of heat, lots of temperature. Or low heat and low temperature. Is temperature and heat the same or different? Demonstration: The teacher takes a 2 litre bottle of very hot water and asks “Will this burn if it is poured on some one?” The teacher takes the temperature of the water. He pours the water into 2 one litre containers and asks the same question about the one litre container. He then pours that into a ½ litre container also taking the temperature. Temperature is an intensive quantity. It is a property of the substance as a whole. All parts of the substance have the same temperature. Heat is an extensive quantity. It depends on the amount of the substance. 100 litres of boiling water will melt more ice than 1 litre of boiling water. Both are at the same temperature. There are not many intensive quantities. Density is another. Every small piece of a substance has the same density. Increasing the dimensions of a quantity do not increase density, it increases only mass and volume. Peer instruction on intensive quantities: If the dimensions of a block of steel are doubled. Then 1. its density doubles 2. its density quadruples 3. its volume increased by 8 times 4. its density remains the same Answers 3 and 4 are correct. The mass also increases by 8. More peer instruction on temperature and heat Students should appreciate that the temperature of a body is not a measure of the amount of heat in it. The amount of heat is determined by how much mass as well as the temperature. Students could discuss why this is not the same as the amount of heat energy it contains. Peer Instruction on temp and heat. Students should understand the relationship between the temperature of a body and the kinetic

Competencies	Contents	Suggested Activities
		energy of the particles from which it is composed. As the temperature of a body rises the kinetic energy of its particles increases. Heat is not a substance. It is a measured by the amount of molecular "jiggling" of the components of the substance
• Name the measuring devices of temperature	**6.2. Measuring temperature** *(1 period)*	Students should know that a thermometer is used to measure the temperature of a body. Students could be shown a range of different types of thermometer including examples of: • mercury and alcohol-filled • different ranges • specialised types e.g. clinical, max and min
• State the SI unit of temperature • Name the different temperature scales	**6.3. temperature scales** *(2 periods)* • Fahrenheit scale • Celsius scale • Kelvin scale	Students should be aware that different temperature scales have evolved over the course of the years and that they may come across three different scales: Fahrenheit, Celsius (or centigrade) and Kelvin. Students should appreciate the importance of having 'fixed points' on a temperature scale against which the temperatures of bodies can be compared. The fixed points used are the freezing point and boiling point of water. Students should know that on Fahrenheit scale the freezing point of water is 32 °F and the boiling point of water is 212 °F. This scale is sometimes used in connection with reporting on the weather but is not used for scientific work in the laboratory. Students should know that on the Celsius scale the freezing point of water is 0 °C and the boiling point of water is 100 °C. Students should know that on the Kelvin scale the freezing point of water is 273 K and the boiling point of water is 373 K. This scale is commonly for scientific work. Students should know K is the SI unit of temperature and that the degree symbol is not used before K. They should appreciate that the Kelvin scale has the advantage of not having any negative values. 0 K is the lowest theoretical temperature it is possible to attain and is therefore termed absolute zero. For this reason the Kelvin scale is sometimes called the absolute scale.
• Read temperature readings	• Reading on thermometer scale	Students should use a thermometer to measure the temperatures of samples of water or other liquids using a thermometer with the Celsius scale. Students should been shown how to use a thermometer accurately, emphasising the importance of aligning the eye with the liquid level and reading from the correct part of the meniscus.
• Show the relation of Celsius, Fahrenheit and Kelvin scales • Convert one temperature scale to another	**6.4. Conversion of temperature scales** *(2 periods)*	Students should be shown how to convert between the Celsius and Fahrenheit scales: $\text{Celsius} = (\text{Fahrenheit} - 32) \times \frac{5}{9}$ $\text{Fahrenheit} = \text{Celsius} \times \frac{9}{5} + 32$ Students should practice converting temperatures between these two scales.

Competencies	***Contents***	***Suggested Activities***
		Students should be shown how to convert between the Celsius and Kelvin scales: Celsius = Kelvin – 273 Kelvin = Celsius + 273 Students should practice converting temperatures between these two scales. Challenge more able students to derive expressions for converting between the Fahrenheit and Kelvin scales.
• Define heat as a form of energy that flows from one body to another due to temperature difference • Distinguish between heat and temperature • List some sources of heat.	**6.5. Source of heat** *(1 period)*	Students should appreciate that heat is a form of energy and that heat flows from a warmer body to a colder body. Students could carry out an experiment in which they place a metal weight from hot water into cold water and confirm that the metal weight cools while the temperature of the cold water increases. From this they can deduce the direction of heat flow. Students could discuss everyday examples where heat flows from a hot body to a cooler one e.g. a hot cup of coffee soon cools when left surrounded by cooler air. Students could discuss everyday examples of sources of heat
• Describe the effects of heating • Explain the difference between evaporation and boiling • State the factors affecting the rate of evaporation	**6.6. Effect of heating** *(2 periods)* • Temperature rise • Expansion • Change of state	Students should discuss the effects of heating on bodies. This should include: • temperature rise – this can be investigated by heating a beaker of water and measuring its temperature at regular intervals • expansion – this can be investigated using a ball and hoop • change of state – this can be investigated by heating an ice cube until it becomes water and heating water until it becomes steam. Students should be aware that water can turn to steam by two different processes: boiling and evaporation. Students should appreciate that: • boiling of a liquid occurs only at a specific temperature, called the boiling point, whereas evaporation takes place at any temperature • boiling occurs throughout a liquid while evaporation occurs only at the surface of a liquid. Students could investigate the factors which increase the rate at which water evaporates including: • temperature • surface area • moving / still air Peer Instruction on temperature and heat and scales HEAT/Temp JEOPARDY

Assessment

The teacher should assess each student's work continuously over the whole unit and compare it with the following description, based on the specific objectives, 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 terms and concepts like temperature, heat and temperature scales; tell the name of temperature measuring devices, SI unit of temperature, thermometer scales; read thermometer scales and measure temperature using thermometers. Use the relation between different scales to convert thermometer readings from a given scale to another; explain the difference between heat and temperature, and evaporation and boiling.

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 the 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 7: Sound *(5 Periods)*

Unit outcomes: Students will be able to:

- Understand concepts related to Sound ;
- Develop skill of manipulating numerical problems related to Sound:
- Appreciate the interrelatedness of all things.
- Use a wide range of possibilities for developing knowledge of the major concepts within physics.

Competencies	***Contents***	***Suggested Activities***
Students will be able to:	***7. Sound***	
• Define sound as a form of energy which arise the sensation of hearing	**7.1 Definition of sound** *(1 period)*	The instructor invites students to list what they think sound is. Students should know that sound is a form of energy and that sounds within a certain range can be detected by the ears. There are other kinds of sounds human cannot hear but animals can.
• Explain how sound is produced • Tell that sound needs material medium for its propagation	**7.2 Production and transmission of sound** *(1 period)* • In solids, liquids, and gases**.**	Students should appreciate that sound is the result of objects vibrating in a medium. The vibrations are carried in the medium thus sound cannot travel through a vacuum where there is no medium. Students could experiment by making sound by causing different objects to vibrate in air. Students should be aware that sound travels through all media: solids, liquids and gases. Students could be shown that sound doesn't travel in a vacuum by suspending an electric bell on rubber bands in a bell jar and slowly removing the air from the bell jar. Students could devise experiments to demonstrate that sound travels through solids and through liquids
• Compare the speed of sound in air, solids and in liquids	**7.3 Speed of sound in different media** *(1 period)*	Students should be aware that speed of sound in solids > speed of sound in liquids > speed of sound in gases. Students could be given data on the speed of sound in different solids, liquids and gases, and asked to look for a pattern.
• Define the term echo as a reflection of sound from hard surfaces • Give examples of good absorbers and reflectors of sound	**7.4 Reflection of sound** *(1 period)* • Sound reflector and absorber materials • Echo.	Students should appreciate that sound can be reflected in the same way as light and that a reflected sound is called an echo. Students could experiment with different surfaces to see which make good reflectors – absorbing little of the sound; and which are poor reflectors – absorbing a significant proportion of the sound. If possible an experiment can be set up outside with a sound source that can be made directional with cylindrical deflectors around a speaker. The source can be aimed at a reflecting wall, these must be hard surfaces. The speaker will echo. Students brainstorm about what the echo really is and how one can make a stronger one.

Competencies	***Contents***	***Suggested Activities***
• List some application of echoes • Use v=2s/t to calculate numerical problems related to sound	**7.5 Application of echo sounding** *(1 period)*	Students should be aware that the time between a sound being emitted and its echo being detected can be used to estimate the speed of sound using the equation: Speed = $\frac{2 \text{ x distance}}{\text{Time}}$ Students could carry out an experiment to estimate the speed of sound in air by reflecting sound off a suitable surface such as a cliff or the end of a building. Students should solve problems relating to the speed of sound and the distance travelled by sound using given and collected data. Calculations could involve sound in media other than air. This could be used to emphasise the difference in speed of sound in solids, liquids and gases. Sound Jeoparydy

Assessment

The teacher should assess each student's work continuously over the whole unit and compare it with the following description, based on the specific objectives, 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 terms and concepts like sound, echo **;** explain how sound is produced and transmitted, give examples of materials that are good reflectors, absolvers of sound, tell some application of sound from daily life experience; use V= 2S/t to calculate numerical problems related to transmission of sound.

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 the 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 8: Electricity and magnetism *(14 Periods)*

Unit outcomes: Students will be able to:

- Understand concepts related to electricity and magnetism;
- Develop skill of manipulating numerical problems related to electricity and magnetism ;
- Appreciate the interrelatedness of all thing;
- Use a wide range of possibilities for developing knowledge of the major concepts within physics.

Competencies	***Contents***	***Suggested Activities***
Students will be able to: • Define magnet as a piece of metal that has a power to attract iron or steel objects	*8. Electricity and magnetism* **8.1. Magnets** *(2 periods)*	The instructor should invite students' concepts about what electricity is and what magnetism is. Why are they invisible? Or are they? Students should know that a magnet is a piece of soft iron of steel which can attract objects made of iron or steel.
• Identify materials as magnetic and non magnetic	• Magnetic and non magnetic substances	Students could experiment to determine which of a set of objects are attracted to a magnet and consider what they are made from. Magnetism or non-magnetism is a an atomic property of substances.
• Describe the properties of magnets • State the laws of magnetism • Explain why a suspended magnet always points to the geographic north and south poles • Make a magnet from a nail using stroking method	• Properties of magnets (magnetic poles, compass, Earth magnetism)	Students should know that magnet contain two poles Students should experiment with two magnets and from their observations deduce the laws of magnetism: • Unlike poles attract • Like poles repel Students should be aware that the Earth acts as if it contains a huge bar magnet with the magnetic poles near to the geographical north and south poles. Students could magnetise a needle by stroking it with a magnet and then suspend it on a hair or thread to make a simple compass. Students should observe that the north pole of a compass always points north and from this deduce that the Earth's north pole is magnetic south, and the south pole is magnetic north.
• Describe the magnetic properties of magnetic lines of force • Sketch magnetic lines of force around a bar magnet and between two magnets	**8.2. Mapping magnetic lines of force** *(1 period)*	Students should be aware that invisible lines of force surround a magnet. Students could use iron filings or plotting compasses to map and draw the magnetic lines of force around a bar magnet and around a horse-shoe magnet. Students could use the same technique to investigate the lines of force between two unlike and two like magnetic poles. When drawing and interpreting lines of force, students should appreciate: • Lines of force run conventionally from north to south outside a magnet and from south to north inside a magnet. • Lines of force should never cross each other • The strength of a magnetic field is indicated by the closeness of magnetic field lines

Competencies	***Contents***	***Suggested Activities***
• List some uses of magnet in technology	**8.3. Uses of magnets** *(1 period)* • Navigation • Lifting • Separation of magnet and non-magnetic materials	Students should appreciate how a compass can be used to navigate. Students could investigate the use of lodestone by Viking and ancient Chinese sailors. Students should appreciate how a magnet can be used in a scrap yard to separate magnetic and non-magnetic materials. Students could use a magnet to separate objects made of iron/steel and other metals.
• Define electrostatics as a science dealing with charges at rest • Describe the existence of electric charge	**8.4. Electrostatics** *(2 periods)* • Introduction to electrostatics • Where do charges come from? • Types of charges	Students should appreciate that lightning occurs when electric charge builds up in clouds – and eventually passes to earth. Use this to introduce idea of electrostatic charge. Students should experiment by rubbing rods of different insulating materials, such as glass, plastic etc. with samples of different materials, such as cotton, fur, silk etc. and then carrying out simple tests to see if they are charged. These could include: • Picking up small pieces of paper • Bending a thin stream of water passing from a tap Students can experiment on charging an uncharged rod by touching it with a charged rod. Students should suspend a charged rod and bring other charged rods close to it. From their observations they should deduce that there are two types of charges. They should also deduce that similar charged rods repel while some different charged rods attract.
• Describe the charging process; charging by rubbing and by sharing (contact) • Identify the two types of charge • State the laws electrostatics • Describe what an electroscope is • List the uses of electroscope • Construct a simple electroscope and use it	**8.5 Methods of charging** *(2 periods)* • Charging by rubbing • Charging by conduction **8.6 Law of electrostatics** *(2 periods)* • Electroscope and its use • Project work (constructing an electroscope)	Students should deduce the law of electrostatics from their experiments: • Unlike charges attract • Like charges repel Students should be introduced to the electroscope and shown how it is used to detect electrostatic charge. Students should attempt to build their own electroscope. They could use it to investigate charge on different materials. Students could investigate ways of charging an electroscope.

Competencies	Contents	Suggested Activities
• Define an electric current as the flow of charge per unit time • List some sources of potential difference • Distinguish between primary and secondary cells	**8.7. Electric current and potential difference** *(3 periods)* • Definition of current • Source of potential difference • Primary and secondary cells	Students should appreciate that electrostatic charge is held on insulators because it is unable to flow but if the charge is in contact with a conductor, such as metal wire, it will flow giving rise to an electric current. Students should appreciate that charge flows in a circuit because there is a different in energy levels between two points – called the potential difference. Students should identify sources of electricity including cells and batteries. Students could investigate the different sizes of cells available and the potential difference between the terminals. Students should appreciate that some cells can only be used once; when the chemicals they contain are used up they are thrown away. These are called primary cells. Other cells can be recharged when they are exhausted by passing electricity through them. These are called secondary cells. Students should be able to identify examples of primary and secondary cells. Students could discuss the advantages and disadvantages of each type of cell.
• Define electric circuit • List circuit elements of simple electric circuit (connecting wire, source, bulb, and switch) • Show electrical symbols of circuit element • Distinguish between conventional and electron current. • Define the terms conductors and insulators. • Identify materials as conductors and insulators	**8.8 Electric circuit** *(1 period)* • Circuit elements (connecting wire, source, bulb, switch) and electrical symbols • Direction of electric current • Conductors and insulators.	Students should understand that a circuit is a conducting pathway around which an electric current can flow. Students should experiment making simple circuits using cells, bulbs, switches and connecting wires. Students should know that a material which allows an electric current to flow is called a conductor while one which prevents an electric current from flowing is called an insulator. Students should use a simple circuit containing a cell and a bulb to test whether materials are electrical conductors or insulators. Peer instruction on Circuit and Magnets Electric and magnetic Jeopardy

Assessment

The teacher should assess each student's work continuously over the whole unit and compare it with the following description, based on the specific objectives, 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 terms and concepts like magnet, electrostatics, electric current, electric circuit, conductors and insulators, give list of the use of magnets in technology, conductors and insulators, sources of potential difference and elements of simple electric circuit; tell properties of magnet and magnetic lines, types of charges, differences between secondary and primary sources and conventional and electron current, the use of electroscope; sketch magnetic lines of force ; construct simple electroscope and use it to test the type of charge on a given material.

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 the 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.