Iridescent Lesson Plan

PRE-PLANNING	**OBJECTIVE** What will your students be able to do?	**KEY CONCEPTS AND VOCABULARY** What three-five key points will you emphasize?
	Understand the basics of electromagnetic waves and how they enable wireless communications. They will also be able to build primitive wireless transmitters.	• Electromagnetic waves • Spark-key transmitters • Wireless communications
	CONNECTION TO THE BIG IDEA How does the objective connect to the big idea?	
	Learning about electromagnetic waves and how transmitters and receivers work is the first step toward understanding how wireless communications work.	
	ASSESSMENT How will you know whether your students have made progress toward the objective? How and when will you assess mastery?	
	Exit slips and concept maps will enable us to check for student understanding.	

LESSON	**OPENING** (2 min) How will you communicate *what* is about to happen? How will you communicate *how* it will happen? How will you communicate its *importance*? How will you communicate *connections* to previous lessons?	**MATERIALS** What materials will you need for your lesson?
	Good morning everyone! Let us review quickly what we have learnt so far. Do you remember how magnets attract certain materials? Can you give some examples? Right! Iron, steel, etc. And that there are two poles in a magnet? How many of you remember that electricity and magnetism interact with each other? Did we make something in the last class which used electricity to produce magnets? Yes, they are called electromagnets. Today we will learn more about this interaction between electricity and magnetism. We will learn about the concept of electromagnetic waves, and how they are fundamental to understanding wireless communications. Along the way, we will also understand the basic components, like transmitters and receivers, which make wireless communications possible.	(for each experiment) • 2 D-cell batteries (1.5 V each) • 4 flat metal strips • 8 screws • 3 big iron nails • 1 flat big rubber band • 5 feet insulated copper wire • 2 wooden plates • Scissors or sand paper • Laptop • Projector
	DIRECT INSTRUCTION (8 min) What key points will you emphasize and reiterate? How will you ensure that students actively take-in information? How will you vary your approach to make information accessible to all students? Which potential misunderstandings will you anticipate? How will your students be using a Concept Map or other structured tool?	
	Play the water drop video (filename: lesson2_waterdrop.flv) and ask them what they observe (that the waves dissipate away from the center in a circular fashion and slowly die out at a distance). Ask them what the ripples are called (waves). *Show slide 2 and talk about waves. Ask them if they have heard of other kinds of waves besides water waves that are shown on the slide – like sound waves, light waves, heat waves, etc.*	

Ask them if they think that waves need a medium to travel, like air, water, iron, steel. To illustrate, take sound waves as an example and explain by describing the following experiment (draw a picture on the board or show it on the slide) how it needs a medium to travel. Take a buzzer and place it inside a closed air-tight glass jar. We can hear the buzzing sound from the outside. Now, gradually pump the air out from the jar. The buzzing sound slowly becomes fainter, and eventually we do not hear the buzzer at all. Ask them what property (that sound waves need a medium, air in this case, to travel) it illustrates about sound waves.

Now, instead of a buzzer, ask them if we place a light bulb inside the jar and pump out the air slowly, will the bulb get dimmer? What property does it illustrate about light waves?

Explain the concept of wavelength and ask them if they think waves that have longer wavelengths would travel faster or slower. Does the speed depend on the medium through which it travels? Or is it independent?

Show slide 3 that shows a picture of light waves coming from the Sun, and ask them if they know how long it takes (about 8 minutes) for light to reach the Earth from the Sun. Ask them the distance (about 93 million miles) between the Earth and the Sun and to calculate the speed of light waves (93000000/480 miles/sec).

Play another short video (filename: lesson2_emwaves1) that gives a one and half minute brief about light waves and the electromagnetic spectrum.

Slow slide 5 (picture) and 6 (animation), and explain how electromagnetic waves are formed by electric and magnetic fields interacting with each other. To reinforce what they learnt from last class, ask them what causes an electric field (electricity) and what causes a magnetic field (magnet).

Show slide 7 that shows a picture of the electromagnetic spectrum and how the waves get shorter in length from left to right as we go from radio waves, infrared, visible light, to ultra violet, x-rays, and gamma rays. Ask them if they think these other waves with shorter or longer wavelengths than visible light can be seen by other animals. Give examples: vipers can "see" infrared (which is basically heat waves) and use it to catch preys; bats can "see" ultra violets rays. Also, explain the concept of frequency, which is the speed of light (3x10^8 meters/sec) divided by the wavelength (in meters).

Show slide 8 that shows pictures of different antennas (space antennas, car radio antennas, TV antennas, cell phone antennas) and ask them if they can identify them. Ask them if they know what antennas do.

Show slide 9 that shows a picture of radio stations and ask them what (electromagnetic waves) goes back and forth between these stations. Ask them what might produce an electromagnetic wave.

Show slide 10 that shows electromagnetic waves coming out of an antenna (an AM transmitter) and being bounced/reflected by the Earth's atmosphere. Ask them, what might happen if we place two such antennas (one transmitter and one receiver). Ask them if they have heard of the terms "transmitters" and "receivers".

Show slide 11 that shows a picture of a spark-key transmitter that produces electromagnetic waves. On the same slide, show and explain the basic principle behind the working of a spark-key transmitter, and motivate that we will make one such primitive transmitter today.

DIRECTIONS FOR EXPERIMENT(5 min)

How will you clearly state and model behavioral expectations?
How will you give 3-5 clear directions for the activity and model them?

Now we are going to make a very primitive wireless transmitter – called a "spark gap transmitter" – it was widely used in the early days of wireless communications. Modern day transmitters are variants and improvements on a spark gap transmitter.

Show slide 11 that lists the materials to build the transmitter.
Distribute two D-cell batteries, 4 metal strips, 8 screws, 3 big iron nails, 5 feet long insulated copper wires, a thick rubber band, and two wooden plates.

EXPERIMENT (40-60 min)

What kind of activity can be performed by students that directly relates to your objective and the big idea?
How will you engage students and capture their interest to explore the concept?
What exactly will your students be doing during the activity? What will you be doing?
How will your students be using a Concept Map or other structured tool?

A simple wireless transmitter – a spark gap transmitter – consists of three parts all hooked up via wires: a battery, a key, and a buzzer.

A buzzer is something they learnt and built in the last lesson – it is basically an electromagnet that breaks the circuit which is activating it as soon as it is activated and then makes it again and again. Here are some simple steps to make a buzzer (if we are not buying a ready made one) and explanation on how it works.

(Refer to slide 12 for a schematic diagram)

1. Wind about 100-200 turns of insulated copper wire around a nail
2. Arrange the coil around the nail so that when electricity is applied, the coil is activated (turning into an electromagnet) and it pulls DOWN the metal plate (called an armature) breaking the circuit and producing a spark.
3. As soon as the circuit is broken, the metal plate springs back UP completing the circuit again, causing the coil to pull it down again and so on.
4. This cycle of break-the-circuit and make-the-circuit continues and makes the metal plate vibrate or buzz for as long as a voltage is applied. The electric contact produces sparks (and in turn radio waves) as it makes and breaks the circuit.

(Note: You may have to carefully adjust the metal plate so that it is close enough to the coil to be pulled down reliably and the location of the contact in order to

	get the buzzer to buzz reliably.) Show slide 13 for a complete circuit of the transmitter.	
	REFLECTION (5 min) How will students summarize what they learned? How will students be asked to state the significance of what they learned? How will students relate what they learned back to your objective and big idea using key vocabulary?	
	Exit Slip questions: 1. We saw sparks are produced when a voltage is applied across the buzzer. What exactly is happening when the sparks are produced? 2. Why do the sparks produce radio waves? 3. How long in terms of distance do you think these radio waves generated from a spark gap transmitter can travel? How can you make the range longer? 4. What concept are you proud of learning today?	