

## Flipped IN-CLASS Lesson Plan Template

Topic or concept: Kirchhoff's Rules

### Basic objectives for preparatory work:

1. Determine when Kirchhoff's Rules are appropriate to use.
2. Restate Kirchhoff's Junction Rule
3. Describe how the Junction rule is related to charge conservation
4. Restate Kirchhoff's Loop Rule
5. Describe how the Loop Rule is related to energy conservation

### Advanced objectives for classwork & after class work:

1. Apply Kirchhoff's rules to set up a system of equations to solve for unknowns in a circuit.
2. Predict how charge and current behave with time as a capacitor charges and discharges.

### Group Space Activities [120 minutes]:

	Time planned	Activity and rationale	Resources needed
Beginning of class period	10 mins	<u>Pre-lecture Quiz</u> consisting of 2-3 conceptual questions <i>Rationale: activate knowledge from preparatory activities and make students put their explanations in writing. (quiz is then checked to make sure they completed this activity and given back to students so they can correct at end of lecture.)</i>	Paper Quiz
Middle of period	30 min	<u>Mini-lecture</u> based on muddiest point and quiz answers from preparatory activities. Second part of lecture is to show them how to apply Kirchhoff's Rules to more complicated capacitive circuits.	Lecture prep/slides, computer

	Time planned	Activity and rationale	Resources needed
		<i>Rationale: Clarify misconceptions and offer new info.</i>	
Middle of period (use if needed)	70 min	<p><u>Problem Solving</u></p> <p><b>Part 1: Think-Pair-Share conceptual questions (20 min)</b></p> <p>Students think about problem independently, pair up and discuss possible solutions, and share answers to class with ABCD voting card. (4 questions total, 5 min each)</p> <p><b>Part 2: Work Board Problem Solving Session (40 min)</b></p> <p>Students work in groups and work on different whiteboards to solve 2-3 problems with multiple parts.</p> <p><b>Part 3: Formulate Problem Approach Outline (10 min)</b></p> <p>Students reflect on problems they worked on in class and write down a general method to approach problems independently.</p> <p><i>Rationale: Practice solving problems and articulating solutions.</i></p>	<p>Part 1: Multiple choice computer slides, student ABCD voting cards</p> <p>Part 2: White boards and markers</p> <p>Part 3: Paper.</p>
End of period	10 mins	<p><u>Post lecture Quiz:</u></p> <p>Pre-lecture quiz is handed back to students and they get to revise their pre-lecture quiz. Correct answers are to be circled in green pen. Incorrect answers must cross out in red pen. Students also need to write the correct answer, and explain their previous misconception.</p> <p><i>Rationale: To solidify understanding. Students confront their initial misconceptions by reflecting whether their initial ideas hold merit after the problem-solving session.</i></p>	Paper Quiz, green and red pens.

## Flipped AFTER CLASS Work Plan Template

Advanced learning objective	Activity and rationale	Instructions to students
<ul style="list-style-type: none"><li>- Apply Kirchhoff's rules to set up a system of equations to solve for unknowns in a circuit.</li><li>- Predict how charge and current behave with time as a capacitor charges and discharges.</li></ul>	<p><i>1. Annotated Problem Solving</i></p> <p>Rationale: For two problems with published solutions, write notes explaining each step. For two new problems, solve the problems and explain each step. This provides practice in problem-solving and also articulating the problem-solving process so that small errors do not derail you.</p> <p><i>2. Traditional Homework</i></p> <p>Rationale: Students use their experience in class to solve 4 more complicated problems and get practice applying their knowledge.</p>	<p><i>Example:</i> Annotate solutions to problems 1 and 2 in this week's after-class folder in Canvas. Solve and annotate problems 3 and 4. You may work together; just be sure that YOU can solve and annotate problems independently as the exam will be similar to this work.</p> <p>Traditional Homework: Complete problems 5-8 in this week's after class file. You may work together; just be sure that YOU are able to solve the problems independently.</p>

## GUIDED PRACTICE

Class: Electricity and Magnetism Calculus based physics: Kirchhoff's Rules

Date assigned: Wednesday

Date due: Sunday at midnight. (4 days later)

Time estimate to complete individual space pre-class assignment: 45 minutes

### Overview/Introduction

Phones, computers, lights. These all require electrical circuits. We learned about one of the most important and basic laws of electrical circuits, Ohm's law which states that the current passing through a conductor is proportional to the voltage over the resistance. Knowing voltage, current, and resistance, we can design and analyze circuits to utilize electricity in a useful manner. Last time we saw how resistor networks can be broken down into a series or parallel arrangement to find the current and voltage in a circuit. But what happens, when resistor arrangement cannot be classified as series or parallel? To analyze these types of networks, we need to use a more general circuit analysis technique known as Kirchhoff's Rules that were developed by Gustav Robert Kirchhoff in 1845. Kirchhoff's rules are fundamental laws used for circuit analysis to understand how current and voltage work within a circuit. In these rules, we can analyze complicated circuits by breaking them down into current loops and current junctions.

### Learning Objectives

#### Basic objectives

List 3-5 learning objectives that you expect students to be able to master on their own before class.

1. Determine when Kirchhoff's Rules are appropriate to use.
2. Restate Kirchhoff's Junction Rule
3. Describe how the Junction rule is related to charge conservation
4. Restate Kirchhoff's Loop Rule
5. Describe how the Loop Rule is related to energy conservation

#### Advanced objectives

List 3-4 learning objectives that you expect students to need help mastering.

1. Apply Kirchhoff's rules to set up a system of equations to solve for unknowns in a circuit.
2. Predict how charge and current behave with time as a capacitor charges and discharges.

## Preparatory Activities and Resources:

All of the steps below are due at midnight, the day before the In-Class Group Space meeting.

### *Pre-Class Individual Space Activities and Resources [45 minutes]:*

Instructions to Students	Timing	Rationale
<b>Step 1:</b> Watch video: Capacitors and Kirchhoff: Crash Course Physics #31 <a href="https://www.youtube.com/watch?v=vuCJP_5K0II&amp;t=1s">https://www.youtube.com/watch?v=vuCJP_5K0II&amp;t=1s</a>	11 min.	<i>Learning Objective #1</i> Introduction to concept and overall idea
<b>Step 2:</b> Watch Video: Kirchhoff's current law   Circuit analysis   Electrical engineering   Khan Academy <a href="https://www.youtube.com/watch?v=Bt6V7D5av9A">https://www.youtube.com/watch?v=Bt6V7D5av9A</a>	6 min.	<i>Learning Objective #2 &amp; #3</i> More details on how to utilize Junction Rule
<b>Step 3:</b> Following video 2, take Quiz #1 on canvas worth 2 points	6 min.	<i>Learning Objective #2 &amp; #3</i> Practice applying Junction Rule for simple problem
<b>Step 4:</b> Watch Video: Kirchhoff's voltage law   Circuit analysis   Electrical engineering   Khan Academy <a href="https://www.youtube.com/watch?v=OYerdzZPSI0&amp;t=16s">https://www.youtube.com/watch?v=OYerdzZPSI0&amp;t=16s</a>	6 min.	<i>Learning Objective #4 &amp; #5</i> More details on how to utilize Loop Rule
<b>Step 5:</b> Following video 2, take Quiz #2 on canvas worth 2 points	6 min.	<i>Learning Objective #4 &amp; #5</i> Practice applying Junction Rule for simple problem
<b>Step 6:</b> Submit a single "Muddiest Point" question by Canvas worth 5 points.	10 min.	<i>Learning Objective #1 -5</i> Allows instructor to customize mini lecture for student's needs.

## ADVANCED PRACTICE

This is given for students to complete after the class meeting in which they work together.

Class: Electricity and Magnetism Calculus based physics: Kirchhoff's Rules

Date assigned: Monday (day of class the topic is introduced)

Date due: Monday, 1 week later, at the beginning of class.

Time estimate to complete this assignment: 3 hours

## Learning Objectives

### Advanced objectives

List 3-4 learning objectives that you expect students to need help mastering in class and after class.

1. Apply Kirchhoff's rules to set up a system of equations to solve for unknowns in a circuit.

2. Predict how charge and current behave with time as a capacitor charges and discharges.

## Activities & deliverables

### Procedure:

Complete both assignments, staple them together and title this assignment: “**Chapter 6 HW: Kirchhoff’s Rules**” along with your name and due date. This assignment will be due in class 1 week later at the beginning of class.

- **Post-Assignment 1: Annotated Problem Solving**

Look in this week’s after class folder labelled, Post-Assignment 1.

Annotate solutions to problems 1 and 2 by writing notes explaining the rationale behind each step. The solutions to problems 1 and 2 are supplied.

Next, for two new problems: 3 & 4, solve the problems and explain each step.

- **Post-Assignment 2: Traditional Problem Solving**

Look in this week’s after class folder labelled, Post-Assignment 2.

4 homework problems are given for you to solve. You may work together in groups but be sure that YOU are able to solve the problems independently as the exam will be similar to this work.

## ADDITIONAL INFORMATION

### Additional Resources for Chapter 6 and Kirchhoff’s Rules besides your textbook

#### Videos:

- [https://www.youtube.com/watch?v=vuCJP\\_5K0II&t=1s](https://www.youtube.com/watch?v=vuCJP_5K0II&t=1s)
- <https://www.youtube.com/watch?v=Bt6V7D5av9A>
- <https://www.youtube.com/watch?v=OYerdzZPSI0&t=16s>

#### Websites

- <https://www.khanacademy.org/science/physics/circuits-topic/circuits-resistance/a/ee-kirchhoffs-laws>
- [https://www.electronics-tutorials.ws/dccircuits/dcp\\_4.html](https://www.electronics-tutorials.ws/dccircuits/dcp_4.html)

### Questions?

If you have any questions: ask me by email or in person during my office hours.