Teacher Guide
Semiconductors:
Electroplating & Integrated Circuit Production

NEW FOR 2025-2026!

- Quality check was performed to ensure web links still work and equipment lists are up to date.

PLANNING FOR THE CHALLENGE:

SUGGESTED LESSON PLAN - 50 minute periods	
Total Time ~100-120 minutes • ~35 minutes to watch the lab introduction video (MAIN Lab portion) • ~10 minutes to review safety precautions • ~40-50 minutes for students to design, build and test their prototype • ~ 5-15 minutes to record answers and observations in Student Workbook or Abbreviated Worksheet • ~10 minutes for a closing activity or discussion *(Note: An optional 30-45 minutes can be scheduled to do a Wrap-Up and QA with an Engineer and College Mentor at Teacher's discretion).*	
Hook/Essential Question	How are semiconductors the "brains" of all modern electronics?
Supplies to Have in Class	ET Semiconductors Kit materials can be found at the end of this file. • Gloves • Safety Goggles • Copper Wire • AA Battery w/ holder • Jumper Cables • Alcohol cleaning pad • Substrate (Nickel or metal disk) • 3 oz plastic cup Additional Items to Consider Having on Hand: • Water • Paper towels • Tape **NOTE**: Some sites referred to in the workbook may be blocked by school internet protocols. Please request admin access for the sites **below** in advance so that you students will have access before they begin working through the student workbook/worksheet • https://docs.google.com/document/d/1LSyc1l2uAuWM7sv3h7puUra3bpDn_j4rPlIIhWA4RBc/edit?usp=drive_link The videos **below** should be unblocked for **teachers-only** if presenting the student workbook to the whole class OR for **all students** if they are completing the student workbook on their school devices Main Workbook

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	• https://www.youtube.com/watch?v=c9arR8T0Qts
Optional Pre-Work	Have students watch the first 19 min of the intro video providing the background for the challenge and answer the questions on through slide 29 (just before Part 4 Your Semiconductor Challenge) of the student workbook.
Class #1 Introduction and Procedure	Watch the Engineering Tomorrow: Semiconductors Intro Recording on the Semiconductors webpage either as a class or assign background section as pre-work (see above). ➔ Have students answer the comprehension questions in the first 29 slides of the student workbook ➔ Watch the rest of the video that outlines the instructions for the challenge. Student teams begin to design their semiconductor experiment → research designs, review materials, generate an initial design concept and describe in their Workbook or Abbreviated Worksheet. *(1 workbook or worksheet per team is suggested)*
Class #2 Work Time and Testing	➔ Students design their semiconductor experiment → research designs, review materials, generate an initial design concept and describe in their Student Workbook or Abbreviated Worksheet. (Slides 30-49) ◆ Prepare the Bath (Copper II Sulfate) and Object to be Plated and cleaning coin / substrate with alcohol wipes ◆ Prepare the Circuit and Start Plating ◆ Allow time for plating ◆ Wipe off any masking and wash your hands
Part of Class #3 Possible Closing Questions and Activities	Class Discussion Questions: • The semiconductor industry implements highly precise processes to create microchips. How could you reduce errors in this experiment? • What other industries do you think could implement semiconductors? • What would happen if there was a semiconductor shortage? Who would be affected? (This did happen in 2020) • For students who have taken chemistry: what type of reaction is occurring here between the copper sulfate and the substrate?

INTRODUCTION TO ENGINEERING TOMORROW:

- Click here to see an introduction of what Engineering Tomorrow can do for your students.

INTRODUCTION TO THE ENGINEERING DESIGN PROCESS:

- Students should complete the Engineering Design Process Introduction Activity before starting the lab

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- NOTE: This activity only needs to be completed before the student's **first** ET lab, not repeated for every lab.

SAFETY PROCEDURES:

- Safety procedures for this lab may be found in this document. This includes proper attire and disposal of the solution.

TEACHER NOTES:

- Students will work through the **Semiconductors** Student Workbook or the Abbreviated Student Worksheet.
  - When assigning this lesson on Google Classroom, first make a copy of the slides to save within your Google Drive, then assign so that each student has their own copy.
  - The workbook and worksheet are designed to be interactive so that students can type directly into the files. It is suggested that the workbook or worksheet be completed over a few class periods (as the information is delivered to students).
  - Students may work individually or within groups (at the discretion of the instructor).

ASSESSMENT:

- Informal assessments can be completed by looking at the reflection slides within the Student Workbook and/or the discussion questions in the Abbreviated Worksheet.

- **Answer Keys** can be found here for the:
  - Student Workbook Answer Key
  - Abbreviated Worksheet Answer Key

TROUBLESHOOTING TIPS:

- Make sure the copper piece and the nickel are not touching
- Make sure the copper and nickel are at least 3 cm apart from each other to prevent a short circuit
- Make sure the nickel is clean before plating by wiping it with an alcohol wipe. Plating may not stick if the nickel is not clean

PRE AND POST WORK IDEAS:

- Pre-work Assignment - students watch 4 min video which introduces the semiconductor manufacturing process and goes inside the world's largest semiconductor factory
- Post Work Assignment - students watch part of all of the "Chip In" documentaries, which highlight three young professionals as they explore the semiconductor industry.

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EXTENSION ACTIVITIES:

- Research how other processes work in semiconductor production
- Discuss the economics of semiconductors, and read this article to learn more
- Watch this video to learn more about semiconductor manufacturing.

ADDITIONAL TEACHING RESOURCES:	
Curriculum Connections: • Chemical Engineering: using math, science, and engineering concepts to produce solutions using chemical processes • Materials Science: creating specific and complex materials using scientific processes. • Electrical Engineering: designing systems which use electricity, electromagnetism, and electronics • Mechanical Engineering: creating machinery to make specific products and perform tasks • Computer Science: developing software systems to control modern technology	**Students will be able to -** • Analyze real-world problems and use critical thinking skills in order to solve them • Work through and understand the engineering design process • Use an electroplating technique commonly found in semiconductor production • Understand the growth and impact of the semiconductor industry
Content Vocabulary/Terms: • Integrated circuit: small electronic circuits on a piece of semiconductor material. They contain electronic "brains" that are programmed for various tasks, including storing and managing data. • Semiconductor: a material with conductivity that lies between that of an insulator and a conductor. • Transistor: a 3 terminal device made of semiconductor material. They have many uses, including amplification, switching, voltage regulation, and the modulation of signals. • Moore's Law: an observation that the number of transistors on a microchip roughly doubles every two years. • Photolithography: A fabrication process that transfer a pattern from a photomask to a silicon substrate wafer • Etching: A process that removes layers or slices of a material, such as semiconductors, metals, dielectrics, and polymers • Metal Deposition: A process where thin metallic film coating is carefully deposited onto a substrate to yield specific material properties	

NEXT GENERATION SCIENCE STANDARDS:

HS-ETS1-1. Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.

HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

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MATERIALS:

TEACHER'S KIT		
Materials will be distributed throughout the class		
Item/Link	**Quantity**	**Photo**
Goggles	30	

CLASSROOM EXTRAS		
Item/Link	**Distribution**	**Photo**
Scissors	1 for Every 10 Students	

STUDENT KIT ITEMS		
1 kit: 3 students		
Item/Link	**Quantity**	**Photo**
Plastic Cup (3 oz.)	1	
Gloves	6	
Alcohol Pads	6	
Jumper Wires	2	
Metal substrates (can also use a coin)	3	 **OR** 

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Copper Wire	1	
Permanent Marker	1	
Single Battery Holder	1	
AA Battery	1