

Integrating school curricula with the ATL



| Volume II |

Grades: 6–8



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Acknowledgments

Chief Advisors

Sri. B Srinivasa Rao, IAS State Project Director Samagra Shiksha, Andhra Pradesh	Dr. Vidya Kumari. K, IAS State Project Director Samagra Shikshana, Karnataka	Sri. Dr. E. Naveen Nicolas, IAS State Project Director Samagra Shiksha, Telangana
---	---	--

Advisors

Sri. M.R. Prasanna Kumar Additional State Project Director, Samagra Shiksha, Andhra Pradesh	Sri. K. Nageswara Rao Joint Director, SAMO Samagra Shiksha Andhra Pradesh	Smt. D. Madhavi Latha ATL State Nodal Officer, Samagra Shiksha, Andhra Pradesh
---	---	--

Sri. Maruthi M R Director (Quality), Samagra Shikshana, Karnataka	Smt. Sreelatha Kotemutt Program Officer, Vocational Education, Samagra Shikshana, Karnataka (previously)
--	---

Smt. M Radha Reddy Addl. State Project Director, Samagra Shiksha, Telangana	Sri. P. Rajeev Joint Director, Samagra Shiksha, Telangana	Sri. P. Venkata Swamy State Quality Coordinator, Samagra Shiksha, Telangana
--	--	--

Teacher Contributors

Sri. G. Lakshmana Rao S.A-PS & DSO, ZPHS Veeraghattam, Parvathi Puram Manyam Dist., AP	Smt. S. Umamaheshwari SA-BS, ZPHS School Ippili, Srikakulam Dist., AP	Smt. C.V. Sravani PGT-Physics, APMS, Dharmavaram, Sri Satya Sai Dist., AP
Sri. M. Kalyana Chakravarthi SA-PS, GHS Jaggampeta, Kakinada Dist., AP	Sri. V. Ramesh SA-PS, ZPHS Chandhuluru, Vizianagaram Dist., AP	Sri. B.L.V.N. Anand Babu SA-PS, GHS Boys, Rajahmundry, East Godavari Dist., AP
Smt. Dr. N.V. Nagamani Dept of Maths & Science, SCERT, Andhra Pradesh	Smt. G. Rajeshwari Coordinator, Labs, SCERT, Andhra Pradesh	Smt. Dr. G.R Bhagyasri SA-Eng, ZPHS Plus, Telaprolu, Krishna Dist., AP
Smt. Sindhu V K Teacher, GJC (HS), Bettampady, DK Dist., Karnataka	Smt. Chethana S Teacher, MDRS Madenahalli, Kolar Dist., Karnataka	Sri. Sandesh KL Teacher, KPS Kalasa (HS), Chikkamagaluru Dist., Karnataka
Sri. Kalagouda G. Patil Teacher, GHS Shiragaon, Chikkodi, Belagavi Dist., Karnataka	Sri. Venkanna Pujar Teacher, GGHS Basapattana, Koppal Dist., Karnataka	Sri. Prasanna Keshava Hegde Teacher, Govt. Adarsh Vidyalaya, Yadravi, Belagavi Dist., Karnataka
Smt. S Praveena S.A., ZPHS Veljerla, Ranga Reddy Dist., Telangana	Sri. Tammala Raju S.A., ZPHS Boys, Bhiknoor, Kamareddy Dist., Telangana	
Sri. Bandari Shankar S.A., ZPHS Boys, Manthani, Peddapally Dist., Telangana	Sri. K Lingaiah PGT, Telangana Model School (TGMS) Anajipuram, Suryapet Dist., Telangana	

Content Creation, Writing and Technical Support by Vigyan Ashram

Dr. Yogesh Kulkarni

Director

Mr. Kishore Gaikwad

Program Manager

Mr. Bommididi Ramesh

ATL Field Officer, Andhra Pradesh

Mr. Penumarthi Venkatesh

ATL Field Officer, Andhra Pradesh

Mr. Manoj M

ATL Field Officer, Karnataka

Mr. Somashekar S.

ATL Field Officer, Karnataka

Ms. Pilli Hema Sai Chandrika

ATL Field Officer, Telangana

Mr. Vasana Pavan Kumar

ATL Field Officer, Telangana

Field Support by UNICEF

Mr. Sheshagiri K.M. Rao

Education Specialist

Mr. T. Sudershan

State Consultant, Andhra Pradesh

Ms. Namita Rao

State Consultant, Karnataka

Ms. Veena K

State Consultant, Karnataka

Ms. Brinda Pillai

State Consultant, Telangana

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Fountainhead Solutions Pvt Ltd.

New Delhi

Message from Samagra Shiksha, Andhra Pradesh



It is with immense pleasure and a deep sense of commitment to the future of our young learners that I present this handbook for teachers on using the Atal Tinkering Labs to provide a quality experiential learning for children. The ATLs, as we know, offer a unique opportunity for 'learning by doing', decisively moving away from rote-based learning. Learning by doing is the principle that is at the heart of STEM education. The ATLs, offering access to modern and conventional technology tools to young minds, have been established across the country at a pivotal moment, as we collectively strive to nurture a generation of innovators, problem-solvers and critical thinkers.

To the teacher, I would like to say that this handbook has been meticulously developed to serve as your invaluable companion on this exciting journey of exploration and learning. It is a practical guide that helps you to link the subject curriculum with the activities that can be done at the ATL. The integration of the ATL into your school timetable and routines is essential, and this will lead to an effective use of this innovative space. The handbook is designed to make this integration possible. At the same time, the handbook goes beyond the immediate needs of the syllabus, and offers a simple and powerful framework for identifying solutions to the myriad problems and challenges of daily life.

The handbook has two main parts – a section on Design Thinking, and a section on sample activity plans for grades 6-10 (40 of them, across the subjects of Physics, Chemistry, Mathematics and Biology), which offer clear guidance on how to integrate curricular concepts with ATL activities, using the tools available at the ATLs. As you implement the activity plans, you will understand how they help to bring key concepts alive, using a variety of tools available in your ATL. Also, use these activity plans to develop your own activity plans. Your aim should be to cover all the key concepts that you teach in science and mathematics.

A word or two must be said about the section on Design Thinking. This idea is at the heart of the Atal Tinkering Lab. It can be called a human centered process, a mindset or an approach to problem solving, with a focus on developing solutions. One can identify many challenges or problems that need to be solved in daily lives. Design thinking offers a framework that can be used by teachers and children to identify these problems and work towards their practical solutions. Increasingly, this is seen as an ability that needs to be developed through the educational

experiences that schools provide. The ATLs offer all the tools for design thinking. The handbook offers a simple and clear introduction to this powerful learning process, and we hope that the case studies presented here will motivate children and teachers to get on to this exciting journey.

Samagra Shiksha, Andhra Pradesh, is deeply committed to supporting all our teachers. The ATL handbook is a concrete step in that direction. We believe that by investing in the professional development of our teachers, we are directly investing in the future of our state.

I urge every teacher to thoroughly engage with this ATL handbook. Do share your experiences and continuously innovate within your labs. Let us collectively strive to transform our schools into hubs of innovation, where every child feels empowered to dream, design and create. Together, let us empower the next generation to be creators of solutions, not just consumers of knowledge and build a brighter, more innovative Andhra Pradesh.

With best wishes,

B. Srinivasa Rao (IAS)

State Project Director

Samagra Shiksha

Andhra Pradesh

Message from Samagra Shikshana, Karnataka



It is with immense pleasure and optimism that I present this *Atal Tinkering Lab Handbook for Teachers*. This is a thoughtfully crafted guide designed to bridge the gap between classroom learning and hands-on innovation. The Atal Tinkering Labs (ATLs) represent a transformative vision for education, fostering creativity, curiosity, and problem-solving among young minds. This handbook serves as a vital resource for teachers, empowering them to integrate core academic subjects—Physics, Chemistry, Biology, and Mathematics—with the dynamic, experiential activities of the ATL.

The activity plans included in this handbook are meticulously designed to be both detailed and are user-friendly, enriched with illustrations, video guidance through QR codes, and thought-provoking questions to spark meaningful discussions. By clearly mapping curricular linkages, these plans enable educators to seamlessly "bring the classroom to the ATL, and the ATL to the classroom." They are not just tools for teaching but invitations to explore, experiment, and connect theoretical knowledge with real-world applications.

Equally significant is the handbook's dedicated section on design thinking, a powerful framework for fostering innovation. ATLs are more than laboratories; they are vibrant spaces where ideas take flight. Design thinking, as outlined in this guide, equips teachers and students with a structured yet flexible approach to problem-solving, encouraging them to step beyond textbooks and embrace the world of innovation. Through engaging examples, this section illustrates how design thinking can ignite creativity and inspire solutions that are both practical and transformative.

This handbook is a testament to the belief that education thrives when it blends structure with imagination, discipline with exploration. It is our hope that teachers will find this resource an inspiring companion in their journey to nurture the next generation of innovators, thinkers, and changemakers. Let the Atal Tinkering Labs be the launchpad for ideas that shape a brighter future.

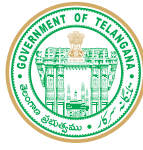
Dr. Vidya Kumari (IAS)

State Project Director

Samagra Shikshana

Karnataka

Message from Samagra Shiksha, Telangana



It gives me great joy to share with the teachers and students of Telangana the Atal Tinkering Lab Handbook for Teachers, as we take another meaningful step towards transforming education. Atal Tinkering Labs (ATLs), established in schools across the state, are redefining learning through a strong experiential and inquiry-driven approach. I truly believe this handbook will enable teachers to build the necessary skills to transform our schools into vibrant hubs of innovation.

The role of education has always been to nurture curiosity, encourage original thinking, and prepare students to face the challenges of a changing world. This is precisely what ATLs set out to do. They invite both teachers and students to return to the roots of discovery, by asking questions, exploring solutions and learning by doing. ATLs remind us of the true essence of education: a joyful, curious, and purpose-driven journey.

This handbook contains 40 carefully crafted activity plans across science subjects, serving as a reliable guide for teachers. Each activity plan includes detailed instructions, illustrations, and supplementary video explanations. These plans show how key curriculum concepts can be brought to life through hands-on projects. Teachers are encouraged to use these examples not only as blueprints but as inspiration to design their own activity plans tailored to their students' needs and interests.

The handbook also has a dedicated section on Design Thinking, a mindset and process that lies at the heart of the tinkering labs. Design Thinking rests on a fundamental belief: that everyone has the capacity to create change, regardless of how big the challenge, how small the budget, or how limited the time. I am especially proud to note that the handbook includes six inspiring case studies from ATL schools across Telangana, Andhra Pradesh, and Karnataka, where students have developed creative, practical solutions to everyday problems in their community. I hope these stories motivate our students to take on new challenges and turn their ideas into action.

I urge every teacher to engage deeply with this handbook. Encourage your students to experiment, question, and design solutions without restriction. Share your experiences, collaborate with peers, and also support your students to engage with this resource as the content in the handbook is accessible and

student-friendly, especially for those with the interest and curiosity to go further. I appreciate the hard work of all our teachers who played a key role in the design of the handbook, as well as Vigyan Ashram and UNICEF teams for their continuous support in this endeavour.

With our combined commitment and belief, let us make Telangana a model for transformative education - where every child is seen not just as a learner, but as a potential innovator, change-maker, and problem-solver. Let every school become a space where creativity, inquiry, and innovation take centre-stage.



Dr. E. Naveen Nicolas (IAS)

State Project Director

Samagra Shiksha

Telangana

Message from Atal Innovation Mission



It gives me great pride and enthusiasm to present this handbook for teachers—an essential resource developed to support the transformative work happening in Atal Tinkering Labs (ATLs) across India. At its core, the ATL initiative is not just about tools or technology—it is about cultivating a mindset. A mindset that encourages curiosity, creativity, critical thinking, and problem-solving among young learners.

This handbook is a step towards empowering teachers to seamlessly integrate the spirit of innovation into the fabric of everyday classroom learning. By linking theoretical concepts with ATL-based hands-on activities, this resource guides teachers to facilitate experiential learning that is both engaging and purposeful. With a clear structure that includes sample activity plans across STEM subjects and a foundational orientation to design thinking, the handbook equips educators to create vibrant learning experiences that go beyond textbooks.

The section on Design Thinking is particularly noteworthy—it introduces a human-centric approach to problem-solving that is essential in today's rapidly evolving world. Teachers are encouraged to use this section not just as a pedagogical tool, but as a way to inspire students to observe their surroundings, empathize with real-world problems, and develop innovative solutions with confidence and intent.

This handbook reflects our unwavering commitment to supporting educators on this journey. It is our belief that when equipped with the right tools and mindset, teachers can ignite in every child a lifelong passion for exploration and innovation.

Let this handbook be more than a guide—let it be an invitation to transform your ATL into a space where imagination thrives, questions lead to discovery, and every learner is empowered to be a change maker.

With warm regards and best wishes,

Deepali Upadhyay

Program Lead

Atal Innovation Mission, NITI Aayog

Message from UNICEF



The Atal Tinkering Laboratories (ATLs), established under the aegis of the Atal Innovation Mission (AIM) of NITI Aayog (National Institution for Transforming India Commission), represent a transformative initiative in reimagining the way children in middle and secondary grades learn. These innovative learning spaces provide students and teachers with opportunities to explore modern as well as traditional technological tools, engage in hands-on projects, and foster creativity through experiential learning. This aligns closely with the vision of the National Education Policy (NEP) 2020 and the 21st century skills framework, which are guiding schools across India in preparing children for the future.

The work done by the Departments of School Education in Andhra Pradesh, Karnataka, and Telangana to strengthen ATLs in partnership with UNICEF has yielded highly encouraging results. Teachers have responded positively to various capacity-building initiatives, delivered through both face-to-face and digital platforms, while students-girls and boys alike-have shown remarkable enthusiasm in utilizing these spaces. Several innovative ideas and examples of *design thinking in action*, some of which are presented in this handbook, have emerged from government schools in these states. A rigorous study to capture and analyse the outcomes of these initiatives is also being undertaken by UNICEF in collaboration with the respective state governments.

The Government of India's recent announcement to establish an additional 50,000 ATLs across the country is a welcome move which will help expand the reach of this innovative initiative, with one ATL catering to every three or four secondary schools and will also enable ATLs to serve as hubs for neighbouring schools that may not yet have such facilities.

This handbook has been developed as a practical resource for teachers, with the aim of supporting them in further advancing this exciting journey of tinkering, problem solving, discovery, and innovation. The handbook comprises two distinct sections:

- The first section introduces the principles and practice of *Design Thinking* in an accessible, illustrated format, enriched with case studies from government schools across Andhra Pradesh, Karnataka, and Telangana.

- The second section responds to a frequently expressed teacher concern-the need to meaningfully integrate ATL activities with the school curriculum. To this end, 40 sample activity plans are included, demonstrating how STEM (Science, Technology, Engineering, and Mathematics) concepts can be effectively reinforced through ATL resources and materials.

We believe that the implementation of these approaches and activity plans will not only provide children with engaging, but hands-on learning experiences that build their confidence, creativity, and problem-solving skills but also enhance the quality of education to enable better learning outcomes across the states.

It is my earnest hope that this handbook will complement the Government's efforts to make middle and secondary grades vibrant spaces of learning and innovation, equipping students with the skills and mindset required to contribute to the goals and aspirations of a developed nation by 2047.

With best regards,



Dr. Zelalem Birhanu Taffesse

Chief of Field Office

UNICEF Field Office for Andhra Pradesh, Karnataka and Telangana

Message from Vigyan Ashram



“Learning by doing” plays a vital role in nurturing understanding, creativity, and entrepreneurial skills in children. However, until recently, most schools lacked the necessary tools, equipment, and workshops to effectively implement this approach. The establishment of Atal Tinkering Labs (ATLs) has now made such opportunities accessible to schools.

Over the past three years, Vigyan Ashram, with the support of UNICEF and Samagra Shiksha, has conducted more than hundred online sessions for ATL teachers in Andhra Pradesh, Karnataka, and Telangana. In addition, several in-person training programs have been organized to help teachers effectively utilize ATL resources. Apart from this, we guided several schools in developing projects using the design thinking methodology to address challenges within their communities. During these programs, teachers developed projects that are useful for their classroom sessions and for their community, many of which form the basis of this manual. This manual is therefore a collaborative outcome, created in consultation with school teachers.

Tinkering extends far beyond electronics, 3D printing, coding, or mechanical projects—it is about fostering unstructured learning. Students are encouraged to explore ideas through experiments with food, waste materials, farming, biodiversity, and more. The projects compiled here are illustrative examples, intended to spark ideas and inspire teachers to guide students beyond the activities suggested. These projects serve as examples to inspire teachers about the many ways ATLs can be utilized.

In line with the National Education Policy (NEP) 2020, vocational education has been introduced from Grade 6 onwards. ATL labs provide the perfect platform for implementing vocational projects using the available tools and equipment. In fact, ATLs are not limited to STEM subjects; they are meant to support teachers across all disciplines in making their subjects more engaging and interactive.

We express our gratitude to UNICEF and the Samagra Shiksha teams of Andhra Pradesh, Karnataka, and Telangana for the continuous support they provided during the program. We look forward to many more innovative projects emerging from ATLs—projects that not only build on the examples provided here but also set new benchmarks in creativity and learning.

Dr Yogesh Kulkarni

Director

Vigyan Ashram

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Note for the Teacher

About the Handbook

This handbook has been thoughtfully designed to help you connect classroom learning with hands-on experiences for students. It enables them to visualise concepts taught in the classroom through tinkering, exploration, and innovation in the ATL.

The activity plans presented in this handbook focus on core academic subjects—Physics, Chemistry, Biology, and Mathematics—and include experiential activities.

The handbook is organised as a series of three volumes:

Volume 1: ‘Learning by Doing’ focuses on Design Thinking and equips students with problem-solving skills.

Volume 2: Provides you with activity plans for grades 6–8.

Volume 3: Provides you with activity plans for grades 9–10.

All activities are aligned with the curriculum and expected learning outcomes for each grade level.

Using the Activity Plans

The manual has been detailed in a user-friendly manner, enriched with illustrations, QR codes, web links, images, software programme codes and circuit diagrams to help you facilitate the activities at every step and guide you through the process of building and demonstrating the model. The explanation provided in the videos will help you understand how the model illustrating the concept needs to be built. This helps in reinforcing the concepts discussed in the classroom. Additionally, a glossary is provided in the Annexure to clarify key terms found within the activity plans.

Thought-provoking questions have also been provided to you at the end of each activity plan to spark meaningful discussions with your students. This will help you to assess their understanding of concepts and the project. To help you and your students explore the model further, ideas for modifications of the model have been provided to you in each activity plan. These ideas will help you and your students enhance the model and make it more interesting and applicable to everyday life situations.

Implementing the lesson plans needs to be seen as an activity involving students. This will initiate them to the world of the ATL and will help in developing the confidence needed to use the various technology tools (mechanical, electrical, electronic and software tools). This ‘learning by doing’ experience they will be valuable and is likely to contribute to their curiosity and creativity.

All activities require teamwork and coordination among students. We urge you to promote the spirit of collaboration and self-learning among students. Kindly discuss individual contributions in group settings and award each group member the badges - 'Ideator, Goal Getter, Co-Creator and Questioner to motivate students. You could use the simple explanations given below to guide you in this activity. Each student can play these various roles as part of a team.



Safety Practices in the ATL

It is important that you and your students stay safe in the ATL. This calls for practicing safety measures that the outlined below. Kindly follow them diligently.

- Ensure the work area is clean and free from hazards.
- Keep all sharp tools and small parts out of reach of younger children
- Always wear safety gloves when cutting or soldering.
- Keep the soldering station well-ventilated and away from flammable materials.
- Supervise soldering and the use of hot glue gun to avoid burns or accidents
- Handle the drill machine carefully; adult supervision is recommended.
- You and your students must wear safety goggles while drilling.
- Handle electrical components like LEDs and resistors carefully to prevent damage.
- Ensure the wires are insulated to prevent electric shocks.
- Avoid touching the metallic parts of the Arduino board while powered.
- Handle the DC motor and battery connections carefully to avoid short circuits.
- Disconnect the battery after testing to avoid overheating.

Reflections for Improvement

Discussing the models you have built with the students - that is, looking more closely at the various components you have used and the role they play in the making of the model, will help students appreciate how various materials and facilities in the ATL can be used to develop

something useful. Most importantly, these discussions will help students to understand various concepts practically. This will go a long way in deepening their learning.

The activity plans aim to strengthen the linkage between the ATL and the classroom you have with your students while teaching Physics, Chemistry, Biology and mathematics. It also creates a more positive and engaging learning environment and ensures that you are using your time and resources in the ATL effectively.

At the same time, this experience prepares your students to identify challenges around them and do something about these daily life challenges. This is where the volume on Design Thinking will help you to undertake exciting journeys in innovation.

You could keep maintain a record your thoughts, observations, and reflections to help you motivate students to constantly modify the model and innovate.

We hope that you will find these activity plans interesting and helpful in inspiring students to become innovators, thinkers, and changemakers.

Happy tinkering!!

Activity plans

Activity 1

Making a Model for Measuring Mass, Force, and Pressure Using a Load Cell



Grade

8



Subject

Physics



Topic/
Concept

Force and
Pressure

Objective

To build a model for measuring mass, force, and pressure using a load cell along with Arduino and help students understand and apply the concepts of force and pressure.

What will you help students learn?

You will reinforce the understanding of the concept of Mass, Force and Pressure by building a model to measure them using a Load Cell. In this process, students will

- Understand the relation between Mass, Force and Pressure.
- Understand the role of the HX711 ADC and its interfacing with Arduino Uno.
- Learn how to calibrate the load cell and display data on an LCD screen.
- Understand the working principle of load cells and ADC modules.

What will you build/make?

A Model for Measuring Mass, Force, and Pressure Using a Load Cell.



Measurement of Mass, Force and Pressure using Load Cell and Arduino Uno



<https://youtu.be/SBv44FnUFUc>

Click the link or scan QR code to watch DIY cum working video of the project.

What will you need?

Materials Needed

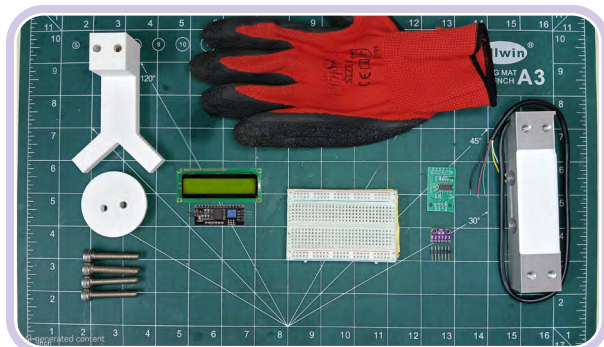
- Arduino Uno
- Small breadboard
- HX711 ADC module (To convert the analog signal from the load cell into a digital format for the Arduino)
- Load cell (40 kg or appropriate for weight measurement)
- 3D printed parts for mounting Load cell. (Link to download the STL file is provided in the subsequent part of the activity plan)
- 12V DC adapter
- 16x2 LCD screen
- I2C connector for LCD
- Foam board for mounting the entire project
- Connecting wires

ATL Tools/Equipment

- Soldering kit- gun, stand, metal, flux, fume extractor
- Hot glue gun with glue sticks
- Multimeter
- Precision screw driver
- Wire cutter/stripper

Software/Application

- Arduino IDE to write, compile, and upload code to the Arduino Uno.



Procedure

Please Note: Meanings of words in the activity plan you may want to know are given in the Annexure

1. Download the STL files for Load Cell Mounting Bracket and Top Plate:

- Click on the link or scan QR code and download the STL file for Load Cell Mounting Bracket (Base) and Top Plate.
- 3D print these two parts. You will be using them in subsequent steps.

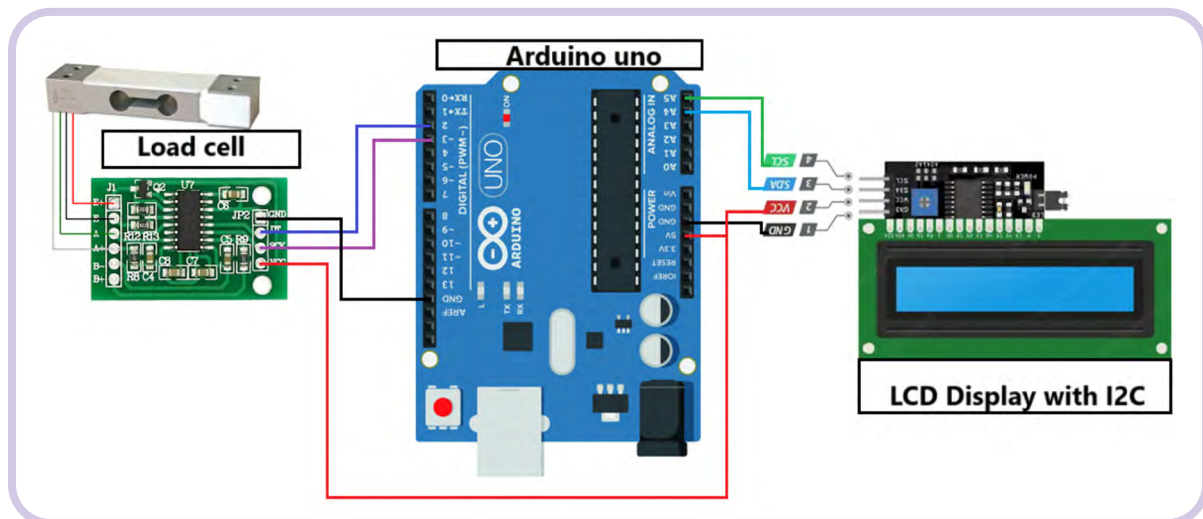


<https://tinyurl.com/3znb872x>

2. Setting Up the Mounting Board:

- Secure the foam board on a flat surface.
- Assemble the load cell on the 3D printed mounting bracket as shown in the video.
- Fix the mounting bracket to the foam board using hot glue. Ensure it is firmly mounted for stable measurements.
- Mount the small breadboard and Arduino Uno to the foam board.
- Mount HX711 module on the breadboard as shown in the circuit diagram.

3. Connecting the Components:



- Connect the load cell to the HX711 module using the labelled wires through soldering the joints.
- Connect the HX711 to the Arduino Uno as follows:

- o VCC → 5V
- o GND → GND
- o DT → Pin D2
- o SCK → Pin D3
- Connect the 16x2 LCD screen to the Arduino Uno using the I2C connector.
 - o SDA → A4
 - o SCL → A5
- Connect the 12V DC adapter to the Arduino Uno to power the circuit.

4. Download the Required Libraries and Install on them Computer:

- Click on the link or scan QR code to download the required Arduino libraries.
- Install required Arduino libraries as per the step-by-step instructions given in the video. Click on the link or scan QR code to watch the video.



<https://tinyurl.com/4zsf6ayc>



https://youtu.be/ZD7kTV7-_qk

5. Programming the Arduino:

- Write and upload the code for the load cell to measure mass and convert it into force and pressure.

```
#include <HX711_ADC.h> // Include HX711 library
#include <Wire.h>
#include <LiquidCrystal_I2C.h>
#define DT 2 // Data pin
#define SCK 3 // Clock pin
HX711_ADC LoadCell(DT, SCK); // Initialize HX711
LiquidCrystal_I2C lcd(0x27, 20, 4);
const float GRAVITY = 9.8; // Acceleration due to gravity (m/s^2)
const float AREA = 0.005; // Surface area in square meters (example: 10 cm^2 = 0.01 m^2)
void setup() {
  Serial.begin(9600);
  Serial.println("Initializing Load Cell...");
  // Initialize the HX711
  LoadCell.begin(); // Start HX711 connection
```

Continue...

Continue...

```
LoadCell.start(2000);          // Stabilize for 2 seconds
LoadCell.setCalFactor(108.5); // Calibration factor (adjust for your setup)
Serial.println("Load Cell Initialized.");
lcd.init();                    // Initialize the LCD
lcd.backlight();
}

void loop() {
  LoadCell.update(); // Retrieve data from the load cell
  float weight = LoadCell.getData(); // Get the weight in grams
  float weight_kg = weight / 1000.0; // Convert grams to kilograms

  float force = weight_kg * GRAVITY; // Calculate force in Newtons
  float pressure = force / AREA;     // Calculate pressure in Pascals
  // Display values on Serial Monitor
  Serial.print("Weight: ");
  Serial.print(weight);
  Serial.print(" g, Force: ");
  Serial.print(force);
  Serial.print(" N, Pressure: ");
  Serial.print(pressure);
  Serial.println(" Pa");
  // Display values on LCD
  lcd.setCursor(0, 0);
  lcd.print("W:");
  lcd.print(weight);
  lcd.print("g");
  lcd.setCursor(9, 0);
  lcd.print("F:");
  lcd.print(force);
  lcd.print("N");
  lcd.setCursor(0, 1);
  lcd.print("P:");
  lcd.print(pressure);
  lcd.print("Pa");
  delay(300);
  lcd.clear();
}
```

- Alternatively, you can click the link or scan QR code to download the code .ino file.
- Include calibration steps in the code to ensure accurate readings.



<https://tinyurl.com/ycyhbzbch>

6. Calibrating the Load Cell:

- Click on the link or scan QR code to learn how to calibrate the load cell.
- Place known weights on the load cell to calibrate it. Do not apply excessive force on the load cell as it may damage the sensor.
- Adjust the calibration factor in the code to match the actual weights.
- Use the multimeter to verify the voltage levels at the HX711 module.
- The voltage must be in 5V.



<https://tinyurl.com/bd9ykkja>

7. Testing and Troubleshooting:

- Test the model by placing different weights on the load cell.
- Ensure the mass, force, and pressure values are displayed correctly on the LCD screen.
- Use a precision screwdriver to adjust the LCD brightness, if necessary.

8. Finalizing the Model:

- Secure all components using hot glue for stability.
- Double-check all connections and ensure proper insulation of wires.

How does the Model work?

- Click on the link or scan QR code to demonstrate this project to the students.



<https://tinyurl.com/mufv7wr4>

How can you assess students' understanding?

Assessment of Concept Understanding

Conduct a quick Q&A session to evaluate their understanding of Mass, Force, and Pressure

Assessment of Project Understanding

Observe and assess the students' ability to follow the procedure and correctly assemble and operate the set up.

- Evaluate the understanding of the working principle of the project for measuring mass, force, and pressure using a load cell.
- Check for the quality of circuit connections, creativity and accuracy in assembling the model.
- Verify the accuracy of mass, force, and pressure measurements.
- Assess their understanding of the working of the Mass, Force, and Pressure Measuring Model Using a Load Cell.
 - o What is the role of the HX711 module in this project?
 - o How does a load cell convert weight into an electrical signal?
- Show them the day-to-day applications of this project- Weighing scales.



<https://youtu.be/fMRywV2N9G4?si=Vojjcy-l7zzBboOC>

Click the link or scan QR code to know more.

Assessment of Teamwork

Discuss individual contributions in group settings and award each group member the badges - 'Ideator, Goal Getter, Co-Creator and Questioner (*Rubric for this is provided in the note for the teacher*) based on their involvement in the project.

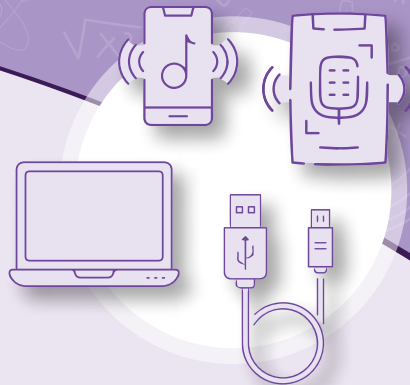
Design Thinking/Extensions and Modifications?

Ask students the following questions and elicit answers from them. Some questions you can ask them and encourage them to think are given for your reference.

1. Can you think of some real-life scenarios where this concept can be applied?
2. How can you modify this model?
 - Try adding a buzzer to sound an alarm when a certain mass threshold is exceeded.
 - You can integrate a Wi-Fi module to transmit data wirelessly to a remote device.

Activity 2

Building a Decibel Meter with Sound-Sensitive LEDs using Arduino



Grade



6, 7



Subject



Physics



Topic/
Concept



Sound

Objective

To reinforce the understanding of 'sound as energy' by building a decibel meter and record sound levels/intensity through different activities.

What will you help students learn?

You will reinforce the understanding of the concept of 'sound as energy' and understand how it is measured in decibels, by building a decibel meter. In this process, students will:

- Learn basic Arduino programming and sensor interfacing, using electronics and coding.
- Think about solutions for smart automation (e.g., smart home systems like sound-activated lighting or alarms, security alarms, interactive art installations.).
- Be introduced to real-world applications such as noise monitoring systems, sound-sensitive devices, and audio engineering.

What will you build/make?

Sound-sensitive LED system that measures the sound intensity in decibels using Arduino and displays the sound levels on OLED screen.

What will you need?

Materials Needed

- Arduino Uno, Sound sensor module (e.g., KY-037 or similar)
- LEDs (multiple colours), Resistors (220 Ω for LEDs) (Optional)
- Jumper cables



<https://youtu.be/5FXdrn1PFGU>

Click on the link or scan QR code to watch working videos of the project.

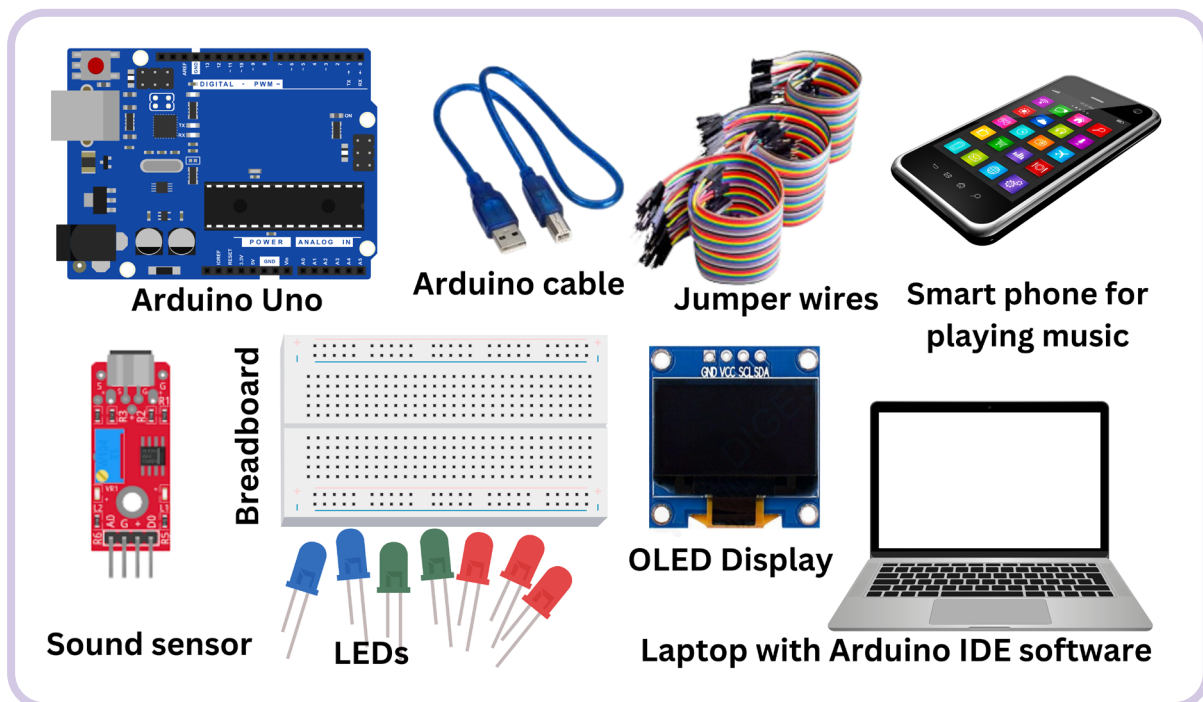
- Breadboard
- OLED display module (e.g., 0.96-inch I2C)
- USB cable (for Arduino programming) to upload code from the computer to the Arduino

ATL Tools/Equipment

- Computer with Arduino IDE installed
- Soldering kit- gun, stand, metal, flux, fume extractor (optional, if connections need to be soldered)
- Multi-meter (optional, for testing connections)
- Screwdriver (if needed for adjustments)

Software/Application

- Arduino IDE



Procedure

Please Note: Meanings of words in the activity plan you may want to know are given in the Annexure

1. Introduction:

- Briefly explain/revise the idea of sound intensity and its measurement in decibels.
- Introduce Arduino and its use in interfacing sensors and LEDs.

- Explain how a sound sensor detects audio signals, such as claps or noise, and sends an electrical signal to the Arduino, which then processes the input to trigger an appropriate response. Click the link of scan QR code to watch the video to learn how sound sensors work.



<https://www.youtube.com/watch?v=c3T22y4c0rU>

2. Setting Up the Sound Sensor:

- Connect the sound sensor to the Arduino:
 - o VCC to 5V
 - o GND to GND
 - o Signal pin to A0 (analog input)

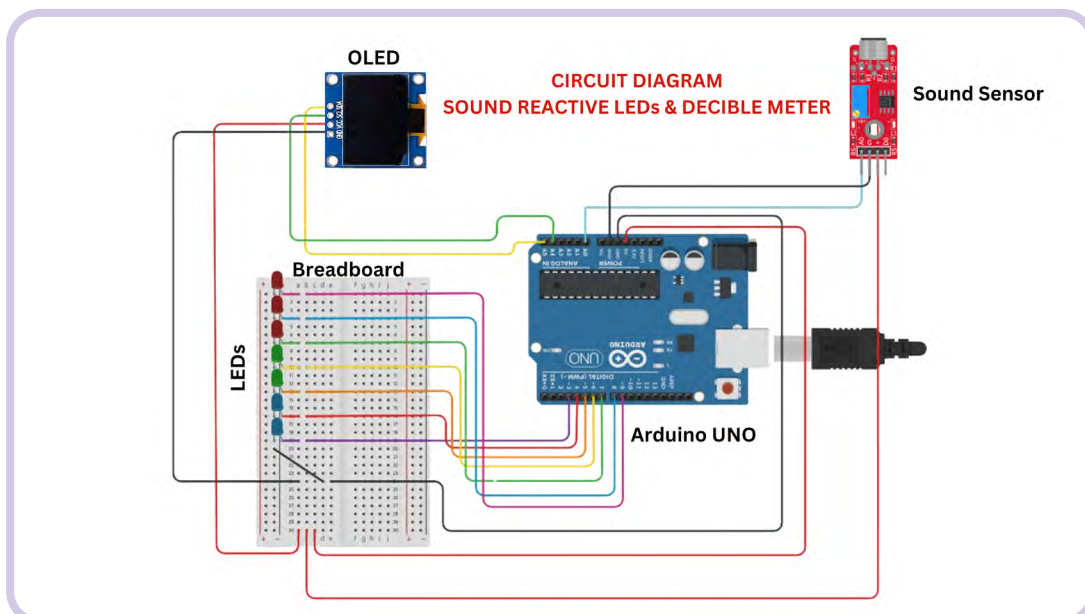
3. Connecting the LEDs:

- Place the LEDs on the breadboard.
- Connect the cathode (shorter leg) of each LED to the ground rail of the breadboard.
- Connect the anode (longer leg) to a 220 Ω resistor and then to digital pins on the Arduino (e.g., D2, D3, D4).

4. Connecting the OLED Display:

- Connect the OLED to the Arduino using I2C:
 - o VCC to 5V
 - o GND to GND
 - o SDA to A4
 - o SCL to A5

Circuit Diagram



5. Writing the Arduino Code:

- Open Arduino IDE and install the necessary libraries (e.g., Adafruit SSD1306 for the OLED and Adafruit GFX Library).
- Write or upload code to:
 - Read sound intensity from the sensor.
 - Display the decibel level on the OLED screen.
 - Light up LEDs based on sound levels.

5.1 Code:

```
#include <Adafruit_GFX.h>
#include <Adafruit_SSD1306.h>

// OLED Display Settings
#define SCREEN_WIDTH 128
#define SCREEN_HEIGHT 64
#define OLED_RESET -1
Adafruit_SSD1306 display(SCREEN_WIDTH, SCREEN_HEIGHT, &Wire, OLED_RESET);

// Pin Definitions
const int soundSensorPin = A0; // Sound sensor connected to A0
const int ledPins[] = {3, 4, 5, 6, 7, 8, 9}; // LED pins
const int numLeds = 7;
// Maximum sensor reading and sound intensity threshold
const int maxLimit = 1023; // Maximum possible analog value from the sensor
const int soundThreshold = 200; // The threshold increment (for each 100 sensor value)

// Function to turn off all LEDs
void turnOffAllLeds() {
  for (int i = 0; i < numLeds; i++) {
    digitalWrite(ledPins[i], LOW);
  }
}

// Setup function
void setup() {
  // Initialize LED pins as outputs
  for (int i = 0; i < numLeds; i++) {
    pinMode(ledPins[i], OUTPUT);
  }
}
```



```

// Initialize Serial Communication
Serial.begin(9600);
// Initialize OLED Display
if (!display.begin(SSD1306_SWITCHCAPVCC, 0x3C)) {
    Serial.println(F(" OLED initialization failed! "));
    while (true); // Stop if OLED is not found
}
display.clearDisplay();
display.display();
}
// Main loop function
void loop() {
    // Read the sensor value
    int sensorValue = analogRead(soundSensorPin);
    // Print the sensor value
    Serial.print("Sound Sensor Value: ");
    Serial.println(sensorValue);
    // Check if the reading exceeds the maximum limit
    if (sensorValue > maxLimit) {
        Serial.println("Reading exceeds maximum limit! Turning off all LEDs.");
        turnOffAllLeds();
        updateOLED(sensorValue, -1); // Update OLED with no active LED
        delay(500);
    }
    return;
}
// Calculate the number of LEDs to light up
int activeLeds = sensorValue / soundThreshold;
// Update LEDs based on the activeLeds count
updateLeds(activeLeds);
// Update the OLED display with the current sensor value and active LEDs
updateOLED(sensorValue, activeLeds);
delay(100); // Stabilization delay
}
// Update LEDs function
void updateLeds(int activeLeds) {
    // Turn off all LEDs first
    turnOffAllLeds();
    // Turn on LEDs up to the activeLeds count
    for (int i = 0; i < activeLeds; i++) {
        digitalWrite(ledPins[i], HIGH);
    }
}

```



```

// If any LEDs are active, print the active LED count
if (activeLeds > 0) {
    Serial.print(" Active LEDs: ");
    Serial.println(activeLeds);
}
}

// Update OLED function
void updateOLED(int sensorValue, int activeLeds) {
    display.clearDisplay();
    // Display Sound Intensity Value
    display.setTextSize(1);
    display.setTextColor(SSD1306_WHITE);
    display.setCursor(0, 0);
    display.print("Sound Intensity: ");
    display.println(sensorValue);
    // Display Active LEDs
    display.print(" Active LEDs: ");
    if (activeLeds > 0) {
        display.println(activeLeds);
    } else {
        display.println(" None");
    }
}

// Draw Bar Graph
int barWidth = map(sensorValue, 0, maxLimit, 0, SCREEN_WIDTH);
display.fillRect(0, 20, barWidth, 10, SSD1306_WHITE);
// Display the updated content
display.display();
}

```

5.2 Click the link or scan QR code to download the Arduino Code:



<https://tinyurl.com/3wakxzda>

5.3 Click the links or scan QR codes to download and install the Arduino libraries

1. Adafruit_GFX.h



<https://tinyurl.com/83myeasw>

2. Adafruit_SSD1306.h



<https://tinyurl.com/583hydhp>

- Click the link or scan QR code to know how to install the libraries in your Arduino IDE.



<https://youtu.be/wmNMJu9yU-w>

5.4 Testing the system:

- Power the Arduino and observe the OLED display showing decibel levels.
- Test the LEDs by clapping or speaking near the sound sensor and see which LEDs are turning ON and verify the sound intensity in the display.

5.5 Exploring and Troubleshooting:

- Adjust the sensitivity of the sound sensor, if needed.
- Check the connections if the components do not function as expected.

How does the Decibel Meter Model work?

The Decibel Meter with Sound-Sensitive LEDs project works by using an Arduino Uno, a sound sensor, an OLED display, and LEDs to measure sound intensity and visually represent different sound levels.

1. Sound Detection:

- The sound sensor (e.g., KY-037) detects ambient noise and converts the sound waves into an analog electrical signal.
- This signal is sent to the Arduino's analog input (A0) for processing.

2. Data Processing & Decibel Calculation:

- The Arduino reads the analog values from the sensor and maps them to decibel (dB) levels.
- The converted dB values are then displayed in real-time on the OLED screen.

3. LED Response to Sound Intensity:

- Based on the sound intensity, the LEDs light up in different patterns.

4. Visual and Interactive Feedback:

- The OLED display continuously updates with the measured sound levels in dB.
- LEDs react dynamically to changing sound levels, allowing users to see the effect of different noise intensities.

How can you assess students' understanding?

Assessment of Concept Understanding

- How does sound travel?
- How is sound measured? / What is the unit of sound?
- Show them the day-to-day applications of this project (example: the sound meter application in mobile phones).



https://youtu.be/O1vhauINVH0?si=Sjm_zIynQy4G04O



<https://play.google.com/store/apps/details?id=com.gamebasic.decibel>

Click the links or scan QR codes to know more

Assessment of Project Understanding

- Observe and assess the students' ability to follow the procedure and correctly assemble and operate the set up.
- Assess whether the circuit works correctly lights up compatible LEDs
- Evaluate students' understanding of the decibel meter and the circuit design.
- Check for creativity and accuracy in assembling the model.
- Conduct a quick Q&A session to evaluate their understanding of the working of the Decibel Meter.
 - o How does the sound sensor measure sound intensity in decibels (dB)?

- o How does the sound sensor detect and convert sound waves into an electrical signal? Does this prove that 'sound is a form of energy'?
- o Why do the LEDs react differently to varying sound levels?
- o Why do we need resistors in the circuit for LEDs?
- Observe the functionality of the project during testing and analyze its accuracy.

Assessment of Teamwork

Discuss individual contributions in group settings and award each group member the badges - 'Ideator, Goal Getter, Co-Creator and Questioner based on their involvement in the project.
(Rubric for this is provided in the note for the teacher)

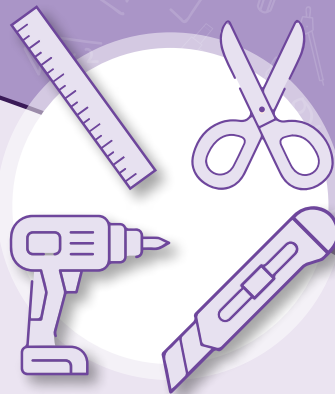
Design Thinking/Extensions and Modifications

Ask students the following questions and elicit answers from them. Some questions you can ask them and encourage them to think are given for your reference.

1. Can you think of some real-life scenarios where this concept can be applied?
2. How can you modify this model?
 - You can use RGB LEDs to create colourful sound-sensitive lighting.
 - Implement thresholds to trigger an alert system on the OLED.
 - Can a buzzer be added to indicate high sound levels? Try it out!

Activity 3

Constructing a Pantograph: Understanding Simple Machines



Grade

6, 7



Subject

Physics



Topic/
Concept

Simple
Machines

Objective

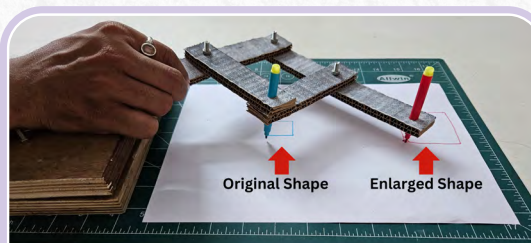
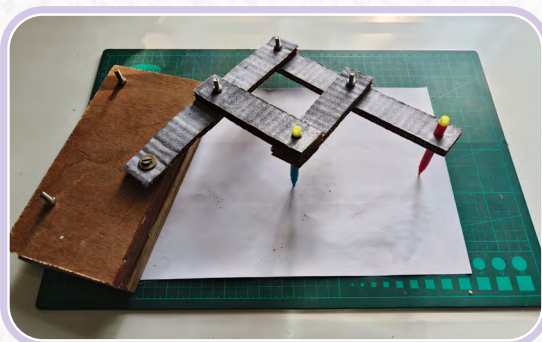
To enable students to understand the mechanics of levers and the process of scaling by constructing a Pantograph.

What will you help students learn?

- Understand the working principle of 'lever' as a simple machine.
- Understand how pantographs work to replicate and scale images.
- The practical applications of levers in daily life.

What will you build/make?

In this activity, students will build a functional cardboard pantograph mechanism – a simple mechanical device used to trace and scale drawings. By assembling a series of linked cardboard strips connected with screws and nuts, students will create a movable linkage system that allows them to enlarge or reduce shapes drawn on paper.



Pantograph – A simple machine that can be used to trace and scale drawings

Click the link or scan QR code to watch DIY cum working video of the project.



<https://youtu.be/SUcUY8utOzE?feature=shared>

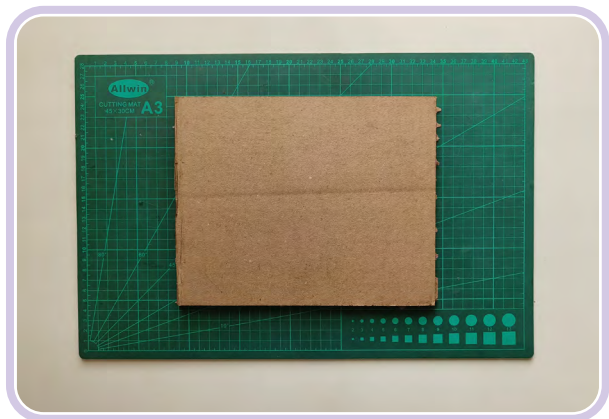
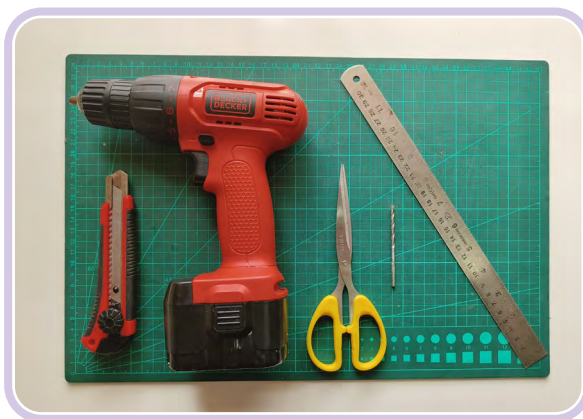
What will you need?

Materials Needed

- Pantograph Template (Link to download the template is given in the procedure)
- Cardboard/Foam Board
- Scale/Ruler
- Scissors
- Cutter Blade
- Wooden Base (Used at the pivotal point as a support to enhance the stability, accuracy, and durability of the pantograph.)
- A4 Sheets
- Pencils/Markers
- Paper glue

ATL Tools/Equipment

- Battery Operated Drill
- Drill Bits (6-8 mm)
- Nuts and Bolts (M6-M8)
- Washers



Procedure

Please Note: Meanings of words in the activity plan that you may want to know are given in the Annexure

1. Introduction:

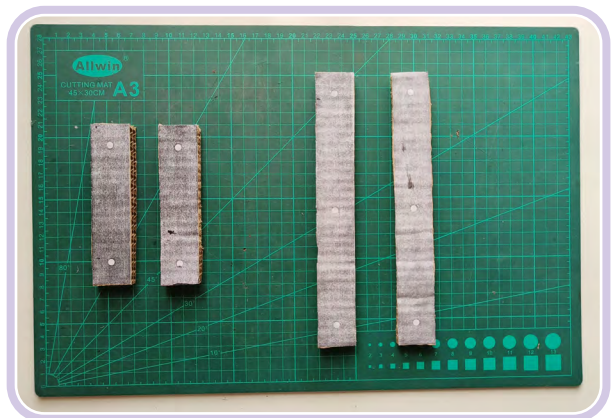
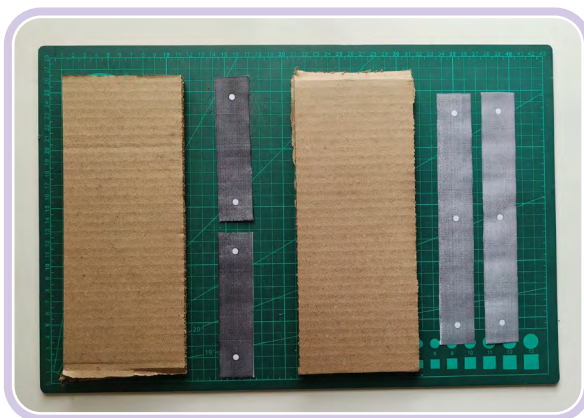
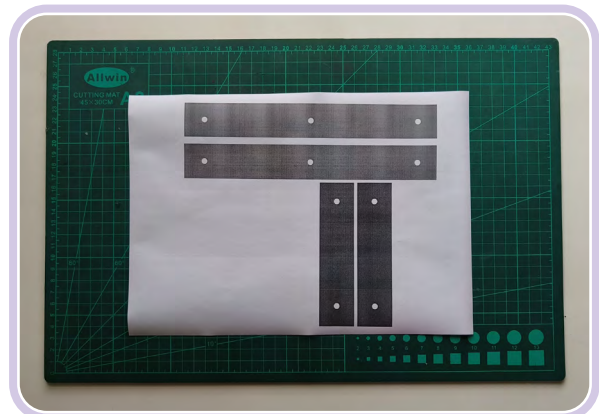
- Explain- A pantograph is a simple machine that operates using a system of levers and linkages to copy, enlarge, or reduce drawings. It consists of four rigid arms connected by pivot points, forming a parallelogram.
- Show an example (video or image) of a working pantograph.

2. Prepare Arms/Strips using a Foam Board/Thick Cardboard:

- Click the link or scan QR code to download the template.
- Paste the printed template on cardboard using glue and cut the required strips.
- You can also make these strips by marking and cutting out 2 sets of strips from a foam board/cardboard using the dimensions given below:
 - 2 pieces of length = 12.5 cm and width = 3 cm
 - 2 pieces of length = 22 cm long and width = 3 cm



<https://tinyurl.com/mr36h5pw>

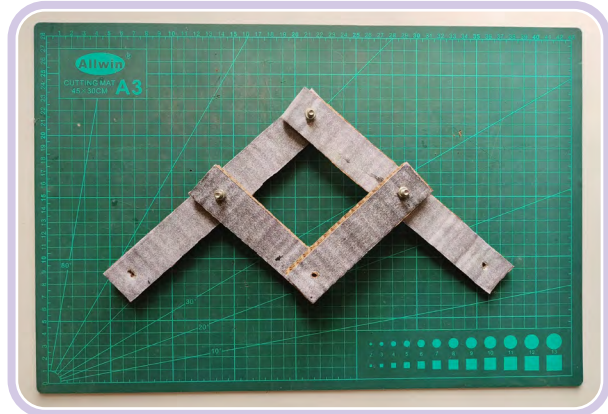
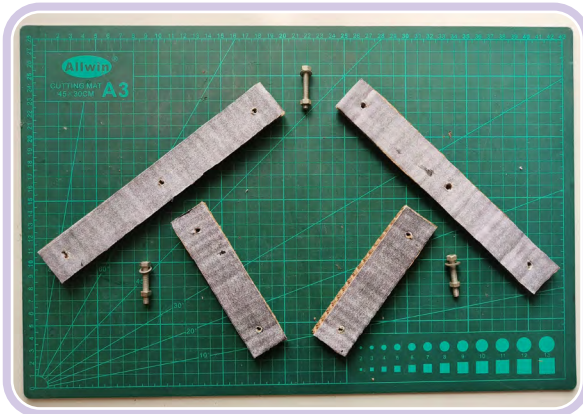


3. Drill Holes for Connections:

- Mark drill points on each strip as per the template.
- Carefully drill holes at these points.

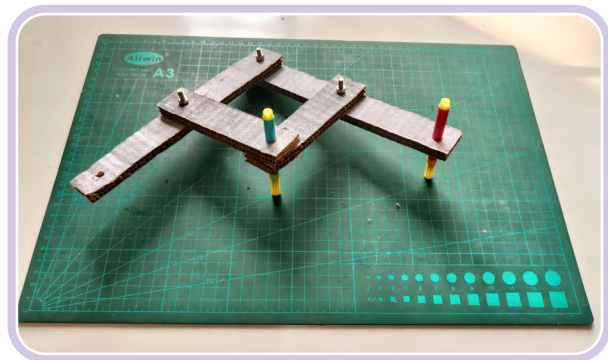
4. Assemble the Frame:

- Lay the two longer strips in a crisscross fashion to form an inverted "V".
- Secure them with a screw and nut at the intersection, leaving enough slack for movement.
- Attach the remaining strips in the middle of the "V" to form a parallelogram using screws and nuts as shown in the image.



5. Install the Pencil and Pointer:

- Attach a pencil to one corner of the parallelogram (this will be the drawing end).
- Attach another pencil or pointer (you can use a pencil without lead as a pointer) as shown in the image.

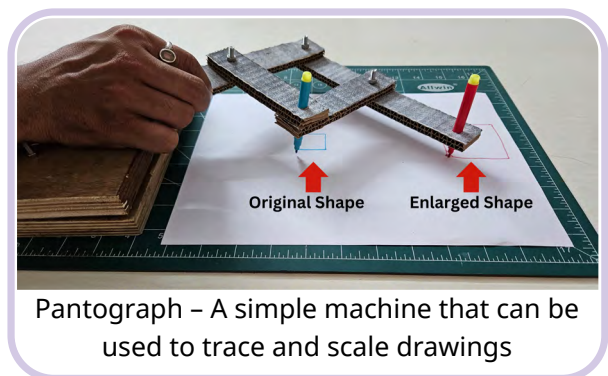


6. Mounting the Mechanism:

- Place one end of the pantograph on a wooden block to fix it as a pivotal point.
- Place the pantograph on a sheet of paper.

7. Testing the Mechanism and Making Adjustments:

- Use the pointer to trace an image and observe the pencil replicate the motion. The new image drawn by the pencil may be large or small based on the set up.



How does the Pantograph Model work?

How Pantograph Works as a Simple Machine:

- **Levers in Action:**
 - Each arm acts as a lever, transmitting motion from one point to another.
 - The pivot points act as fulcrums, allowing rotation and movement.
- **Movement Transmission:**
 - When the tracing arm traces a shape, the linked arms move in coordination.
 - The motion is transferred through the pivot points, guiding the drawing arm to replicate the image.
- **Scaling Effect and Mechanical Advantage:**
 - By adjusting the position of the pivot points, the pantograph can either enlarge or reduce the copied image.
 - The ratio of enlargement depends on the placement of the fixed pivot relative to the tracing and drawing arms.
- **Energy Transfer:**
 - A small movement at the tracing arm results in a proportional movement at the drawing arm.
 - No additional force is required—just the motion of the user's hand guides the system.

How can you assess students' understanding?

Assessment of Concept Understanding

- What is a simple machine?
- What are the types of levers and how are they different from each other?
- What is fulcrum?
- How do the principles of levers apply to the pantograph mechanism?

Assessment of Project Understanding

- Observe and assess the students' ability to follow the procedure and correctly assemble and operate the set up.
- Evaluate students' understanding of the Pantograph.
- Check for creativity and accuracy in assembling the model.
- Conduct a quick Q&A session to evaluate their understanding of the working of the pantograph.

- o How does the pantograph scale drawings?
- o What adjustments can be made for more precision?
- o How does the placement of the pencil and pointer affect scaling?
- o What are some real-life applications of pantographs (e.g., engraving machines, drafting)?
- Observe if students can construct a functional pantograph.
- Observe the functionality of the pantograph during testing and analyze its accuracy.
- Ask- Where have you seen this application being used around you?
- Show them the day-to-day applications of this project- Pantographs used for magnifying sketches.



<https://youtu.be/255PSG4KeyE?si=jB8FBsxHOPaNe9dN>

Click the link or scan QR code to know more

Assessment of Teamwork

- Discuss individual contributions in group settings and award each group member the badges - 'Ideator, Goal Getter, Co-Creator and Questioner based on their involvement in the project. (*Rubric for this is provided in the note for the teacher*)

Design Thinking/Extensions and Modifications

Ask students the following questions and elicit answers from them. Some questions you can ask them and encourage them to think are given for your reference.

1. Can this model be used in real-life applications?
2. How can you modify this model?
 - You can modify the pantograph to explore different scaling ratios by changing the dimensions of the strips. Try it out!.
 - Add weights or tension adjustments using rubber bands and check if the movement is smoother.
 - You can try tracing different shapes or letters using the Pantograph.

Activity 4

Making an Air Powered Car



Grade

7



Subject

Physics



Topic/
Concept

Force, Pressure,
Motion

Objective

To apply principles of thrust and motion to construct an Air Powered car and demonstrate Newton's 3rd law of motion.

What will you help students learn?

- Understand Newton 3rd law of motion.
- Understand the transformation of energy - Potential energy to Kinetic Energy
- Understand the basic principles of propulsion/thrust and motion.
- Appreciation for recycling and reducing waste.

What will you build/make?

A car powered by air and built using recycled materials.



<https://youtu.be/sad1o7Ksrv4?si=eHou7DxoIPKWEHUh>

Click the link or scan QR code to watch
DIY cum working video of the project.

What will you need?

Materials Needed

- Empty plastic bottle (medium size- For the body of the car)
- Balloon (1)
- Levelling pipe (transparent water pipe) 8 mm diameter x 10 cm length (1)
- Paper straws (2)
- Plastic bottle caps (4)
- Bamboo skewers (2)
- Rubber bands (optional)
- 3D printing parts (Optional)

ATL Tools/Equipment

- Hot glue gun and glue sticks
- Scissors
- Craft knife (adult supervision required)
- Ruler
- Marker
- Hand Drill
- 3D printer and PLA filament (Optional)



Procedure

Please Note: Meanings of words in the activity plan you may want to know are given in the Annexure

1. Prepare the Body of the Car:

- Clean and dry the plastic bottle.
- Measure 4-5 cm from the bottom surface of the bottle and mark the point on the surface of the bottle using a marker.
- Make a hole on the marked spot on the surface of the bottle (diameter 8 mm) using a hand drill.
- Make another hole at the bottom of the bottle, exactly at the centre.
- Both these holes will be used to insert a levelling pipe (transparent pipe) that will be used as a balloon nozzle and for the airflow.

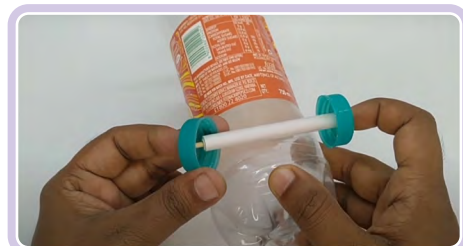
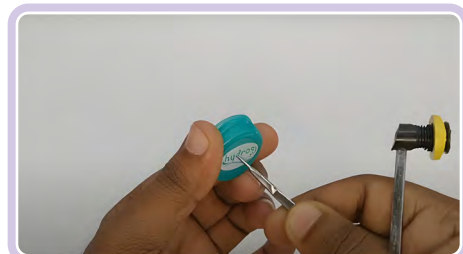


<https://tinyurl.com/4pry54fm>

Note: You can also make a 3D Printable car body. Click the link or scan QR code to download the .stl file.

2. Create the Axles and Wheels:

- Take two pieces of a paper straw of length measuring approximately a little more than the diameter of the bottle you have used.
- Insert bamboo skewers through these two straw pieces to create axles. Length of the skewers should be 10 mm more than the length of the straw you just cut.
- Poke small holes at the centre of the bottle caps, Push the bottle caps on both ends of the skewers. The caps now function as wheels. Secure the caps on the skewers using hot glue. Ensure the wheels can spin freely.



<https://tinyurl.com/bnkvn3h9>



<https://tinyurl.com/3pyhbasp>

Note: You can also make a 3D Printable 3D Printable axle and wheels. Click the links or scan QR codes to download the .stl files.

3. Attach the Propulsion System:

- Cut a levelling pipe to an approximate length of 10 cm. Insert it through the holes made on the top and bottom of the bottle. Glue the pipe securely near the holes. Ensure it aligns with the bottle's direction.
- Stretch the balloon and attach it to one end of the pipe. Use a rubberband to secure it tightly if needed



4. Secure All Components:

- Use hot glue to fix any loose components, ensuring the structure is stable.
- Check if the wheels roll smoothly and the pipe is positioned to expel air directly behind the car.



5. Testing the Air Powered Car:

- Inflate the balloon through the levelling pipe and pinch it to prevent air from escaping. Place the car on a flat surface and release the balloon. Observe the car's movement.

How does the Air Powered Car work?

The Air-Powered Car works by using the potential energy stored in the inflated balloon to move the car forward. The air rushing out of the balloon creates an equal and opposite reaction, pushing the car forward.

How can you assess students' understanding?

Assessment of Concept Understanding

- What does Newton's 3rd law of motion state?
- Can you give some examples in daily life where Newton's 3rd law of motion can be applied?
- Show them the day-to-day applications of this project-

Motorboat
propulsion



<https://youtu.be/RxvjXXuApAY?si=S7-WkSlmEu7xZSbt>

Bouncy ball,
Riding a bike



https://youtu.be/JGO_zDWmkvk?si=v7iivKsTxfpvMaF

Jet engines, Swimming,
Jumping on the ground



<https://youtu.be/mO1qtmFee-k?si=JmEPpt0PWs2Qf6ps>

Click the links or scan QR codes to know more.

Assessment of Project Understanding

- Observe and assess the students' ability to follow the procedure and correctly assemble and operate the set up.
- Evaluate students' understanding of how the Air Powered Car works.
- Observe and assess the functionality of the project during testing (Does it work as expected?).
- Conduct a quick Q&A session to evaluate their understanding of the working of the air powered car.
 - How does the balloon's air create propulsion?
 - What changes could improve the car's speed or distance?
 - How do friction and alignment affect the car's movement?

Assessment of Teamwork

Discuss individual contributions in group settings and award each group member the badges - 'Ideator, Goal Getter, Co-Creator and Questioner based on their involvement in the project.
(Rubric for this is provided in the note for the teacher)

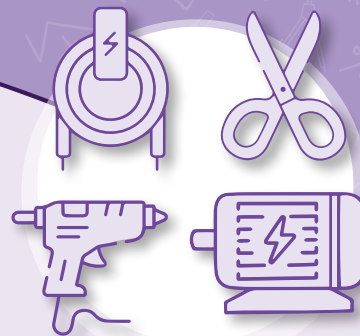
Design Thinking/Extensions and Modifications

Ask students the following questions and elicit answers from them. Some questions you can ask them and encourage them to think are given for your reference.

1. Can you think of some real-life scenarios where this concept can be applied?
2. How can you modify this model?
 - Experiment with different bottle sizes and shapes.
 - You can use larger or smaller balloons to observe changes in propulsion.
 - Vary the amount of air blow in the balloon and compare the change in propulsion
 - What will happen if you add a second balloon? Does the speed of the car change? Try it out!

Activity 5

Making a DIY model of Newton's Disc



Grade

7



Subject

Physics



Topic/
Concept

Dispersion
of Light

Objective

To help students understand the fundamentals of optics and electricity by making an electrically operated Newton's Disc.

What will you help students learn?

- To describe how spinning motion can create optical illusions and blend visual information.
- To understand that white light is composed of a combination of various colors (VIBGYOR).
- To explain the concept of additive color mixing or blending and how it relates to the science of optics.
- To explain the principle of dispersion of light, where the light splits into its constituent colors.
- To understand that these colors can recombine to form white light.

What will you build/make?

A working model of Newton's Disc to demonstrate dispersion of light.



Newton's Disc- Before spinning



Newton's Disc- After spinning

Click the links or scan QR codes to watch DIY cum working video of the project.



<https://youtu.be/30wpy37Ta30>



<https://www.youtube.com/watch?v=RyRONHjfNPY>

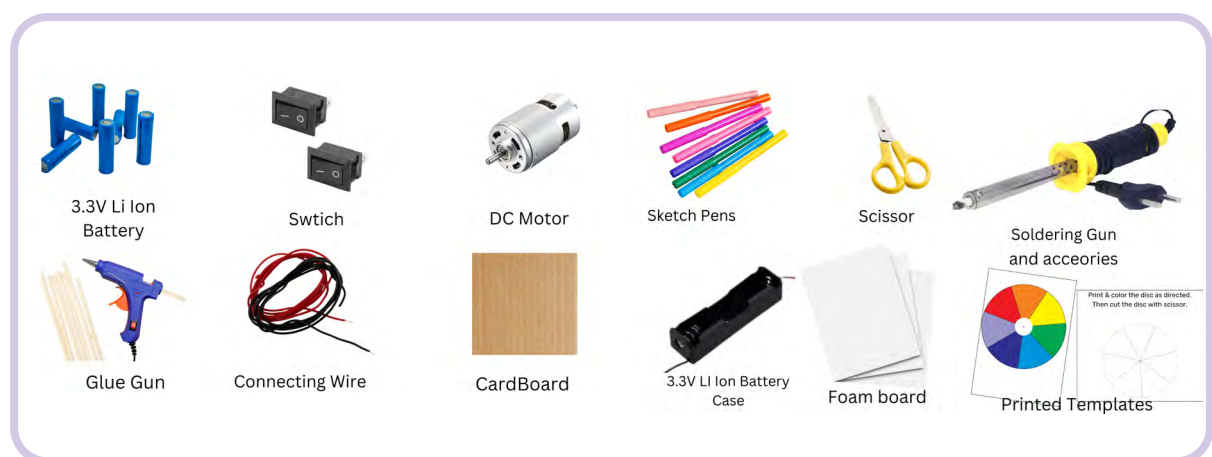
What will you need?

Material and components

- Printable templates for Newton's Disc (Link to download the template is given in the procedure)
- Foam board
- Cardboard
- Ribbon cables (as conductive medium for circuit)
- Two 3.7V Li-ion batteries with battery holder
- Rocker switch(to control the power supply to the motor)
- DC motor
- Paper glue

ATL Tools/Equipment

- Soldering kit- gun, stand, metal, flux, fume extractor
- Wire stripper
- Multimeter
- Hot glue gun with sticks
- Scissors
- Paper cutter
- Cutting mat
- Hand gloves
- Colored sketch-pens (VIBGYOR)- Optional



Procedure

Please Note: Meanings of words in the activity plan you may want to know are given in the Annexure

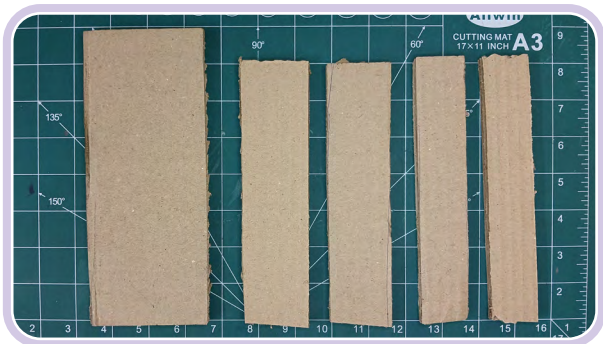
1. Prepare and Assemble the Base and Stand:

- **Base and Stand Preparation:**

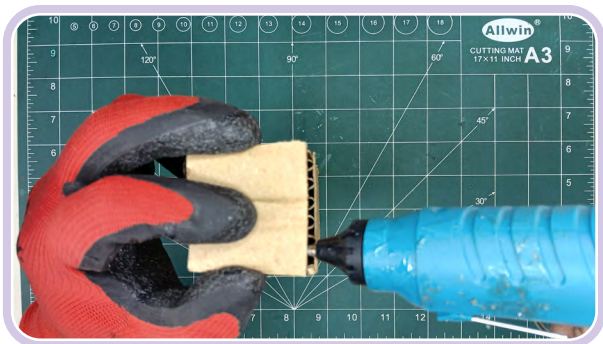
- Cut a rectangular piece of cardboard (20 cm x 8 cm) to serve as the base. This will provide stability for the setup.

- **Stand Construction:**

- Cut 4 rectangular pieces (15 cm x 4 cm) to create the stand.



- Apply glue along the sides of the plates that are cut for creating a stand.
- Cut one square plate (4.5 cm x 4.5 cm) from the cardboard.
- Attach this square plate on the top side of the stand using a glue gun as shown.



- Apply glue along the bottom edges of the stand and carefully align it vertically in the center of the base.
- Hold it in place for a few seconds to ensure a secure bond.



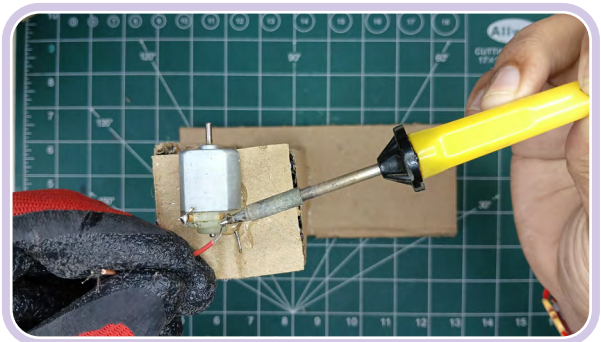
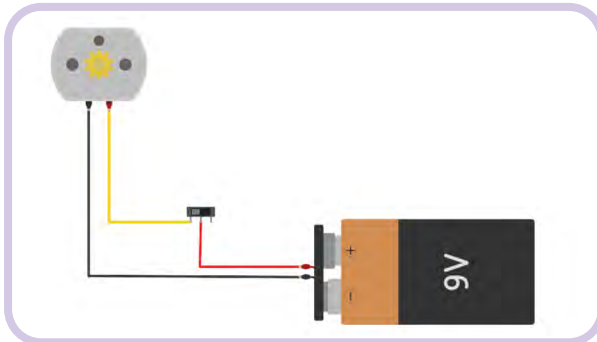
2. Mount the DC Motor on Stand and Solder Connections:

- Attach the DC motor to the top of the cardboard stand with hot glue.
- Ensure the motor's shaft is aligned and stable for smooth rotation.

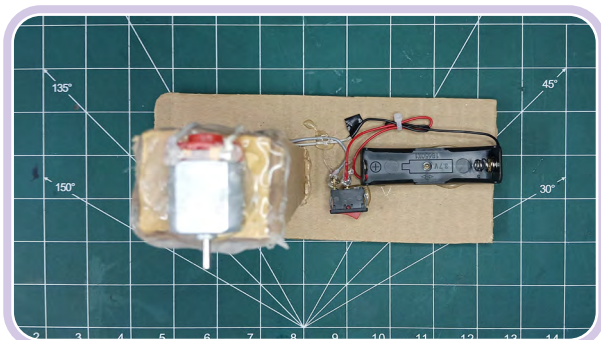
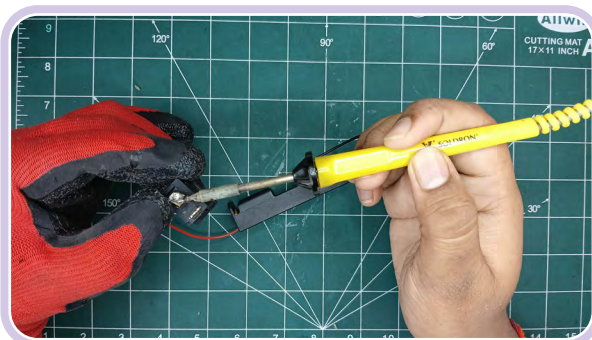


3. Make Electrical Connections:

- Refer to the circuit diagram for making electrical connections.
- Solder ribbon cables to the motor terminals.



- Connect the motor to the battery holder and switch:
 - o Battery (+) → Switch → Motor (+)
 - o Battery (-) → Motor (-)
- Secure the switch and battery holder to the base with hot glue.



4. Cut the Newton Disc:

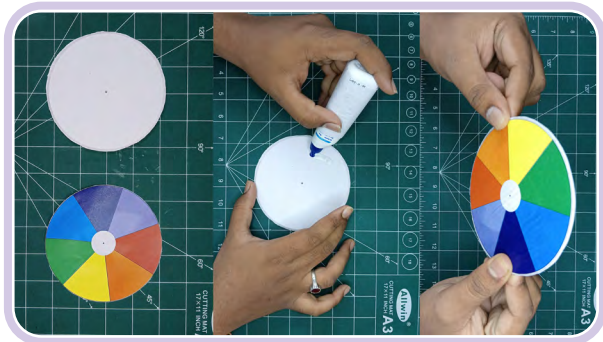
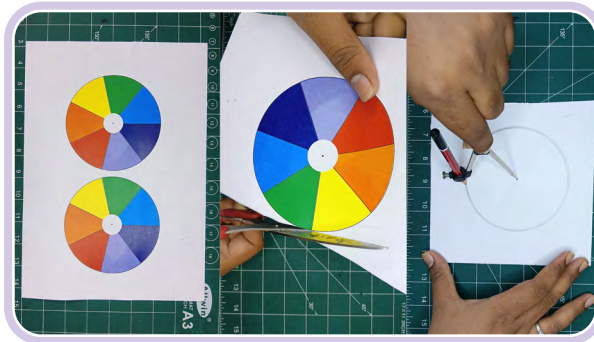
- Click the link or scan QR code to download and color print the template on A4 size paper. This template is required for building this model.
- If you do not have a color printer, you can click the next link or scan next QR code to download and print (Black and white) the blank template on A4 size paper.
- Using scissors, cut the printed template of the Newton's disc. If you have printed blank template, ask students to use colored sketch-pens (VIBGYOR) to make your own VIBGYOR-colored Newton's disc.
- Draw a circle of the same diameter as that of the Newton's disc on the foam board. This will serve as the base disc for the color wheel (Newton disc).
- Cut this disc from the foam board using a paper cutter or scissors.



<https://tinyurl.com/44mrktbe>



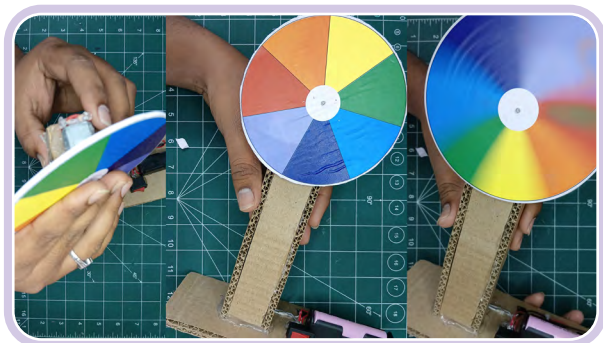
<https://tinyurl.com/5n8cnrfk>



- Carefully glue the VIBGYOR-colored DISC onto the foam disc.
- Ensure that the edge of the paper align neatly with the foam base, and that the paper is smooth without wrinkles or bubbles.
- Do not use excess glue. Allow the glue to dry completely before proceeding.

5. Attach the Disc to the Motor:

- Securely attach the color wheel to the motor shaft using glue or a small screw.
- Make sure the wheel is balanced to prevent wobbling.



6. Testing the Newton's Disc:

- Press the switch to start the motor and observe the disc spinning.
- Observe how the colors blend together as the disc spins rapidly, appearing white.



How does Newton's Disc work?

Newton's disc, also known as the disappearing color disk demonstrates how white light is made up of all the colors in the rainbow: When a disc painted with the colors of the rainbow is spun rapidly, the colors blend together and appear as white, off-white, or gray. This demonstrates that white light is made up of all the colors in the rainbow.

Click on the link or scan QR code to watch DIY cum working video of the project.



<https://youtu.be/30wpy37Ta30>

How can you assess students' understanding?

Assessment of Concept Understanding

- What is the colour of light?
- What colours do you see in a rainbow?
- Can you explain the principle of additive color mixing and its relation to white light?
- Show them the day-to-day applications of this project-

Dispersion of light in Prism and Rainbows



https://youtu.be/ASedGwpyn58?si=DXW_M8vUk4PXtort

How rainbows are formed



<https://youtu.be/HLChkxfSUhI?si=uYqb6FQduZRZVMOe>

Click the links or scan QR codes to know more.

Assessment of Project Understanding

- Observe and assess the students' ability to follow the procedure and correctly assemble and operate the set up.
- Observe and assess the functionality of the project during testing (Does it work as expected?).
- Check for creativity and accuracy in assembling the model.
- Conduct a quick Q&A session to evaluate their understanding of the Newton's Disc, the circuit's functionality and components.
 - o Why does the disc appear white when spinning?
 - o How does the speed of the spinning disc affect the animation?
- Summarize the principle of additive color mixing and its relation to white light.

Assessment of Teamwork

Discuss individual contributions in group settings and award each group member the badges - 'Ideator, Goal Getter, Co-Creator and Questioner based on their involvement in the project.
(*Rubric for this is provided in the note for the teacher*)

Design Thinking/Extensions and Modifications

Ask students the following questions and elicit answers from them. Some questions you can ask them and encourage them to think are given for your reference.

1. Can this model be used in real-life applications?
2. How can you modify this model?
 - You can experiment with discs of different sizes or shapes.
 - Add more or fewer colors to observe the effect on the blending.
 - You can change the motor speed using a motor speed regulator and see its effect.

Activity 6

Making a Jumping Paper Frog with LED Eyes



Grade

6



Subject

Physics



Topic/
Concept

Electric
Circuits

Objective

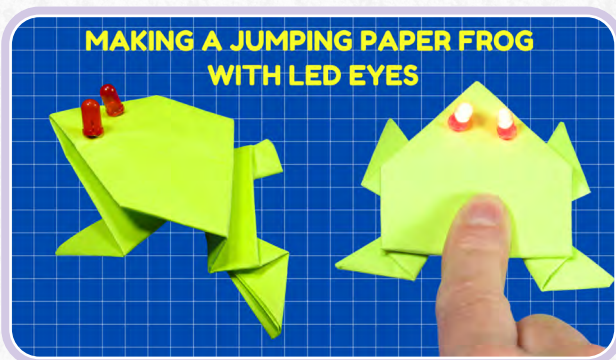
To help students understand open and closed circuits and how current flows in a closed circuit by making a jumping paper frog.

What will you help students learn?

- Basic principles of origami and simple electronics like LEDs, battery and paper switch.
- Understand the concept of an electric circuit, including open and closed circuits.
- Recognize the role of conductors, power sources, and load components like LEDs.
- Develop fine motor skills and confidence using simple electronic components.

What will you build/make?

A jumping frog made from cardstock using foldable origami that includes a simple paper circuit. When the frog is pressed to jump, the circuit closes and its red LED eyes light up.



https://www.youtube.com/watch?v=ga6sNJ_EFXY

Click the link or scan QR code to watch
DIY cum working video of the project

What will you need?

Material and components

- Cardstock sheet (sturdy enough for origami and circuit)
- Scissors
- Red marker or pen
- Copper conductive tape
- Two red LEDs
- 3.3V coin cell battery
- Clear/cello tape (alternative)
- Paper glue

ATL Tools/Equipment

- Ruler
- Tweezers
- Soldering kit- gun, stand, metal, flux, fume extractor
- Wire Cutter/Stripper
- Hand gloves
- Cutting mat
- Paperclips/clamps (optional)



Procedure

Please Note: Meanings of words in the activity plan you may want to know are given in the Annexure

1. Introduction:

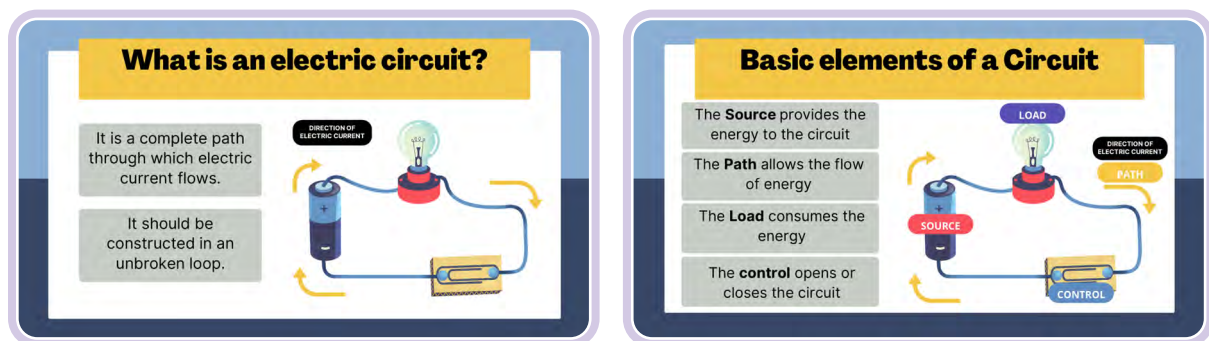
- **Introduction to Electric Circuits:**

Begin the activity by explaining what an electric circuit is. A basic electric circuit includes:

- o Source: The power supply (e.g., a 3.3V coin cell battery).
- o Path: The conductive material (e.g., copper tape) that allows electricity to flow.
- o Load: The device that uses electricity (e.g., the LEDs in this project).
- o Control: A mechanism to open or close the circuit (in this project, pressing the frog acts as a switch).

- **Function of a Switch:**

- o Discuss how a switch controls the status of the circuit- 'off' when the circuit is open and 'on' when the circuit is closed.
- o In this activity, pressing the paper frog closes the circuit by connecting the copper tape to the battery terminals, acting like a switch. When released, the circuit opens and the LEDs turn off.



- o Click the link of scan QR code to watch the video to learn about 'Electric Circuits'.



<https://www.youtube.com/watch?v=j0zf-otH3cY&t=133s>

- **Introduction to Origami:**

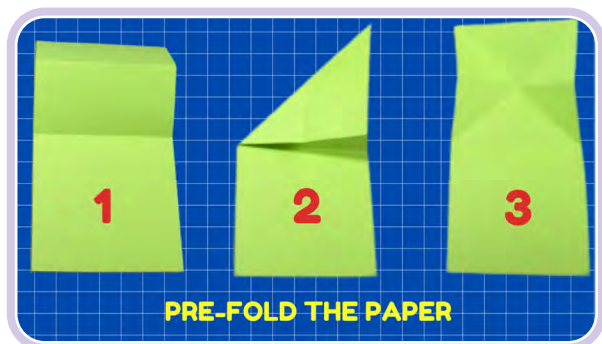
- Introduce origami as the traditional Japanese art of paper folding.
- In this activity, students will use origami techniques to fold a piece of cardstock into the shape of a frog and add a paper circuit to it to light up the LEDs as its eyes. This adds a creative, hands-on element to learning about circuits.

- **Distribute the Material:**

- Distribute the required material to the students.
- Make sure all students are provided with the necessary materials, including stationery and electronic components, before beginning the activity. Now, let's start making the jumping frog with origami.

2. Pre-fold the paper:

- Bring the shorter edge at the top down to the bottom edge. Make the crease sharp.
- Bring the top edge up to the middle fold and crease again. Open the paper up again.
- Bring one top corner down to the opposite end of the middle crease. Crease and open again. Repeat with the other corner.
- Optional: Repeat Steps 2-4 with the bottom edge of the paper.



3. Make the frog's head and front legs:

- Take the X-fold on the top half of the paper and push in the sides to form a triangular "tent." Flatten the triangle.
- Fold the bottom corners of the triangle up as shown to form the legs. Flatten the legs.



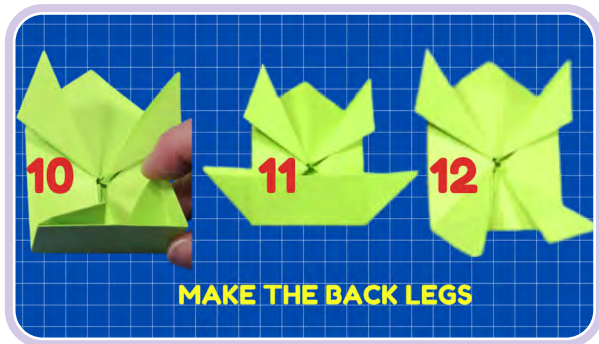
4. Make the frog's body:

- Fold up the bottom edge to the middle crease.
- Fold in the sides so they meet in the middle. You may need to lift the front legs out of the way.
- Fold the bottom up again so it meets the bottom corner of the head.



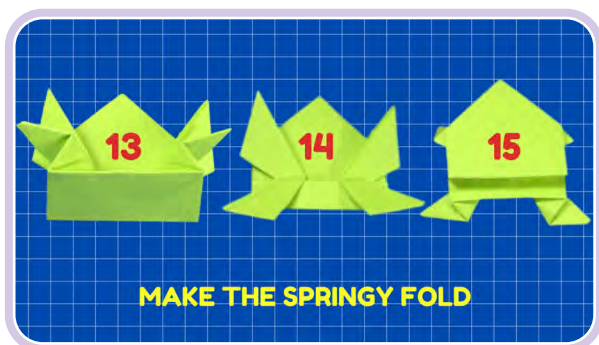
5. Make the back legs:

- Reach inside the last fold to grab the corner of one side. Pull the corner out. Repeat with the other corner. The bottom now looks like a boat.
- Bring the corners of the “boat” down so they meet at the bottom, forming a diamond shape.
- Take one half of the diamond and fold it over so the edge meets the diagonal crease. Repeat with the other side to form the back legs.



6. Make the springy fold:

- Bring the bottom of the frog up along the middle crease, so the back feet are touching the front feet.
- Bring the same piece down so the bottom edge meets the middle crease. Sharpen this fold.
- Turn your frog over. To give it a test jump, press down on the back edge to compress the springy fold. Slide your finger back to release it.

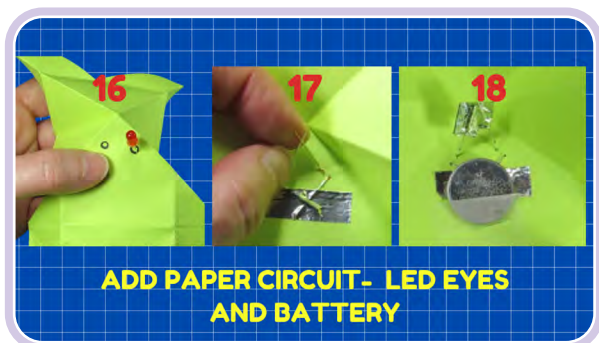


7. Add the LED eyes:

- Make sure the LEDs work together by sliding them both onto the battery. The positive wire leads (usually longer than the other lead) must touch the positive (smooth) side of the battery.
- Draw eyes near the frog's nose, then unfold the origami. Poke the LEDs through the eyes- making sure the positive (longer) lead is closer to the nose.

8. Add the battery and the connect to the LED:

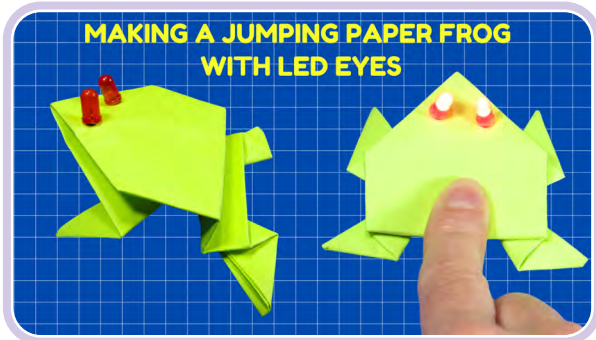
- Take the copper tape strips and fold down one long edge so the glue sticks to itself. This will ensure that the copper tape makes a good connection between the LEDs and the battery.
- Inside the head, bend the bottom (negative) leads down so they're touching. Secure them to the paper with one piece of copper tape.
- Bend the top (positive) leads up and wrap the other piece of copper tape around them tightly.



- Place the battery, positive side up, over the copper tape. Use clear/cello tape to hold it in place-making sure to leave the part of the positive side closest to the positive wires uncovered.

9. Test your light-up frog:

- Bend the positive wires down until they are almost touching the positive side of the battery. Fold the frog back up.
- Time for the final test! When you press down the back, the LEDs should light up. When you release it, the lights should go out as the frog leaps forward.



- If the eyes stay lit, adjust the positive leads. Your lit up frog should last for many hops.

How does the Jumping Paper Frog work?

The frog contains a simple paper circuit made using copper tape, two LEDs, and a coin cell battery. When the frog is not pressed, the circuit is open—so no electricity flows and the LEDs remain off. When someone presses on the back of the frog to make it jump, the copper tape makes contact with both sides of the battery, closing the circuit. This allows electricity to flow from the battery through the copper tape and the LEDs, lighting them up. This demonstrates the basic principle of how a closed circuit allows electric current to power a load through switch.

Click the link or scan QR code to watch DIY cum working video of the project.



https://www.youtube.com/watch?v=ga6sNJ_EFY

Click the link or scan QR code to watch
DIY cum working video of the project

How can you assess students' understanding?

Assessment of Concept Understanding

- Where do you see switches around you in your homes, schools, etc.?
- How does a switch work?
- What is the difference between an open circuit and a closed circuit?
- How would you describe the circuit when the switch is in the ON mode? Open or closed?

Assessment of Project Understanding

- Evaluate the functionality of the frog: Does it jump? Do the LED eyes light up?
- Check for creativity and accuracy in assembling the model.
- Assess the understanding of each component's functionality.
- Conduct a quick Q&A session to evaluate their understanding of the working of the Jumping Paper Frog with LED Eyes.
 - How does the fold structure affect the frog's jumping ability?
 - What is needed to make a complete electric circuit?
 - What role do the copper tape and battery play?
 - How does a switch function in this project?
 - Why do the LEDs only light up when the frog is pressed?
 - What other ways can we make circuits fun and interactive?
 - What role do the positive and negative terminals play in lighting the LEDs?
 - Can this model be used to understand how electric switches work?
 - How can we improve the frog's design to jump farther?
- Conclude by summarizing the integration of art (origami) and science (electronics) in this project.

Assessment of Teamwork

Discuss individual contributions in group settings and award each group member the badges - 'Ideator, Goal Getter, Co-Creator and Questioner based on their involvement in the project. (Rubric for this is provided in the note for the teacher)

Design Thinking/Extensions and Modifications

Ask students the following questions and elicit answers from them. Some questions you can ask them and encourage them to think are given for your reference.

How can you modify this model?

- You can use different color LEDs and paper to create a more vibrant frog.
- Experiment with different folding techniques to modify the frog's movement.
- You can think of making any other animal using origami using a buzzer along with LED in the circuit.

Activity 7

Making a model demonstrating 'Persistence of Vision' (POV)



Grade

8



Subject

Physics



Topic/
Concept

Persistence
of Vision

Objective

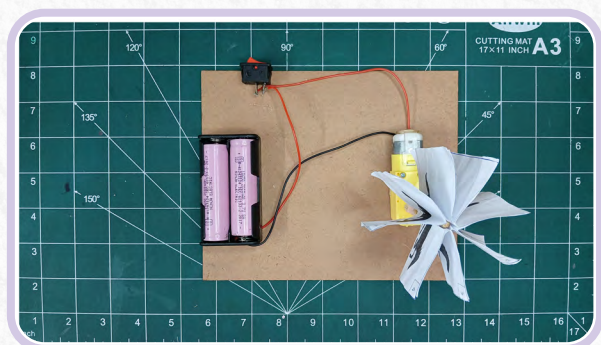
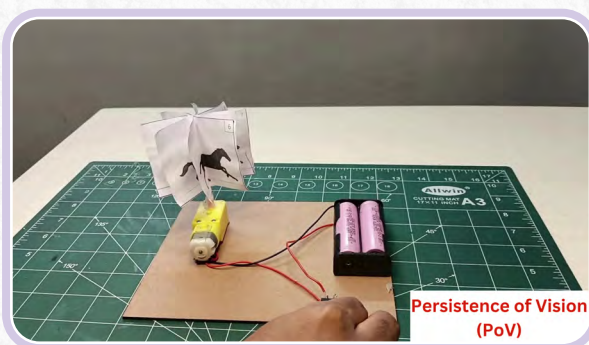
To help students build a functional animation model using simple working circuit and understand the concept of Persistence of Vision.

What will you help students learn?

- The interplay between science and art in visual perception.
- The scientific principle of persistence of vision and its practical applications.

What will you build/make?

A working model to demonstrate the phenomenon of persistence of vision of the human eye through a 'Running Horse Animation'



<https://youtu.be/nUxdyVWnycQ>

Click the link or scan QR code to watch DIY cum working video of the project.

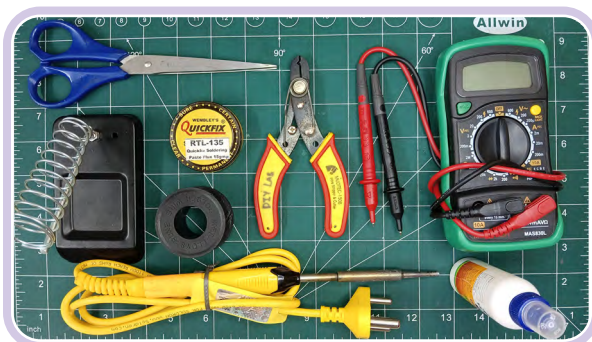
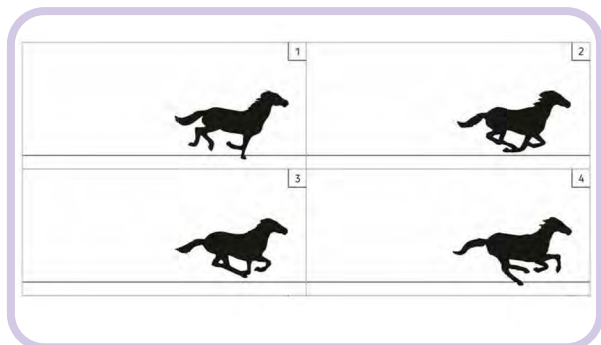
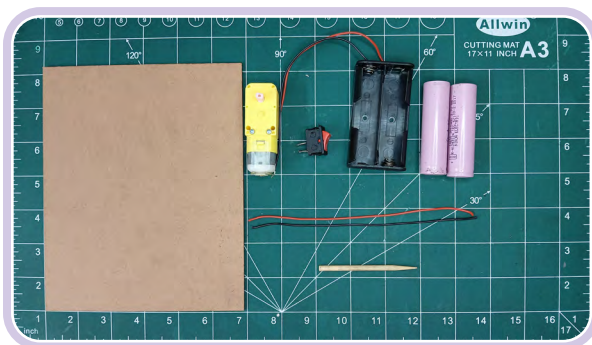
What will you need?

Material and components

- Printed template of a running horse (cut into frames required for the animation)
- Two 18650 lithium-ion batteries (3.7V, 2000mAh each)
- Battery holder
- 300 RPM BO motor
- Bamboo skewer/Tooth pick (to hold the printed frames)
- Ribbon cable/ wires
- Rocker Switch
- Wooden board approximately 15 cm x 15 cm

ATL Tools/Equipment

- Scissors
- Marker pen or pencil and ruler
- Pencil, scale and black colored sketch pen
- Hand gloves
- Hot glue gun with glue sticks
- Paper glue/ Glue stick
- Soldering kit- gun, stand, metal, flux, fume extractor
- Wire stripper
- Multimeter
- Mini hack saw



Procedure

Please Note: Meanings of words in the activity plan you may want to know are given in the Annexure

1. Introduction to Concept and the Activity:

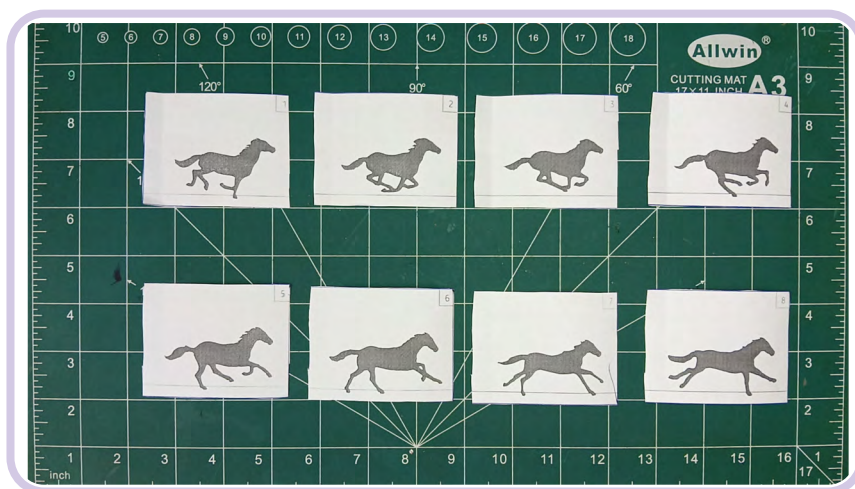
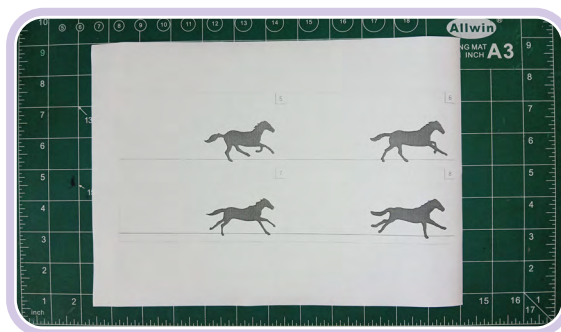
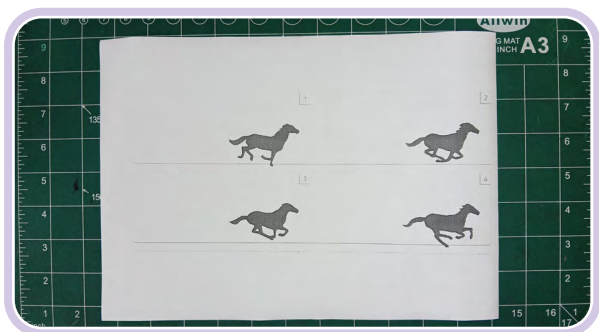
- Explain the persistence of vision and how it creates the illusion of motion in animations.
- Distribute all necessary materials for the activity.
- Review the components and their purposes.

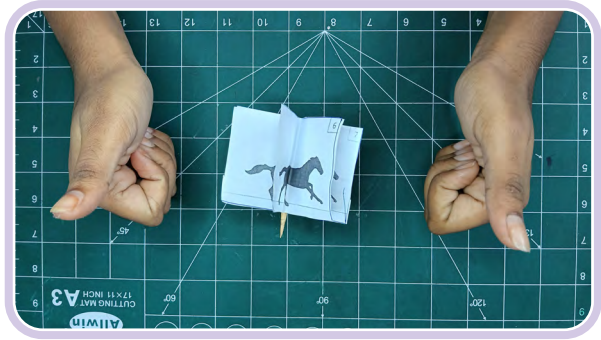
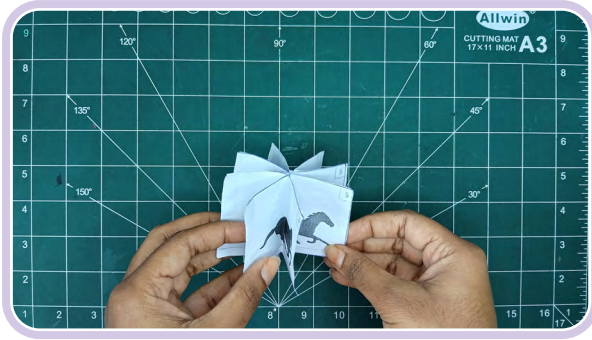
2. Preparing the Animation Template:

- Click the link or scan QR code to download and print the 'Running horse' template on A4 size white paper. This template is required for developing the project model.
- Cut the running horse template into individual frames as shown in the images.
- Stick each frame evenly and in order (the frames are numbered) on a bamboo skewer using a paper glue/ glue stick, maintaining equal spacing between frames as shown in the images.



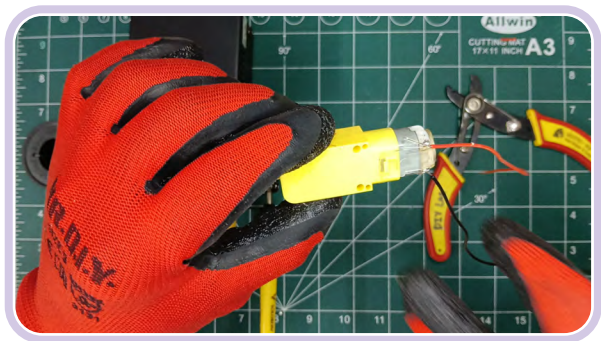
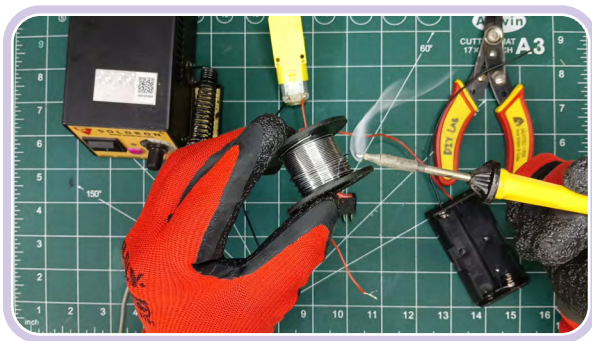
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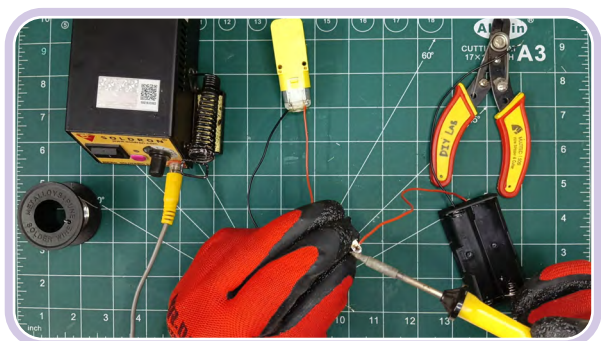
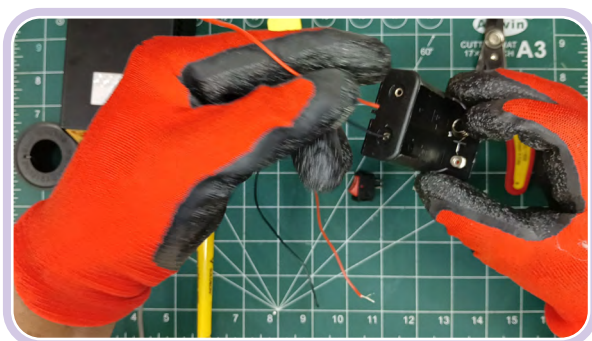
3. Assembling the Motor System:

- Solder ribbon cables to the motor's terminals.



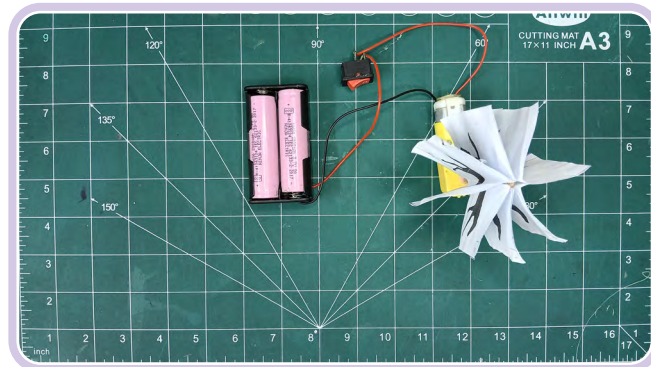
4. Connecting Power Supply:

- Solder the rocker switch to switch the power supply on or off.
- Insert the batteries into the holder. Keep the switch off.
- Connect the battery holder to the motor via the rocker switch, ensuring proper polarity.



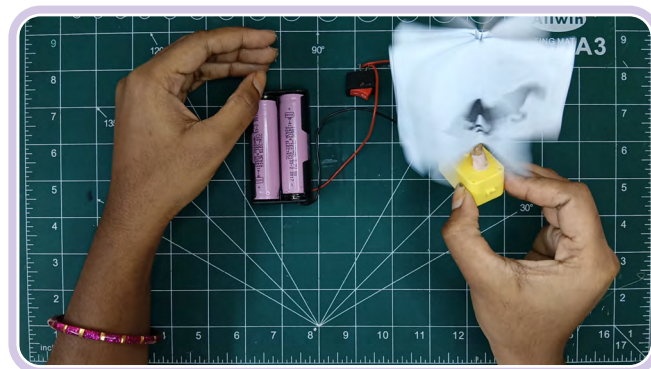
5. Attaching the Skewer on Motor Shaft:

- Mount the bamboo skewer with the horse frames onto the motor shaft using a hot glue gun. Ensure it is balanced to avoid wobbling.



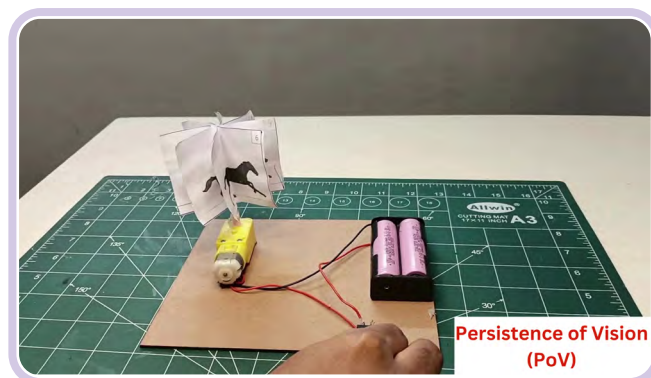
6. Testing the Model:

- Switch on the motor using the rocker switch.
- Observe the frames spin rapidly, creating the illusion of a running horse.



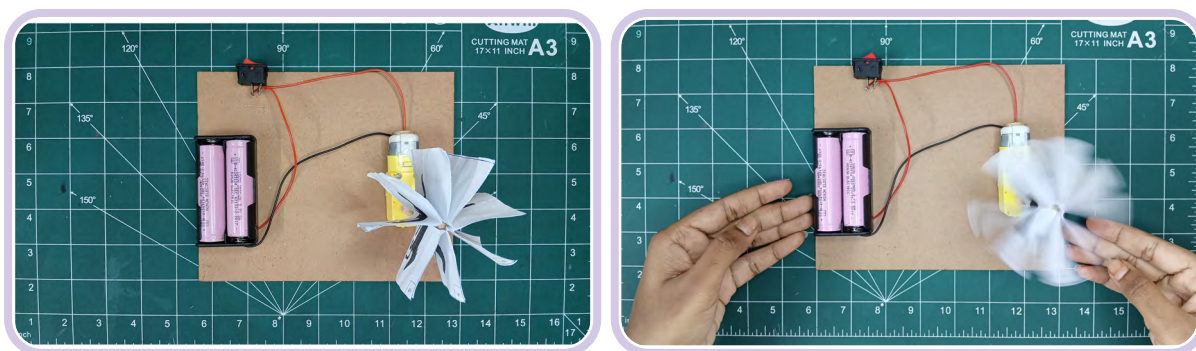
7. Building the Base:

- Use the wooden board (15 cm x 15 cm) as the base of your model to securely mount it.
- Connect the 300 RPM BO motor to the wooden board using hot glue.



8. Fine-Tuning and Testing the Illusion of a Running Horse:

- Adjust spacing or speed as needed to enhance the animation.
- Observe the spinning animation of the running horse.
- Adjust the motor speed (if possible, use DC motor speed regulator if needed) for optimal visual effects.
- Check for alignment and make corrections if the images appear blurred or disjointed.



How does the model demonstrate ‘Persistence of Vision’?

As the figures (of a horse) are arranged around the skewer in a sequence that illustrate running, when the frames spin at a higher speed, these images linger on the retina of our eyes for about $1/16$ th of a second, creating an illusion of a running horse.

Click the link or scan QR code to watch DIY cum working video of the project.



<https://youtu.be/nUxdyVWnycQ>

How can you assess students’ understanding?

Assessment of Concept Understanding

- How are we able to see? Can you explain the mechanism of seeing?
- How long does it take the brain to process these signals and create an image?
- How long does the retina retain the impression of the image ? What is Persistence of Vision?

Assessment of Project Understanding

- Observe and assess the students' ability to follow the procedure and correctly assemble and operate the circuit.
- Evaluate students’ understanding of the Persistence of Vision.
- Assess the functionality and visual clarity of the running horse animation.
- Check for creativity in developing the model.

- Evaluate the accuracy of the circuit and the stability of the model.
- Discuss the scientific principles demonstrated by the model along with the historical development of animation.
- Conduct a quick Q&A session to evaluate their understanding of the model demonstrating 'Persistence of Vision' (POV).
 - o How does persistence of vision create the illusion of motion?
 - o How does the speed of the spinning frames affect the animation?
 - o Discuss other real-world applications of persistence of vision (e.g., Flipbooks, Movies and Animations, TV screens, Digital billboards, Light trail photography, etc.).

Assessment of Teamwork

Discuss individual contributions in group settings and award each group member the badges - 'Ideator, Goal Getter, Co-Creator and Questioner based on their involvement in the project. (Rubric for this is provided in the note for the teacher).

Design Thinking/Extensions and Modifications

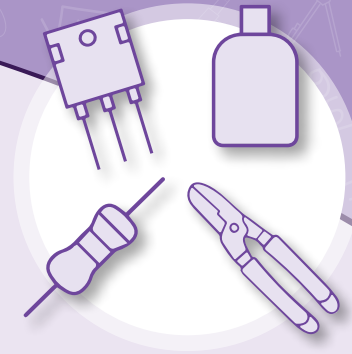
Ask students the following questions and elicit answers from them. Some questions you can ask them and encourage them to think are given for your reference.

How can you modify this model?

- You can experiment with different animations (e.g., a bouncing ball or a flying bird).
- You can use a variable resistor or DC motor speed regulator to control the motor speed and study its effect on the animation.
- Instead of the motor, you can make a model using a handle to rotate the disk and compare the animations.

Activity 8

Making Water Level Detecting Alarm



Grade

6



Subject

Physics



Topic/
Concept

Electrical
circuits

Objective

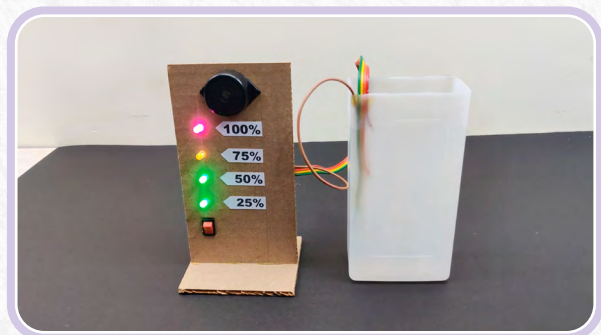
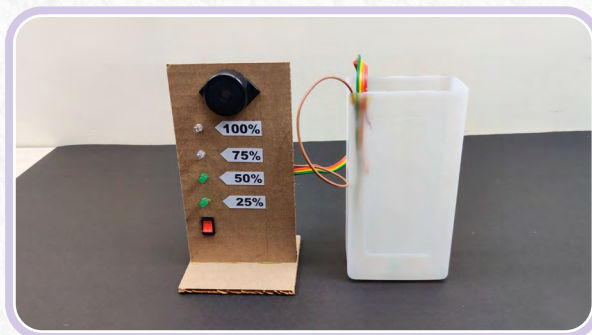
To build a functional water-level detection alarm using basic electronic components.

What will you help students learn?

- To learn the fundamentals of simple electrical circuits and the functioning of components such as transistors, resistors, and buzzers
- To understand how transistors function as switches in electronic circuits.
- To recognize how water conductivity can be used to complete or interrupt an electronic circuit.
- Learn how simple analog systems can automate real-world tasks like water level alerts.
- Importance of water-conservation.

What will you build/make?

A Water Level Detecting Alarm



Click the link or scan QR code to watch DIY cum working video of the project.



<https://www.youtube.com/watch?v=DQdAq8YEgwo>

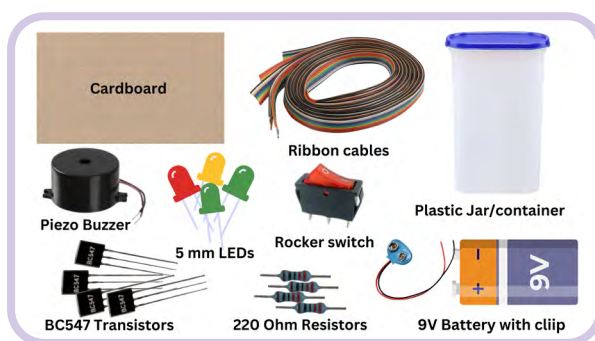
What will you need?

Materials Needed

- 9V Battery with battery clip
- Rocker ON/OFF Switch
- Resistors (220 Ω) x 4 Nos.
- LEDs (One red, one orange, two green)
- Piezo Buzzer
- NPN Transistor (BC547) x 4 Nos.
- Wires
- Probes (Metal or wires)
- Cardboard
- Glass/Plastic Jar

ATL Tools/Equipment

- Paper cutter/knife
- Pencil and ruler
- Soldering kit- gun, stand, metal, flux, fume extractor
- Hot glue gun with hot glue
- Wire cutter/stripper
- Multimeter
- Safety gloves
- Cutting mat

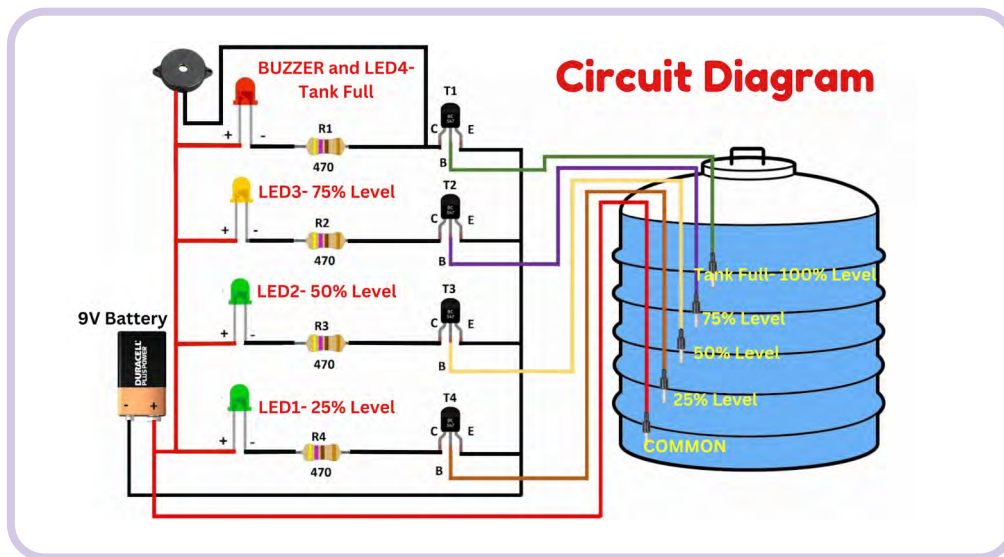


Procedure

Please Note: Meanings of words in the activity plan you may want to know are given in the Annexure

1. Introduction to Concept and the Activity:

- Brief the students on the working principles of the circuit and its components.
- Show a diagram of the circuit and explain how water conductivity triggers the alarm.



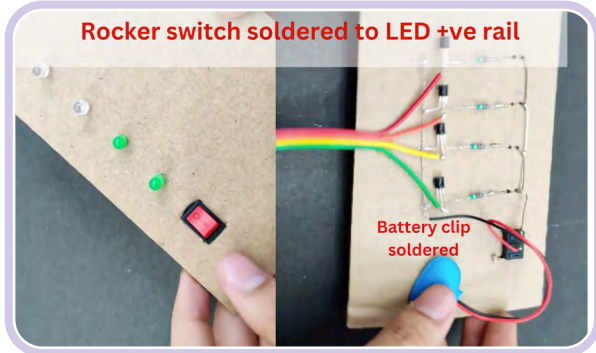
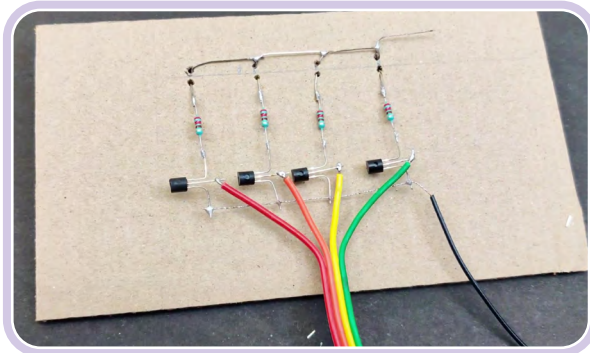
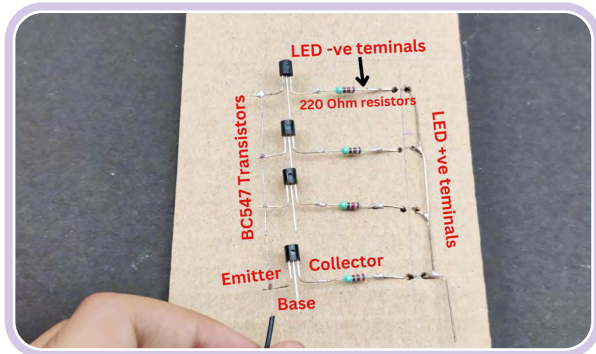
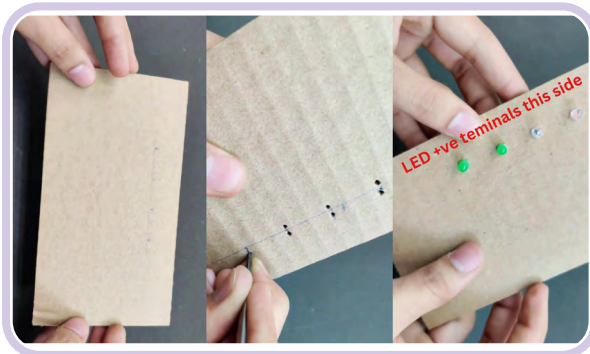
2. Prepare the Structure:

- Cut a sturdy piece of cardboard (approximately 25cm x 10cm) to act as the structure for mounting your circuit components.
- Cut another piece of cardboard (approximately 10cm x 10cm) to act as the base.
- Use a ruler and pencil to mark positions for each component on the structure for neat placement.

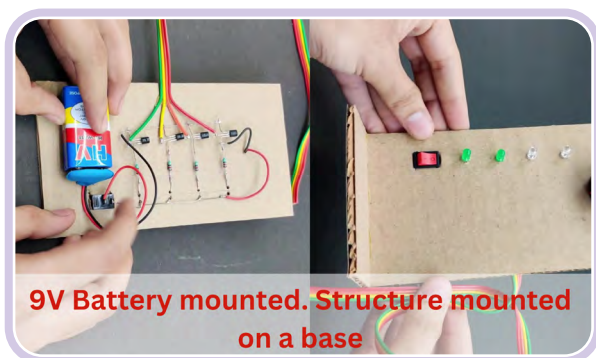
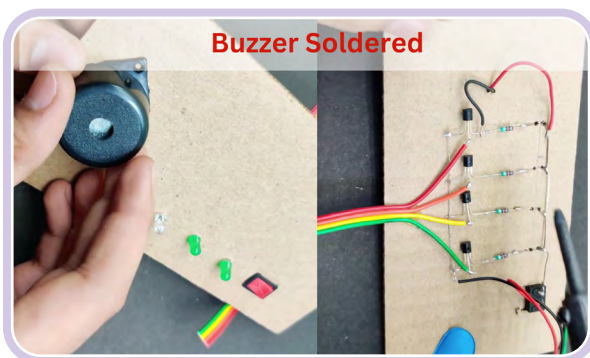
3. Arrange Components and Assemble the Circuit:

- Based on the circuit diagram, plan and lay out the positions for LEDs, resistors, and transistors.
- Mount two green LEDs in the last two rows, an orange LED in the third row and a red LED in the fourth row of the indicator.
- Solder positive terminals of the LEDs together. Connect the negative terminal of each LED to the collector of the BC547 NPN transistor through a 220 Ohm resistor.
- Connect the emitter of each transistor to the negative (ground) rail of the circuit.
- Connect each probe wire to the base of a BC547 transistor. These probes will detect the water level.

- Solder the switch to the positive rail of the circuit. Connect the battery clip's positive end to the switch and negative end to the emitter terminal of the transistor in the first row.

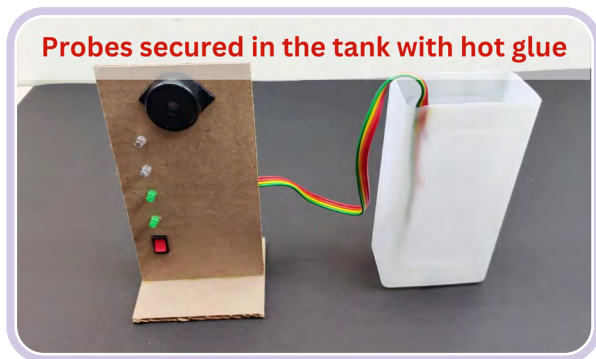


- Mount and solder the piezo buzzer in the fourth row along with the red LED (Connected in parallel to the red LED).
- Connect the 9V battery to the battery clip. Secure it on the cardboard with hot glue.
- Finally mount and secure the structure on to the base using hot glue.

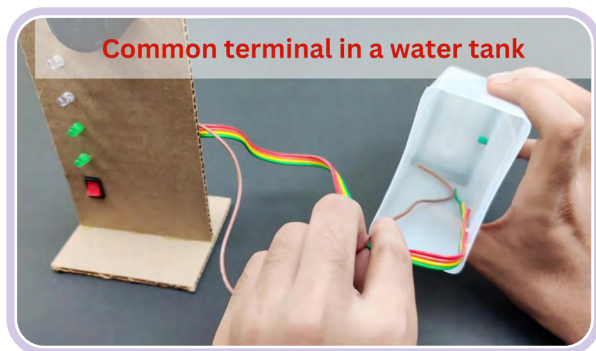
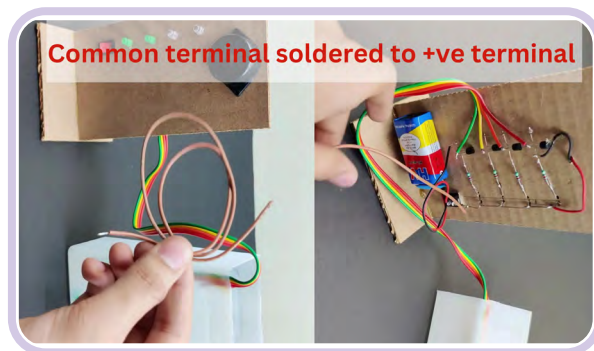


4. Insert Probes into the Jar:

- Insert four probes at different vertical levels inside the plastic jar (water storage tank). These will act as water level sensors. Secure these four probes inside the jar using hot glue.

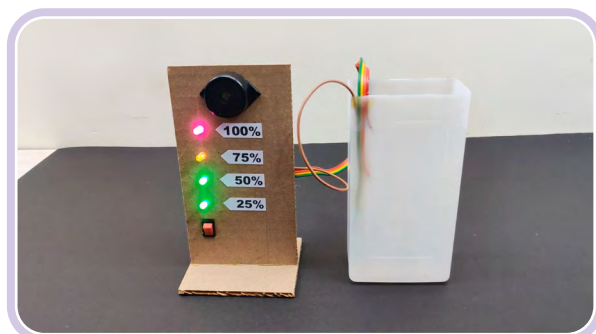
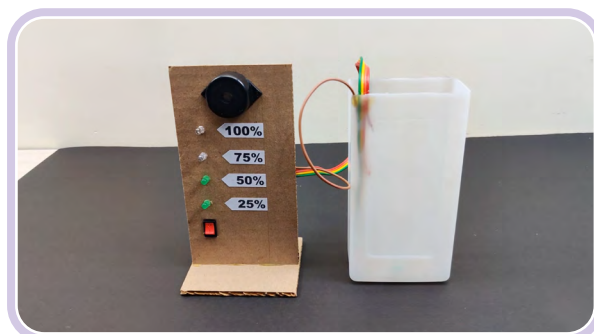


- Connect one more wire as a common terminal to the positive rail of the circuit and place it inside the jar along with the four probes. Secure it inside the jar using hot glue.



5. Final touch-up and Testing the Circuit:

- Use stickers to write the water levels (25%, 50%, 75% and 100%) next to the LEDs.
- Only after verifying the circuit and connections as per the circuit diagram, switch the circuit ON.
- Slowly fill the jar with water and observe the behaviour of LEDs and buzzer as each probe gets submerged.
- The green LEDs light up at lower water levels (25% and 50% percent), followed by orange (75%), and finally the red LED and buzzer at maximum level (100%).



6. Troubleshoot if Needed:

- Use a multimeter to test voltage across probes and components if any part of the circuit does not function as expected.

How does the Water Level Detecting Alarm work?

When water reaches a certain level and touches a wire probe, it conducts a small current to the base of a connected transistor. This switches the transistor ON, allowing current to flow from collector to emitter. As a result, the corresponding LED lights up to indicate the water level. When the highest probe is activated, both a red LED and a buzzer are triggered to alert that the container is full. Each probe corresponds to a specific water level, and the use of multiple transistors allows for individual detection and response at different stages.

Click the link or scan QR code to watch DIY cum working video of the project.



<https://www.youtube.com/watch?v=DQdAq8YEgwo>

How can you assess students' understanding?

Assessment of Concept Understanding

- Ask students questions on the working principles of the circuit and its components.
- Show a diagram of the circuit and ask them questions about the components of the circuit and elicit answers from them.

Assessment of Project Understanding

- Observe and assess the students' ability to follow the procedure and correctly assemble and operate the set up.
- Assess whether the circuit correctly lights up LEDs for each level.
- Evaluate students' understanding of 'Water Level Detecting Alarm'.
- Evaluate the working of the final circuit during the testing phase.
- Conduct a quick Q&A session to evaluate their understanding of the working of the Water Level Detecting Alarm.
 - o How does the transistor act as an amplifier/switch in the circuit?
 - o Show them 'how transistors are used in tactile switches'. (Click the link or scan QR code to know more)
 - o Why is a resistor needed in the circuit?
 - o Can this setup be modified for other applications, such as detecting liquid levels in non-conductive materials?



<https://youtu.be/sOhaRjIcsBk?si=EC-stzxocDMU0zG4>

- Ask- Where have you seen this application being used around you?
- Show them the day-to-day applications of this project- Overhead water tank alarm. (Click the link or scan QR code to know more)



<https://vadic.vigyanashram.blog/2023/04/08/water-overflow-system/>

Assessment of Teamwork

Discuss individual contributions in group settings and award each group member the badges - 'Ideator, Goal Getter, Co-Creator and Questioner based on their involvement in the project. (Rubric for this is provided in the note for the teacher).

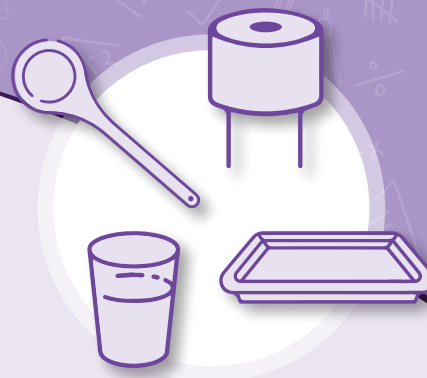
Design Thinking/Extensions and Modifications

Ask students the following questions and elicit answers from them. Some questions you can ask them and encourage them to think are given for your reference.

1. Can this model be used in real-life applications?
2. How can you modify this model?
 - You can use a microcontroller (e.g., Arduino) to create a digital water-level monitor.
 - You can modify the circuit for use in larger tanks or containers with multiple water levels.

Activity 9

Making Artistic Circuits using Dough to test Conductors and Insulators



Grade ▶ **6, 7 and 8**



Subject ▶ **Chemistry**



Topic/ Concept ▶ **Conductivity and Simple Circuits**

Objective

To introduce students to electrical circuits, make simple circuits using dough and test them to check if they are conductive or insulative.

What will you help students learn?

- Understand the differences between conductors and insulators.
- Learn about electrical conductivity, insulators, and the basics of circuits.
- Create conductive and insulating dough using household ingredients.

What will you build/make?

Simple circuits using conductive and insulating dough that can power LEDs or other small electronic components.



<https://www.youtube.com/watch?v=BGnHZVz7zoQ>



<https://www.youtube.com/watch?v=azTzwcnmvg>



<https://squishycircuits.com/blogs/projects>

Click on the links or scan QR codes to watch DIY cum working videos of the project.

What will you need?

Materials and components

For making a conductive dough

- All-purpose flour (1 cup)- This forms the base of the conductive dough.
- Water (1/2 cup)- This adds moisture for conductivity.
- Salt (1/4 cup)- This enhances the dough's conductivity.
- Vegetable oil (1 tablespoon)- This improves the texture and prevents drying.
- Cream of Tartar or Lemon Juice (1 tablespoon)- This acts as an acid to stabilize the mixture.
- Edible food color (optional)

For making an insulating dough

- All-purpose flour (1 cup)
- Water (1/2 cup)
- Sugar (1/4 cup)- This reduces the dough's conductivity.
- Vegetable oil (1 tablespoon)

ATL Tools/Equipment

- Battery (3V, 9V depending on the component/s you want to connect) with battery holder
- 5mm LEDs
- Piezo buzzer
- DC toy motor with a propellor
- Mixing bowls/Trays/Sauce Pan
- Measuring cups and spoons
- Stirring sticks/spoons/ladle
- Gas stove/Induction top
- Cloth



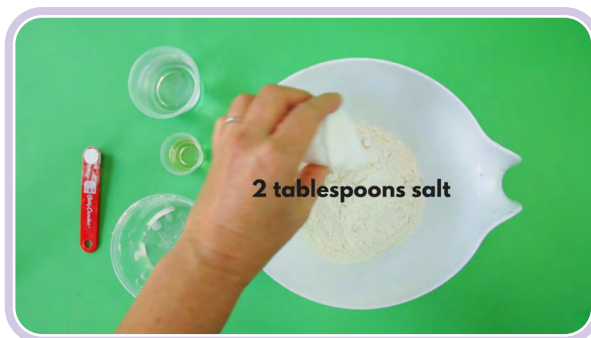
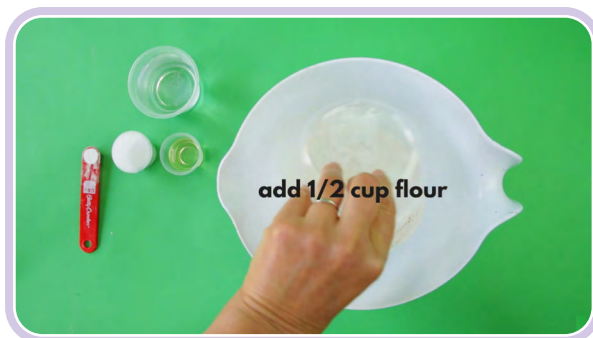
Procedure

1. Introduction:

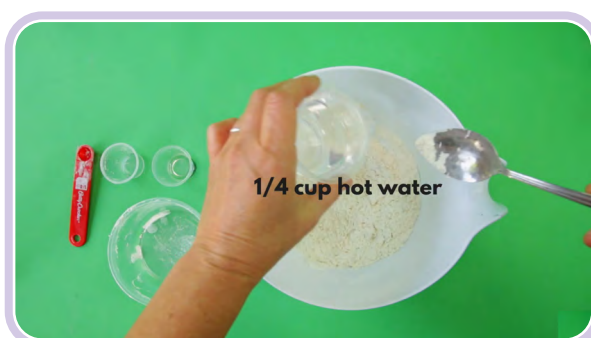
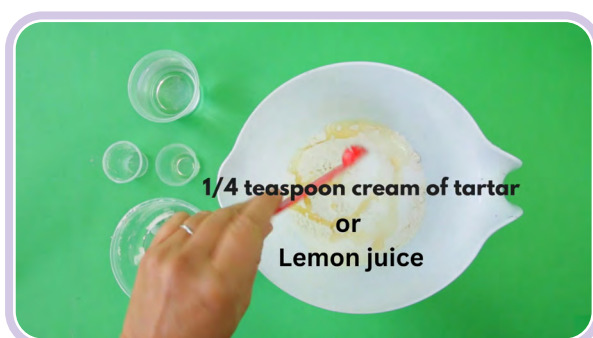
- Explain the concept of conductors and insulators.
- Discuss how a circuit works and the role of conductive and insulating materials in a circuit.

2. Prepare the Conductive Dough:

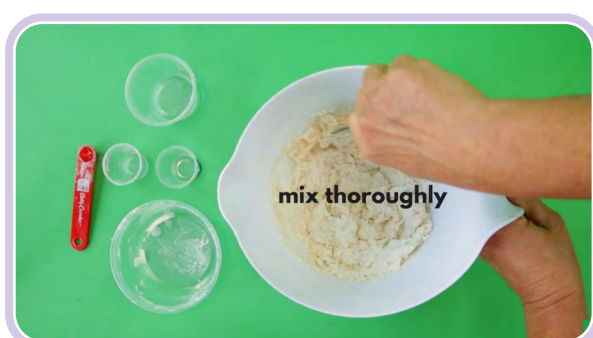
- Mix 1/2 cup of flour and 2 tablespoons of salt in a bowl.



- Add 1 tablespoon of lemon juice (or cream of tartar) to the mixture. Gradually add 1/4 cup of hot water to it while kneading until a dough consistency is achieved.



- Mix all the ingredients thoroughly to make dough consistent. Add some flour if the dough has become sticky or thin.
- Divide the dough into portions as required and add different food colors to each portion to make colourful dough portions.
- Keep the dough in an air-tight container before using it to make different artistic circuits.



3. Making the Insulating Dough:

- Mix 1/2 cup of flour, 1/4 cup of sugar, and 1 tablespoon of vegetable oil in a separate bowl or a pot.
- Gradually add 1/2 cup of distilled or deionized water to it while kneading, until the dough is soft and pliable.
- Optionally, add food colours to make the dough colourful for easy identification.

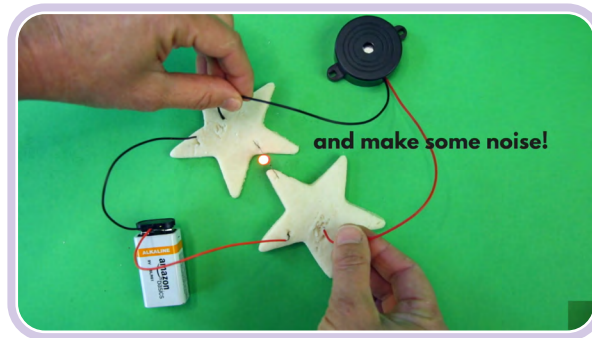
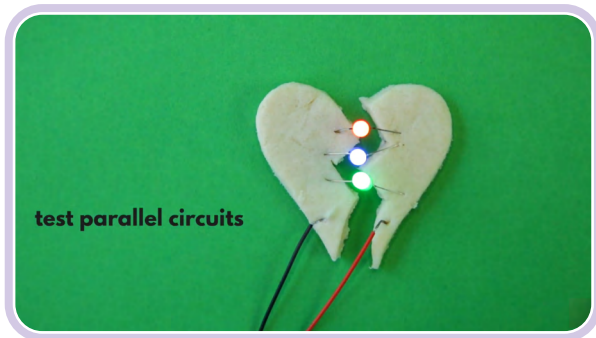
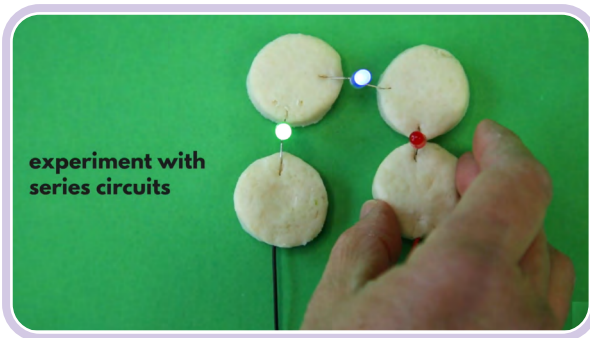


- Turn the dough out onto a tray or a countertop sprinkled with flour. Knead it well and roll it into a single lump.
- Add small increments of flour or water to yield a dough-like, pliable consistency.



4. Creating Circuit using Conducting and Insulating Dough:

- Use conductive dough to make the circuit. It forms the path for electricity to pass through.
- You can make circuits that are in series or parallel by arranging the conductive dough in different ways as shown in the images below.
- Place an LED or buzzer between the dough portions (or shapes). Ensure the longer leg (anode) of the LED or buzzer is connected to the positive path of the circuit (which is connected to the positive terminal of the battery).
- Make sure the conductive dough portions do not touch each other as they can cause a short circuit. If you want to place them close to each other, add a layer of insulative dough between them.
- Connect a 3V or 9V battery (depending on the electronic component you will be using) to the conductive dough through the battery clip.
- Test and adjust the circuit to make sure the LEDs light up or the buzzer sounds.



5. Artistic Exploration:

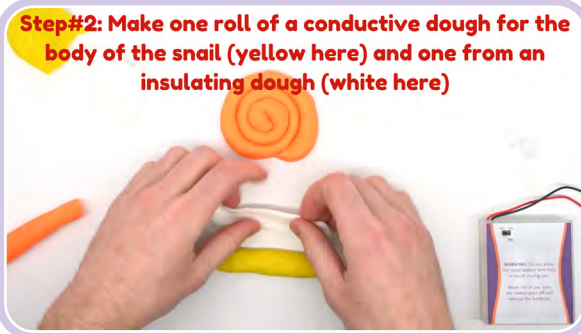
- Encourage students to shape the dough into creative designs like flowers, honey bees, snails, aeroplanes, or other objects while integrating LEDs, buzzers, motors with propellers, etc.



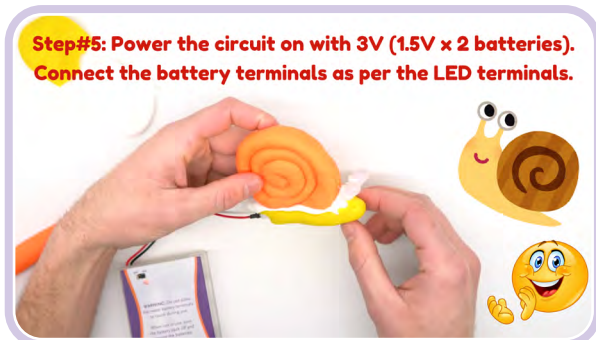
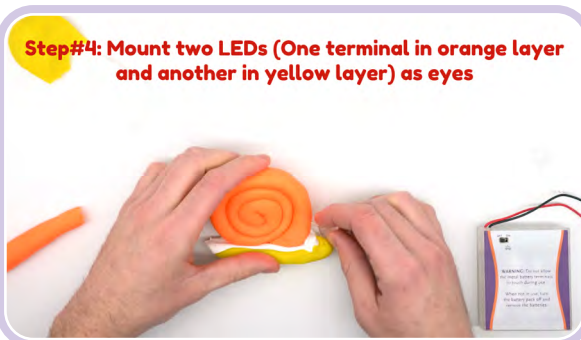
- Let's make a colourful snail with LEDs as its eyes.
- Take 2 portions of conductive dough, one orange and the other yellow in color.
- Prepare the snail's shell using the orange-colored conductive dough.



- Make the snail's body using the yellow-colored conductive dough.
- Prepare a layer of insulating dough and place it in between the shell and the body (conductive layers) to avoid short circuiting.



- Mount two LEDs as the snail's eyes. Insert one terminal of the LED in the orange layer and another in yellow layer of dough. Likewise repeat the same with the other LED.
- Power the circuit using a 3V (or 1.5V x 2) battery. Connect the battery terminals according to the placement of the LED terminals.
- Observe the LEDs lighting up to confirm the circuit is complete.



- Similarly, you can make other creative projects. Click the link or scan the QR code to go through the website and watch the video demonstrations.

6. Cleanup:

- Disconnect all electrical components and store them safely.
- Clean the work area after the project is complete.

7. Storage:

- If you want to store the dough for up to a week, keep it in a sealed container or bag. The dough can be frozen to store it for longer periods.
- When stored, the dough may lose its dough-like consistency and oil may separate from it. Simply add some flour to it to remove the stickiness before using it again.



<https://squishycircuits.com/blogs/projects>

How does the circuit with conductive and insulating dough work?

- **Conductive Dough:** This dough is made with ingredients like flour, salt and lemon juice, which allow electric current to flow through. It acts like a wire in a conventional circuit that is used to connect components such as LEDs to the battery.
- **Insulating Dough:** This is made with ingredients like flour, sugar and oil. This dough blocks the flow of electricity. It is used to separate portions of conductive dough in a circuit to prevent short circuiting.

How the Circuit Works:

When a battery is connected to the conductive dough using a battery clip, electrons flow from the negative terminal through the dough, into the component (like an LED), and back to the battery's positive terminal.

By adding insulating dough to a part of the circuit, we can block the flow of electricity to that part and make sure it flows only where it's required (to light up the LED).

How can you assess students' understanding?

Assessment of Concept Understanding

Conduct a quick Q&A session to evaluate their understanding of the working of the conducting and insulating dough:

- What makes the conductive dough a good conductor?
- Why is the insulating dough necessary in the circuit?

Assessment of Project Understanding

- Observe and assess the students' ability to follow the procedure and correctly make the dough.
- Observe and assess the functionality of the dough during testing and analyze its accuracy.
- Assess the functionality of their circuits (e.g., whether LEDs light up or buzzers sound).
- Assess their creativity in designing artistic circuits.
- Ask- Where have you seen this application being used around you?

Assessment of Teamwork

Discuss individual contributions in group settings and award each group member the badges - 'Ideator, Goal Getter, Co-Creator and Questioner based on their involvement in the project. (Rubric for this is provided in the note for the teacher)

Design Thinking/Extensions and Modifications

Ask students the following questions and elicit answers from them. Some questions you can ask them and encourage them to think are given for your reference.

1. Can this model be used in real-life applications?
2. How can you modify this dough?
 - Use multiple LEDs and experiment with series and parallel connections.
 - Design more complex shapes like animals or vehicles with integrated circuits.
 - Test alternative ingredients to make conductive and insulating doughs.
 - Introduce basic switches to the circuits for more functionality.

Activity 10

Making a DIY Salt-water Battery



Grade

7

9, 10



Subject

Physics

Chemistry



Topic/
Concept

Electricity

Electroplating

Objective

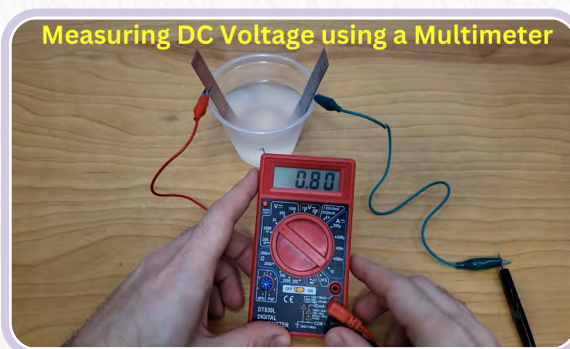
To provide students an understanding of the components of a battery and how it works reinforcing concepts in Physics and Chemistry.

What will you help students learn?

- The concept of electrochemical reactions.
- The basic principles of how a battery converts chemical energy into electrical energy.
- To construct and test a simple battery using everyday materials.
- To identify the roles of anode, cathode, and electrolyte in a battery.
- To measure and analyse current and voltage generated by the battery using a multimeter.

What will you build/make?

A simple battery that demonstrates the electrochemical process.



<https://youtu.be/WdCBoRW-J2I?si=BzXdLZB7ijMFvD6C>



https://youtu.be/V_2KYdZUUV8?si=K6ZpqR0SvC2MGgm4

Click the links or scan QR codes to watch DIY cum working video of the project.

What will you need?

Materials Needed

- Zinc plate (for the anode)
- Copper plate (for the cathode)
- Water
- Salt (sodium chloride- to increase the conductivity of water)
- Hydrogen peroxide
- Piezo buzzer (to verify if battery is working)
- 5mm LEDs

ATL Tools/Equipment

- Two crocodile clips
- Glass beaker/waste jar
- Kitchen weighing scale
- Multimeter
- Hand gloves
- Cloth
- Stirring stick/spoon
- Measuring spoon



Procedure

Please Note: Meanings of words in the activity plan you may want to know are given in the Annexure.

1. Introduction to the Concept:

- Explain the basic principle of a galvanic cell and how the saltwater acts as an electrolyte.

2. Preparing the Setup:

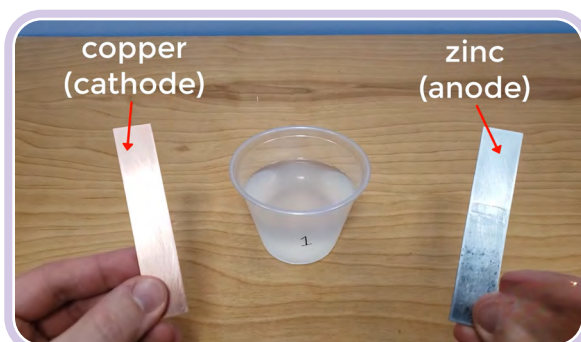
- Fill the glass beaker/jar with 500 mL of water.

- Add 25 gm of salt into the water and stir until dissolved.
- Take 150 ml of the salt-water in a separate cup or a small beaker.



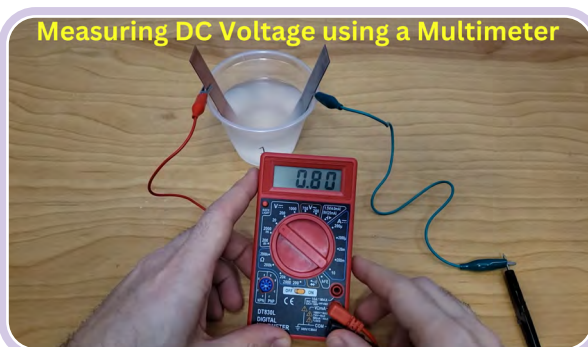
3. Constructing the Battery:

- Clean the zinc and copper plates using a sand paper/cloth before using them in the experiment.
- Insert the plates into the salt water solution, ensuring they do not touch each other.
- Connect the red crocodile clip to the copper plate (Cathode) and black crocodile clip to the zinc plate (Anode).
- Our DIY salt-water battery is ready.



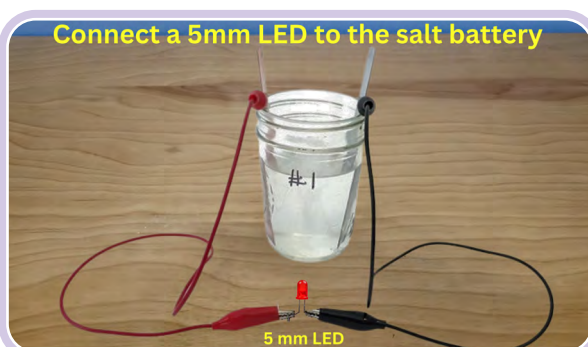
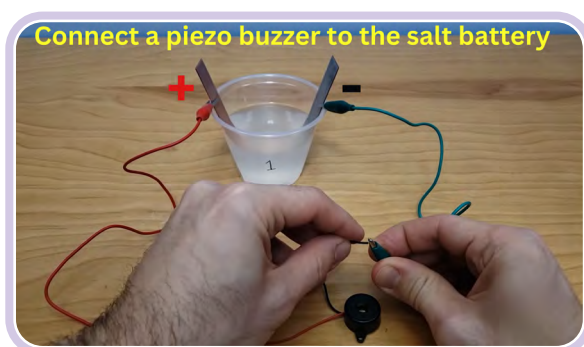
4. Measuring the Output:

- Use crocodile clips to connect the zinc plate to the negative terminal and the copper plate to the positive terminal of the multimeter.
- Observe and record the DC voltage and DC current readings on the multimeter.



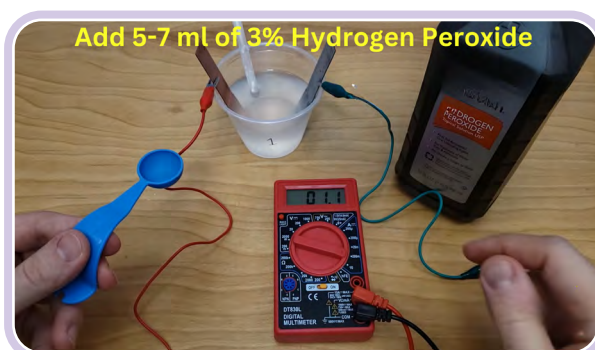
5. Connecting piezo buzzer and LED to the battery:

- Connect the piezo buzzer's positive terminal to the copper plate and negative terminal to the zinc plate and see if the buzzer turns on, making a sound.
- Similarly, you can connect a 5mm LED to the circuit. Connect LED's positive terminal to the copper plate and negative terminal to the zinc plate. See if it turns on.



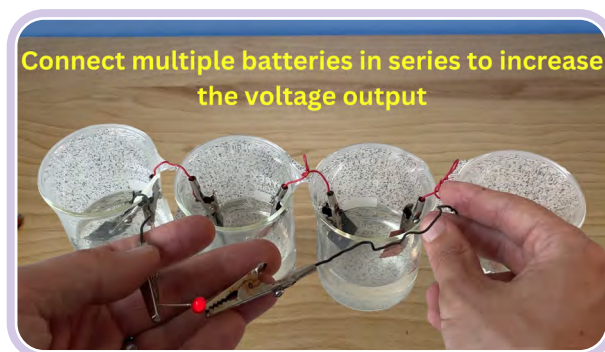
6. Creating the Electrolyte Solution:

- Add 1 teaspoon (5-7 ml) of 3% hydrogen peroxide in to the solution to enhance the reaction.
- Measure the DC voltage using a multimeter again after adding the hydrogen peroxide.



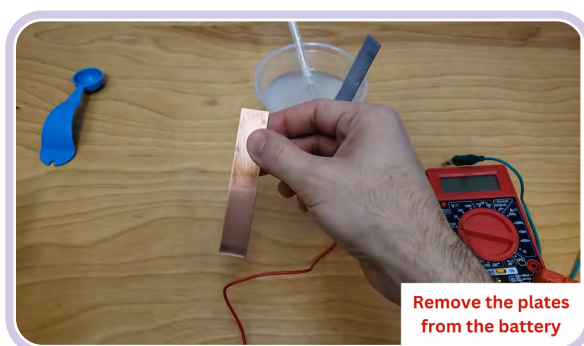
7. Improving Performance of the battery:

- Experiment with different amounts of salt or hydrogen peroxide.
- Use multiple cells connected in series to increase voltage.



8. Cleanup:

- Remove the plates, wipe them dry with a paper napkin/cloth.
- Finally clean the workspace after the experiments are over.



How does the Saltwater Battery work?

The DIY Saltwater Battery works based on the principles of electrochemistry, specifically through a galvanic cell reaction that converts chemical energy into electrical energy.

1. Electrolyte Solution:

- When salt (sodium chloride) is dissolved in water, it dissociates into sodium (Na^+) and chloride (Cl^-) ions, making the solution conductive.
- Hydrogen peroxide enhances the reaction by improving ion exchange.

2. Electrode Reactions:

- The zinc plate acts as the anode and undergoes oxidation, meaning it loses electrons and releases Zn^{2+} ions into the solution.
- The copper plate serves as the cathode, where reduction occurs, allowing it to gain electrons.

3. Electron Flow and Electricity Generation:

- Due to the chemical potential difference between zinc and copper, electrons flow from zinc (negative terminal) to copper (positive terminal) through the external circuit, creating an electric current.

- The movement of ions in the electrolyte helps sustain this reaction.

4. Voltage and Current Measurement:

- A multimeter connected to the circuit measures the voltage and current produced.
- The voltage depends on the metal pair used, and multiple cells can be connected in series to increase output.

In summary, this simple battery demonstrates the conversion of chemical energy into electrical energy using basic household materials, showcasing the fundamental working principles of batteries.



<https://youtu.be/WdCBoRW-J2I?si=BzXdLZB7ijMFvD6C>



https://youtu.be/V_2KYdZUUv8?si=K6ZpqR0SvC2MGGm4

Click the links or scan QR codes to watch DIY cum working video of the project.

How can you assess students' understanding?

Assessment of Concept Understanding

- What is a battery? How does it work? Where is it used?
- Explain the components of a battery and their functions
 - Anode
 - Cathode
 - Electrolyte
- Explain the components of a battery and their functions
 - Anode
 - Cathode
 - Electrolyte
- Show them the day-to-day applications of this project- Types of batteries



<https://youtu.be/Tye3dcBOqtY?si=PYgGqAxKR2KxxmPe>

Click the link or scan QR code to know more.

Assessment of Project Understanding

- Observe and assess the students' ability to follow the procedure and correctly construct the battery.
- Assess whether the model works as desired.
- Check the accuracy of the voltage and current readings during testing and analyze its accuracy.
- Conduct a quick Q&A session to evaluate their understanding of the working of the DIY Saltwater Battery.
 - o What role does the salt water solution play in the battery?
 - o Why do zinc and copper generate electricity when placed in the solution?
 - o How can we enhance the battery's efficiency?

Assessment of Teamwork

Discuss individual contributions in group settings and award each group member the badges - 'Ideator, Goal Getter, Co-Creator and Questioner based on their involvement in the project.
(Rubric for this is provided in the note for the teacher)

Design Thinking/Extensions and Modifications

Ask students the following questions and elicit answers from them. Some questions you can ask them and encourage them to think are given for your reference.

1. Can this model be used in real-life applications?
2. How can you modify this model?
 - You can use other electrolytes like lemon juice or vinegar and compare results.
 - Experiment with different electrode materials (e.g., aluminium, iron).
 - You can connect multiple cells in series or parallel and observe the changes in voltage/current.

Activity 11

Making a Model for Identifying Junk and Healthy Food Using Electronics



Grade



6, 7 and 8



Subject



Biology



Topic/
Concept



Components
of food

Objective

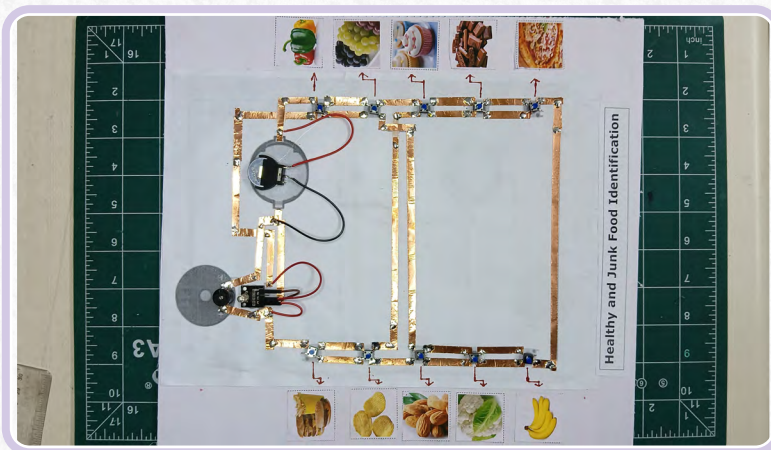
To enable students to understand basic concepts in electronic circuits and build a model to classify food as junk/ healthy and create nutrition awareness among them.

What will you help students learn?

- Basic electronic circuit concepts (conductivity, power sources, etc.).
- Nutrition awareness- identify and classify foods as healthy or junk.
- Soldering and circuit assembly skills.
- Problem-solving and creative thinking skills.

What will you build/make?

An interactive model to identify healthy and junk food using Copper Tape, RGB LED, Buzzer, Push Buttons.



<https://youtu.be/ZOBtBTs5Ls>

Click the link or scan QR code to watch DIY cum working video of the project.

What will you need?

Materials Needed

- Copper tape (conductive medium for the circuit)
- RGB LED/RGB module
- 220 Ohm resistor
- 3.3V battery and battery holder
- Healthy food and junk food stickers
- Ribbon cables for connecting components
- Buzzer

ATL Tools/Equipment

- Hot glue gun
- Ruler
- Pencil
- Cutting tools (scissors or precision cutter)
- Cutting mat
- Wire Stripper
- Multimeter (optional)
- Soldering kit- gun, stand, metal, flux, fume extractor
- Hand gloves



Procedure

Please Note: Meanings of words in the activity plan you may want to know are given in the Annexure

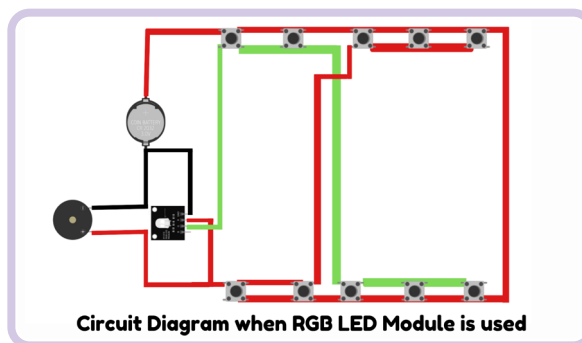
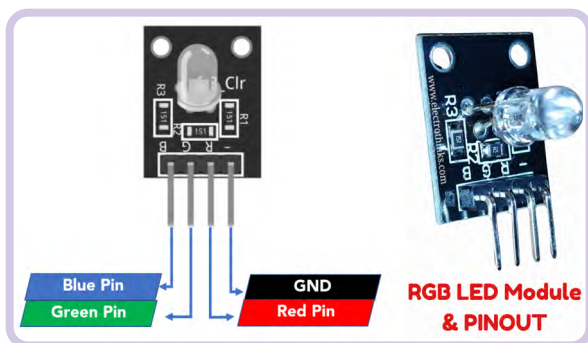
1. Preparation of Base:

- Click the link or scan QR code to download the paper circuit template if you are going to use an RGB LED module in your circuit.



<https://tinyurl.com/2a479nm2>

Below are the images representing RGB Module and circuit diagram for the project if you are using a RGB module in the circuit:



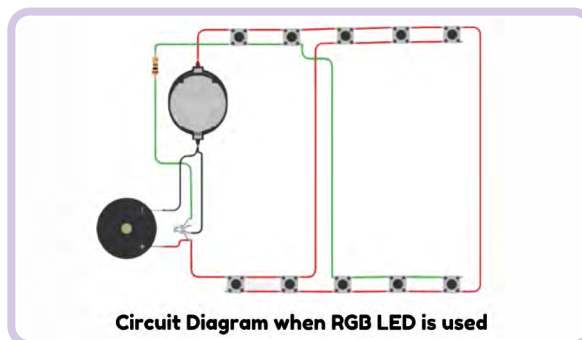
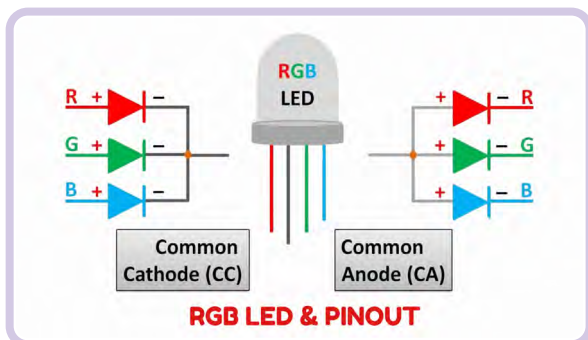
Circuit Diagram when RGB LED Module is used

- If you do not have an RGB module, you can use RGB LED and add 220 Ohm Resistor in series with battery's positive terminal as per the circuit diagram. Click the link or scan QR code to download the paper circuit template if you are going to use RGB LED in your circuit.



<https://tinyurl.com/mubtpbk>

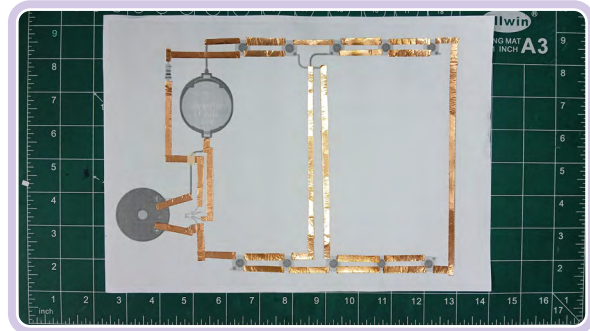
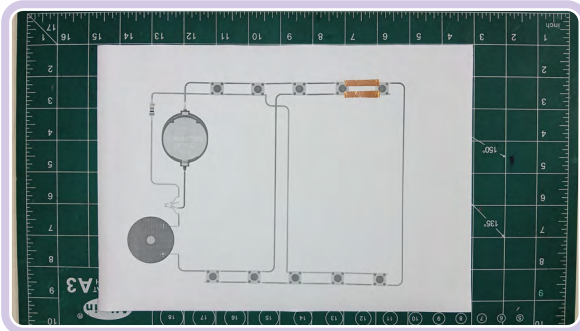
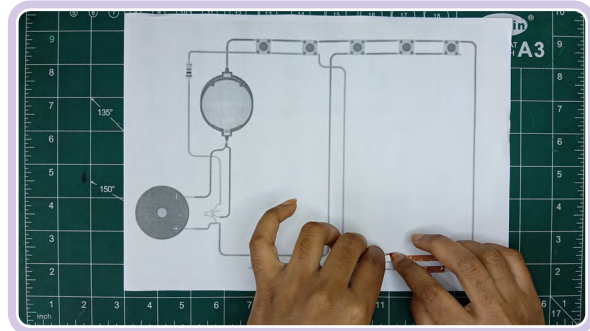
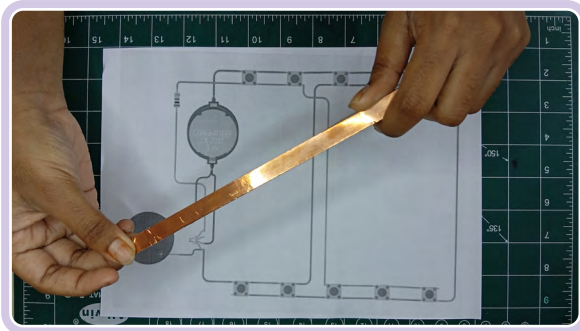
Below are the images representing RGB LED and circuit diagram for the project if you are using an RGB LED instead of RGB LED module in the circuit:



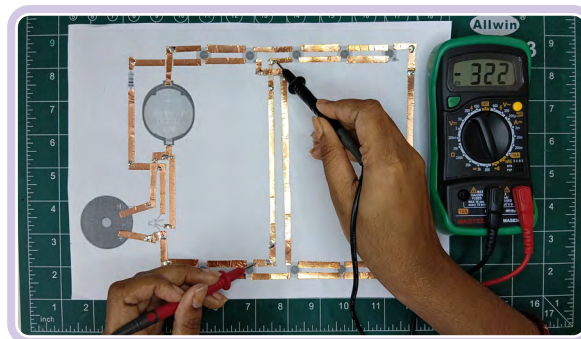
Circuit Diagram when RGB LED is used

2. Circuit Assembly (In this demonstration, we are using an RGB module):

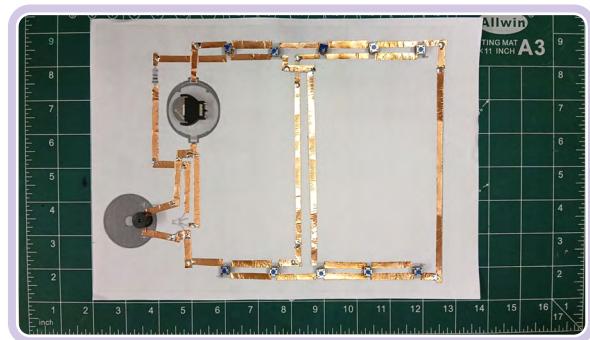
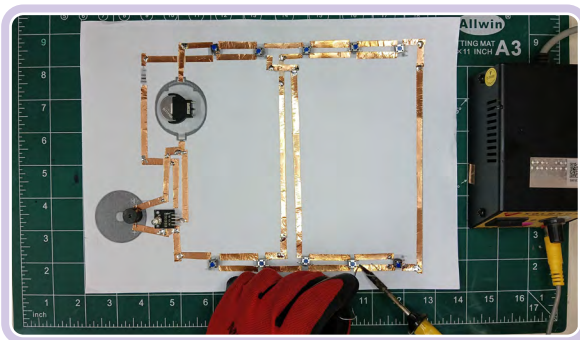
- Place copper tape along the printed circuit paths to create the conductive medium.



- Test the circuit multiple times using a multimeter for consistency.



- Solder push buttons at the marked locations along the circuit. The Push buttons are soldered in parallel.

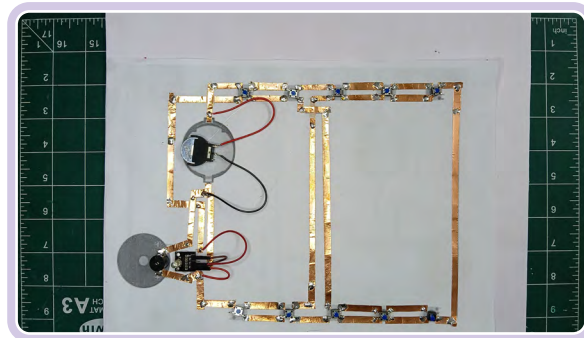
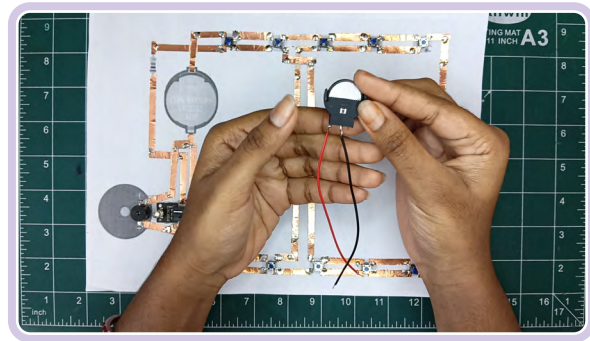
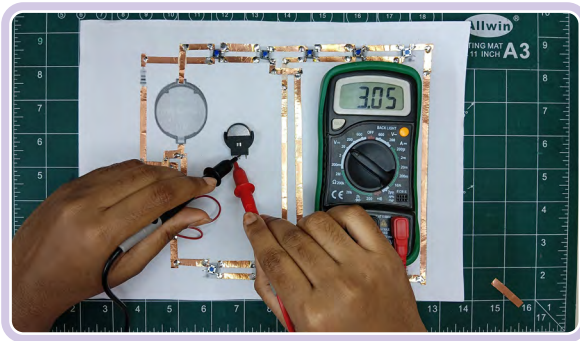


3. Integrating Components (In either of the cases (using RGB module or RGB LED):

- Connect the RGB LED module to the circuit. Ensure the red, green, and blue pins are clearly marked.
- Connect Green LED terminal of RGB module/RGB LED to the battery through push buttons corresponding to healthy food stickers as per the circuit diagram.
- After connecting the Red LED terminal of RGB module/RGB LED and buzzer in parallel, connect them to the battery through push buttons corresponding to junk food stickers as per the circuit diagram.

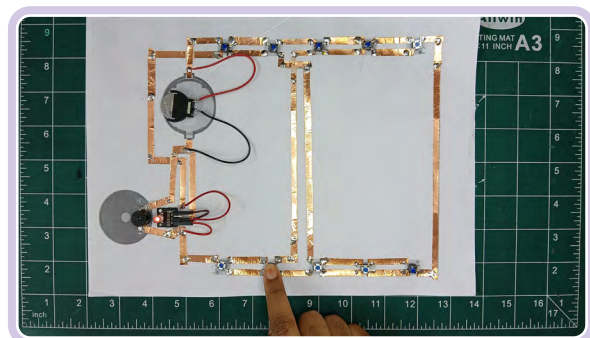
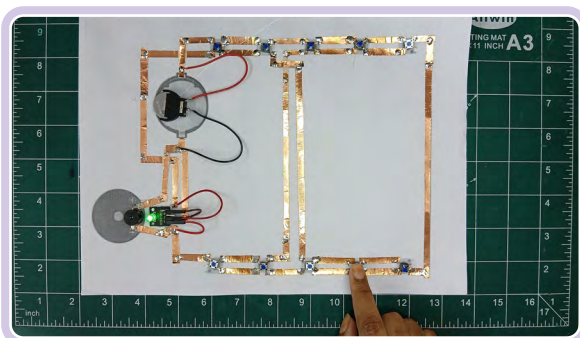
4. Power Connection:

- Attach the 3.3V battery holder to the circuit using ribbon cables and connect the 3.3V battery.



5. Testing the Circuit:

- Press the push button next to a healthy food sticker and ensure the green LED turns on.
- Press the push button next to a junk food sticker and verify that the red LED and buzzer turn on.

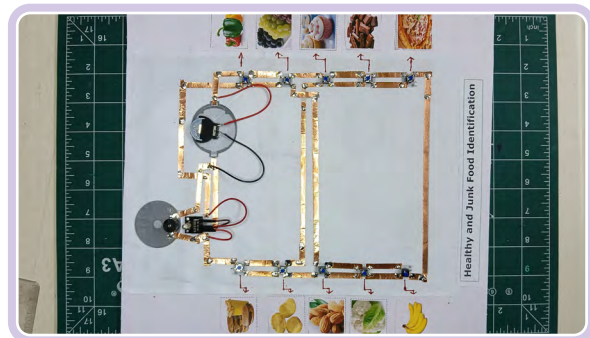
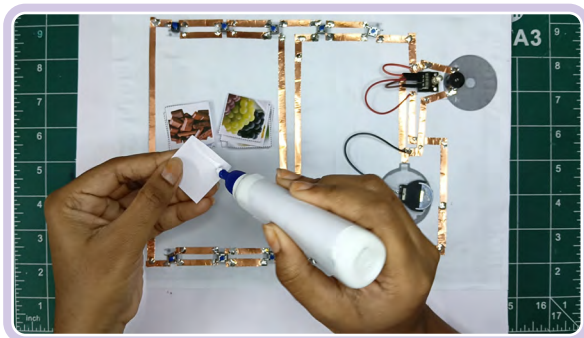
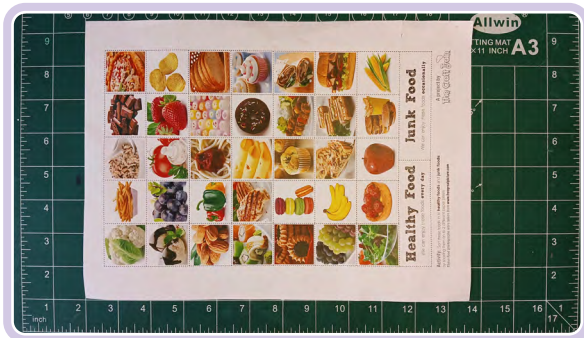


6. Final Touches:

- Stick the printed paper circuit template onto the foam sheet to serve as the base.
- Click the link or scan QR code to download stickers for healthy food and junk food.
- Arrange the healthy and junk food stickers in rows with space for the push buttons next to each sticker.



<https://tinyurl.com/4dwsut8>



How does the model work?

The model works by using a simple electronic circuit with push buttons, copper tape as conductors, an RGB LED module, and a buzzer to differentiate between healthy and junk food based on user input. By pressing a button next to any food item, the circuit determines whether it is healthy or junk based on the circuit design. The green light confirms healthy food, while the red light and buzzer indicate junk food.



<https://youtu.be/ZOBBtBTs5Ls>

Click the link or scan QR code to watch DIY cum working video of the project.

How can you assess students' understanding?

Assessment of Concept Understanding

- Evaluate students' understanding of healthy and junk foods.
- Why is identifying healthy and junk foods important for our health?

Assessment of Project Understanding

- Observe and assess the students' ability to follow the procedure and correctly assemble and operate the set up.
- Assess whether the circuit correctly lights up the compatible LEDs for each button press.
- Check for creativity in assembling the model.
- Conduct a quick Q&A session to evaluate their understanding of the working of the model.
 - o How does this model work in terms of electronic principles?
 - o What other applications could this concept have in real life?
- Observe the functionality of the model +during testing and analyze its accuracy.

Assessment of Teamwork

Discuss individual contributions in group settings and award each group member the badges - 'Ideator, Goal Getter, Co-Creator and Questioner based on their involvement in the project.
(Rubric for this is provided in the note for the teacher)

Design Thinking/Extensions and Modifications

Ask students the following questions and elicit answers from them. Some questions you can ask them and encourage them to think are given for your reference.

How can you modify this model?

- You can use different colored LEDs to represent different categories of food apart from the category of healthy and junk food.
- You can expand the model to include information on the nutritional value of each food item on the model created.
- You can develop a fun-filled animation using scratch program showing healthy and junk food.

Activity 12

Making an Animation Showing Healthy and Junk Food using Scratch or PictoBlox



Grade ▶ **6, 7 and 8**



Subject ▶ **Biology**



**Topic/
Concept** ▶ **Components
of Food**

Objective

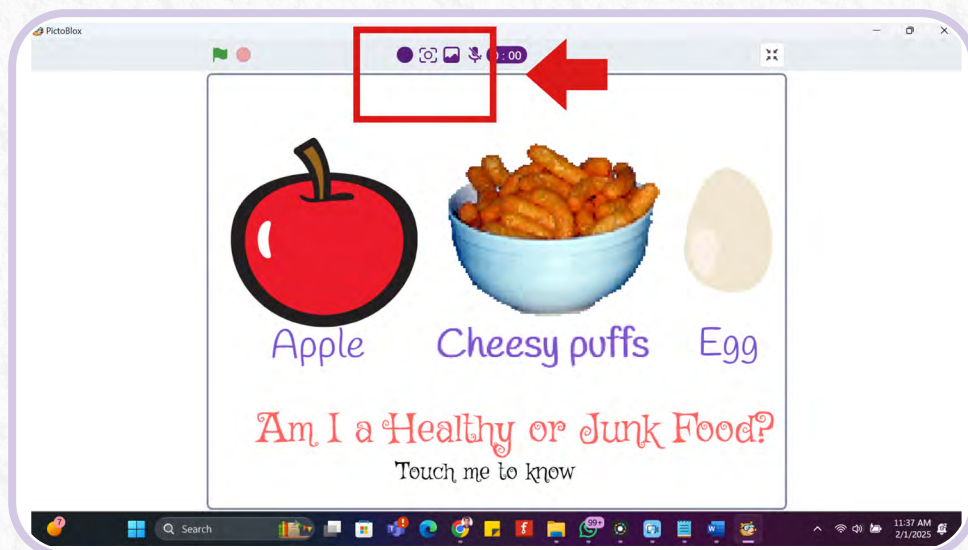
To develop basic programming skills using Scratch or PictoBlox.

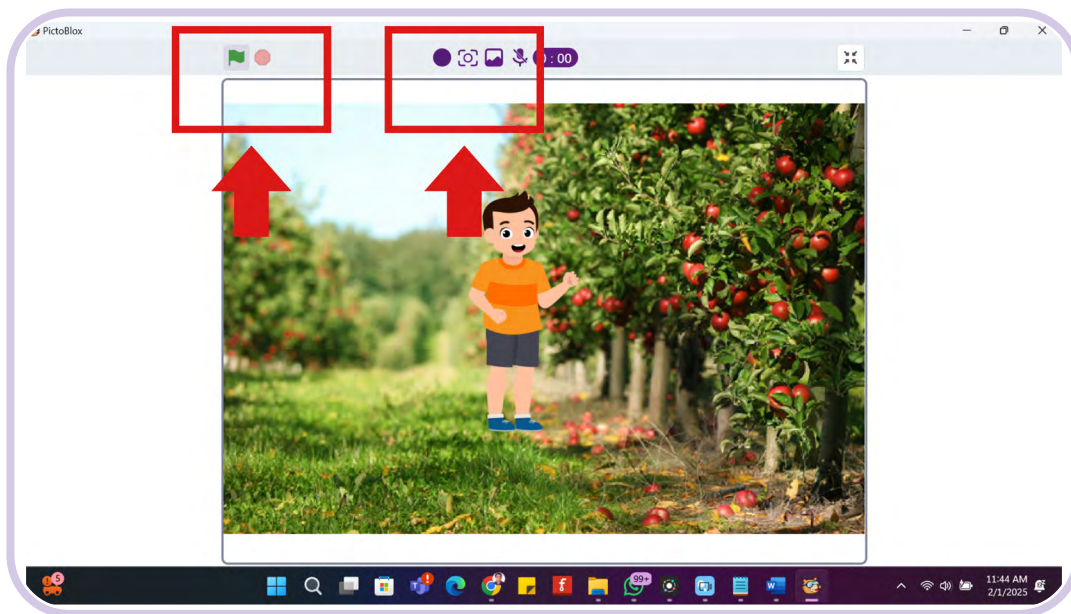
What will you help students learn?

- Basic programming concepts like sprites, backdrops, events, motion, sensing, control, and sound blocks in their animation to understand the difference between healthy and junk food.
- To develop basic programming skills using Scratch or PictoBlox.
- To develop any other interactive concept using block coding.

What will you build/make?

An interactive model to identify healthy and junk food using Scratch or PictoBlox through an animation.





<https://youtu.be/8SkD1o0x35U>



<https://youtu.be/MHQ7tdHjN2A>

Click on the links or scan QR codes to watch DIY cum working videos of the project.

What will you need?

Materials Needed

- Images of Foods (Link to download the images is given in the procedure or you can use your own images)
- Background Images (To be used as backdrops in the animation.)
- Notebook and pen/pencil

ATL Tools/Equipment

- Computer or Tablet
- Internet Access
- Headphones with mic and Speakers

Software/Application

- Scratch or PictoBlox
- Image Editing Software like Canva (optional) to customize or create sprites and backdrops, if needed)

Procedure

Please Note: Meanings of words in the activity plan you may want to know are given in the Annexure

1. Introduction to Healthy food and Junk Food:

- Discuss the characteristics of healthy food and junk food.
- Show examples of fruits, vegetables, eggs (healthy) and chips, burgers, soda (junk).
- Explain why eating healthy food is important for good health.

2. Introduction to Scratch or PictoBlox:

- Click the link or scan QR code to download and install the PictoBlox software.
- Briefly explain what Scratch or PictoBlox is. Click the link or scan QR code to learn more on Pictoblox software.



<https://tinyurl.com/bdewc3e6>



<https://tinyurl.com/yc5zr98e>

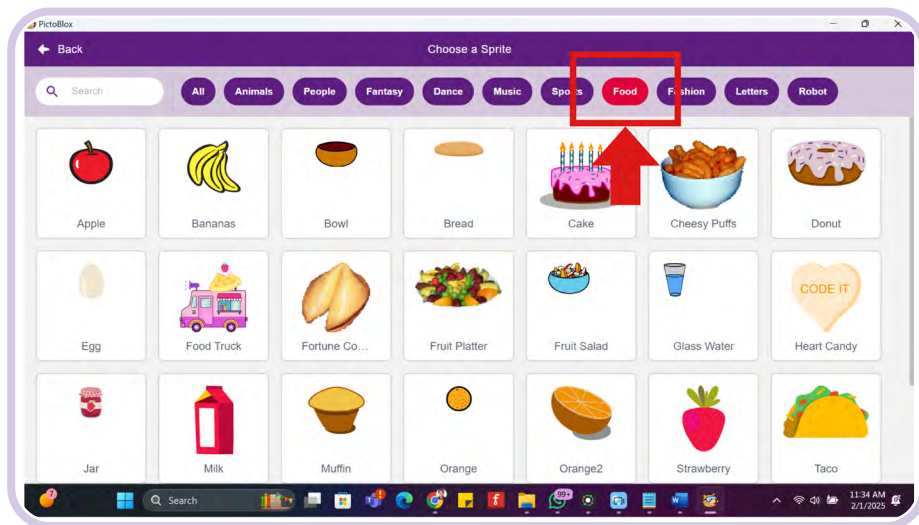
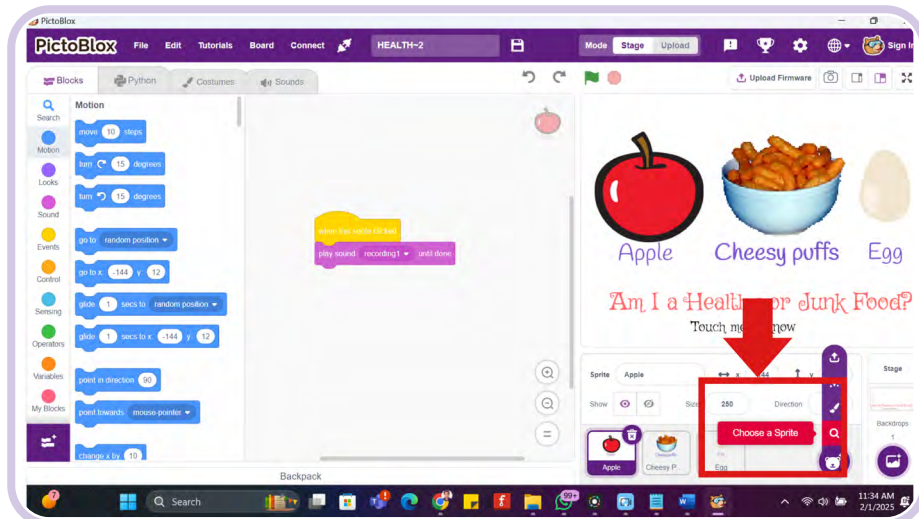
- Show students the interface, including:
 - o Sprites panel
 - o Backdrop section
 - o Coding blocks (motion, events, control, sounds, and sensing)

3. Model 1: Basic Animation:

This model introduces a simple interaction with sprites.

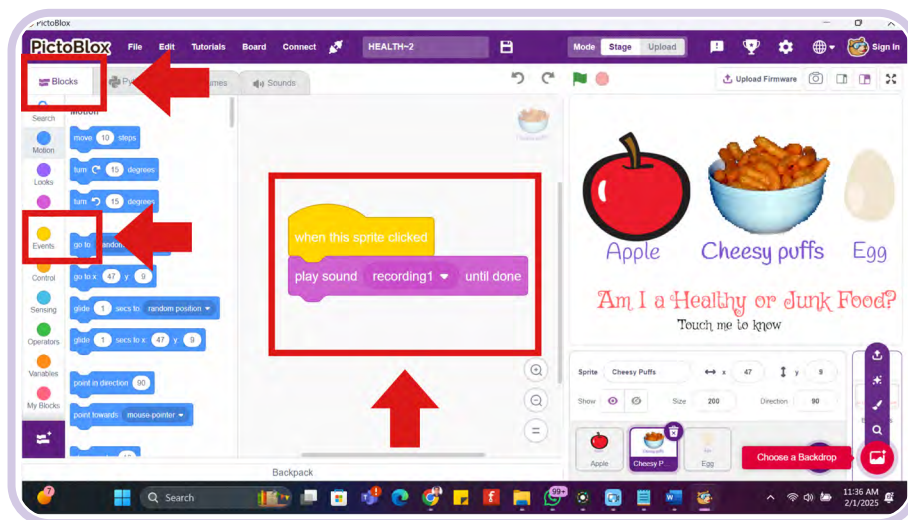
Step 1: Add Sprites

- Open Scratch or PictoBlox.
- Add three sprites from sprites Library within the software:
 1. Apple (Healthy food)
 2. Egg (Healthy food)
 3. Cheesy Puffs (Junk food)

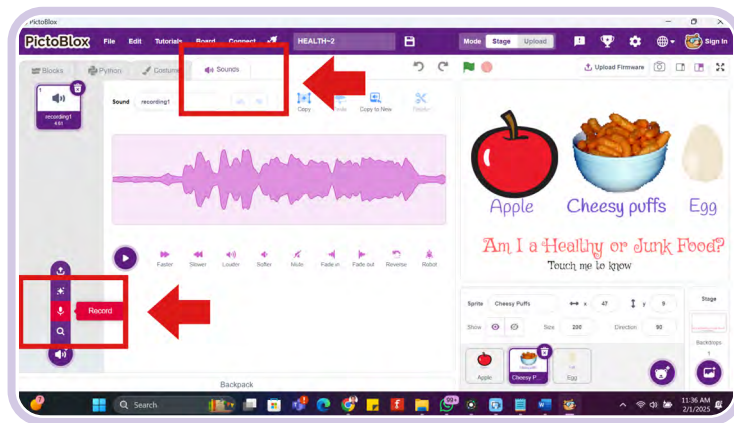


Step 2: Code the Sprites

- Use the "When this sprite is clicked" block for each food sprite.



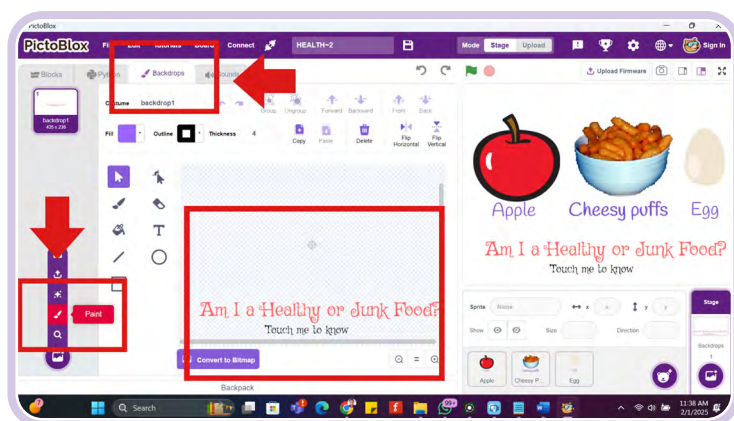
- Record the sounds and add the sound effect when each sprite is clicked.



- Program the apple and egg to say "Healthy food" or you can customize your own message. Program the cheesy puffs to say "Junk food" or you can customize your own lines.

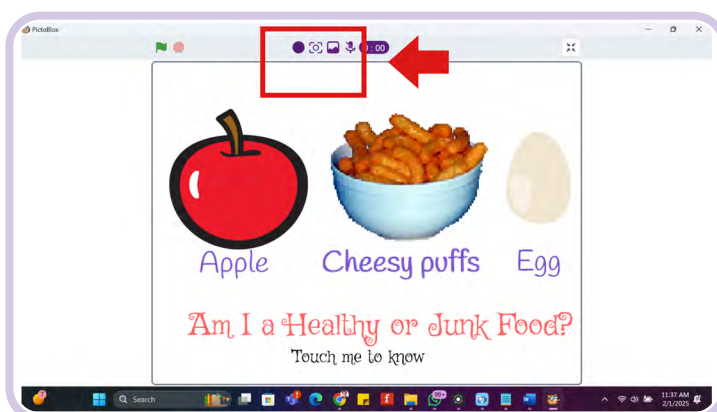
Step 3: Add Some Backdrop

- Go to "Backdrop editing section" to add text to make the animation interesting.



Step 4: Play and Test the Animation

- Click on each food item to check if the correct sound is played. You can also record the entire animation as shown in the image below.



<https://youtu.be/8SkD1o0x35U>

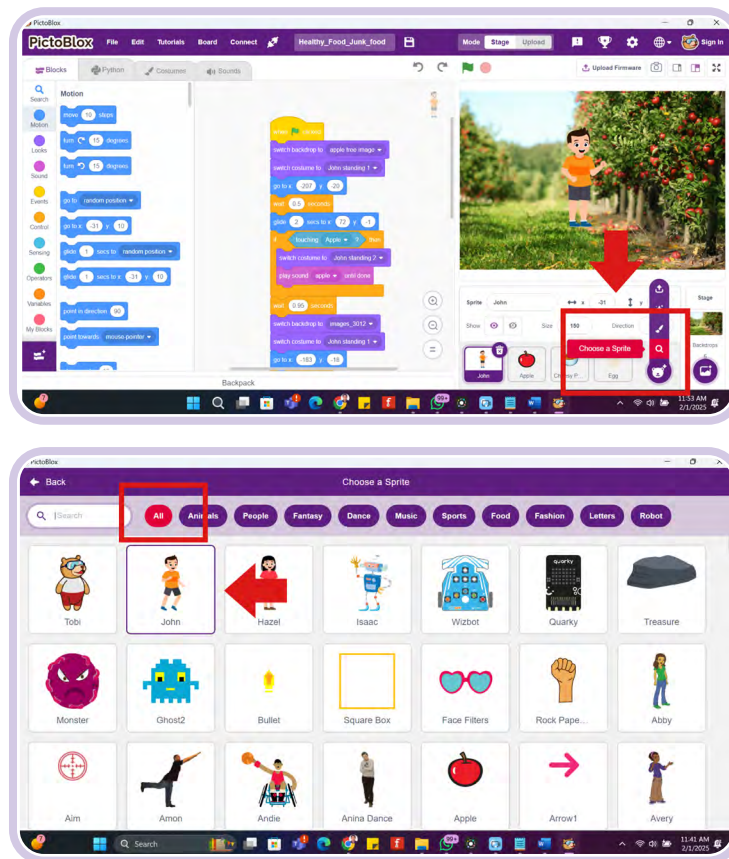
Click on the link or scan QR code to watch DIY cum working videos of the project.

4. Model 2: Advanced Animation:

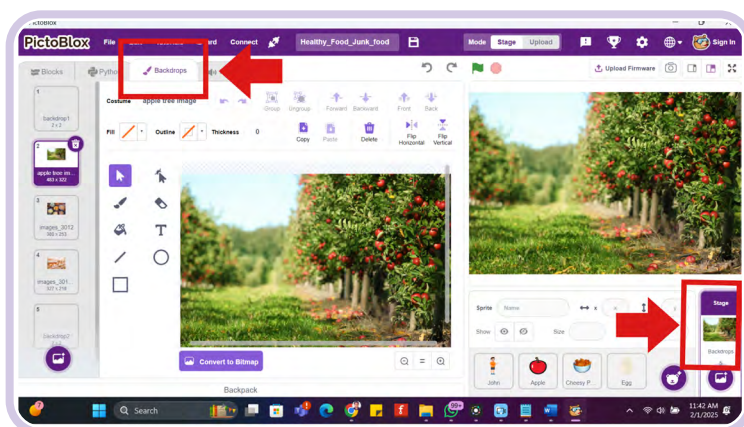
This model includes a boy sprite, more detailed animations, and interactive elements.

Step 1: Add Sprites and Backdrops

- Add the boy sprite from sprite library in the software.



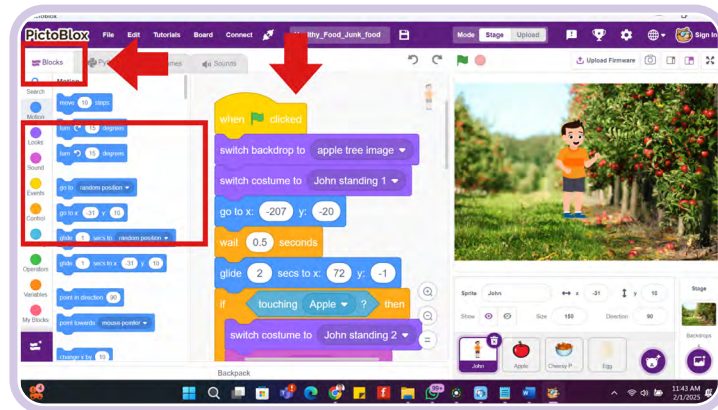
- Add backdrops: Apple trees (For 'Healthy food' setting).
- Cheesy food shelves (For 'Junk food' setting).
- Egg crates in a supermarket (For 'Healthy food' setting).
- Click the link or scan QR code to download the images we have provides that you can use as backdrops.



<https://tinyurl.com/2x59a86e>

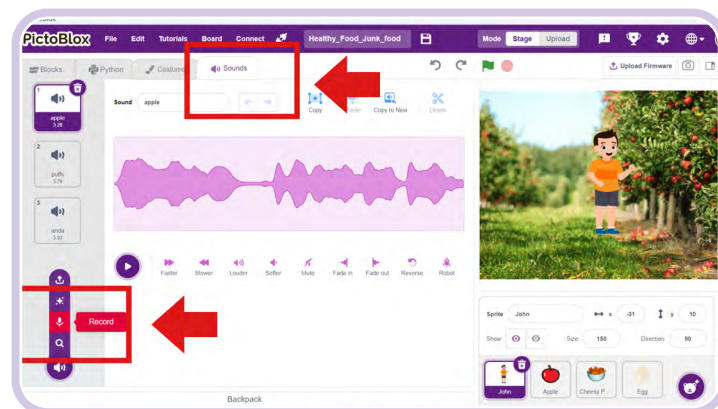
Step 2: Make the Boy Move

- Use the "Move" block to allow the boy to move towards the food.
- Use the "Sensing" block to detect the action of the boy when he touches a food sprite.



Step 3: Program Interaction

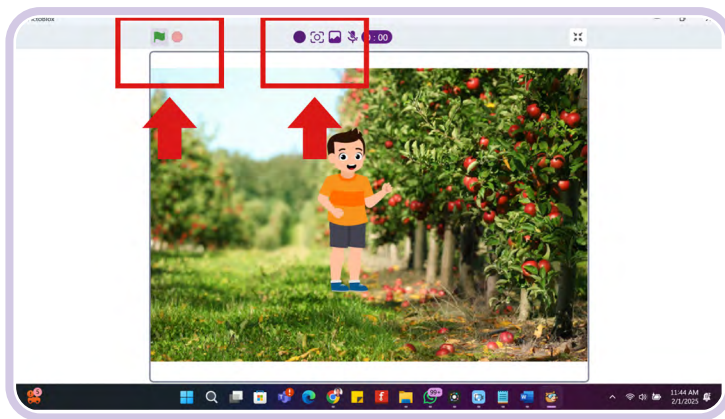
- Record the sounds and then add sound effects for healthy and junk food.



- When the boy touches an apple or egg, he says "This is healthy food!" or you can customize your own message.
- When the boy touches cheesy puffs, he says "This is junk food!" or you can customize your own message.

Step 4: Test and Refine the Animation

- Check if the boy correctly identifies the food. You can also record the entire animation as shown in the image below.
- Make necessary adjustments to ensure smooth animation.



<https://youtu.be/MHQ7tdHjN2A>

Click on the link or scan QR code to watch DIY cum working videos of the project

How does the Animation work?

The animations created in Scratch or PictoBlox is an interactive program to identify different food items as either healthy or junk food. The animation progresses in two stages:

1. Basic Interaction (Model 1)

- The user clicks on food sprites (Apple, Egg, Cheesy Puffs).
- Each sprite plays a sound saying either "Healthy food" or "Junk food" when clicked.
- This helps students understand the categorization of food.

2. Advanced Animation (Model 2)

- A boy sprite is introduced, along with backdrops representing different settings (e.g., apple orchards, supermarket with cheesy puffs and eggs).
- The boy moves towards the food sprites using motion blocks.
- When the boy touches a food item, the program uses sensing blocks to trigger a response.
- The boy speaks a message (e.g., "This is healthy food!" for apples and eggs, "This is junk food!" for cheesy puffs). The program uses a sound block.
- Sound effects enhance engagement, and the animation helps reinforce learning through interaction.

The animation works dynamically by combining events, motion, sensing, sound, and control blocks.

How can you assess students' understanding?

Assessment of Concept Understanding

Evaluate students' understanding of healthy and junk foods.

Assessment of Project Understanding

- Observe and assess the students' ability to follow the procedure and correctly develop the program.
- Check for creativity in developing the program.
- Conduct a quick Q&A session to evaluate their understanding of the working of the model.
 - o How does animation help in learning new concepts?
 - o What challenges did you face while coding the animation?
 - o How can you improve this project?
- Observe if students can construct a functional animation.
- Observe the functionality of the program during testing and analyze the following.
 - o Functionality: Does the animation work correctly?
 - o Creativity: Are the sprites and backdrops well-designed?
 - o Code Complexity: Have students used motion, sensing, and events correctly?
- Ask- Where have you seen this application being used around you?

Assessment of Teamwork

- Discuss individual contributions in group settings and award each group member the badges - 'Ideator, Goal Getter, Co-Creator and Questioner based on their involvement in the project. *(Rubric for this is provided in the note for the teacher)*

Design Thinking/Extensions and Modifications

Ask students the following questions and elicit answers from them. Some questions you can ask them and encourage them to think are given for your reference.

How can you modify this model?

- Add more food items and categorize them.
- You can create game with levels where the boy collects only healthy foods within a time limit.
- You can add a score system to track the number of healthy and junk foods collected.

Activity 13

Creating an Animation Showing Self-Pollination and Cross-Pollination Using Scratch or Pictoblox



Grade ▶ **6, 7 and 8**



Subject ▶ **Biology**



Topic/ Concept ▶ **Pollination and its types**

Objective

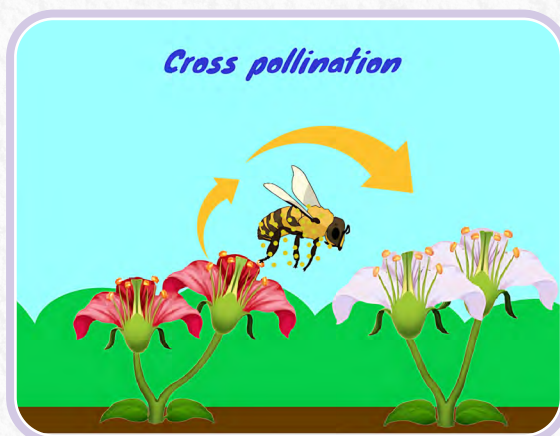
To learn about different types of pollination and reinforce the understanding of pollination.

What will you help students learn?

- Computational thinking and creativity in representing biological concepts.
- The process of self-pollination and cross-pollination.
- Basics of block coding in Scratch/PictoBlox and use sprites, backdrops, sounds, etc. to develop an animation.

What will you build/make?

This activity helps to illustrate the various types of pollination by designing digital/computer animation.



Click the link or scan QR code to watch DIY cum working video of the project



<https://youtu.be/g7mIK2OOamI>

What will you need?

Materials Needed

- Pre-designed images (flower, pollen, bee, wind arrow, clouds, sun)- (Link to download the images is given in the procedure or you can use your own images)
- Sound files (wind, bee buzz, thunderstorm)- (Link given to download or you can use your own)
- Notebook and pen/pencil

ATL Tools/Equipment

- Computer or Tablet
- Internet Access
- Headphones with mic and Speakers

Software/Application

- Scratch or PictoBlox
- Image Editing Software like Canva (optional)

Procedure

Please Note: Meanings of words in the activity plan you may want to know are given in the Annexure

1. Introduction to Pollination Concepts:

- Explain **self-pollination**: The transfer of pollen from the anther to the stigma of the same flower or between flowers on the same plant.
- Explain **cross-pollination**: The transfer of pollen from the anther of flowers one plant to the stigma of a flower on another plant, often facilitated by agents like bees, wind, or water.
- Use diagrams or videos to reinforce concepts.

2. Introduction to Scratch/Pictoblox Software:

- Demonstrate how to use the software interface, including sprite creation, programming blocks, and stage setup.
- Click the link or scan QR code to download and install the PictoBlox software.
- Briefly explain what Scratch or PictoBlox is. Click the link or scan QR code to learn more on Pictoblox software.



<https://tinyurl.com/bdewc3e6>



<https://tinyurl.com/yc5zr98e>

- Show students the interface, including:
 - o Sprites panel
 - o Backdrop section
 - o Coding blocks (motion, events, control, sounds, and sensing)

3. Preparations: Download the required files:

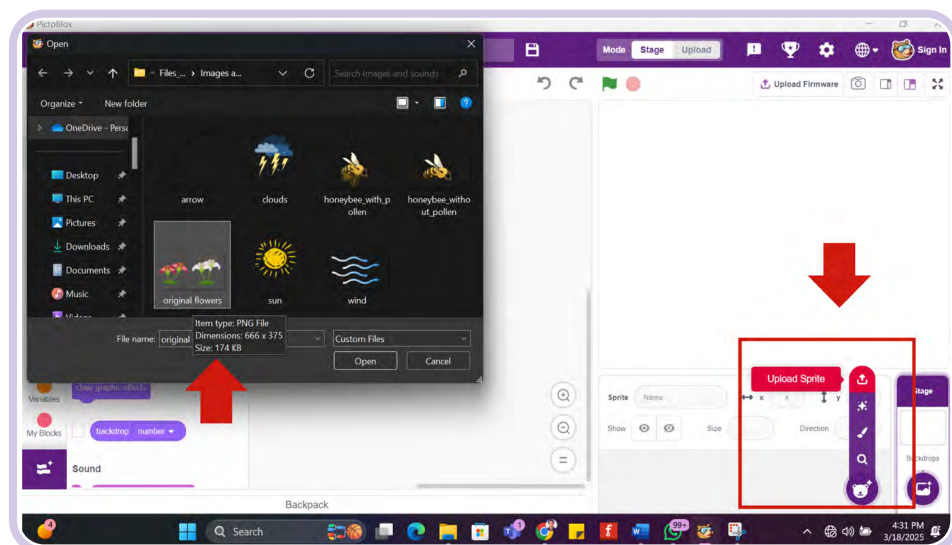
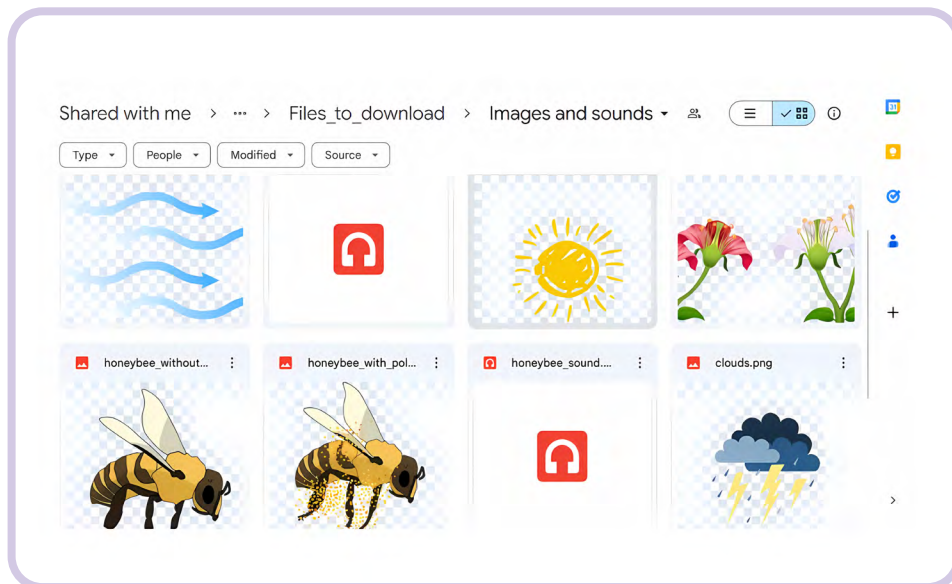
- Download the required images and sound files that have been provided.
- Click the link or scan QR code to download the files



<https://tinyurl.com/yc53j68x>

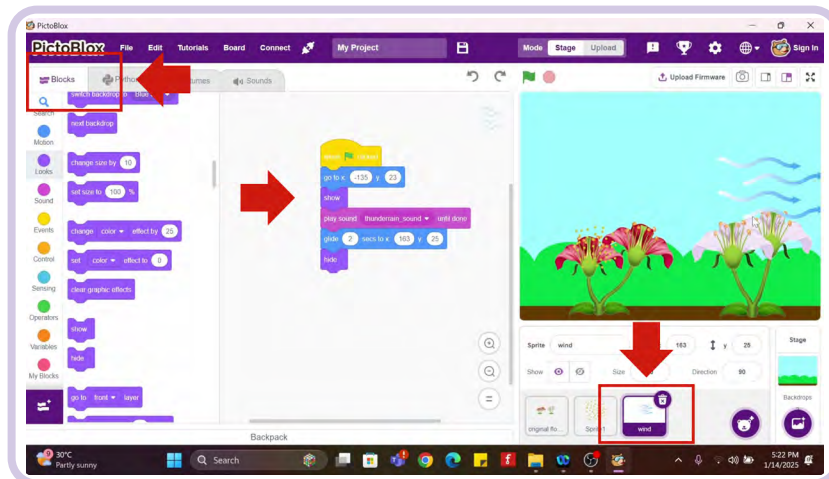
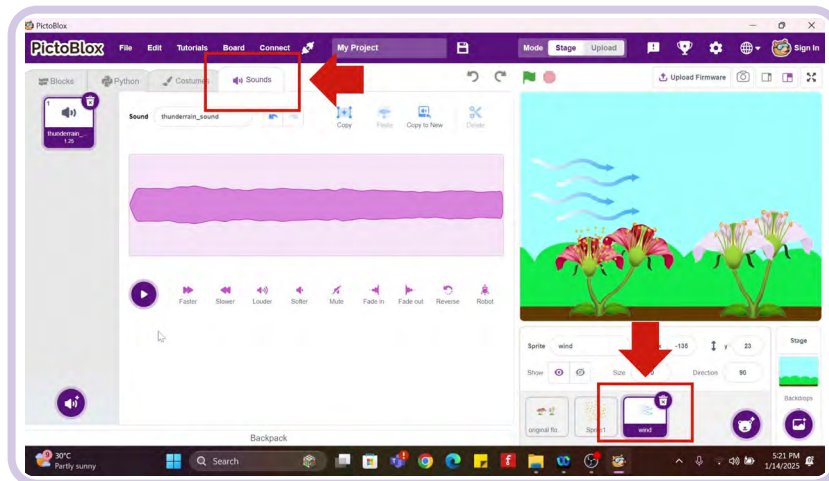
4. Creating the Animation:

- **Step 1:** Import sprites (flower, pollen, bee, wind arrow, sun, clouds).
 - o Import the downloaded files in PictoBlox as sprites as shown in the image.



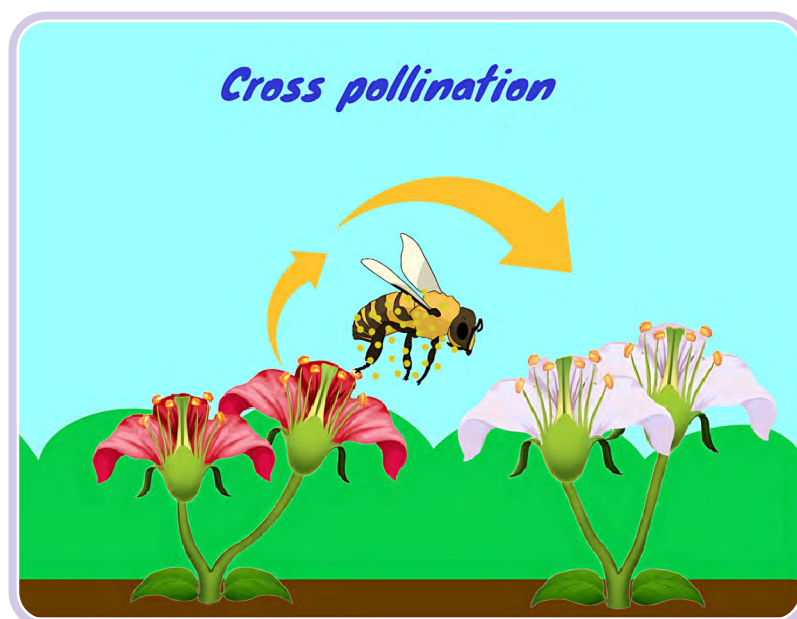
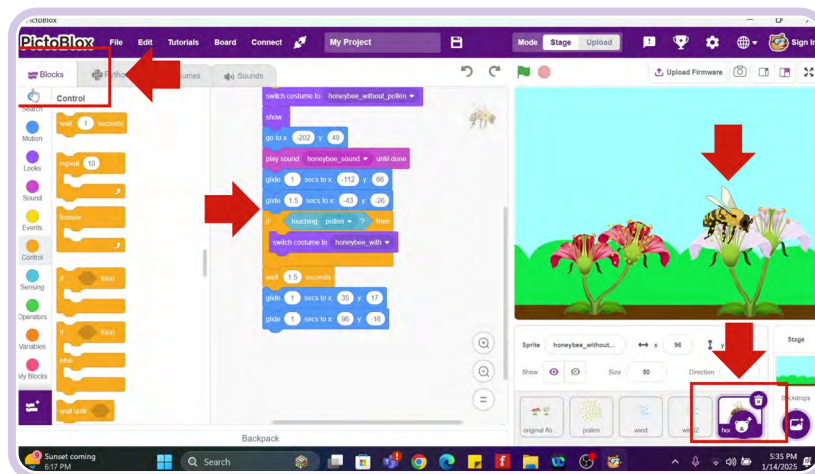
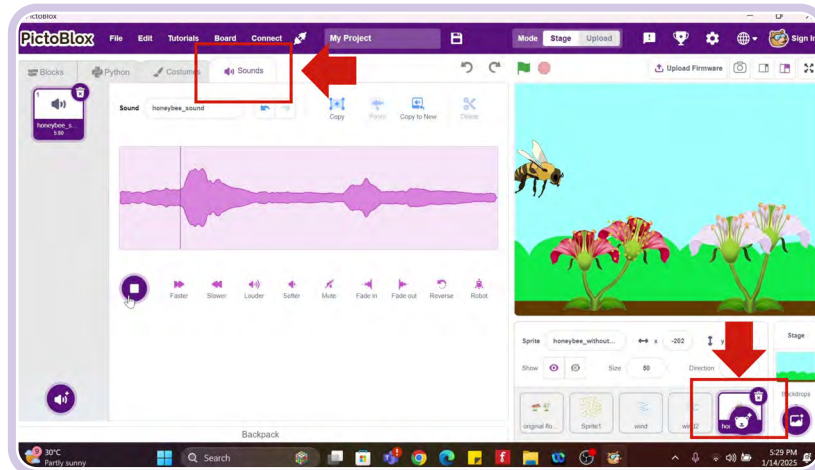
- **Step 2: Program the animation for self-pollination:**

- o Use wind sprites to simulate pollen movement.
- o Show pollen moving within the same flower.
- o Add sound effects of wind.

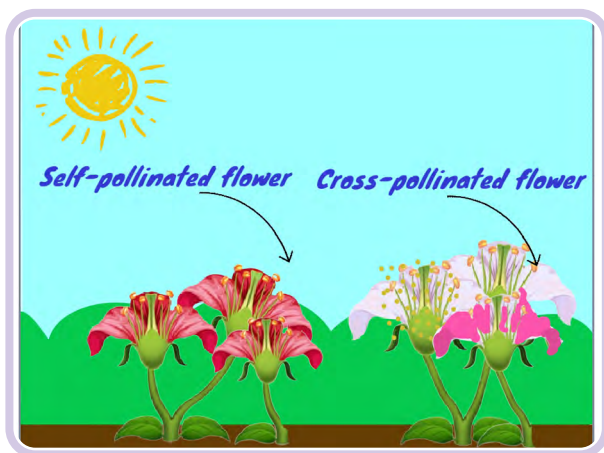
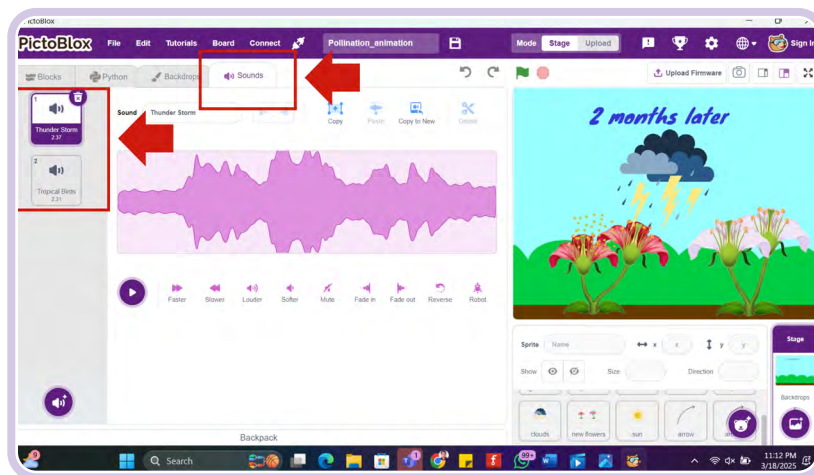
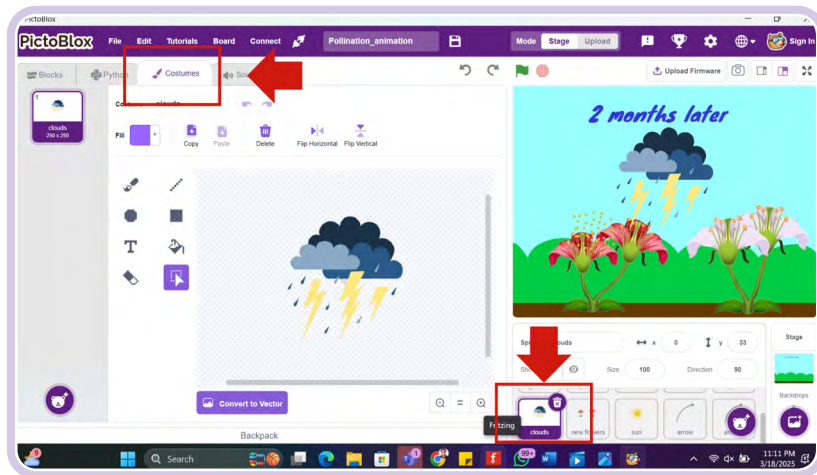


- **Step 3: Program the animation for cross-pollination:**

- o Use the bee sprite to carry pollen between flowers.
- o Show the pollen landing on a different flower.
- o Add the buzzing sound for the bee.



- **Step 4: Add thunderstorm animation and new flowers blooming as a result of pollination:**
 - o Use cloud sprites to create a rain effect.
 - o Play thunderstorm sounds to simulate rain occurring two months later.
 - o Add new flowers blooming as sprites in to animation at the end.

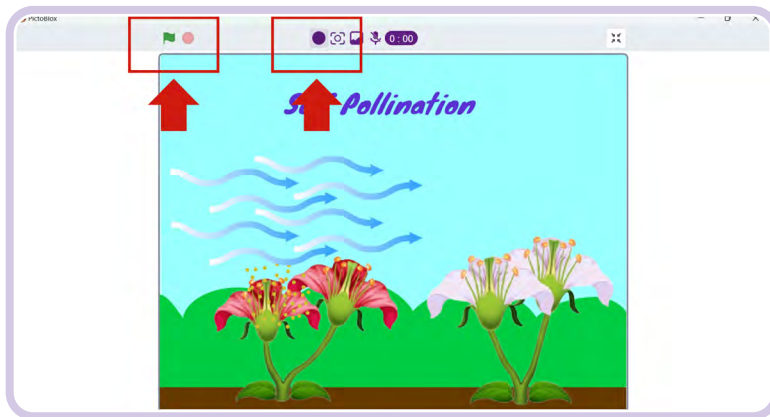


- **Step 5: Testing and Debugging:**

- o Allow students to test their animations and identify issues specifically with wait times, sprite movements, etc.
- o Provide guidance on debugging.

5. Recording the final Animation on full screen mode:

- Use the video record button on the full screen mode to record the entire animation from start to end so that you can use that video as a learning aid in the classroom.



<https://youtu.be/g7mlK2OOamI>

Click the link or scan QR code to watch
DIY cum working video of the project

How does the Animation work?

The animation created in Scratch or Pictoblox visually represents the processes of self-pollination and cross-pollination using interactive sprites and programmed movements. The animation follows a logical sequence with smooth transitions from one event to the other. This is possible because of the fine adjustments in the block coding. The sequence of events in the animation follows these steps:

1. Self-Pollination Animation (Wind as Pollinator).
2. Cross-Pollination Animation (Honeybee as Pollinator).
3. Thunderstorm and Rain After Two Months.

As the user clicks on the 'Go' button (Green flag on the top left), the animation starts as per the sequence of events mentioned above. One can record the entire animation in full screen mode and use the recorded video as a learning-aid in your biology class.

How can you assess students' understanding?

Assessment of Concept Understanding:

- Evaluate students' understanding of pollination and its types.
- How do wind and bees contribute differently to pollination?
- Why is cross-pollination important for biodiversity?
- What other agents of pollination can be included in the animation?

Assessment of Project Understanding:

Observe and assess the students' ability to follow the procedure and correctly assemble and operate the set up.

- Observe and assess the students' ability to follow the procedure and correctly develop the program.
- Check for creativity and accuracy in developing the program.
- Observe if students can construct a functional animation.
- Observe the functionality of the program during testing and analyze the following.
 - o Functionality: Does the animation work correctly?
 - o Creativity: Are the sprites and backdrops well-designed?
 - o Code Complexity: Have students used sounds, motion, sensing, and events correctly?
- Ask- Where have you seen this application being used around you?

Assessment of Teamwork:

Discuss individual contributions in group settings and award each group member the badges - 'Ideator, Goal Getter, Co-Creator and Questioner based on their involvement in the project.
(Rubric for this is provided in the note for the teacher)

Design Thinking/Extensions and Modifications

Ask students the following questions and elicit answers from them. Some questions you can ask them and encourage them to think are given for your reference.

1. How can you modify this model?
 - Advanced students can add more agents of pollination (e.g., birds or water).
 - Encourage students to design a storyline (e.g., life of a flower).
 - You can integrate quizzes into the animation.

Activity 14

Making a DIY Model to Learn Types of Triangles



Grade



6, 7 and 8



Subject



Mathematics



Topic/
Concept



Types of
Triangles

Objective

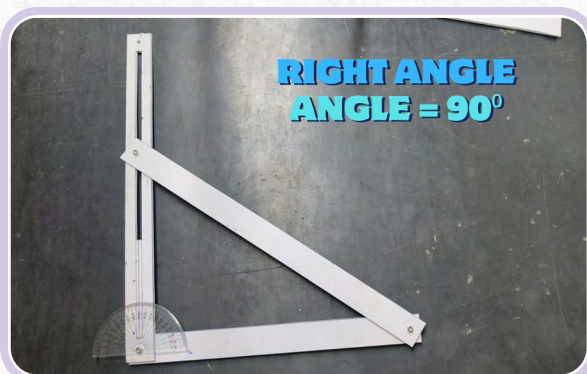
To reinforce geometric concepts related to angles and triangles.

What will you help students learn?

- Use problem-solving and hands-on construction techniques to reinforce mathematical understanding.
- To construct a functional model demonstrating different types of triangles.
- To identify acute, right, and obtuse triangles by adjusting the mechanism and measuring angles.
- Properties of acute, right, and obtuse triangles.
- Measuring, cutting, and assembling skills through hands-on activities.

What will you build/make?

In this activity, students will build a DIY adjustable triangle model using foam board, screws, and nuts. This model consists of three brackets assembled together, with one bracket featuring a slot mechanism that allows movement to change the angle of intersection. By adjusting this mechanism, students can form different types of triangles—acute, right, and obtuse—and use a protractor to measure angles.



Click the link or scan QR code to watch DIY cum working video of the project.



<https://youtu.be/G3gJOFqMHxk>

What will you need?

Materials Needed

- 180-degree protractor
- Foam board
- Printable template (given below)
- Paper glue
- M4 size Screws and nuts

ATL Tools/Equipment

- Paper cutter
- Cutting mat
- Cordless drilling machine with drill bit of Dia 5 mm
- Hand gloves
- Safety goggles
- Marker pen/Pencil
- Ruler
- Screwdriver
- Paper cutter

Software/Application

- 'Mathsisfun', a web-based application (Optional)

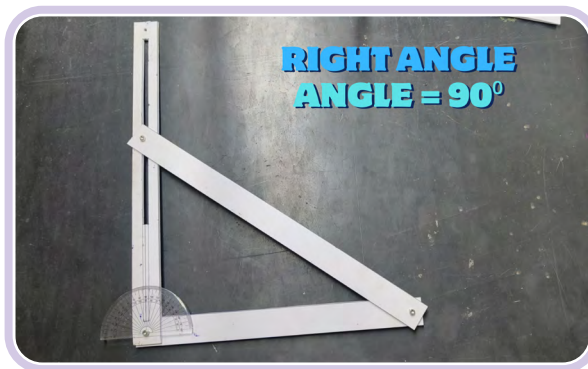


Procedure

Please Note: Meanings of words in the activity plan you may want to know are given in the Annexure

1. Introduction & Explanation:

- Begin by reviewing types of triangles (acute, right, obtuse) and their properties.
- Show students a sample model or a diagram explaining the mechanism.
- Explain how the adjustable bracket allows one to demonstrate the types of triangles.



2. Preparation:

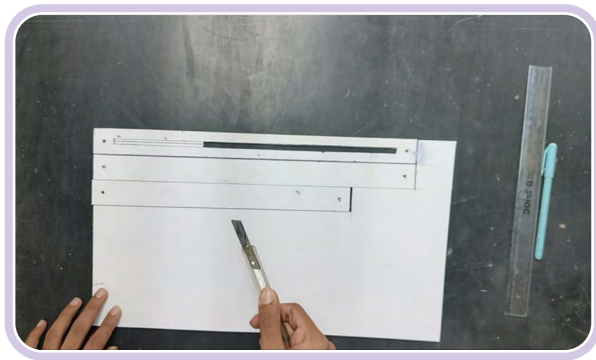
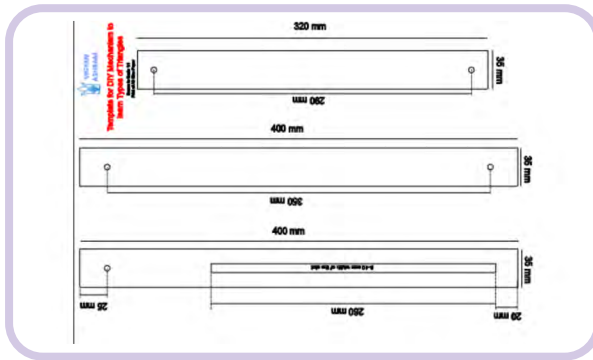
- Click the link or scan QR code to download and print the template on A3 size paper. This template is required for building the model.
- You can also refer to the dimensions mentioned in the template and draw the structure yourself using pencil/marker and ruler.
- Distribute printable templates and foam boards to students.
- Ensure all materials and tools are available at workstations.



<https://tinyurl.com/3c72u9j3>

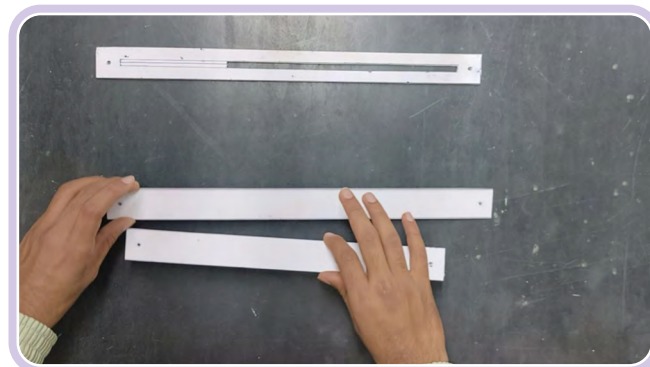
3. Cutting the Brackets:

- Stick the printable template onto the foam board using paper glue.
- Use a paper cutter to carefully cut along the marked lines.
- Double-check the bracket shapes for accuracy.



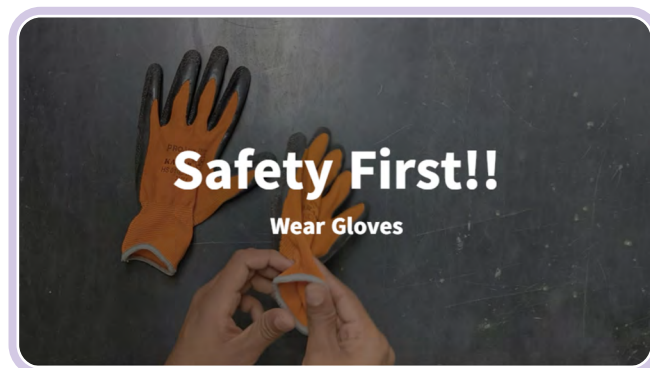
4. Making the Adjustable Slot:

- Identify the bracket that needs a slot for adjusting the angle.
- Carefully cut out the slot using the paper cutter, ensuring it is smooth.



5. Assembling the Model:

- Wear hand gloves and safety goggles for your safety.

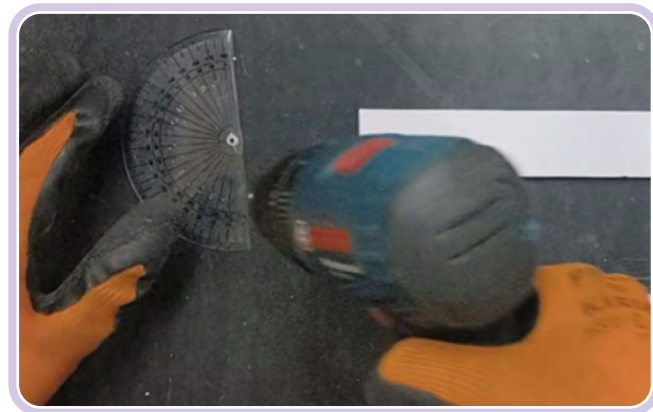


- Take the cordless drilling machine and drill bit as per the dimensions of the screws you will be using to assemble the model (Recommended size is 4-5 mm)

- Make holes on the extreme ends of the brackets as shown in the template and the DIY video (QR code is provided in the subsequent part of the activity plan).



- Make a hole at the zero marking (origin) on the protractor also. Be careful while making this hole as the protractor material is brittle and it may crack easily if you apply great pressure on the drill machine.



- After making holes, align the three brackets to form a triangle.
- Mount the 180-degree protractor at the ends of the smallest bracket in such a way that the zero marking on the protractor matches the center line of the bracket having a slot.
- Use screws and nuts to attach the brackets at their joints.
- Ensure the screws are tight enough to hold the brackets but loose enough to allow movement.



<https://youtu.be/G3gJOFqMHxk>

Click the link or scan QR code to watch DIY cum working video of the project.

6. Testing the Model:

- Adjust the slotted bracket to change the angle of intersection.
- Use the protractor to measure angles and classify the triangle as acute, right, or obtuse.
- Encourage students to compare their results and discuss observations.

How does the model work?

The DIY adjustable triangle model works by using three foam board brackets connected with screws and nuts at the joints to form a triangle. One of the brackets has a slotted mechanism, allowing movement to change the angle of intersection.

Steps of Operation:

1. Adjust the slotted bracket to change the shape of the triangle.
2. Measure the angles using a protractor to classify the triangle as acute, right, or obtuse.
3. By moving the adjustable bracket, students can explore geometric relationships and observe how a right triangle turns into an acute or obtuse triangle.
4. The model visually demonstrates how angles change, helping students understand angle properties and triangle classification in a hands-on way.

How can you assess students' understanding?

Assessment of Concept Understanding

- Evaluate students' understanding of geometrical concepts eg-
 - o What is the sum of angles of a triangle?
 - o What are the types of triangles?
 - o What is an acute angle?
 - o What is a right angle?
 - o What is an obtuse angle?

Assessment of Project Understanding

- Observe and assess the students' ability to follow the procedure and correctly assemble and operate the set up.
- Assess whether the model works as desired.
- Check for creativity and accuracy in assembling the model.

- Conduct a quick Q&A session to evaluate their understanding of the working of the DIY Model to learn about Triangles.
 - o Ask students to identify the angles formed and compare their results with theoretical values using the formula the sum of angles of a triangle is 180 degrees.
 - o How does adjusting the slotted bracket change the triangle type?
 - o How does this model help us understand geometric transformations?
- Observe the functionality of the model during testing and analyze its accuracy.
- Ask- Where have you seen this application being used around you?

Assessment of Teamwork

Discuss individual contributions in group settings and award each group member the badges - 'Ideator, Goal Getter, Co-Creator and Questioner based on their involvement in the project. (Rubric for this is provided in the note for the teacher).

Design Thinking/Extensions and Modifications

Ask students the following questions and elicit answers from them. Some questions you can ask them and encourage them to think are given for your reference.

1. Can this model be used in real-life applications?
 - Discuss its applications in architecture and engineering where adjustable angles are needed
2. How can you modify this model?
 - You can modify the design to represent isosceles and equilateral triangles.
 - Introduce computer-aided design (CAD) to create bracket templates.
 - You can simulate the same mechanism using the web-based application.



<https://www.mathsisfun.com/geometry/triangles-interactive.html>

Click the link or scan QR code to access the application

Activity 15

Understanding Algebraic Identities using Cardboard Tiles



Grade

7, 8 and 9



Subject

Mathematics



Topic/
Concept

Algebra- Algebraic
Identities

Objective

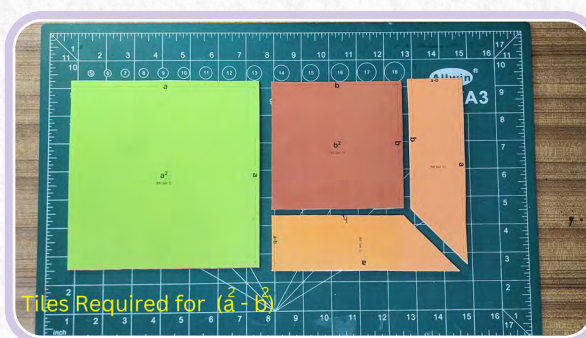
To enable students to recall, construct and visualize algebraic identities.

What will you help students learn?

- Construct, visualize and understand the following algebraic identities through a geometrical approach by using cardboard tiles-
 - $(a+b)^2 = a^2 + 2ab + b^2$
 - $(a-b)^2 = a^2 - 2ab + b^2$
 - $(a+b+c)^2 = a^2 + b^2 + c^2 + 2ab + 2bc + 2ac$
 - $a^2 - b^2 = (a+b)(a-b)$
 - $(c+a) \times (c+b) = c^2 + (a+b)c + ab$
- Verify the above algebraic identities geometrically.
- Understand squares and product-based identities.
- Develop spatial reasoning and practical mathematical skills.

What will you build/make?

An exploratory model using cardboard tiles to understand Algebraic Identities





<https://youtu.be/o-rgVNmMMuw>



<https://youtu.be/fOIrLzz5yWo>

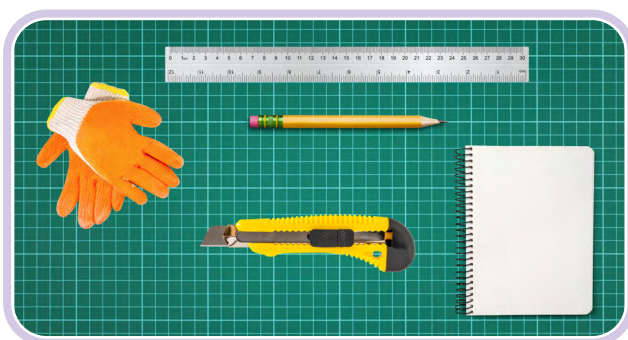
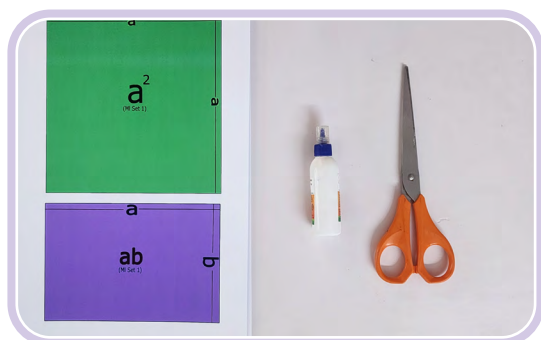
What will you need?

Materials Needed

- Printed templates of tiles (pre-designed shapes representing a^2 , b^2 , c^2 , ab , bc , ac , $(a-b)^2$, etc.) (Link to download them is given in the procedure)
- Cardboard or foam board sheets
- Glue or adhesive
- Instruction manual with steps to use tiles for each identity (scan the QR codes provided in this activity plan to download the detailed instructions)
- Blank A4 sheets or notebook

ATL Tools/Equipment

- Ruler (Optional)
- Pencil
- Cutting tools (scissors or precision cutter)
- Cutting mat
- Hand gloves

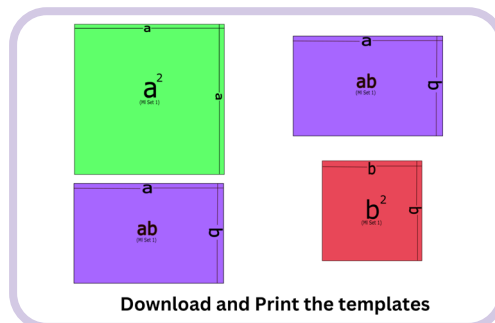


Procedure

Please Note: Meanings of words in the activity plan you may want to know are given in the Annexure

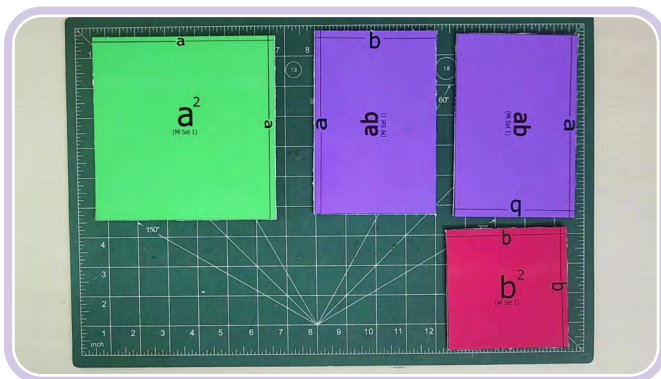
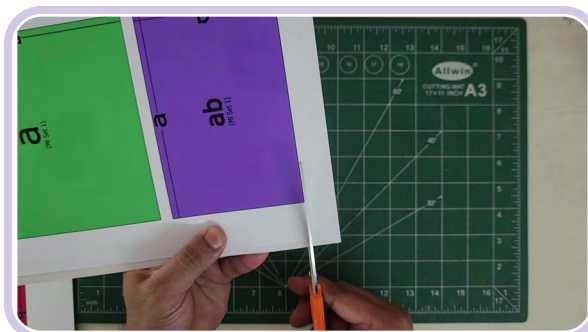
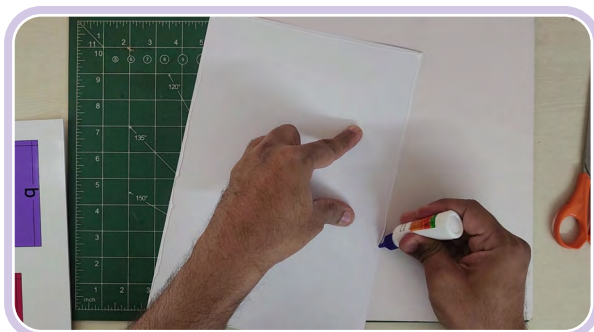
1. Preparation:

- Download and print the template (color printing recommended) for the tiles of a particular algebraic identity you want to work upon. If colour printing is not possible, colour the squares and rectangles as indicated in the image.
- Distribute pre-printed templates of tiles, representing:
 - Squares: a^2 , b^2 , c^2 , $(a-b)^2$
 - Rectangles: ab , bc , ac
- Provide cardboard or foam board sheets for the base.



2. Tile Creation:

- Paste each paper template onto cardboard or foam board sheet using glue.
- Ensure neat and precise alignment of the template on the sheets.
- Cut out the templates precisely using scissors or a precision cutter.



<https://youtu.be/eTcybVYtXeM>

Click the link or scan QR code to watch the video to help you make the tiles.

3. Understanding Identities:

3.1 Understanding the Tile Shapes and Their Meaning

- **Square Tiles:**
 - These tiles represent terms like a^2 , b^2 , c^2 , $(a-b)^2$, which are areas of squares with side lengths 'a', 'b', 'c' and $(a-b)$ respectively.
- **Rectangular Tiles:**
 - These tiles represent terms like ab , bc , and ac , which are areas of rectangles with side lengths 'a' and 'b', 'b' and 'c' and 'c' and 'a' respectively.
- **Color Printing of tiles (Color printing is recommended):**
 - Print templates in color for better visualization. If colour printing is not possible, colour the squares and rectangles as indicated in the templates.

3.2 Solving Algebraic Identity#1: $(a+b)^2 = a^2 + 2ab + b^2$

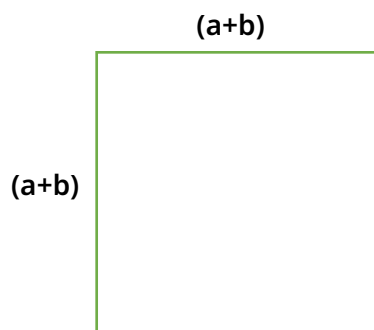
- Click the link or scan the QR code and download the template for the algebraic identity $(a+b)^2$. This template also has detailed instructions on how to use tiles to solve this identity.



<https://tinyurl.com/2u6r6j9k>

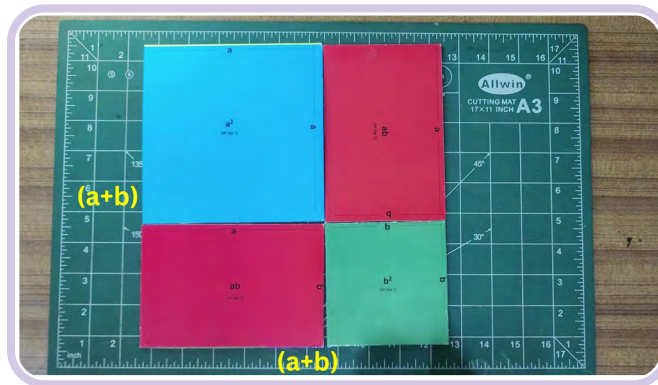


- $(a + b)^2$ could be represented as the area of a square of side $(a+b)$



- Arrange the tiles as follows:
 - Place one square tile representing a^2 (From Set-1) on the top left corner (side $a \times a$).
 - Place one square tile representing b^2 (From Set-1) on the bottom right corner (side $b \times b$).

- o Place one rectangular tile representing ab (From Set-1) (with dimensions $a \times b$) on the top right and one on the bottom left below the tile of a^2 .



- Observe that the total area of the large square $(a+b)^2$ is equal to the sum of the areas of the smaller pieces:
Area of large square = $a^2 + 2ab + b^2$
 - o Therefore, we can say that $(a+b)^2 = a^2 + 2ab + b^2$
- For detailed instructions on how to solve this identity, refer the video by clicking the link or scanning the QR code



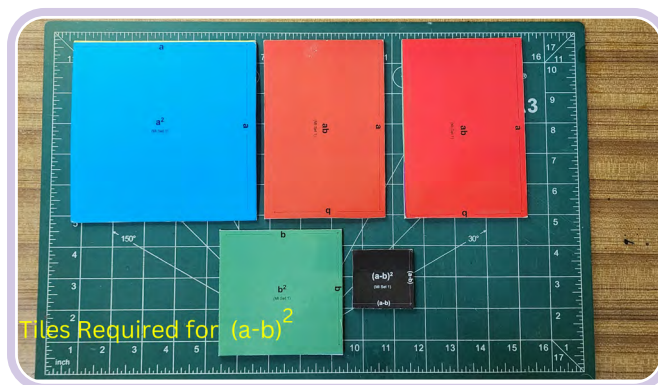
<https://youtu.be/o-rgVNmMMuw>

3.3 Solving Algebraic Identity#2: $(a-b)^2 = a^2 - 2ab + b^2$

- Click the link or scan the QR code and download the template for the algebraic identity $(a-b)^2$. This template also has detailed instructions on how to use tiles to solve this identity.



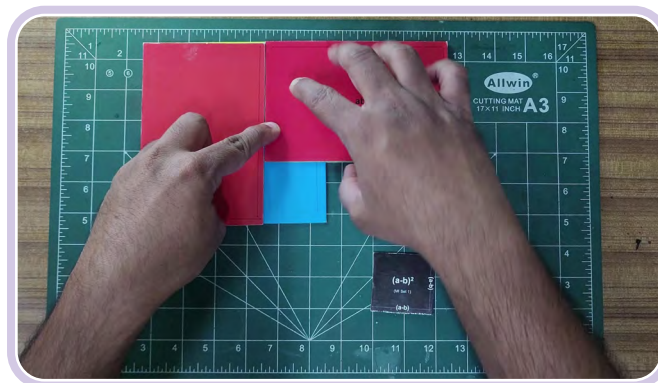
<https://tinyurl.com/cmtw8rvt>



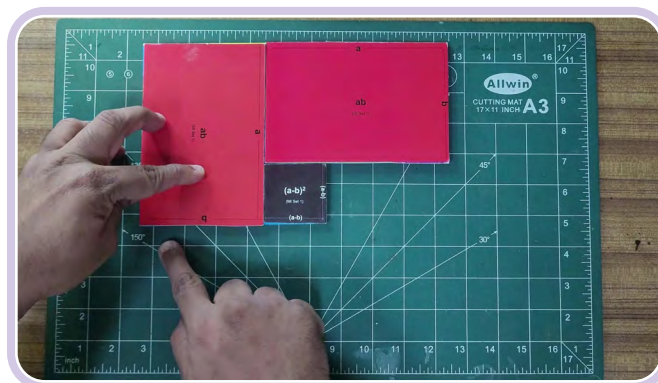
- Arrange the tiles as follows:
 - Place one square tile representing a^2 (From Set-1) on the top left corner (side $a \times a$).
 - Place one square tile representing b^2 (From Set-1) adjacent to a^2 on the top right corner (side $b \times b$).



- Place two rectangles representing ab (From Set-1) over the two squares (one vertically and the other horizontally) as shown in the image. **(covering the two squares with the two rectangles indicates subtraction of the areas of 2 rectangles i.e $2ab$ from the areas of the squares)**



- Place the square tile, representing $(a-b)^2$ (From Set-1) in the remaining portion.



- The remaining tile represents: **$(a-b)^2$**
- Therefore, we can say that **$(a-b)^2 = a^2 - 2ab + b^2$**

- For detailed instructions on how to solve this identity, refer the video by clicking the link or scanning the QR code.



<https://youtu.be/fOIrLzz5yWo>

3.4 Solving Algebraic Identity#3: $(a+b+c)^2 = a^2+b^2+c^2+2ab+2bc+2ac$

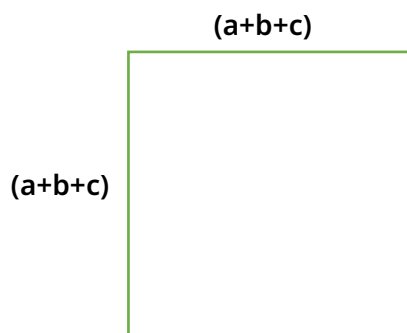
- Click the link or scan the QR code and download the template for the algebraic identity $(a+b+c)^2$. This template also has detailed instructions on how to use tiles to solve this identity.



<https://tinyurl.com/24s29jzj>

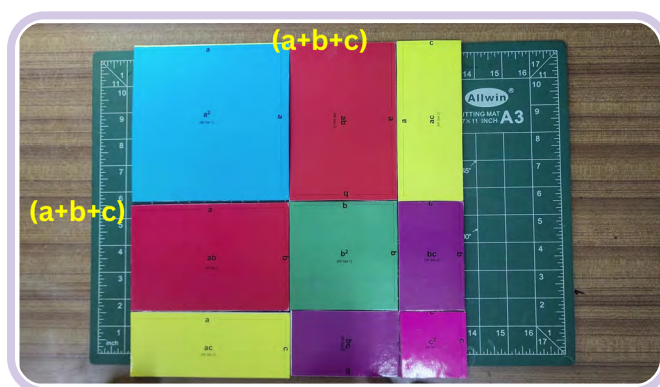


- Imagine a square with a side length of $(a+b+c)$



- Arrange the tiles as follows:
 - Place square tiles a^2 , b^2 , and c^2 .
 - Add two rectangular tiles for each combination of cross-products: $2ab$, $2bc$, and $2ac$ as described in the detailed instructions given on the template.
- Observe that the total area of the large square $(a+b+c)^2$ is equal to the sum of the areas of the smaller pieces:

Area of large square $= (a+b+c)^2 = a^2 + b^2 + c^2 + 2ab + 2bc + 2ac$



- For detailed instructions on how to solve this identity, refer the video by clicking the link or scanning the QR code



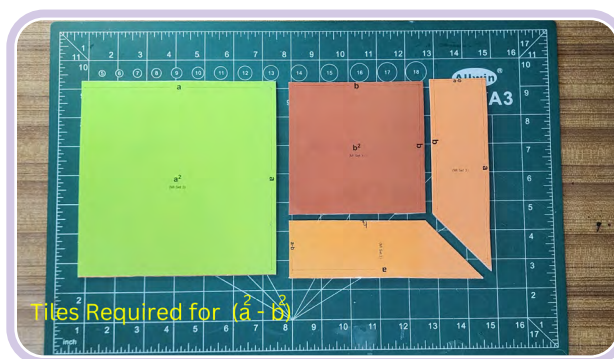
<https://youtu.be/BTln2Yn3VXE>

3.5 Solving Algebraic Identity#4: $(a^2 - b^2) = (a+b)(a-b)$

- Click the link or scan the QR code and download the template for the algebraic identity $(a^2 - b^2)$. This template also has detailed instructions on how to use tiles to solve this identity.

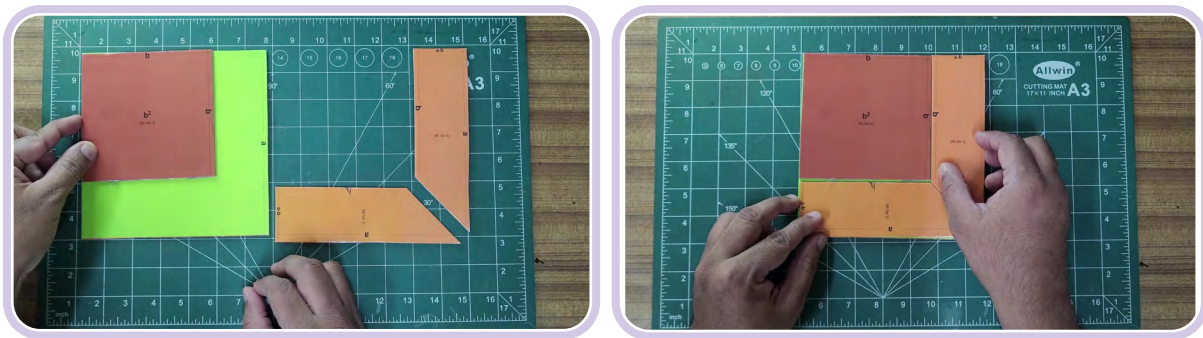


<https://tinyurl.com/3aj7e3eu>

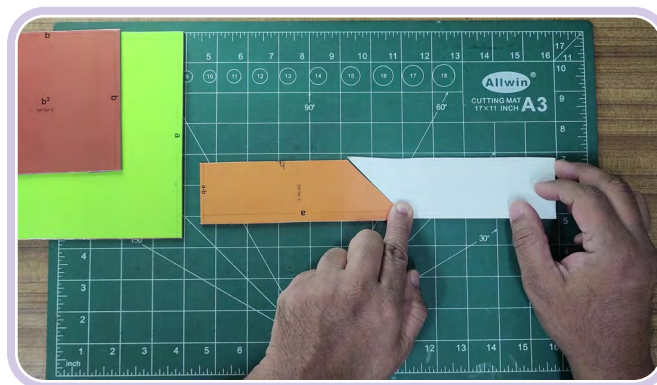


- Arrange the tiles as follows:
 - Place the square tile representing a^2 on a flat surface.
 - Place the smaller square b^2 inside the larger square a^2 , aligned to top left corner of square a^2 .
 - This visually removes the area of b^2 from a^2 , leaving the remaining area as $a^2 - b^2$.

- o Place the additional two tiles given in the template as shown in the image.



- o Remove the two additional tiles from the remaining area
- o Place them in a such way that they form a rectangle
- o Observe the lengths of the rectangle's sides. It has $(a+b)$ as length and $(a-b)$ as width. Refer the video for more details.



- The total area of this rectangle is equal to the product of $(a+b)$ and $(a-b)$:
- Thus, the total area of the rectangle = $(a^2 - b^2) = (a+b)(a-b)$
- For detailed instructions on how to solve this identity, refer the video by clicking the link or scanning the QR code



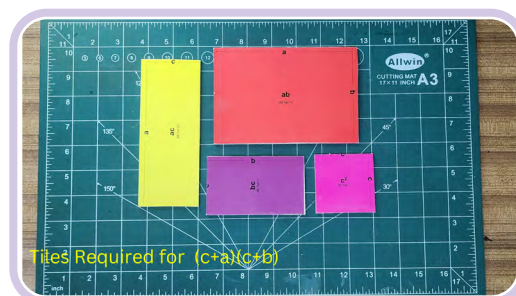
<https://youtu.be/Fn7H5zdw920>

3.6 Solving Algebraic Identity#5: $(c+a)(c+b) = c^2 + (a+b)c + ab$

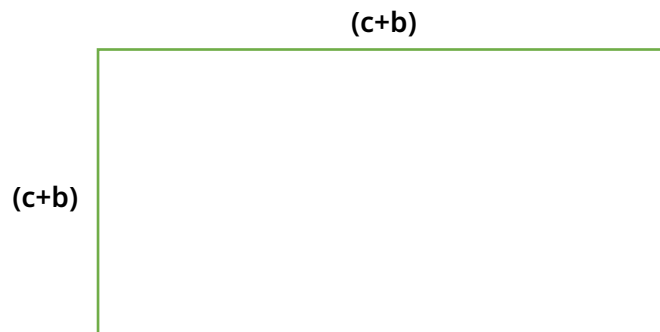
- Click the link or scan the QR code and download the template for the algebraic identity $(c+a)(c+b)$. This template also has detailed instructions on how to use tiles to solve this identity.



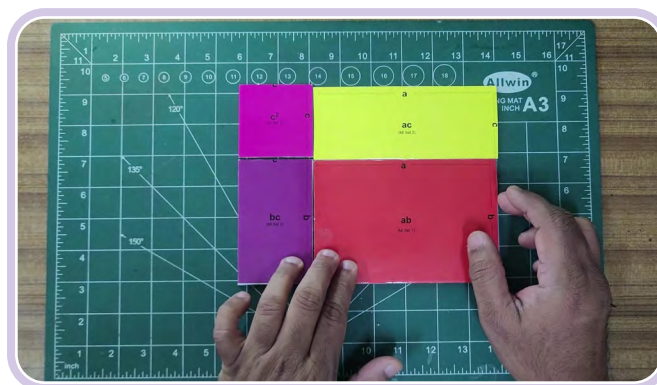
<https://tinyurl.com/bdepdvt9>



- $(c+a) \times (c+b)$ could be represented as the area of a rectangle of sides $(c+a)$ and $(c+b)$



- Arrange the tiles as shown in the figure:



- Place a rectangular tile 'ac' on the top right corner
 - Place a square tile for c^2 on the top left corner adjacent to the tile of ac.
 - Add rectangular tile of bc just below the square tile of c^2
 - Add rectangular tile of 'ab' just below the rectangular tile of 'ac'.
- Observe that the total area of the rectangle represents: $(c+a)(c+b) = c^2 + ac + bc + ab$
Group the terms involving 'c':

$$c^2 + ac + bc + ab = c^2 + (a+b)c + ab$$

This matches the expanded algebraic identity:

$$(c+a)(c+b) = c^2 + (a+b)c + ab$$

- For detailed instructions on how to solve this identity, refer the video by clicking the link or scanning the QR code



<https://youtu.be/2LmX1mMtxko>

4. Practice and rearrangement for tiles of all the 5 identities:

- Start with simple identities like $(a+b)^2$ before moving to more complex ones.
- Encourage students to experiment by rearranging the tiles to verify the identities.
- Work in pairs or groups to promote discussion and teamwork.

How does the exploratory model work?

Working of the model has been explained with one algebraic identity below. You can similarly try solving other identities. The detailed instructions for each identity are given with the printable templates as well.

Verify the identity $(c+a)(c+b) = c^2 + (a+b)c + ab$ using your own model to understand how this model works

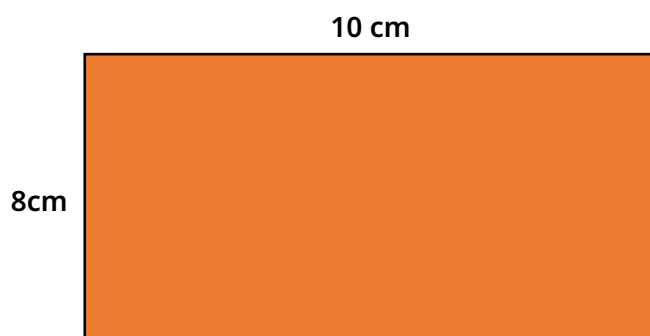
Let us give numerical values to 'a', 'b' and 'c'

Let 'a' = 7 cm and 'b' = 5 cm 'c' = 3 cm

$$a + c = 7 + 3 = 10 \text{ cm}$$

$$b + c = 5 + 3 = 8 \text{ cm}$$

1. Draw a rectangle of length 10 cm and breadth 8 cm. This represents $(c+a)(c+b)$



2. Draw a square of side 3 cm on a plain sheet of paper and cut it out. This represents (c^2)
3. Draw three rectangles on a plain sheet of paper and cut them out
 - Rectangle of length 7 cm and breadth 3cm (ac)
 - Rectangle of length 5 cm and breadth 3cm (bc)
 - Rectangle of length 7 cm and breadth 5cm (ab)
4. Arrange the square representing c^2 and the 3 smaller rectangles (representing ac, bc and ab) on the big rectangle of area 10 cm X 8 cm

Do they fit perfectly?

Calculate the areas of the 3 rectangles and the square and add the results.

Is the sum equal to 80 cm²?

How can you assess students' understanding?

Assessment of Concept Understanding

- Evaluate students' understanding of algebraic identities-

- Ask them to complete the following identities:
 - o $(a+b)^2 = a^2 + 2ab + b^2$
 - o $(a-b)^2 = a^2 - 2ab + b^2$
 - o $(a+b+c)^2 = a^2 + b^2 + c^2 + 2ab + 2bc + 2ac$
 - o $a^2 - b^2 = (a+b)(a-b)$
 - o $(c+a) \times (c+b) = c^2 + (a+b)c + ab$
- Which of the above are product based identities and square based identities

Assessment of Project Understanding

- Observe and assess the students' ability to follow the procedure and correctly assemble and operate the set up.
- Assess the accuracy of tile construction.
- Evaluate the students' ability to correctly arrange tiles for each identity.
- Observe participation and understanding during the discussion.
- Check for accuracy in assembling the model.
- Conduct a quick Q&A session to evaluate their understanding of the working of the exploratory model.
 - o How does the geometrical representation aid in understanding algebraic identities?
 - o Why is $(a^2 - b^2)$ called the difference of squares?
 - o Can you derive new identities using the tiles?
 - o Discuss how the visual approach aids understanding
- Observe the functionality of the model during testing and analyze its accuracy.

Assessment of Teamwork

Discuss individual contributions in group settings and award each group member the badges - 'Ideator, Goal Getter, Co-Creator and Questioner based on their involvement in the project. (Rubric for this is provided in the note for the teacher).

Design Thinking/Extensions and Modifications

Ask students the following questions and elicit answers from them. Some questions you can ask them and encourage them to think are given for your reference.

- You can design your own templates in any 2D design software.
- You can extend your learning to cubic identities such as $(a+b)^3$ using 3D models.

Activity 16

Constructing a DIY Electronic Model to Understand Fractions



Grade



6, 7 and 8



Subject



Mathematics



Topic/
Concept



Fractions

Objective

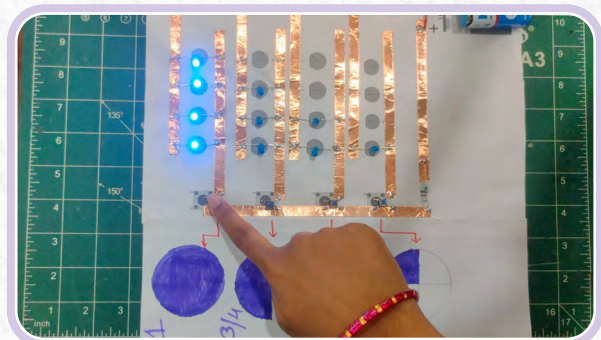
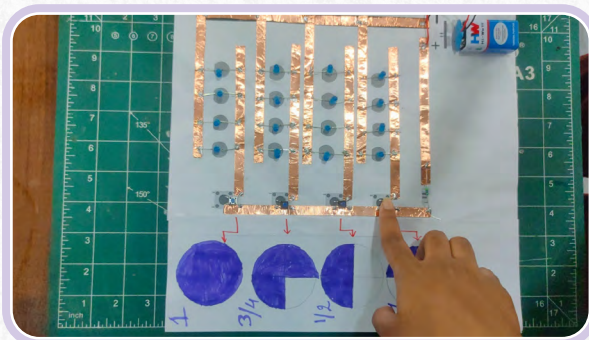
To reinforce understanding of Fractions.

What will you help students learn?

- Develop basic electronics skills, including circuit assembly and soldering.
- Understand fractions visually by pressing push buttons to light up LEDs.
- Hands-on skills in soldering and circuit assembly.

What will you build/make?

An activity to learn Fractions using Copper tape, Push buttons, LEDs, Battery and Resistor.



<https://youtu.be/BUVORKrQKBs>

Click the link or scan QR code to watch DIY cum working video of the project.

Procedure

Materials Needed

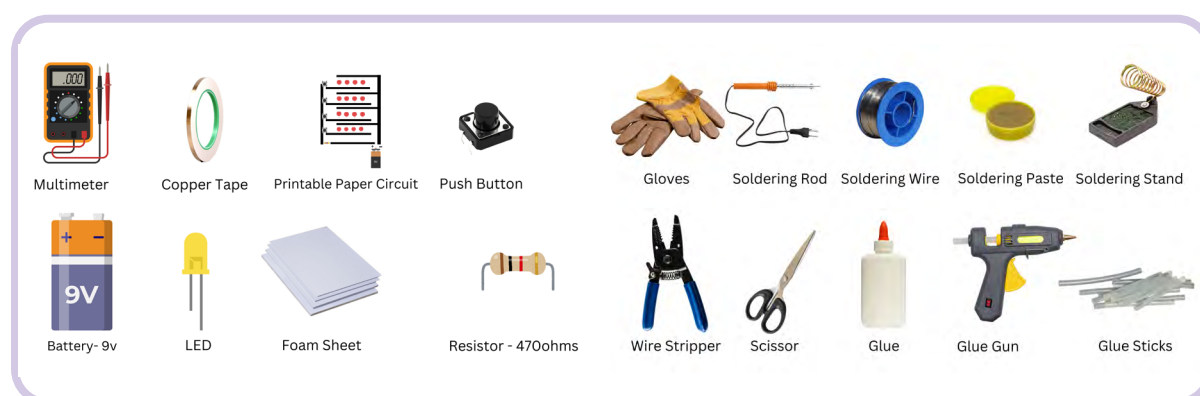
- 5mm Red LEDs x 16 Nos(Represent fractions visually; red color enhances visibility)
- Foam board
- Printable template (Link to download the template is given in the procedure)
- Paper glue
- 10mm wide copper tape
- 4 push buttons
- 220 to 470-ohm resistor (depending on the LEDs used)
- 9V battery & battery clip

ATL Tools/Equipment

- Soldering kit- gun, stand, metal, flux, fume extractor
- Paper cutter
- Cutting mat
- Hand gloves
- Marker pen or pencil
- Ruler
- Geometrical compass
- Color sketch pens

Software/Application

- Polypad (Web based application)- Optional



Procedure

Please Note: Meanings of words in the activity plan you may want to know are given in the Annexure

1. Introduction & Explanation:

- Discuss the importance of fractions in real-life applications.
- Explain how LEDs will visually represent fractions when buttons are pressed.
- Introduce basic electronic concepts, including circuits, components, and soldering.
- Show a completed sample model or an image to clarify the final goal.

2. Preparation:

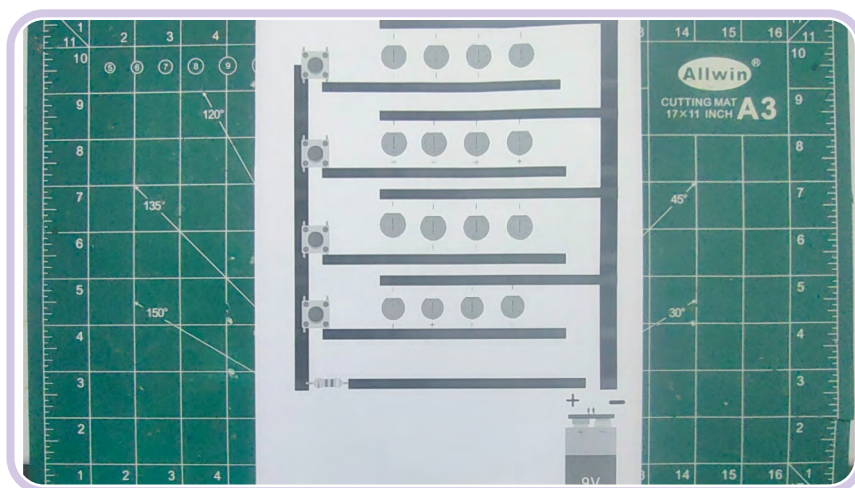
- Distribute materials and tools to students.
- Click the link or scan QR code to download and print the paper circuit template on A4 size paper. This template is required for constructing a model.
- Guide students to outline and cut a foam board base (slightly larger than A4).



<https://tinyurl.com/4k7ny8kt>

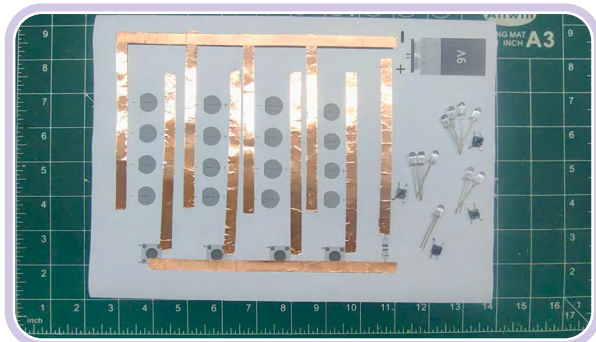
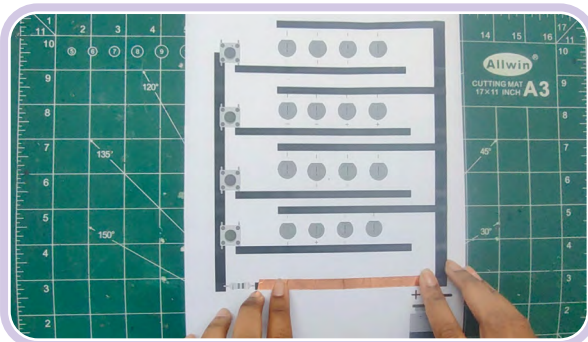
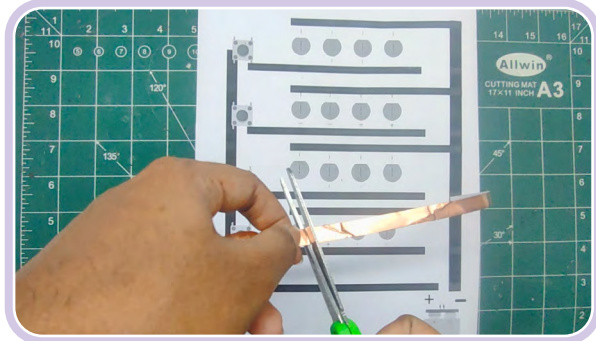
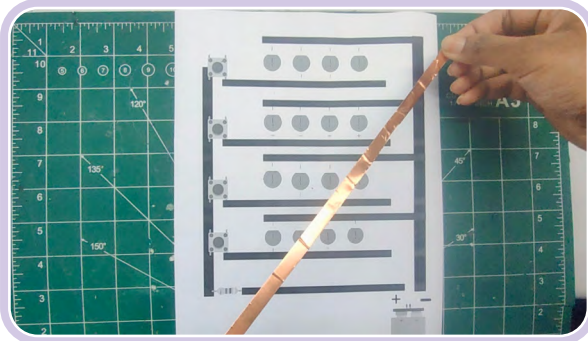
3. Applying the Template:

- Stick the printable template to the foam board using paper glue.
- Ensure smooth adhesion without wrinkles.



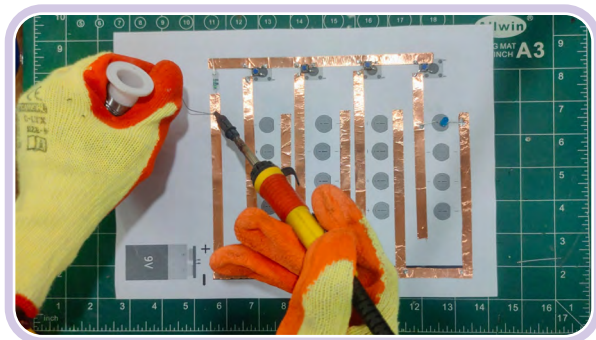
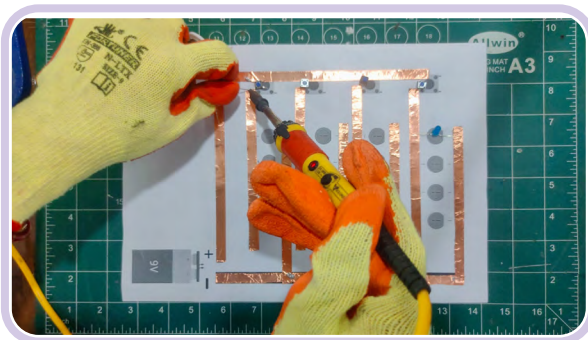
4. Creating Circuit Paths:

- Lay the copper tape on the printed template following the template's circuit lines.
- Ensure there are no gaps in the tape to prevent electrical disconnection.



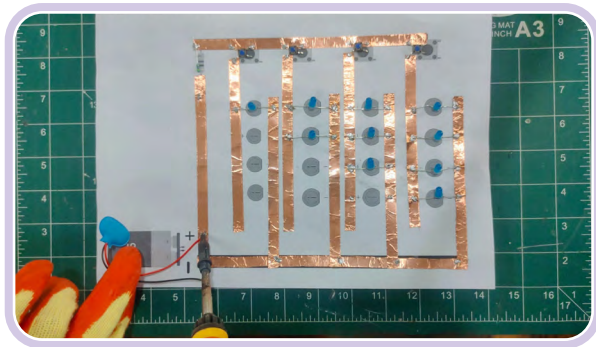
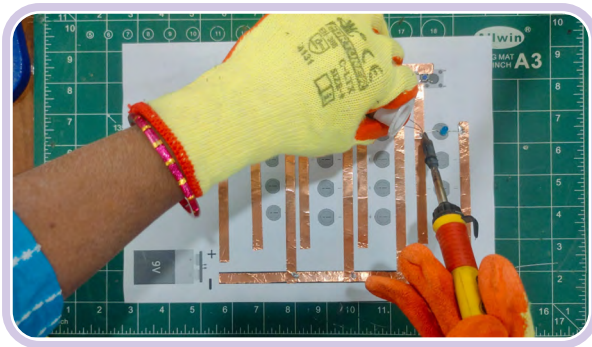
5. Placing and Soldering Components:

- Mount the LEDs into pre-marked positions (4 per row).
- Ensure LEDs are placed with correct polarity (long leg = positive, short leg = negative).
- Position push buttons according to the template.
- Solder the LEDs, push buttons, and 220-ohm resistor to the circuit.



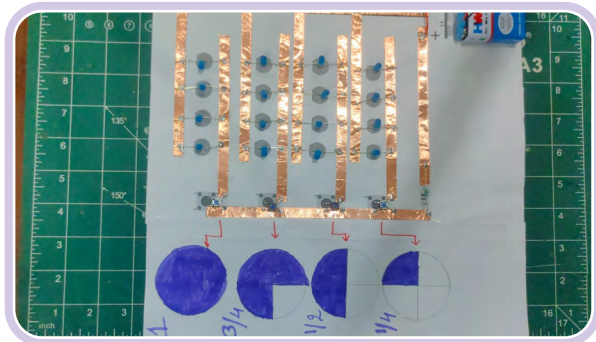
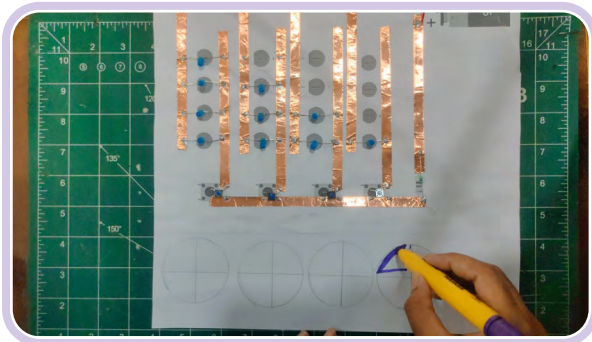
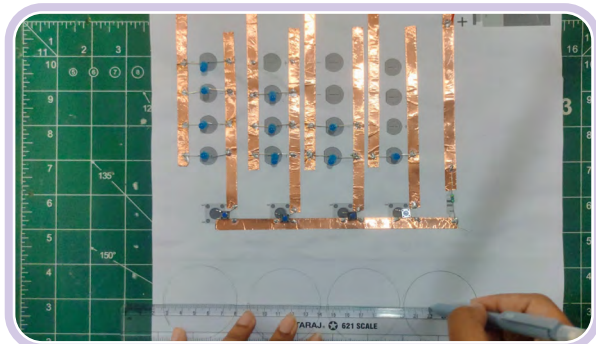
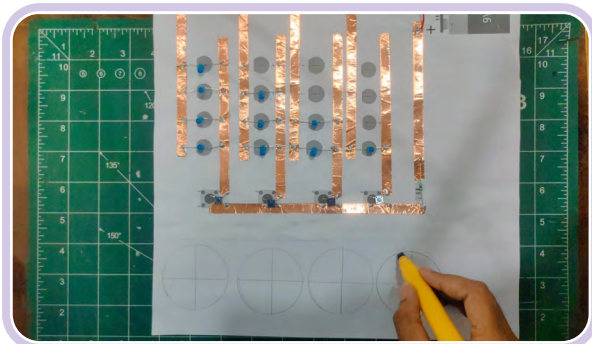
- Note- In a row representing fraction **$\frac{1}{4}$** , **only one out of four** LEDs will be soldered on both terminals, in a row representing **$\frac{1}{2}$** , **only two out of four LEDs** will be soldered on both terminals, in a row representing **$\frac{3}{4}$** , **only three out of four LEDs** will be soldered on both terminals, in a row representing **1**, **all four LEDs** will be soldered on both terminals.

- Solder the battery clip also with proper polarity.



6. Decorating the Interface:

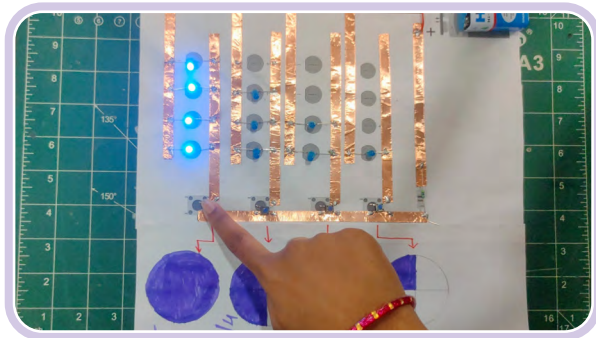
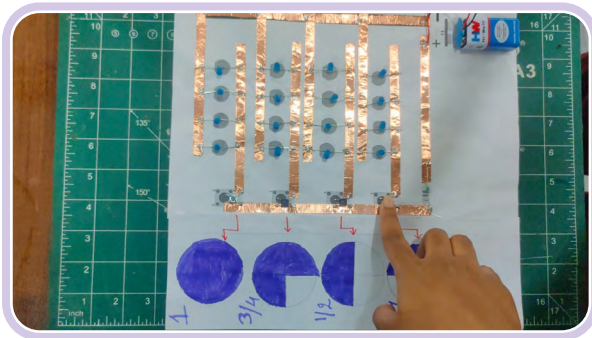
- Draw circles around each push button using a geometrical compass.
- Label and color each fraction section ($\frac{1}{4}$, $\frac{1}{2}$, $\frac{3}{4}$, 1) using sketch pens.



7. Testing the Model:

- Connect the 9V battery to the battery clip.
- Press each push button to observe the correct number of LEDs lighting up:
- $\frac{1}{4}$: 1 out of 4 LEDs lights up.
- $\frac{1}{2}$: 2 out of 4 LEDs light up.
- $\frac{3}{4}$: 3 out of 4 LEDs light up.

- 1: All 4 LEDs light up.
- Troubleshoot any issues, such as unlit LEDs or incorrect wiring.



8. Web-based simulation tool (Polypad) to learn more on fractions (Optional):

Polypad's fraction module provides an interactive platform where students can visually manipulate fraction tiles, compare fractions, perform operations (addition, subtraction, multiplication, and division), and explore equivalent fractions, making abstract fraction concepts more concrete and engaging.

Click the links or scan QR codes to go through additional web-based resources for learning more on fractions.



<https://polypad.amplify.com/lesson/fraction>



<https://polypad.amplify.com/p#fractions>

How does the model work?

The DIY electronic model for learning fractions works by using LEDs and push buttons to visually represent different fractions. The model is built on a foam board using paper circuit. When a button is pressed, it illuminates the LEDs. The number of LEDs illuminated depends on the button (fraction) selected.

Step-by-Step Working Mechanism:

- Pressing a push button completes the circuit, allowing current to flow.
- LEDs light up according to the fraction value:
 - $1/4$: 1 out of 4 LEDs turn on.
 - $1/2$: 2 out of 4 LEDs turn on.
 - $3/4$: 3 out of 4 LEDs turn on.
 - 1 (whole): All 4 LEDs turn on.



<https://youtu.be/BUVORKrQKBs>

Click the link or scan QR code to watch the complete DIY and working video of the project

How can you assess students' understanding?

Assessment of Concept Understanding

- Evaluate students' understanding of fractions

Assessment of Project Understanding

- Observe and assess the students' ability to follow the procedure and correctly assemble and operate the set up.
- Check if the model correctly lights up the appropriate number of LEDs per fraction.
- Observe whether students can correctly explain how their model represents fractions.
- Conduct a quick Q&A session to evaluate their understanding of the working of the DIY Electronic Model to Understand Fractions.
 - o How does pressing a button represent a fraction?
 - o Why do different fractions illuminate a different number of LEDs?
 - o How is this concept used in real-world electronics?
 - o Can this model be expanded to represent more fractions?
- Observe if students can construct a functional model.
- Observe the functionality of the model during testing and analyze its accuracy.
- Evaluate neatness, soldering quality, and proper circuit connections.

Assessment of Teamwork

Discuss individual contributions in group settings and award each group member the badges - 'Ideator, Goal Getter, Co-Creator and Questioner based on their involvement in the project. (Rubric for this is provided in the note for the teacher).

Design Thinking/Extensions and Modifications

Ask students the following questions and elicit answers from them. Some questions you can ask them and encourage them to think are given for your reference.

1. Can this model be used in real-life applications?
2. How can you modify this model?
 - Challenge students to modify the model to represent other fractions (e.g., $1/8$, $2/3$).
 - You can introduce variables by changing resistor values to adjust LED brightness.
 - You can incorporate a microcontroller (such as Arduino) to create an automated fraction learning system.

Activity 17

Making a DIY Model to Learn Types of Quadrilaterals through Paper Electronics



Grade ► **6, 7 and 8**



Subject ► **Mathematics**



Topic/
Concept ► **Quadrilaterals**

Objective

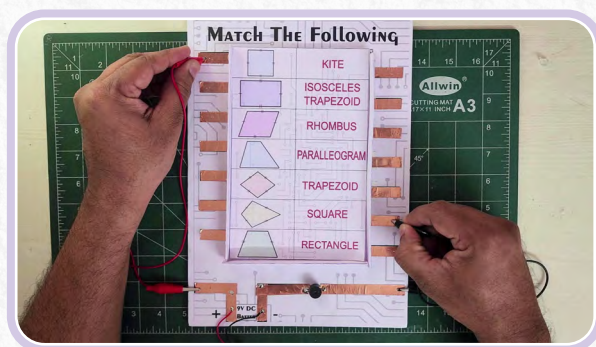
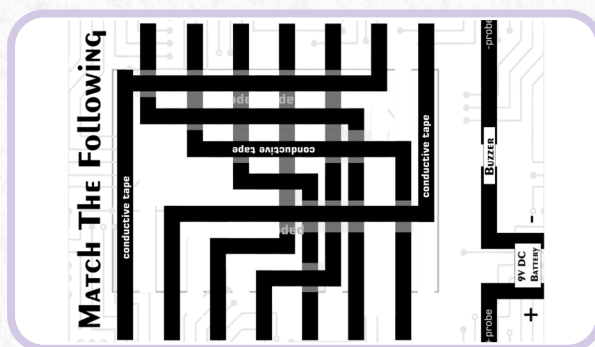
To reinforce and help students identify and classify various types of quadrilaterals.

What will you help students learn?

- Identify and classify various types of quadrilaterals.
- How basic electrical circuits work.
- Problem-solving and troubleshooting skills.
- Skills in precise cutting, soldering, and assembling

What will you build/make?

A DIY Model to Learn Types of Quadrilaterals through Paper Electronics.



Click the link or scan QR code to watch DIY cum working video of the project.



<https://youtu.be/0gP4bpd-vsI>

What will you need?

Materials Needed

- Printed template of 'Match the pair' paper circuit
- Template to make a rectangular box using foam board
- Colored template with pictures of quadrilaterals (left column) and their types (right column)
- Two A4 size foam board sheets
- 10 mm wide copper tape
- Paper tape/masking tape
- 9V battery and battery clip
- 5V active buzzer
- Double-sided tape
- Two crocodile (alligator) clip cables (red for positive, black for ground)

ATL Tools/Equipment

- Scissors
- Marker pen or pencil and ruler
- Paper cutter
- Hand gloves
- Hot glue gun with glue sticks
- Paper glue
- Soldering kit- gun, stand, metal, flux, fume extractor
- Wire stripper
- Multimeter

ATL Tools/Equipment

- 'Mathsisfun', a web-based application (Optional)



Procedure

Please Note: Meanings of words in the activity plan you may want to know are given in the Annexure

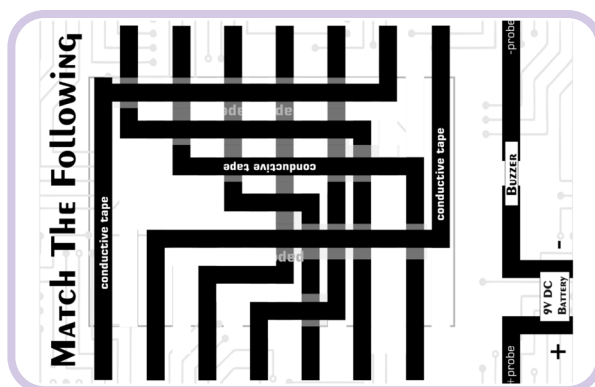
1. Introduction & Explanation:

- Begin by reviewing the concept of quadrilaterals, their types and their properties.
- Show students a sample model or a diagram explaining the project.
- Explain how the paper circuit of 'Match the pair' will allow to visually identify the types of quadrilaterals
- Simulate and learn more about different types of quadrilaterals using the web-based application. Click the link or scan QR code to access the application:



<https://www.mathsisfun.com/quadrilaterals.html>

2. Preparation: Download and Print the Template:



- Click the link or scan QR code to download and print the 'Match the Pair' template on A4 size white paper. This template is required for developing the project model.
- Distribute all necessary materials.
- Review the components and their purposes.

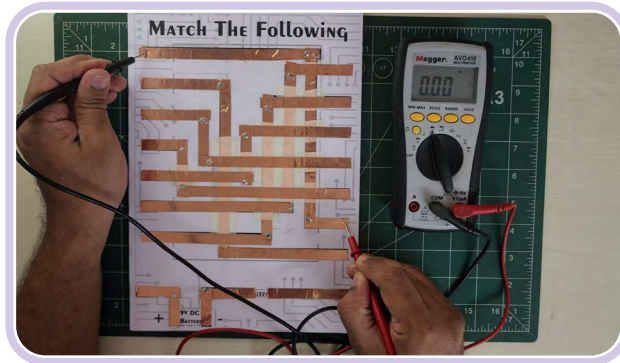


<https://tinyurl.com/59ch4xph>

3. Setting Up the Paper Circuit:

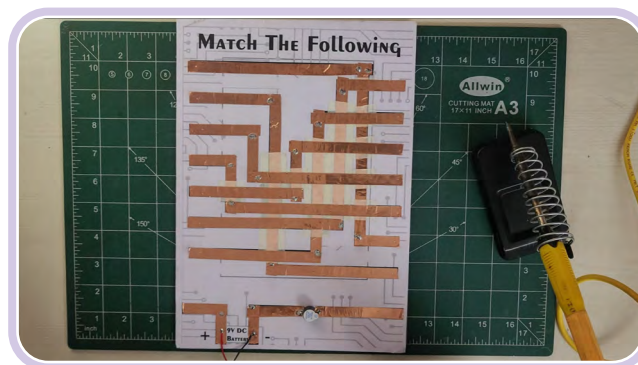
- Paste the 'match the pair' paper circuit template onto the first foam board sheet using paper glue.
- Apply copper tape along the designated paths. Use paper tape to insulate overlapping copper tape sections.
- Apply small amount of solder metal on the overlapping joints of the copper tape.

- After soldering the overlapping tape joints, use the multimeter to check for continuity along the circuit paths.
- If there is no continuity in any of the joints, again apply small amount of solder on the joints.



4. Integrating the Buzzer and Power Source:

- Connect the 5V active buzzer at the specified point as mentioned on the paper circuit.
- Attach the 9V battery clip to the circuit.



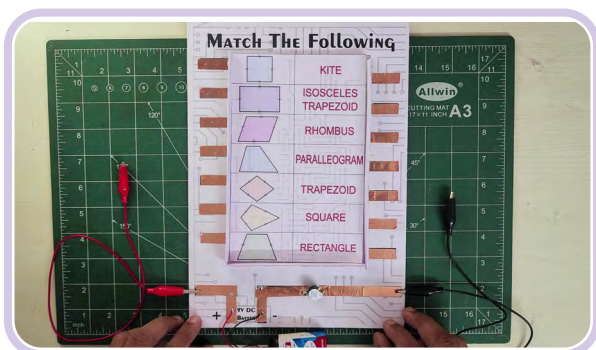
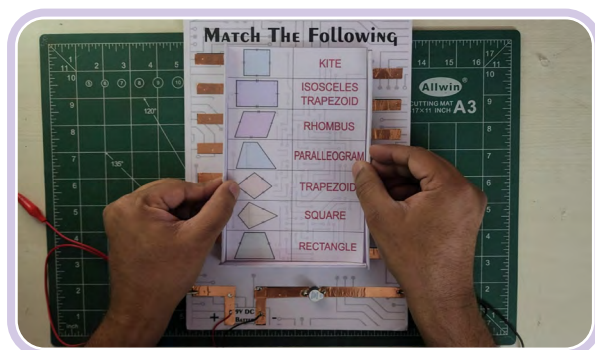
5. Constructing the Rectangular Box:

- Paste the box template on the second foam board.
- Mark dimensions on the board along the edges of the template using a ruler and marker.
- Cut out the pieces using the paper cutter.
- Assemble the box using the hot glue gun.



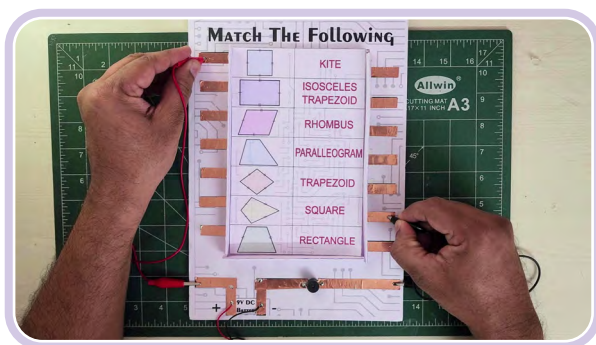
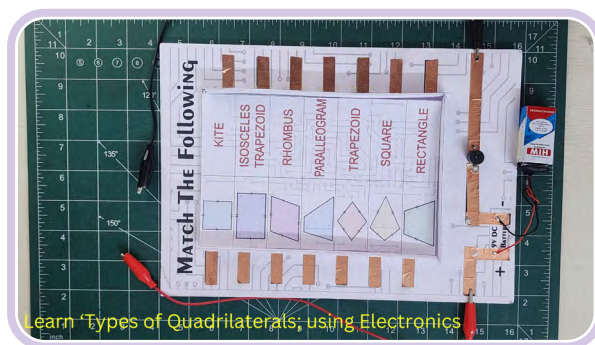
6. Final Assembly:

- Mount the rectangular box onto the circuit board using double-sided tape.
- Insert the colored template with quadrilateral images and types into the box.
- Connect the crocodile clip cables to the battery terminals.
- Secure the battery in place using double-sided tape.



7. Testing the Circuit:

- Test the circuit by matching the pairs; the buzzer should sound upon a correct match.



How does the model work?

The model uses a paper circuit with conductive copper tape and a buzzer system to provide instant feedback when students match the correct quadrilateral image with its corresponding type. The model consists of a printed template with quadrilateral images in one column and their types in another column. Copper tape pathways are laid out on a template that is pasted to the foam board to create an electrical circuit. The user connects one alligator clip to the positive terminal and another to the negative terminal of the circuit. When the correct match is made, the circuit is closed, and the buzzer sounds to indicate success.

Click the link or scan QR code to watch DIY cum working video of the project.



<https://youtu.be/0gP4bpd-vsI>

How can you assess students' understanding?

Assessment of Concept Understanding

- Evaluate students' understanding of quadrilaterals.

Assessment of Project Understanding

- Monitor students' ability to assemble the circuit and box correctly.
- Ensure that the buzzer activates when a correct match is made.
- Ask students to explain how the circuit works.
- Have students modify the circuit to test understanding
- Check for creativity and accuracy in assembling the model.
- Conduct a quick Q&A session to evaluate their understanding of the working of the model
 - o How does the circuit work when a correct pair is matched?
 - o What happens when an incorrect match is made?
 - o How does the buzzer respond to an open and closed circuit?
- Ask- Where have you seen this application being used around you?

Assessment of Teamwork

Discuss individual contributions in group settings and award each group member the badges - 'Ideator, Goal Getter, Co-Creator and Questioner based on their involvement in the project. (Rubric for this is provided in the note for the teacher).

Design Thinking/Extensions and Modifications

Ask students the following questions and elicit answers from them. Some questions you can ask them and encourage them to think are given for your reference.

1. Can this model be used in real-life applications?
2. How can you modify this model?
 - Can you add LEDs instead of a buzzer for different pairs to create an advanced circuit design?:
 - Modify the templates to include types of triangles, polygons, or 3D shapes to extend your learning. You can include formulas for perimeter and area in the matching template too

Continued.....

Continued.....

- Can you integrate coding into the project? Develop a scratch-based program for an advanced digital version of this model (you could try this for higher grade students of 9th and 10th).
- Simulate and learn more about different types of quadrilaterals using the web-based application. Click the link or scan QR code to access the application:



<https://www.mathsisfun.com/quadrilaterals.html>

Click the link or scan QR code to access the application.

Annexure – Glossary

SN.	Word/Term	Meaning
1	.txt / .csv	File formats used to store plain text data or tabular data.
2	1-Wire Digital Protocol	A communication method used by sensors like DS18B20 to send data using a single data line.
3	2D Net	A flat shape that can be folded into a 3D object
4	3.3V Battery	A small power source that supplies the necessary voltage to the circuit.
5	3D Model	A three-dimensional representation of an object
6	3V Coin Cell Battery	A small round battery providing 3 volts of power, used to light the LEDs.
7	Acceleration	The rate of change of velocity over time, measured in meters per second squared (m/s^2).
8	Acceleration Sensor	A component in the Phyphox app that measures the rate of speed change.
9	Acid-Base Reaction	A chemical reaction that produces CO_2 , water, and salt when vinegar reacts with baking soda.
10	Action and Reaction Forces	Paired forces acting on two interacting objects – as one exerts a force, the other responds with an equal and opposite force.
11	Acute Triangle	A triangle with all angles less than 90° .
12	ADC (Analog-to-Digital Converter)	A device that converts an analog signal (continuous data) into a digital signal (discrete values) for processing.
13	Additive Color Mixing	The process of creating color by mixing different colors of light, typically resulting in white when combined.
14	Aerodynamics	The way air interacts with moving objects, affecting speed and efficiency.
15	Algebraic Identity	A mathematical equation that holds true for all values of its variables, such as $(a+b)^2 = a^2 + 2ab + b^2$.
16	Algorithm	A step-by-step set of instructions used to complete a task, such as making the boy identify food types in the animation.
17	Alignment	The correct positioning of parts for smooth functioning.
18	Ambient conditions	The surrounding environmental factors such as temperature, humidity, and air pressure that can affect the performance of a component or device or system
19	Ambient Temperature	The temperature of the surrounding environment before the reaction begins.

SN.	Word/Term	Meaning
20	Amplitude	The height of the sound wave, determining loudness.
21	Analog Sensor Data	Continuous variable output from a sensor, often represented as a voltage level. It is measured through the Analog output pins like A0 to A5 on Arduino uno.
22	Analog System	A system that processes varying electrical signals, as opposed to digital binary signals.
23	Angle of Depression	The angle between the horizontal line and the line of sight when looking down.
24	Angle of Elevation	The angle between the horizontal line and the line of sight when looking up.
25	Angular Momentum	A measure of the amount of rotation an object has, which remains conserved unless acted upon by an external force.
26	Animation	A technique that gives the illusion of movement by displaying sequential images quickly.
27	Anode	The electrode in a circuit where current flows into the device from the external circuit; e.g. a longer leg of the LED, which must be connected to the positive terminal of the battery.
28	Anomalies	Irregular or unexpected values in the data, often indicating errors or unusual environmental events.
29	Anther	The part of a flower that produces pollen.
30	AQI - Air Quality Index	A scale used to report daily air quality and indicate how polluted the air currently is.
31	Arduino Cloud	An online platform for remote coding, device management, and data visualization for Arduino.
32	Arduino Cloud Agent	A local service that connects your Arduino hardware with Arduino Cloud via your browser.
33	Arduino IDE	A software platform used to write and upload code to Arduino boards.
34	Arduino Libraries	Prewritten code packages that make it easier to control hardware like sensors and displays.
35	Arduino Nano	A compact microcontroller board used to control and process sensor data.
36	Arduino Uno	A microcontroller board used for building electronic projects and processing data from sensors.
37	Arteries	Blood vessels that carry oxygenated blood away from the heart.
38	Artificial Intelligence (AI)	The ability of a computer to perform tasks that usually require human intelligence, such as recognition and decision-making.
39	Assembling	Putting together different parts to make a whole.
40	Automate	To make something work automatically using machines or technology.

SN.	Word/Term	Meaning
41	Automatic Emergency Braking (AEB)	A system that stops a vehicle without driver input when an obstacle is detected.
42	AUX Cable	A cable used to transmit audio signals from a device to the speaker system.
43	Axle	A rod or spindle that allows wheels to rotate.
44	Backdrop	The background of a Scratch or Pictoblox project, setting the scene for animations.
45	Baking Soda	A mild base (sodium bicarbonate) that can act as an alternative electrolyte
46	Balance	The even distribution of weight to maintain stability.
47	Base (of transistor)	The terminal that controls the flow of current between collector and emitter.
48	Base Plate	The fixed bottom part of the model.
49	Battery	A power source that provides voltage to drive current
50	Battery Clip	A connector that attaches the battery to the conductive dough, allowing current to flow into the circuit.
51	Battery Holder	A compartment that securely holds and connects a battery to the circuit.
52	BC-547 transistor	A general-purpose NPN transistor often used in amplifier circuits.
53	Biomimicry	Designing tools or systems based on models found in nature, like replicating the function of a hand.
54	Block Coding	A method of programming where code is built using drag-and-drop blocks.
55	Blocks	Visual programming components used in PictoBlox to create scripts.
56	Blood Circulation	The continuous movement of blood through the heart and blood vessels, supplying oxygen and nutrients while removing waste.
57	Blood Donor-Recipient Compatibility	A set of medical rules that determine which blood types can safely donate or receive blood from others.
58	Bluetooth Module	A module (e.g., HC-05) that allows wireless communication between devices at short ranges.
59	BO Motor	A small DC motor commonly used in DIY and robotics projects.
60	BO Motor Wheel	A supporting wheel designed for use with small motors.
61	Boundary	The edge or perimeter of a shape or structure in a model.
62	Breadboard	A board for making temporary electrical connections without soldering.

SN.	Word/Term	Meaning
63	Buzzer	An audio signalling device that makes a buzzing sound.
64	Cable Tie / Zip Tie	A plastic fastener used to hold or pull string ends easily in the gripper mechanism.
65	Calibration:	The process of adjusting a system to ensure accurate measurements.
66	Capacitors	An electronic component that stores and releases electrical energy, commonly used in filters and amplifiers.
67	Carbon Rods from Batteries	Conductive rods inside old dry cell batteries used as durable electrodes
68	Card stock	A thick, sturdy paper used as the diaphragm in the paper speaker.
69	Cardboard/Foam Sheet	A stiff sheet used as the base material for creating algebraic tiles.
70	Cathode	The negative electrode where reduction occurs
71	Centrifugal Force	The apparent outward force experienced by a rotating object.
72	Chassis	The base frame that supports the components of the RC car.
73	Chromosome	A DNA structure that carries genetic information.
74	Circuit	A closed-loop electrical pathway that allows current to flow.
75	Circulatory System	The system responsible for transporting blood throughout the body.
76	Class in ML Environment	A category or label used in machine learning to differentiate between different objects or data types.
77	Click Event	An action triggered when the user clicks on a sprite, used in Model 1 to play sounds indicating if food is healthy or junk.
78	Clinometer	A device used to measure angles of elevation or depression.
79	Closed Circuit	A complete circuit—current can flow and power devices
80	CO ₂ (Carbon Dioxide)	A gas produced in the acid-base reaction and monitored using the sensor.
81	Code Blocks	Predefined commands in Scratch or Pictoblox that allow users to program sprite actions and interactions.
82	Coil (Voice Coil)	A wire loop that creates a magnetic field when current flows through it, interacting with the magnets to create vibration.
83	Collector (of transistor)	The terminal through which current enters the transistor.
84	Color Blending	The visual effect created when different colors appear to merge or mix.
85	Column Chart	A graphical representation using columns to show comparisons among categories of data.
86	Compatibility	The ability of two things to work together.

SN.	Word/Term	Meaning
87	Compression	A force that pushes materials together, often used to stabilize or return to shape.
88	Conditionals	A programming concept where actions depend on a certain condition, such as "If the boy touches an apple, say 'Healthy food.'"
89	Conductive Medium	A material that allows electricity to pass through, such as copper tape.
90	Conductivity	The ability of a material to allow electric current to flow.
91	Conductor	A material that allows electric current to pass (e.g., copper tape)
92	Construction	The process of creating geometric figures using a set of given tools like a ruler and compass.
93	Control Block	A block that manages the flow of the program, like repeating actions or waiting for user interaction.
94	Copper Conductive Tape	Adhesive-backed tape made of copper that conducts electricity; used to create paper circuits
95	Cos (Cosine)	Adjacent side / Hypotenuse.
96	Cosec (Cosecant)	Hypotenuse / Opposite side.
97	Cot (Cotangent)	Adjacent side / Opposite side.
98	Cream of Tartar	A white, powdery acid (potassium bitartrate) often used in baking. In this activity, it acts as an ion source to improve conductivity in the dough.
99	Cross-Pollination	When pollen from a flower is transferred to a flower on a different plant of the same species, often with the help of wind, insects, or other agents.
100	Current (A)	The flow of electric charge through a circuit, measured in amperes.
101	Cutting Mat	A surface used to safely cut materials without damaging underlying surfaces.
102	Cutting Tools	Tools such as scissors or precision cutters used to cut tiles from templates.
103	Dabble Application	A mobile application that allows communication with Arduino via Bluetooth.
104	Data Logging	The process of collecting and storing data over time for analysis.
105	Data Visualization	The graphical representation of information, such as charts.
106	DC Motor	An electric motor that runs on direct current to produce rotational motion.
107	Debugging	The process of finding and fixing errors in a program to ensure it runs smoothly.
108	Decibel (dB)	A unit used to measure the intensity of sound.
109	Decomposition	The breakdown of a compound into simpler substances

SN.	Word/Term	Meaning
110	Deoxygenated Blood	Blood low in oxygen, returning from the body to the heart and then to the lungs for purification. Represented by blue LEDs.
111	Design-based Decisions	Choices made during the planning and construction of a project based on functionality.
112	Dexterity	Skill and ease in using the hands or fingers, often required to operate or build mechanical devices.
113	DHT11	A low-cost digital sensor that measures temperature and humidity.
114	Diaphragm	A thin surface (cardstock, in this case) that vibrates to push air and produce sound.
115	Diode	A component that allows current to flow in only one direction.
116	Distance Calculation	The process by which the Arduino calculates how far an object is using sensor data.
117	Drawing arm	The arm that creates the scaled version of the traced image.
118	DS18B20 Sensor	A digital waterproof temperature sensor used to detect changes in temperature.
119	Electrolysis	A chemical process that uses electricity to split a compound into its elements
120	Electrolyte	A substance that dissolves in water to produce a conductive solution that enables ion movement in an electrochemical cell.
121	Electromagnetism	A physical phenomenon where electric current produces a magnetic field, used in the speaker to generate movement.
122	Electronic Components	Various parts such as LEDs, buzzers, and switches that work together in an electrical circuit.
123	Emitter (of transistor)	The terminal through which current leaves the transistor.
124	Enamel Coating	The insulating layer on copper wire that must be removed for electrical contact.
125	Endothermic Reaction	A chemical reaction that absorbs heat from the surroundings, causing a drop in temperature.
126	Environmental Monitoring	The process of observing environmental parameters like temperature, humidity, or pollution.
127	Event Block	A type of Scratch or PictoBlox block that starts a script when an action occurs, such as clicking a sprite or pressing a key.
128	Exhaust Hood	A ventilation device in labs used to safely expel harmful fumes produced during chemical reactions.
129	Exothermic Reaction	A chemical reaction that releases heat into the surroundings.
130	Expanded Form	A mathematical expression written as a sum of terms rather than in its factored form.

SN.	Word/Term	Meaning
131	Extensions	Additions that expand the original project.
132	Eye Wash Bottle	A safety tool used to rinse eyes in case of chemical exposure or splashes.
133	Flipbook Animation	A simple animation technique using a series of images flipped quickly to create motion.
134	Foam Board	A lightweight and sturdy material used as a base for mounting electronic components.
135	Force transmission	The process of transferring force through a linkage system like in a pantograph.
136	Fraction	A part of a whole, represented by a numerator and a denominator (e.g., $\frac{1}{4}$, $\frac{1}{2}$).
137	Frequency	The number of sound wave cycles per second, determining pitch.
138	Friction	The resistance that occurs when two surfaces move over each other.
139	Fulcrum	The point about which a lever pivots, allowing movement in the pantograph.
140	Fume Extractor	A device that removes harmful fumes created during soldering.
141	Galvanic Cell	A type of electrochemical cell that converts chemical energy into electrical energy through redox reactions.
142	Game Design	The process of planning and developing an interactive game or animation. This project is a simple educational game-like animation.
143	Gas Concentration	The amount of gas present in a given volume of air, measured here as CO ₂ .
144	GeoGebra	An interactive mathematics software that combines geometry, algebra, and calculus for dynamic visualizations and problem-solving.
145	Geometric Representation	A visual representation of mathematical concepts using shapes and spatial arrangements.
146	Germination	The process by which a seed grows into a new plant, supported by favorable conditions such as water and temperature.
147	Glue Gun	A tool used to melt and apply adhesive sticks to bond materials.
148	Glue/Adhesive	A sticky substance used to attach templates to cardboard sheets.
149	Graphite	A form of carbon used as an electrode material
150	Gripper	A mechanical device designed to grasp and hold objects, often mimicking a human hand.
151	Gyroscope	A rotating device that maintains orientation due to angular momentum.

SN.	Word/Term	Meaning
152	HC-05 Bluetooth Module	A wireless communication module used to connect Arduino with mobile devices.
153	Healthy Food	Nutritious food items such as fruits, vegetables, and nuts, which are beneficial for health.
154	Heart	The muscular organ that pumps blood throughout the body.
155	Honeybee	An insect that plays a key role in cross-pollination by collecting nectar and transferring pollen between flowers.
156	Humidity	The amount of water vapor present in the air, measured by sensors like DHT11.
157	HVAC Systems	Heating, Ventilation, and Air Conditioning systems used for regulating indoor environments.
158	HX711 Module:	A 24-bit ADC (Analog to Digital) module designed to amplify and convert the analog signal from a load cell into a digital format.
159	Hydrogen	A gas released at the cathode during electrolysis of water
160	Hypotenuse	The longest side of a right triangle, opposite the right angle.
161	Illusion	A misleading visual perception, such as colors blending when spun rapidly.
162	Illusion of Motion	A visual effect where static images appear to move due to persistence of vision.
163	Image Classification	The process of identifying and categorizing objects in an image.
164	Image Recognition	Technology that identifies objects in digital images.
165	Inertia	The tendency of an object to resist changes in its motion.
166	Insect Pollination	Pollination that occurs when insects (e.g., bees, butterflies) transfer pollen from one flower to another.
167	Insulation	A material or method that prevents the unintended flow of electricity.
168	Insulator	A material that resists the flow of electric current. The insulating dough is used to block current flow in unwanted areas of the circuit.
169	Interaction	When a user or a sprite takes action in the program, such as clicking on a food sprite to hear a sound.
170	Internet of Things	A network of physical devices connected to the internet that collect and share data.
171	Internet of Things (IoT)	A network of interconnected devices capable of collecting and exchanging data.
172	IR Sensor	An Infrared sensor that detects objects by reflecting infrared light.

SN.	Word/Term	Meaning
173	Jumper Cables	Wires used to make electrical connections on a breadboard.
174	Jumper Wires	Insulated wires used to connect different parts of a circuit.
175	Junk Food	Unhealthy food items high in sugar, fat, and processed ingredients, which can be harmful if consumed excessively.
176	Kinematics	The study of motion without considering the forces that cause it, applied in pantograph movement.
177	L298N Motor Driver:	An electronic module that controls the speed and direction of a DC motor.
178	LCD Display	An electronic screen used to show CO ₂ concentration in parts per million (ppm).
179	LED	A light-emitting diode; lights up when current flows in the correct direction
180	LED	Light Emitting Diode, emits light when current flows through it.
181	LED	A Light Emitting Diode that glows when current passes through.
182	LED (Light Emitting Diode)	A small electronic component that lights up when electric current passes through it in the correct direction.
183	Lever	A simple machine that helps transfer motion and force in the pantograph system.
184	Line Chart	A chart used to show trends over time by connecting data points with a continuous line.
185	Linkage	A system of connected levers used to transmit motion and force.
186	Lithium-ion Battery	A rechargeable battery that provides power to electronic circuits.
187	Load	The component in a circuit that uses electricity (e.g., LED)
188	Load Cell	A sensor that converts mechanical force or weight into an electrical signal.
189	Logical Thinking	The ability to break down a problem into smaller steps and solve it using a structured approach, essential for programming.
190	Loop	A control block that repeats a specific action multiple times, such as moving the boy continuously towards the food items.
191	Lungs	Organs that oxygenate the blood and remove carbon dioxide.
192	Machine Learning (ML)	A type of AI where computers learn from data instead of being explicitly programmed.
193	Machine Learning (ML)	A type of artificial intelligence that enables computers to learn from data.
194	Magnet	A material that produces a magnetic field; neodymium magnets are strong and ideal for compact speakers.
195	Mathematical Visualization	The process of using diagrams, graphs, and interactive models to understand mathematical concepts.

SN.	Word/Term	Meaning
196	Mechanical advantage	The factor by which a mechanism multiplies force, seen in pantograph motion.
197	Mechanism	A system of parts working together to perform a function or movement.
198	Metallic Probe	The metal tip of the DS18B20 sensor that is immersed into the reaction to detect heat.
199	Microcontroller	A compact integrated circuit designed to govern a specific operation in an embedded system.
200	Microsoft Excel	Spreadsheet software used to open CSV/TXT files and create charts for data visualization.
201	Middle Disc/Plate	The rotatable disc displaying the trigonometric ratios.
202	Mobile Sensor	The inbuilt motion-tracking system in smartphones that helps measure movement.
203	Model Training	The process of teaching an ML algorithm to recognize patterns in data.
204	Modifications	Changes made to improve something.
205	Momentum	The tendency of a moving object to keep moving unless stopped by an external force.
206	Motion Block	A block that moves a sprite in a specific direction, such as making the boy walk toward the food items.
207	Motor Driver	A circuit or component that controls motor speed and direction.
208	MQ-135 Sensor	A gas sensor capable of detecting CO ₂ and other air pollutants.
209	Multimeter	An instrument used to measure voltage, current, and resistance in a circuit.
210	Muscles	Tissues in the body that contract to move bones; in the gripper, the string-pulling action mimics muscle contraction.
211	Newton's Disc	A disc with segments colored in the seven colors of the rainbow; when spun, the colors blend to appear white, demonstrating that white light is a mix of all colors.
212	Newton's Third Law	A law of motion stating that for every action, there is an equal and opposite reaction.
213	Noise Pollution	Unwanted or harmful sound that disrupts normal environmental balance.
214	NPN Transistor	A type of bipolar junction transistor with current flowing from collector to emitter.
215	Obtuse Triangle	A triangle with one angle greater than 90°.
216	Ohm's Law	A fundamental electrical equation: $V = I \times R$ or $V = I \times R$.
217	OLED Display	A small digital screen used to display data.
218	Open Circuit	A circuit with a break in it—current cannot flow

SN.	Word/Term	Meaning
219	Operating current	The amount of electric current a device or circuit consumes during normal operation to function correctly and efficiently
220	Operating voltage	The specific voltage range within which a device or circuit functions safely and efficiently. It ensures proper performance without damage or malfunction
221	Optics	The branch of physics that deals with the behavior and properties of light.
222	Origami	The art of paper folding to create models or shapes
223	Oxidation	A chemical reaction where an element loses electrons, occurring at the anode.
224	Oxygenated Blood	Blood rich in oxygen, carried from the lungs to the heart and body.
225	Ozone	A gas composed of three oxygen atoms, significant in environmental monitoring for air quality.
226	Pantograph	A mechanical drawing tool consisting of interconnected arms that can enlarge or reduce drawings.
227	Paper Circuit	A simple electrical circuit constructed using conductive materials like copper tape.
228	Paper Glue	Adhesive used to stick paper parts together or secure components onto cardstock
229	Parallel Circuit	A type of circuit where components are connected across common points, allowing current to split and flow through multiple paths.
230	Parallel Connection	A circuit configuration where components are connected alongside each other, increasing the total current capacity.
231	Parallelogram	A four-sided geometric shape with opposite sides that are equal and parallel, forming the fundamental structure of a pantograph.
232	Perception	The way in which the brain interprets visual information received from the eyes.
233	Persistence of Vision	A phenomenon where the human eye retains an image for a short period, creating an illusion of motion.
234	pH Scale	A numerical scale (0-14) that measures how acidic or basic a substance is.
235	Pictoblox	A coding platform similar to Scratch that allows users to create animations and control robotics using block-based programming.
236	Pie Chart	A circular chart that represents data as slices of a whole.
237	Pivot point	The fixed joint where two arms of the pantograph rotate around each other.
238	Polarity	The direction in which current flows; important for LEDs

SN.	Word/Term	Meaning
239	Polarity	The direction of electrical flow, especially important in components like LEDs.
240	Pollen	The fine, powdery substance containing male reproductive cells of a plant.
241	Pollination	The process of transferring pollen from the male part (anther) to the female part (stigma) of a flower for fertilization.
242	Potentiometer	A variable resistor that adjusts voltage to control the speed of the motor.
243	Power Source	A device (like a 9V battery) that provides the energy needed to power the circuit.
244	ppm (Parts Per Million)	A unit of measurement indicating the concentration of a substance in air.
245	Precision Screwdriver	A small screwdriver used to adjust components like the LCD contrast knob.
246	Printable Template	A pre-designed guide used to accurately cut the foam board into bracket shapes.
247	Printable Template	A pre-designed guide for accurately placing circuit components.
248	Probe	A conductive element that detects the presence of water in this context.
249	Programming	The process of writing instructions for a computer to execute. In this lesson, students use block-based programming to create animations.
250	Proof	A logical argument demonstrating the truth of a theorem
251	Propeller	A rotating blade that pushes against water to move the boat forward.
252	Propulsion	The action of pushing or driving an object forward.
253	Prototype	An initial model or sample built to test a concept or design.
254	Protractor	A tool used to measure angles in degrees.
255	Pull-up Mechanism	A method of lifting and assembling a 3D shape from a 2D net using strings
256	Push Button	A switch that allows or interrupts the flow of electricity when pressed.
257	Push Button	A switch that allows electrical current to pass when pressed.
258	Push Button	A switch that completes the circuit when pressed.
259	Push Pin	A pin used to secure and rotate the discs.
260	PWM Controller	A device that regulates motor speed by varying the duty cycle of the applied voltage.

SN.	Word/Term	Meaning
261	Pythagorean Theorem	A formula: $a^2+b^2=c^2$, used to calculate the hypotenuse of a right triangle.
262	Pythagorean Theorem	A fundamental principle in geometry that states $a^2+b^2=c^2$ for a right triangle.
263	Python	A powerful and easy-to-learn programming language often used for data analysis and visualization.
264	Quadrilateral	A four-sided polygon with different classifications based on angles and side lengths.
265	Ratio of enlargement	The proportion by which the pantograph enlarges or reduces the input drawing.
266	RC Car (Remote-Controlled Car)	A small vehicle that is controlled using a wired or wireless remote.
267	Reaction Vessel	The container (jar/beaker) where the acid-base reaction takes place.
268	Real-Time Data	Data that is collected and available for use immediately as it is generated.
269	Real-Time Monitoring	Observing and recording data as it happens, without delay.
270	Rechargeable Battery	A battery that can be charged and reused multiple times, reducing waste and cost.
271	Recognition Window	A visual display in PictoBlox where the ML model identifies objects in real time through a web-camera.
272	Rectangular Tile	A rectangular-shaped tile representing product terms like ab , bc , or ac .
273	Recycling	The process of converting waste materials into reusable materials.
274	Reduction	A chemical reaction where an element gains electrons, occurring at the cathode.
275	Resistance	The opposition to the flow of electric current. Materials with high resistance, like insulating dough, limit current flow.
276	Resistor	A component that limits the flow of electrical current.
277	Return Mechanism	A system (like rubber bands) that brings a component back to its original position after movement.
278	RGB LED Module	A light-emitting diode that can produce different colors (Red, Green, Blue) based on electrical input.
279	Ribbon Cable	A flat, multi-wire cable used for making flexible and organized electrical connections.
280	Ribbon Cable	A flat, flexible cable with multiple conducting wires used to make electrical connections.
281	Right Triangle	A triangle with one 90° angle.

SN.	Word/Term	Meaning
282	Right Triangle	A triangle with one angle measuring 90 degrees.
283	Rocker Switch	A switch that allows current to flow or stop by toggling between on and off positions.
284	Rocker Switch	A switch used to turn the power supply on or off in a circuit.
285	Rotation point	The specific location where a pivot occurs in a mechanical system like a pantograph.
286	RPM (Revolutions Per Minute)	A unit measuring the speed of rotation in one minute.
287	RTC Module	Real-Time Clock; a module that keeps time accurately, even when the Arduino is off.
288	Scaling	The process of increasing or decreasing the size of an image while maintaining its proportions.
289	Scratch	A block-based visual programming language used to create animations, games, and interactive projects.
290	Script	A sequence of coding blocks in Scratch or PictoBlox that define the behavior of a sprite.
291	Sec (Secant)	Hypotenuse / Adjacent side.
292	Self-Pollination	When pollen from a flower lands on the same flower or another flower on the same plant, leading to fertilization.
293	Sensing Block	A block that allows a sprite to detect things like touching another sprite, which helps determine whether a food item is healthy or junk.
294	Sensor Calibration	The process of adjusting the sensor readings for higher accuracy.
295	Serial Communication	A method of communication where data is sent one bit at a time over a communication channel.
296	Serial Communication	A method of data transfer between Arduino and external devices.
297	Serial Monitor	A tool in the Arduino IDE that displays data sent from the board via USB.
298	Series Circuit	A type of circuit where components are connected end-to-end, so the same current flows through all components.
299	Series Connection	A circuit configuration where components are connected end-to-end, increasing the total voltage output.
300	Short Circuit	An undesired connection that allows current to flow along an unintended path, often causing circuit failure.
301	Simple machines	Basic mechanical devices that make work easier by amplifying force, including levers, pulleys, and gears.
302	Simulation	A digital representation of a real-world process, such as pollination, created through animation.

SN.	Word/Term	Meaning
303	Simulation	An interactive mathematics software that combines geometry, algebra, and calculus for dynamic visualizations and problem-solving.
304	Smart Homes	Homes equipped with devices that automate tasks and are often connected via the internet.
305	Soldering	The process of joining electronic components using melted metal (solder) for electrical connections.
306	Soldering Flux	A chemical used during soldering to clean surfaces and improve the quality of electrical connections.
307	Sound Block	A block that plays sounds when a certain event occurs, such as the boy saying "Healthy food" or "Junk food" when touching a sprite.
308	Sound Effects	Audio files (e.g., wind, buzzing, thunder) added to animations to enhance realism.
309	Sound Sensor	A device that detects sound levels and converts them into electrical signals.
310	Sound Wave	A wave of compression and rarefaction through a medium (like air) that is heard as sound.
311	Sound-reactive LEDs	LED lights that change their brightness, color, or patterns in response to the intensity or frequency of nearby sounds, creating an audio-visual experience
312	Speaker	A device that converts electrical signals into sound using vibrations.
313	Spectrum	A range of colors produced when light is separated into its component wavelengths.
314	Speed	A measure of how fast an object moves, calculated as distance divided by time.
315	Sprite	A character or object in the animation that can move and interact with other elements. In this project, food items and the boy are sprites.
316	Square Tile	A square-shaped tile representing squared terms like a^2 , b^2 , or c^2 .
317	Stigma	The part of a flower where pollen lands during pollination.
318	Structural Support	Elements like ice cream sticks used to reinforce and stabilize moving parts.
319	Surface Area	The total area covered by a shape, used in verifying algebraic identities.
320	Switch	A control device used to open or close an electric circuit
321	Teachable Machine	A web-based tool that allows users to train and export ML models without coding.

SN.	Word/Term	Meaning
322	Template	A pre-designed paper sheet with printed shapes representing algebraic terms, used as a guide for cutting and assembling tiles.
323	Tendons	Cord-like tissues in the human body that connect muscles to bones and help create movement—simulated by strings in the gripper.
324	Tension	A pulling force applied by a string or rope that creates motion in the system.
325	Terminal	A point where connections are made in an electrical circuit.
326	Test Tube	A cylindrical glass container used to mix or collect the chemicals.
327	Testing Circuit	A temporary setup used to check if the speaker functions properly before finalizing the build.
328	Text-to-Speech	A feature that converts text into spoken words.
329	Theorem	A mathematical statement that has been proven to be true using logical reasoning.
330	Thrust	The force that moves an object forward.
331	Thunderstorm	A weather event with rain, thunder, and lightning, shown in the animation as occurring two months after pollination.
332	Tiles	Cut-out pieces representing algebraic terms that can be arranged to visualize equations.
333	Timestamp	A record of the time at which a particular data entry is collected.
334	Tinkercad	A web-based circuit simulation tool.
335	Tinkercad	A web-based circuit simulation tool.
336	Tolerances on Resistor Values	The permissible variation in a resistor's actual resistance from its stated value, usually expressed as a percentage (e.g., $\pm 5\%$). It indicates the accuracy of the resistor.
337	Top Disc/Plate	The top layer with a window for revealing values.
338	Torque	A measure of the rotational force of a motor, affecting its ability to move objects.
339	Tracing arm	The section of the pantograph that follows the original image or shape.
340	Transistor	A semiconductor device used to amplify or switch electronic signals.
341	Trigonometric Ratios	Ratios of sides of a right triangle related to an angle.
342	Trigonometry	A branch of mathematics dealing with angles and their relationships.
343	Troubleshoot	Finding and fixing problems in a system or circuit.
344	Tweezers	A small handheld tool used for precise placement of small components like LEDs or copper tape

SN.	Word/Term	Meaning
345	Ultrasonic Sensor	A sensor that measures distance by emitting ultrasonic waves and timing their echo.
346	User Input	Interaction from the user, such as clicking a sprite or pressing a key, which influences what happens in the program.
347	Veins	Blood vessels that carry deoxygenated blood to the heart.
348	Velocity	The speed of an object in a given direction, measured in meters per second (m/s).
349	Vibration	Rapid back-and-forth movement, essential for producing sound in a speaker.
350	Vinegar	A weak acid (acetic acid) used in this experiment as the acid component.
351	Visible Spectrum	The portion of light visible to the human eye, including red to violet colors.
352	Visualization	Graphical representation of data, like column charts or line graphs.
353	Voltage (V)	The electrical potential difference between two points in a circuit, measured in volts.
354	Water Tub	A container filled with water used for testing the working of the boat model.
355	White Light	Light that contains all the colors of the visible spectrum combined.
356	Wi-Fi Module	A module used to wirelessly connect Arduino to the internet.
357	Wind Pollination	Pollination that occurs when wind carries pollen from one flower to another.
358	Wire Stripper	A tool used to remove insulation from wires for electrical connections.
359	Wooden Plank	A flat wooden board used as a stable base to mount and organize components in the model.
360	XX Chromosome	Represents a female in humans.
361	XY Chromosome	Represents a male in humans.
362	Zero PCB	A prototyping board used for soldering and creating permanent circuit connections.

