



Government of Pakistan
Ministry of Science and Technology

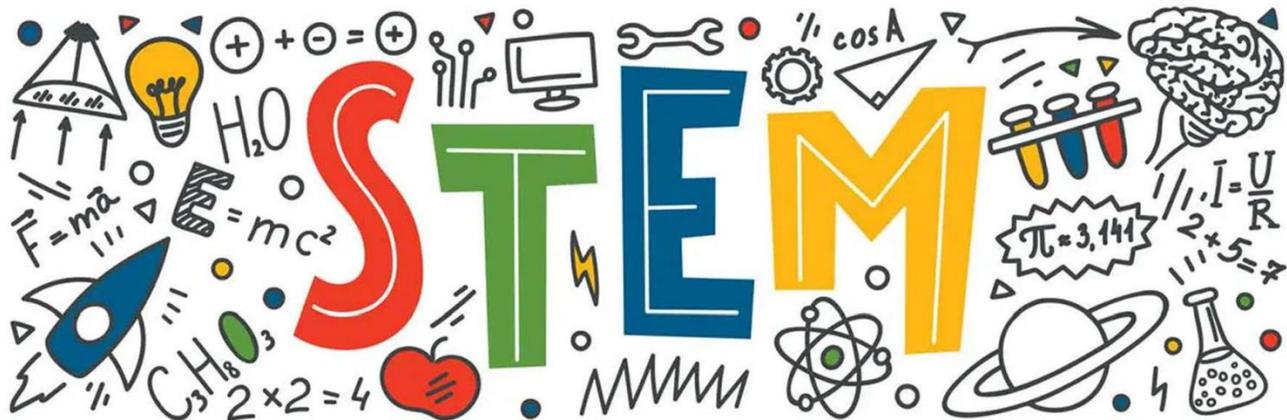
GRADE



STEM PROJECTS

Aligned with National Curriculum of
Mathematics, Physics, Chemistry,
Biology and Computer Science

TEACHING GUIDE
LESSON PLANS
STEP-BY-STEP INSTRUCTIONS
ACTIVITY SHEETS



Science, Technology, Engineering, and Mathematics

Launching of STEM in Pakistan
A project of Pakistan Science Foundation
Ministry of Science and Technology



Pakistan Science Foundation

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www.psf.gov.pk

Children and Youth Science Center (CYSC)
Chinese Association of Science and Technology (CAST)



PREFACE

Welcome to this collection of STEM Projects. In a world driven by science, technology, engineering, and mathematics, curiosity has the power to shape the future. This book is a culmination of that curiosity—an assemblage of hands-on projects designed to inspire, educate, and ignite a passion for the wonders of the STEM disciplines.

The journey through STEM is a dynamic one, marked by discovery, innovation, and the endless pursuit of understanding the intricacies of our universe. As you turn these pages, you'll find a diverse array of projects that encompass various fields, each carefully crafted to encourage you to question, experiment, and engage with the world around you.

From constructing model bridges that test the principles of engineering, to coding simulations that unravel complex scientific phenomena, to delving into the realms of mathematics that underpin our technological advancements—this collection offers a plethora of opportunities to delve into the heart of STEM. Whether you're a student taking your first steps into these domains or an experienced enthusiast or a teacher seeking new challenges, there's something here for everyone.

These projects not only serve as outlets for creativity and critical thinking, but also as gateways to understanding how the principles of STEM shape our daily lives. They showcase the practical applications of theory, enabling you to bridge the gap between abstract concepts and tangible outcomes. Each project is a chance to observe the interplay between theory and reality, while also fostering the invaluable skills of problem-solving, teamwork, and perseverance.

This book wouldn't be possible without the dedication and enthusiasm of countless individuals who have a deep-rooted passion for STEM. It's a testament to their unwavering commitment to sharing knowledge and inspiring the next generation of thinkers, creators, and innovators.

PREFACE



So, whether you're embarking on these projects independently, as part of a classroom experience, or even as a family endeavor, remember that exploration knows no bounds. The world of STEM is boundless and ever-evolving, and each project you undertake is a step toward unraveling its mysteries.

As you embark on this adventure of exploration and discovery, we hope that these projects will not only provide you with the tools to create and learn, but also with a lasting sense of awe for the beauty and complexity of the STEM world. May your journey through these pages be just the beginning of a lifelong pursuit of knowledge and a deep-seated appreciation for the marvels that STEM has to offer.

Happy exploring!

PREFACE

BIOLOGY

01

DEMONSTRATING EFFECT OF DIFFERENT SALT CONCENTRATIONS ON OSMOSIS WITHIN LIVING CELLS

Investigate the effect of concentration of sugar/salt solution on the mass of the plant tissue.

19

RATE OF PHOTOSYNTHESIS

Investigate how limiting factors affect the rate of photosynthesis and how they are controlled in a greenhouse to give a maximum yield?

38

FACTORS AFFECTING THE RATE OF TRANSPIRATION

How can you as Botanists demonstrate that temperature, wind, humidity, and light intensity affect the rate of transpiration in plants?

61

HOW TO COUNTERACT DEFORESTATION

Design a seeding machine to counteract deforestation.

78

HOW TO USE SCIENTIFIC METHOD IN BIOLOGY?

Be a Scientist! Use the Scientific Method to Solve a Problem.

102

LEARNING MITOSIS AND MEIOSIS THROUGH SIMULATION

Distinguish between stages of mitosis and meiosis and illustrate and interpret with correct description.

CHEMISTRY

124 GALVANIZE TO PROTECT

Electro galvanizing for Corrosion Resistance - Unveiling the Science of Shielding Metal from Decay.

139 GAS LAWS

How can we as chemists perform a scientific inquiry that helps us to understand Boyle's Law by practically demonstrating it?

153 TURN MILK INTO PLASTIC

Can you as an aspiring Chemist use your knowledge of Chemistry to Investigate the process of converting milk into a polymer material through the use of chemical reactions and evaluate the properties of the resulting plastic?

174 SIGNING OFF ON THE METAL

You want to give your best friend a gift with both of yours initials printed on it. Can you make a key chain or nameplate for your friend using materials from your chemistry and physics lab?

192 EXPLORE ELEMENTS OF THE PERIODIC TABLE AROUND YOU

How can you as Material Scientists identify the elements present in the things around you?

207 SOLUBILITY OF SALTS

You may have noticed that you can dissolve more sugar in hot water as compared to cold water. But is it the case with all solvents? Explore the effects of temperature on solubility using computer simulation.

PHYSICS

220

HYDRAULIC BRIDGE

How can you as an Architect or Civil Engineer design and build a model for a hydraulic bridge that connects towns in Gilgit Baltistan over its glacial lakes?

233

WIND POWER

Do you want to be a part of the solution to Pakistan's energy crisis? Only 5.4% of the country's energy currently comes from renewable sources, but you can help change that. Can you build your own DIY anemometer?

253

DIY BI-METALLIC STRIP: EXPLORING THERMAL EXPANSION

Bi-metal strips are hard to find in many areas of Pakistan and are a very useful tool in temperature-controlled switches. Can you make your own bi metal strip?

268

ARCHIMEDES SQUEEZE

Apply the Archimedes principle on a boat floating in a pond and determine when it sinks.

281

INVENTING OUR OWN UNITS: A PRACTICAL EXPLORATION

In ancient times there were standardized units of measurement but small variations in those standards led to big disputes. Can you build your own standard and identify flaws in it?

294

IS YOUR ROLLERCOASTER RIDE SWIFT ENOUGH?

How can we as design engineers simulate a roller coaster in such a way that the design can be used to build a safe, stable and fun ride for an upcoming amusement park in Multan?



MATHEMATICS

308

GRAPHING LINES

How can we, as mathematicians, digitally simulate linear graphs to acquire a nuanced understanding of their applications in real-life situations?

324

MATRIX MULTIPLICATION

How can we as mathematicians digitally simulate matrices to help us visualize how matrices multiply with each other?

338

POPSICLE TRUSSES

How can we as civil engineers design and construct different mathematical working models of truss structures?

356

LAWNMOWER MATHS

How can we visualize real-life applications of algebraic expressions?

370

THE PYTHAGORAS THEOREM

How can we use the Pythagoras Theorem to understand patterns in other Mathematical theorems?

390

FACTORING HIGHER DEGREE POLYNOMIALS

How can we as mathematicians simulate games from digital resources to acquire an understanding of factorizing polynomials using different methods?

COMPUTER SCIENCE

406 **USE THE FEATURES OF MICROSOFT OFFICE FOR DOCUMENTATION**
Learn how professional workplaces report and document information.

425 **CONTROLLING LEDS USING IOT**
How can you as Computer Scientists operate and control electronic components wirelessly using IoT technology?

447 **CYBER QUEST**
A journey through the world of cyber security

459 **AI BASED STREET LIGHT**
How are appliances made energy efficient and cost efficient?

475 **DESIGN A QUIZ SYSTEM TO HELP HR IN THE HIRING PROCESS**
As a software developer, you have been asked by the HR department to make a quiz-based system to help them in hiring.

493 **DESIGNING THE JUMPING DUCK GAME**
As a game developer, you have been tasked with designing a simple game that anyone can play no matter their age.

PROJECTS CONTRIBUTED BY CYSC-CAST

*(Children and Youth Science Center, China Association
of Science and Technology)*

THE MAGIC OF MEDICAL MASKS

513

In the context of the new crown epidemic, masks have become the guardians of our health, effectively blocking out most dust and droplets and greatly reducing the risk of being infected. Let's explore the structure and effectiveness of masks!

INTELLIGENT TRAFFIC LIGHTS

528

For the visually impaired, it is difficult to distinguish the crossing direction and traffic light status at the intersection, which is a prominent travel "pain point". Explore how barrier-free signal lights can greatly resolve this embarrassment.

ROCKET TO THE MOON TO EXPLORE AEROSPACE ENERGY

541

How to select an appropriate energy system has become an important link in the aerospace industry

DETERMINATION OF GLUCOSE CONCENTRATION - MAKING A SIMPLE POLARIMETER

549

Explore the working principle of the polarimeter and make a simple polarimeter that can be used to measure the concentration of glucose.

IMPROVING A SINGLE PENDULUM TO MEASURE THE "g"

561

Be able to use the smartphone to measure data from the single pendulum and analyze the relationship between the data measured by smartphones and the pendulum's period.



PROJECTS ON EMERGING TECHNOLOGIES

572

**DATA SCIENCE: EXPLORING TWITTER - DATA
EXTRACTION AND ANALYSIS WITH RAPIDMINER**

How do Data Analysts and Scientists gather data to perform Pre-Processing and Text Mining.

593

MECHATRONICS: VOICE CONTROLLED LED'S

Can Your Voice Illuminate the LEDs. Learn to use an Arduino microcontroller and an HC06 Bluetooth module to control LEDs with voice commands.

608

**RENEWABLE ENERGY: SOLAR POWER EXPLORATION -
INVESTIGATING SOLAR PANELS AND CAREER PATHS**

As future solar scientists, you'll investigate photovoltaic cells, test solar panels, and uncover renewable energy careers
