Module 1

Upper Primary Technology

Teaching Technology in the Primary School

The Commonwealth of Learning

Science, Technology and Mathematics Modules

for Upper Primary and Junior Secondary School Teachers
of Science, Technology and Mathematics by Distance
in the Southern African Development Community (SADC)

Developed by
The Southern African Development Community (SADC)

Ministries of Education in:

- **Botswana**
- **Malawi**
- **Mozambique**
- **Namibia**
- **South Africa**
- **Tanzania**
- **Zambia**
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In partnership with The Commonwealth of Learning

Published jointly by The Commonwealth of Learning and the SADC Ministries of Education.

Residents of the eight countries listed above may obtain modules from their respective Ministries of Education. The Commonwealth of Learning will consider requests for modules from residents of other countries.

ISBN 1-895369-71-1

SCIENCE, TECHNOLOGY AND MATHEMATICS MODULES

This module is one of a series prepared under the auspices of the participating Southern African Development Community (SADC) and The Commonwealth of Learning as part of the Training of Upper Primary and Junior Secondary Science, Technology and Mathematics Teachers in Africa by Distance. These modules enable teachers to enhance their professional skills through distance and open learning. Many individuals and groups have been involved in writing and producing these modules. We trust that these modules will benefit not only the teachers who use them, but also, ultimately, their students and the communities and nations in which they live.

The twenty-eight Science, Technology and Mathematics modules are as follows:

Upper Primary Science
Module 1: *My Built Environment*
Module 2: *Materials in my Environment*
Module 3: *My Health*
Module 4: *My Natural Environment*

Junior Secondary Science
Module 1: *Energy and Energy Transfer*
Module 2: *Energy Use in Electronic Communication*
Module 3: *Living Organisms' Environment and Resources*
Module 4: *Scientific Processes*

Upper Primary Technology
Module 1: *Teaching Technology in the Primary School*
Module 2: *Making Things Move*
Module 3: *Structures*
Module 4: *Materials*
Module 5: *Processing*

Junior Secondary Technology
Module 1: *Introduction to Teaching Technology*
Module 2: *Systems and Controls*
Module 3: *Tools and Materials*
Module 4: *Structures*

Upper Primary Mathematics
Module 1: *Number and Numeration*
Module 2: *Fractions*
Module 3: *Measures*
Module 4: *Social Arithmetic*
Module 5: *Geometry*

Junior Secondary Mathematics
Module 1: *Number Systems*
Module 2: *Number Operations*
Module 3: *Shapes and Sizes*
Module 4: *Algebraic Processes*
Module 5: *Solving Equations*
Module 6: *Data Handling*

A MESSAGE FROM THE COMMONWEALTH OF LEARNING

The Commonwealth of Learning is grateful for the generous contribution of the participating Ministries of Education. The Permanent Secretaries for Education played an important role in facilitating the implementation of the 1998-2000 project work plan by releasing officers to take part in workshops and meetings and by funding some aspects of in-country and regional workshops. The Commonwealth of Learning is also grateful for the support that it received from the British Council (Botswana and Zambia offices), the Open University (UK), Northern College (Scotland), CfBT Education Services (UK), the Commonwealth Secretariat (London), the South Africa College for Teacher Education (South Africa), the Netherlands Government (Zimbabwe office), the British Department for International Development (DFID) (Zimbabwe office), and Grant MacEwan College (Canada).

The Commonwealth of Learning would like to acknowledge the excellent technical advice and management of the project provided by the strategic contact persons, the broad curriculum team leaders, the writing team leaders, the workshop development team leaders, and the regional monitoring team members. The materials development would not have been possible without the commitment and dedication of all the course writers, the in-country reviewers and the secretaries who provided the support services for the in-country and regional workshops.

Finally, The Commonwealth of Learning is grateful for the instructional design and review carried out by teams and individual consultants as follows:

- Grant MacEwan College (Alberta, Canada):
  General Education Courses
- Open Learning Agency (British Columbia, Canada):
  Science, Technology and Mathematics
- Technology for Allcc. (Durban, South Africa):
  Upper Primary Technology
- Hands-on Management Services (British Columbia, Canada):
  Junior Secondary Technology

Dato' Professor Gajaraj Dhanarajan
President and Chief Executive Officer

ACKNOWLEDGEMENTS

The Technology Modules for Upper Primary and Junior Secondary Teachers in the Southern Africa Development Community (SADC) were written and reviewed by teams from the participating SADC Ministries of Education with the assistance of The Commonwealth of Learning.

CONTACTS FOR THE PROGRAMME

The Commonwealth of Learning
1285 West Broadway, Suite 600
Vancouver, BC V6H 3X8
Canada

Ministry of Education
Private Bag 005
Gaborone
Botswana

Ministry of Education
Private Bag 328
Capital City
Lilongwe 3
Malawi

Ministério da Eduação
Avenida 24 de Julho No 167, 8
Caixa Postal 34
Maputo
Mozambique

Ministry of Basic Education,
Sports and Culture
Private Bag 13186
Windhoek
Namibia

National Ministry of Education
Private Bag X603
Pretoria 0001
South Africa

Ministry of Education and Culture
P.O. Box 9121
Dar es Salaam
Tanzania

Ministry of Education
P.O. Box 50093
Lusaka
Zambia

Ministry of Education, Sport and Culture
P.O. Box CY 121
Causeway
Harare
Zimbabwe

MODULE WRITERS

R.F. Sherwood: Technology for All
Kloof, South Africa

V. Lehlekane: Senior Lecturer
Rubisane College of Education
Eastern Cape, South Africa

H.H. Johnstone: Technology for All
Kloof, South Africa

K.J. Ter-Morshuizen: Technology for All
Kloof, South Africa

FACILITATORS/RESOURCE PERSONS

Dr. Peter Craig: Education Consultant
Northern College
Aberdeen, Scotland, UK

PROJECT MANAGEMENT & DESIGN

Ms. Kgomotso Motlotle: Education Specialist, Teacher Training
The Commonwealth of Learning (COL)
Vancouver, BC, Canada

Mr. David Rogers: *Post-production editing*
Co-ordinator of Instructional Development
Open Learning Agency
Victoria, BC, Canada

Ms. Lee McKenzie McAnally: *Post-production editing*
Open Learning Agency
Victoria, BC, Canada

Ms. Sandy Reber: *Graphics & desktop publishing*
Reber Creative
Victoria, BC, Canada

Introduction

Welcome to the programme in Teaching Upper Primary Technology. This series of five modules is designed to help you strengthen your knowledge of technology topics and acquire more instructional strategies for teaching technology in the classroom.

Each of the five modules in the technology series provides an opportunity to apply theory to practice. Learning about technology entails the development of practical skills as well as theoretical knowledge. Each technology topic includes an explanation of the theory behind the technology, examples of how the technology is used in practice, and suggestions for classroom activities that allow students to explore the technology for themselves.

Each module explores several instructional strategies that can be used in the technology classroom and provides you with an opportunity to apply these strategies in practical classroom activities. Each module examines the reasons for using a particular strategy in the classroom and provides a guide for the best use of each strategy, given the topic, context, and goals.

The guiding principles of these modules are to help make the connection between theory and practice, apply instructional theory to practice in the classroom situation, and support you, as you in turn help your students to apply technology theory to practical classroom work.

Programme Goals

This programme is designed to help you to:

- strengthen your understanding of technology topics
- expand the range of instructional strategies that you can use in the technology classroom

Programme Objectives

By the time you have completed this programme, you should be able to:

- guide students as they work in teams on practical projects in technology, and help them to work effectively as a member of a group
- use questioning and explanation strategies to help students learn new concepts and to support students in their problem solving activities
- guide students in the use of investigative strategies to learn more about particular technologies, and to find out how tools and materials are used in technology
- prepare your own portfolio about your teaching activities
- guide students as they prepare their portfolios about their project activities

The relationship between this programme and the technology curriculum

The technology content presented in these modules includes some of the topics most commonly covered in the technology curricula in southern African countries. However, it is not intended to comprehensively cover all topics in any one country's technology curriculum. For this, you will need to consult your national or regional curriculum guide. The curriculum content that is presented in these modules is intended to:

- provide an overview of the content in order to support the development of appropriate teaching strategies
- use selected parts of the curriculum to develop specific teaching strategies
- explain those elements of the curriculum that provide essential background knowledge, or that address particularly complex or specialised concepts
- provide directions to additional resources on the curriculum content

How to Work on this Programme

As is indicated in the programme goals and objectives, this programme allows you to participate actively in each module by applying instructional strategies when exploring technology with your students and by reflecting on that experience. There are several different ways to do this.

Working on Your Own

You may be the only teacher of technology topics in your school, or you may choose to work on your own so you can accommodate this programme within your schedule. If this is the case, these are the recommended strategies for using this module:

1. Establish a schedule for working on the module: choose a date by which you plan to complete the first module, taking into account that each unit will require between six to eight hours of study time and about two hours of classroom time for implementing your lesson plan. For example, if you have two hours a week available for study, then each unit will take between three and four weeks to complete. If you have four hours a week for study, then each unit will take about two weeks to complete.
2. Choose a study space where you can work quietly without interruption, for example, a space in your school where you can work after hours.
3. If possible, identify someone who is interested in technology or whose interests are relevant to technology (for example, a math, science, or technology teacher in your school) with whom you can discuss the module and some of your ideas about teaching technology. Even the most independent learner benefits from good dialogue with others. It helps us to formulate our ideas—or as one learner commented, “How do I know what I'm thinking until I hear what I have to say?”

Working with colleagues

If you are in a situation where there are other technology teachers in your school or in your immediate area, then it is possible for you to work together on this module. You may choose to do this informally, perhaps having a discussion group once a week or once every two weeks about a particular topic in one of the units. If you choose to organise more formally, establish a schedule so everyone works on the same units at the same time. You can even work in small groups or pairs on particular projects. If you and several colleagues plan to work together on these modules, these are the recommended steps:

1. Establish and agree on a schedule that allows sufficient time to work on each unit, yet maintains the momentum so people don't lose interest. If all of you work together in the same location, meeting once a week and allocating two weeks for each unit, this plan should accommodate individual and group study time. If you work in different locations and have to travel some distance to meet, you may decide to meet once every two weeks, and agree to complete a unit every two weeks.
2. Develop and agree on group goals, so that everyone is clear about the intended achievements for each unit and for each group session.
3. Develop a plan for each session, outlining what topics will be covered and what activities will be undertaken by the group as a whole, in pairs, or in small groups. It may be helpful for each member of the group to take a turn in planning a session.

Your group may also choose to call on the expertise of others, perhaps inviting someone with particular knowledge about teaching or about a specific technology topic to speak with the group, as long as this is in keeping with the goals of the module and of the group.

Your group may also have the opportunity to consult with a mentor, or with other groups, by teleconference, audioconference, letter mail, or e-mail. Check with the local coordinator of your programme about these possibilities so that your group schedule is compatible with these provisions.

Colleagues as feedback/resource persons

Even if your colleagues are not participating directly in this programme, they may be interested in hearing about it and about some of your ideas as a result of taking part. Your head teacher or the local area specialist in technology may also be willing to take part.

Working with a mentor

As mentioned above, you may have the opportunity to work with a mentor, someone with expertise in technology education who can provide feedback on your work. If you are working on your own, communication with your mentor may be by letter mail, telephone, or e-mail. If you are working as a group, you may have occasional group meetings, teleconferences, or audioconferences with your mentor.

Using a learning journal

Whether you work on your own or with a group, it is strongly recommended that you use a learning journal. You can divide your learning journal into compartments so it accommodates a number of purposes. Think of your journal as a "place" where you can think out loud by writing down your ideas and thoughts, and this "place" has several "rooms".

Ideas/Reflections/Questions
In one part of your journal, you can keep notes and a running commentary about what you are reading in each unit, write down ideas that occur to you about something in the unit, and note questions about the content or anything with which you disagree. You can use this part to record general ideas about how to use some of the content and strategies in the classroom. If you consistently keep these notes as you work through each unit, they will serve as a resource when you work on the unit activity, since you will have already put together some ideas about applying the material in the classroom. This is also the section of the journal for your notes from other resources, such as books or articles, or conversations with colleagues.

Plans
This is the section where you work on an activity for each unit. At the start of each unit, consider which activity you will choose, and develop your ideas as you go along. Each activity will have specific guidelines.

Observations/Reflections
This is the section where you record observations about classroom experiences, how students tackle various situations, and how each instructional strategy works in practice. This is the place to record notes after you implement the unit activity—what you feel worked well and what could be improved. If you are part of a group, keep your notes about good practice and effective group dynamics, based on the group experience, in this section.

Resources available to you

Although these modules can be completed without referring to additional resource materials, your experience and that of your students can be enriched if you use other resources as well. From locally available materials, you might identify resources to enhance the teaching/learning experience. These could include:

- working examples of energy use in electronic communication or of materials or tools that are available in your environment for scientific inquiries related to these examples
- magazines that have articles about technology topics, with the emphasis on the subject of this module
- books and other resources about technology that are in your school or community library
- Internet resources (if applicable)

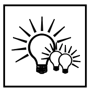
Tips for selecting resources
When reviewing materials to see if they will help you with the module, consider:

- Which module topics does the material address?
- Are the ideas in this material transferable to the technology classroom?
- Are the ideas in this material transferable to the technologies included in the module?

ICONS

Throughout each module, you will find some or all of the following icons or symbols that alert you to a change in activity within the module.

Read the following explanations to discover what each icon prompts you to do.

	**Introduction**	Rationale or overview for this part of the course.
	**Learning Objectives**	What you should be able to do after completing this module or unit.
	**Text or Reading Material**	Course content for you to study.
	**Important—Take Note!**	Something to study carefully, or a possibly harmful action/substance.
	**Individual Activity**	An exercise or project for you to try by yourself and demonstrate your own grasp of the content.
	**Classroom Activity**	An exercise or project for you to do with or assign to your students.
	**Reflection**	A question or project for yourself— for deeper understanding of this concept, or of your use of it when teaching.
	**Summary**	
	**Unit or Module Assignment**	Exercise to assess your understanding of all the unit or module topics.
	**Suggested Answers to Activities**	
	**Equipment**	List or description of any apparatus or tools that this activity requires

CONTENTS

Module 1: Teaching Technology in the Primary School

Module 1: Teaching Technology in the Primary School

Module Introduction

This introductory module of the Upper Primary Technology programme is presented in four units. By the end of this module, you should understand what Technology is and feel excited and confident about teaching it in your classroom.

The module's four units cover the broad content of this subject. Each unit contains activity-based learning experiences. We want you to ***do*** some Technology, not just learn ***about*** Technology. The activities are described step by step and can be done in any classroom, not only in specialised Techno-Centres.

After you work through the module, you should reflect on what you have done and read so the principles you learned can be applied to the learning experiences your pupils will engage in. The assessment activities included with this module are intended to provide evidence that you have reached the expected outcomes defined at the beginning of each unit.

UNIT 1 covers **the technological process**. The unit is intended to help you understand what makes an activity a technological activity and not a science, art, woodwork, or even a needlework activity. The skills you draw on to solve a technological problem might come from other areas, like science, art, woodwork, or needlework. However, these knowledge and skill bases are regarded as resources to help solve technological problems and is not as an end in themselves.

UNIT 2 gives a broad overview of **the content areas of Technology**. The knowledge, skills, and attitudes that are developed cover a range of interesting topics related to the "made world" and to things we encounter in everyday life.

UNIT 3 considers the role of **graphics in communicating technological ideas**. In particular, it deals with two- and three-dimensional drawing skills and attempts to provide teachers with simple techniques that will enable children to clearly and efficiently communicate technological design ideas.

UNIT 4 considers **technology as a human phenomenon**. It reflects our social and cultural character. Whether we live in Africa, America, Australia, Asia, or anywhere else in the world; whether we live on an island, in a city, or in a rural setting, our technology is shaped by our culture, context, and values. Similarly, there are many examples that show how technology influences our culture, our natural environment, and our social values. We need to be conscious of these influences and ensure that our society and environment are not adversely affected by them.

Unit 1: The Technological Process

Introduction

The need for greater technological literacy and competency has been identified as a priority in countries throughout the world; however, technology is a relatively new subject in schools in southern African countries. Since the early 1990s, technology has been introduced into the curriculum of countries on every continent of the globe. African countries similarly recognise that their children should be equipped with the necessary skills and confidence to lead meaningful lives in a highly technological world.

Technology contributes significantly to the acceleration of social change in the world. It affects all areas of our lives—the way food is grown and processed, the manner in which transportation has changed over the last eighty years, and the advances made in the medical world. The invention of the computer has significantly influenced our lives and has possibly had the greatest influence on social change. Technology should be at the forefront of the African Renaissance.

Many of these changes have improved the quality of our lives, while others have caused considerable damage to the planet or are, at present, destroying it. The depletion of the ozone layer is a good example. Not all technological advances have benefited us and therefore it is important that we develop a deep and strong social and environmental responsibility in our youth.

Learning Outcomes for this Unit

On completion of this unit, you should be able to:

- describe what is meant by the term technology
- list the steps in the technological process
- define what constitutes a technological activity
- initiate learning activities which develop technological capability
- be able to assess technological capability

Unit Outline

- Introduction
- What is Technology?
- An Icebreaker Activity: building an efficient, load-bearing paper tower
- Some Definitions of Technology
- The Technological Process:
  - The Linear Model
  - The Circular Model
  - The Interactive Model
- How to develop Technological Capability
- Classroom Activity
- How will I assess technological capability?

What is Technology?

Look carefully at the list below and decide which of these products was made as a result of technology. Use a ✔ or a ✗ to indicate your choice.

computer		fork	
video recorder		space rocket	
chair		knife	
television		match	
fax machine		e-mail	

Sometimes we think of technology as sophisticated high-tech products such as computers and space rockets. We associate technology with a fast-paced developed country such as America. However, some excellent ancient technologies are still effective today.

Do you know that the ruins of Great Zimbabwe indicate that hundreds of years ago the people of Zimbabwe processed metal and traded with other countries? They had the knowledge and skill to build thick stone walls to protect people, possessions, and property. Many of the walls still stand today. The San people used their technology to make poison arrows and to process plants for paint, which was so effective that their paintings can still be seen in the caves of the Drakensberg Mountains today.

What need caused the people of Zimbabwe to build their stone city so long ago?

What need caused the San of the Drakensberg to make poison arrows?

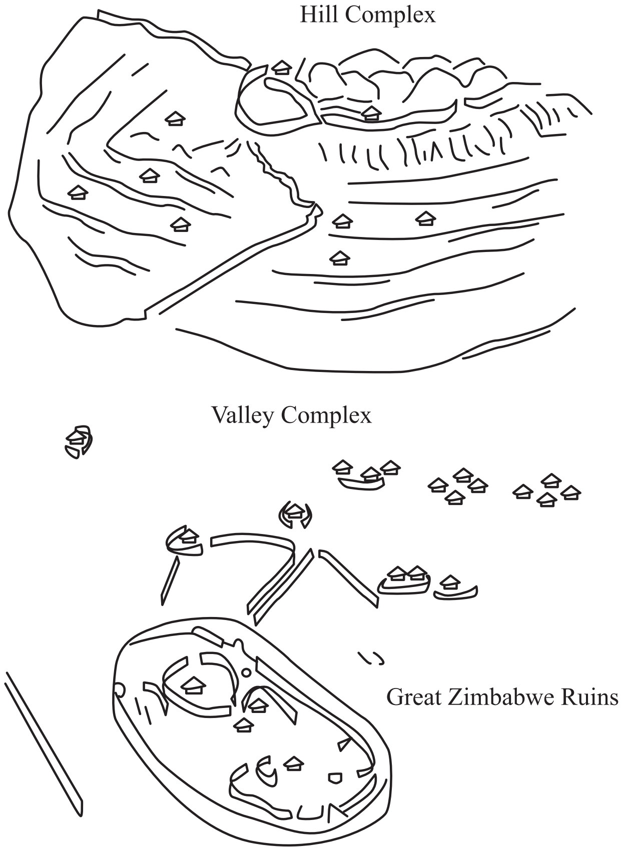


Figure 1: Great Zimbabwe Ruins

The Nguni also used an effective technology to preserve grain. Maize was reaped after it had dried in the fields. Grain was stripped from the cobs and stored in a grain pit called *umgodi wopata* in Zulu. This pit, usually dug in the cattle kraal, was lined with a mixture of cow dung and clay, and the base was covered with small stones and clay from the home of the earth-pig (*isambane* in Zulu). The grain pit was then dried by the sun. When dry, the pit was filled with grain and covered with a lid of roots or sticks sealed with cattle dung or clay. A stone sealed the top. The cool, dark pit kept the grain fresh because a little grain on the edges fermented and gave off carbon dioxide which suffocated any pests that might eat it. This is a good way to preserve grain and it eliminates the need for chemicals.

For the Nguni, the problem was that grain had to last through the long winter months, until the next harvest. Their grain pits represent an effective technological solution to the need to preserve grain from one season to another.

Technology is the application of human and material resources to meet human needs and wants.

Teaching Technology in the Upper Primary Classroom

This course for teachers of Upper Primary Technology covers the concepts of technology—its processes, content areas, and its interaction with society and the individual. It also covers the **practical** aspects of technology through the use of activities and building projects. The primary focus is on concepts.

To teach technology in your upper primary classroom, you have to reverse that emphasis. In your classroom, teaching technology must be mostly students doing technology. It is difficult, on paper, to help you achieve that change in emphasis. Perhaps these teaching guidelines will help:

1. Do the practical activities **before** you attempt to convey the principles. For example, have students build a bridge out of wooden sticks or pasta noodles, test the strength of the structures by applying a load, then have them try to explain why some bridges supported more weight.

2. Base your assessments and student grades on how well they carried out the "technological process" to complete their project, not on correct answers that students supply on tests nor even on the final form of the project. When assigning marks, ask yourself these questions:

   - Which students best carried forward a plan into a real object?
   - Which students achieved the best division of labour among their small team?
   - Which students were best at learning from one failure and being successful a second time?

   Those are the students who should get the highest grades in your class! They are the best technologists!

3. Your expectations for every activity must be clear from the beginning. Hand out the "rules for good grades" before students begin a project, and periodically remind students to compare their progress with your instructions and marking scheme. The more creative teacher might even set up an appeal process, in which a team can present reasons (based on your rules, of course) why they think their effort deserves a higher score.

You will always face the temptation to make technology a study of knowledge. Just think of how many terms one has to learn in order to describe the workings of a gasoline engine. But for students at this age, the lessons of technology should mainly be learned by **doing**.

Classroom Activity

Building an efficient, load-bearing paper tower

This icebreaker activity provides you and your students with an opportunity to engage in technological problem solving. A technological problem is defined, and you are required to consider ways to efficiently resolve the problem using the available resources. Where possible, the activity should be conducted by competing groups of approximately three people. Most of the best design ideas emerge as a result of working with other people.

The design task

Your task is to design and build a free-standing tower or structure:

- on a platform **as far off the ground as possible—**the higher the better
- **capable of carrying a load of tiles—**the more the better

The structure may only be constructed from the materials that are made available through the “bank” (i.e., newspaper and Sellotape).

HINT: Use paper to draw and discuss your ideas before starting. By doing this, you will be able to test your initial ideas with other team members before taking them too far.

Credits

Your tower will be credited with:

- ten credits for every tile it is able to carry
- one credit for every centimetre the load is raised above the ground
- up to five credits for aesthetic value, based on a five point evaluation scale considering form, proportion, stability, elegance, and grace

poor	fair	average	good	excellent
1	2	3	4	5

Cost of materials

To build your tower, you can purchase and use any of the following materials from the “bank”, and your account will be debited accordingly:

- a single sheet of newspaper (cost = 10 units per sheet)
- a 20 cm strip of Sellotape (cost = 10 units per 20 cm strip)

You have 45 minutes for this task, after which another group or a friend will score your masterpiece on the basis of the following efficiency formula:

$$\frac{(\text{total load credits} \times \text{total height credits}) + \text{total aesthetic credits}}{\text{total cost units}}$$

Good Luck!

Score Sheet

Classroom Activity: Efficient, Load-Bearing Paper Towers

Group	1	2	3	4	5	6	7
Paper 10 units per sheet							
Tape 10 units per 20 cm strip							
TOTAL DEBIT							
Load							
Height							
H x L							
Aesthetic							
TOTAL CREDIT							
RESULT							

After the classroom activity, you need to ask yourself the following questions:

- What technological knowledge and skills did participants use to develop these solutions?
- Was their solution effective?
- Did all the groups solve the icebreaker problem in the same way?
- What does this tell us about solutions to technological problems?
- How would they improve their design if they had the chance to do the activity again?

REMEMBER: Technology can be seen as the application of human and material resources to meet human needs and wants.

Some Definitions of Technology

Technology is a:

- process of thinking and doing, by which products are developed to satisfy recognised needs
- process whereby man selectively uses resources and processes to extend human capability and satisfy needs
- design-based problem solving activity intended to bring about change or exert control over the environment

Many technological products are designed for the needs of people in their homes. For each of the following technological products, describe the human need for which it was designed.

1 broom	
2 blanket	
3 egg beater	
4 hammer	
5 alarm clock	
6 bucket	
7 bread knife	
8 book	

Pupils can be presented with a problem or need, or they can identify a problem or need themselves. They will find there are many possible solutions to the same problem. While there is no one right solution, some solutions are better than others. Pupils begin to think for themselves and realise that they can design, make, and evaluate solutions to problems.

Now identify five products at school and identify the need or problem which resulted in someone designing and making the products.

1	
2	
3	
4	
5	

Thus a more detailed definition could read:

Technology is the **use** of **knowledge**, **skills**, and **resources**:

- to **meet** human **needs** and **wants**
- to **recognise** and **solve problems**
- to **investigate, describe, develop**, and **evaluate solutions**
- to **create products, processes**, and **systems**

Now look at the list of products on the previous page. These things were all designed to meet a need, so they are all examples of technology. Did you get 10 out of 10?

Technology allows our pupils to be creative, inventive, and innovative, and encourages them to think for themselves.

The Technological Process

The **Technological Process** is central to technological activity. Technology requires the interaction of hand and brain. This balance between thinking and doing is reflected in the technological process itself and in the results of that process.

There are four main steps in the technological process:

- **identify** a need/problem or opportunity
- **design** a solution
- **make** the product
- **evaluate** the solution

These four steps can occur in sequence, however, in practice they tend to overlap and can change order. Evaluation, for example, is seldom limited to the end of the process and forms part of each stage in the design process. If evaluation reveals a less-than-satisfactory solution, there might be a need to re-design, re-make, and re-evaluate.

Note The learner **designs** the solution.
The teacher does not tell him what to do.

The learner **makes** the product.
Each learner's product will be different.

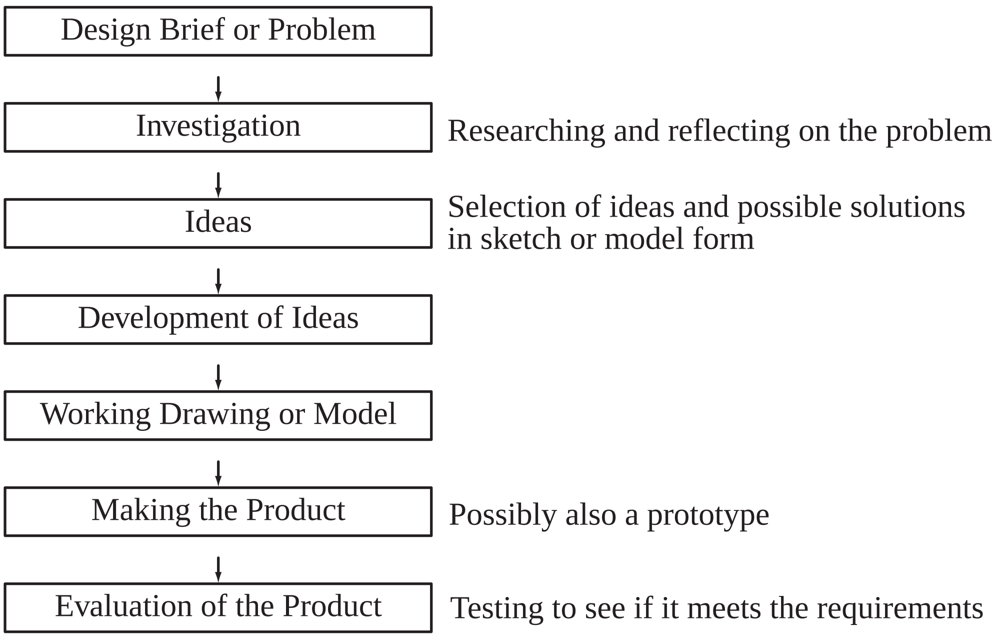
The learner **evaluates** his own product.
Peers and the teacher may also evaluate.

The steps involved in the technological process are central to any type of design. The process should lead from a specific problem to a corresponding solution.

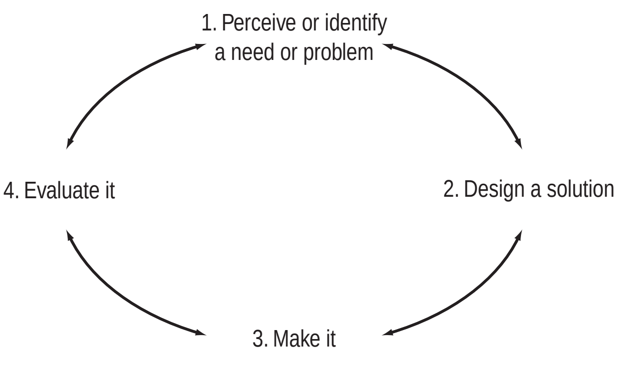
The technological process has been represented in a number of theoretical ways. Regardless of the model, the essential steps are the same.

Three models are presented

The Linear Model



The Circular Model



The Interactive Model

It has been observed that children have both **active** and **reflective** capabilities, and there is constant interplay between doing and thinking.

The design process is much more than a series of steps. There is a "to and fro action" between the hand (developing technological solutions) and the head (reflecting on effectiveness of the solution and considering necessary changes to it). By engaging in this "to and fro action," children learn to be self-critical and reflective, and to manage and work through challenges.

Technology is about teaching children to cope with the future. They learn to:

- look critically at the past and present
- speculate about the future and consider possibilities for improving the world around them

In this regard, think about the differences between:

- the first motor car and the latest model
- the first telephone and the latest model
- the earliest ovens and the latest microwaves
- the earliest dugout canoes and modern ships

How to Develop Technological Capability

Technological capability involves the ability to selectively use knowledge, skills, and innovation to solve problems. The steps in this circular process provide a useful framework for planning activities to test and assess technological capability.

Children usually use all four steps in an interactive way without necessarily following the sequence in which the stages are presented. For example, a child might be inspired to engage in a technological design task by seeing an existing object (e.g., a simple toy) that they think they can modify or improve.

In this situation, they begin by:

- evaluating the product (the last stage in the process)

However, their evaluation probably suggests a number of weaknesses in the toy's design that could be improved. This leads them to:

- design an improved solution (the second stage in the process)
- make the product (the third stage in the process)

Using stories as starting points to develop technological capability

One of the best ways to allow children to put the technological process into practice is to **use stories as starting points** for developing technological capability. It is often easier to identify needs and problems in a story than in real life. These stories can be fictional (e.g., *The Three Goats*) or they can be stories that relate to real life experiences (e.g., *Rainbow Rooster*).

The Three BIlly Goats

This is a story told of Big Goat, Middle-sized Goat, and Little Goat. They lived on one side of the river and every day they needed to cross the river to the grass on the other side. However, a fierce and wicked creature lived under the bridge. He would scare the goats, as he wanted to eat them.

1. Identify the Problem/Need/Opportunity:
   - the goats **needed** to cross the river to get to the sweet, green grass on the other side
   - the **problem** was that the only way across the river was by the bridge where the creature lay waiting to pounce
   - the scary creature used the **opportunity** of the goats crossing the bridge to try to get his meal

   These are some of the points that children will identify in discussion.

2. Design a solution(s) to the problem(s) raised:
   - the goats' hooves made a clattering noise on the bridge. Design something they can put on their feet so they can tiptoe quietly without waking the creature
   - the only way across the river was by bridge where the creature lived. Design another way for the goats to cross the river
   - the creature frightened the goats, but the goats did not scare the creature so he kept trying to catch them. Design something that will make the creature afraid of the goats so it will leave them alone, e.g., a scary mask

3. Create a solution, based on one of the designs.

   Note—Sometimes children design something that is too difficult for them to make as they don't have the skills or expertise. Allow them to be lateral and creative thinkers and designers, not limited by their skill to make something.

   The more junior children might make a set of soft slippers for the goats OR a scary mask for the goats.

   Perhaps they will make a bridge, or a model of the bridge if they have the materials, though this is more suited to older children. They might also design and make something other than another bridge, e.g., a raft or a slide/swing to get across the river.

4. Evaluate the solution:
   - Children put on their footwear and tiptoe across the room (bridge). Can the others hear them crossing?
   - Children evaluate whose mask is the scariest. Why do they feel frightened? What makes it scary?

The Three Little Pigs

Apply the circular process to the story of *The Three Little Pigs*, who had to leave home and start life on their own. One built a house of straw, the other built a house of sticks, and the third pig built a house of bricks. In each case, the Bad Old Wolf came huffing and puffing, trying to blow down the houses and eat up the pig.

1. What **problems** can you identify for:

   The Mother Pig?

   The Three Little Pigs?

   The Bad Old Wolf?

2. Identify two suitable things for the children to design.

   1.

   2.

3. Imagine that you have FOUR groups in your class. Identify four DIFFERENT things they can make. Two of these items could include the designs in 2.

   1.

   2.

   3.

   4.

4. Explain how you will evaluate whether the children have created suitable solutions.

Stories Based in Africa

Children's literature is an excellent starting point for introducing children to characterisation and empathy through identifying the problems and needs of the characters. We have some excellent African story tellers and writers. Gcina Mhlope is one of our best-known storytellers who weaves her magic as she tells tales steeped in African culture. Diane Stewart, Niky Daly, Jenny Seed, and others write excellent stories that make suitable starting points for Technology.

Rainbow Rooster

Rainbow Rooster, an unpublished children's story by K.J. Ter-Morshuizen, is set in the hills of rural Africa. The story is told of Sipho, a boy who had to look after his mother and sister while his father was away at work in the big city as a migrant labourer. His father came home infrequently and communication was poor, so Sipho sometimes had big problems to solve.

When his mother fell ill, he knew she needed medicine, but he had a problem—he did not have any money. He decided to sell his prized rooster that his Dad had given him. Rainbow Rooster was a large, magnificent bird, and he hated being forced into a plastic packet that made awful crackling noises when he was transported to town on the crowded bus. With a flap of his wings he flew out of the bus and onto a tall post.

After chasing the rooster, Sipho eventually caught it, got money for the medicine and even was given two hens to help the poor family with eggs. This act of *ubuntu* rewarded Sipho for his unselfish gesture of being prepared to sell his prized rooster for medicine for his mother. He could even sell eggs each week as a source of income.

Suggested Design Tasks

Identifying problems, needs, and/or opportunities

Children need to identify some of the problems that may be encountered by Sipho and his mother:

- how to earn money for food
- how to market their products
- how to catch a rooster that has escaped

Design and make

Design and make something from scraps of fabric (e.g., rooster or hen).

Think about

- what it will be
- what colour will be appealing
- whether it will hang as a mobile
- whether it is for a very young child, or older
- what to use as stuffing so it is washable
- how to market it
- what price to sell it for

Also design and make

- a key ring from wooden off-cuts
- a necklace or bracelet from junk
- something from clay or grass or found material
- something from wire
- an egg cup

As an extension activity for the older children, you could get them to:

- identify the problems in transporting a rooster in a packet
- design and make a suitable container to transport a rooster

Evaluate

- a range of beadwork
- a range of clay artifacts
- a range of grass artifacts
- wire objects
- different types of egg cups and/or egg boxes

Think about

- the cost of the raw material
- what else you can make from it
- how to find out what people will buy
- what tools and techniques are needed
- how to support an oval egg in order to eat it
- how to transport a fragile egg without breaking it

Examine the products that pavement traders sell. Find a way to record:

- the profit margin made on each item
- the most profitable product to sell (e.g., fruit, cakes, toiletries, or fancy goods like crocheted work or bead work)
- evaluate which product is the most profitable for sale
- evaluate what self-help programmes are functioning in your area

Classroom Activity

Use the story of Rainbow Rooster or another African story of your choice, and apply the technological process to plan and present appropriate activities to your children. Write a report on your evaluation of this session and include your lesson outlines as well as pupil responses.

Assessment

Check that pupils can understand and apply the technological process to solve problems and to satisfy needs and wants. For example:

- Can they identify and explain problems, needs, and wants?
- Have they considered a range of possible and relevant solutions?
- Did they make an informed choice?
- Did they develop a design?
- Were solutions realised?
- How were the solutions evaluated?
- How was the process recorded and communicated?

How Will I Assess Technological Capability?

In order for our pupils to produce quality products, it is important for them to be aware of the criteria that assessment will be based upon.

It is not intended that pupils should be constantly subjected to detailed assessment, but the following suggestions may help you. Offer encouragement so your pupils remain enthusiastic, but remember that it is essential for them to reflect critically on their own designs and products.

When assessing Technological Capability (the ability to solve technological problems), keep in mind that each stage of the process (the left hand column in the table below) assumes growing competence with respect to the skills related to it (listed in the right hand column).

The Technological Process	
Stage	Skills
Identifying Needs	• analysing the problem • writing a design brief
Designing a Solution	• doing research • generating ideas • developing ideas and selecting the best ideas • communicating the design and justifying design choices
Planning and Making	• planning—choosing material, equipment, and processes • working out costs • making a working drawing • quality of construction, accuracy, finishing, appearance, safety
Testing and Evaluating	• testing against design criteria • evaluating performance

Criteria for Assessing Technological Capability

Identifying needs:

Analysing the problem

Children should demonstrate that they can analyse a problem by:

- identifying the core of the problem
- asking questions about aspects of the identified need and giving answers to these questions

They should list everything they need to learn about the problem, and list the places they might go to find the answers.

Writing a design brief

A design brief describes the problem and states how the child plans to solve it. The design brief should be:

- formulated briefly in words
- clear and easy to understand
- contain only essential details
- be written in general, not specific, terms

A design brief **does not offer a solution**. In other words, it does not say exactly what will be made to solve the problem.

Drawing up specifications

- specifications consist of a number of aims for the solution to the problem, and set limits within which the solution must be found. To allow for a wide range of solutions, specifications should be as open as possible and contain much more detail than the design brief.
- specifications will also have constraints over which the designer has no control, e.g., maximum size, financial limits, and time limits

Designing a solution:

Research

Children should show evidence that they can:

- use appropriate research skills
- select information that is relevant to the design requirements
- record information accurately
- present findings effectively

Generating ideas

Children should demonstrate that they can work with other team members to:

- translate research findings into design ideas
- listen to what other group members say
- work with their team to develop an optimum solution. This will involve discussion and debate but should focus on the development of the design rather than a defence of individual ideas.

An informed choice is made

Children should show evidence that they are:

- capable of making sound design choices
- defending these choices with reasoned argument

A design is developed

Children should show evidence that they can:

- use graphic techniques to clearly and effectively present their design ideas
- respond to questions about their design
- adopt improvements arising out of their presentation

Planning and making:

Planning

Children should show evidence that they can:

- plan their construction, given time and other constraints
- sequence their construction so the process is efficient, ordered, and safe

Making

Children should show evidence that they can:

- use equipment safely and effectively
- work accurately and apply the necessary skills and techniques to ensure quality workmanship

Testing and evaluating:

Testing

Children should show evidence that they can:

- apply the design requirements identified at the beginning of their project to the evaluation of their work
- set up a fair test for their product
- ensure their design continues to meet the required specifications by adapting their ideas as work proceeds

Evaluating

Children should show evidence that they can:

- record changes to their original design
- explain and justify changes made to the design

Assessment for this Unit

Design your own learning activity based on either classroom activity or a story of your choice.

Show how you would use this activity to develop students’ understanding of the technological process and its assessment.

Unit 2: Technological Content

Learning Outcomes for this Unit

On completion of this unit, you should be able to:

- identify the eight commonly accepted core content areas in Technology
- apply these as the knowledge and skills base for planning project work
- apply these content areas to project work by means of resource tasks

Unit Outline

- Scavenger Hunt
- Core Content Areas covering Knowledge and Skills
  - Knowledge of
    - Systems and Control
    - Structures
    - Processing
    - Communication
    - Energy
    - Materials and Equipment
    - Information
    - Safety
  - Skills
  - Values and Attitudes
- Forty Facts on Core Content Areas
- Types of Tasks
  - Capability Tasks
  - Case Study Tasks
  - Resource Tasks
- Suggested Project Structure
- Classroom Activity

Scavenger Hunt

If you are working with pupils in groups, this activity can be fun to do as a competition. If pupils do this activity individually, it can be a simple illustration of the content areas of Technology.

Individuals or team members must collect an example of each of the following as quickly as possible. The first team to collect the samples is the winner.

1. a wheel
2. something with a cog
3. a packet
4. a vertical structure
5. something that can cut
6. something that is woven
7. something that can grate
8. a diagram
9. a memo or letter
10. something made of wood
11. something made of clay
12. something made of plastic
13. something made of wool
14. something that uses electricity
15. something that uses a battery
16. the programme for your workshop
17. the telephone number of your nearest grocery store
18. the name of your team (if working in a group) or your name (if working alone) printed neatly on a label

Did you manage to collect all the items?

This exercise was designed to introduce the content areas in Technology. There are eight areas that are commonly accepted as providing content for Technology.

Place the items in order and check them against the following list:

- Items 1 and 2 are examples of **Systems and Control**
  A system is a group of connected parts that work together for a common purpose.
- Items 3 and 4 are examples of **Structures**
  A structure is anything that supports a load or contains or protects.
- Items 5, 6, and 7 are examples of **Processing**
  Raw materials can be processed in a variety of ways that enhance their value or form new products.

- Items 8 and 9 are examples of **Communication**
  In Technology we use graphic (pictorial/diagrammatic) or written ways to communicate our ideas.
- Items 10–13 are examples of **Materials and Tools**
  These are used in the designing of products.
- Items 14 and 15 are examples of items that require **Energy**
  Wind power, water power, electrical, or solar energy are examples.
- Items 16, 17, and 18 are examples of **Information**
  Information is needed by learners to identify a need or problem, access, process, and present data.

You will notice that only seven content areas have been addressed. The eighth is **Safety**, which is implicit in **all** the other areas.

The Core Content Areas Covering Knowledge and Skills

What will we learn about in each of these content areas?

Systems and Control

This area covers mechanical and electrical systems and forms of control.

A mechanism is a simple machine or part of a machine (e.g., a gear). **Mechanical systems** "make work easier" for people by controlling movement and/or providing mechanical advantage.

In all machines, one can identify an energy input and output. When we think of an everyday action such as opening a door with a key, we can see the input/output components at work:

INPUT > OUTPUT

Input is a change in condition that will influence the output. What happens when you turn the key?

Output can take many forms and is predictable. In the case of the lock, the bolt of the lock is withdrawn and the door is unlocked.

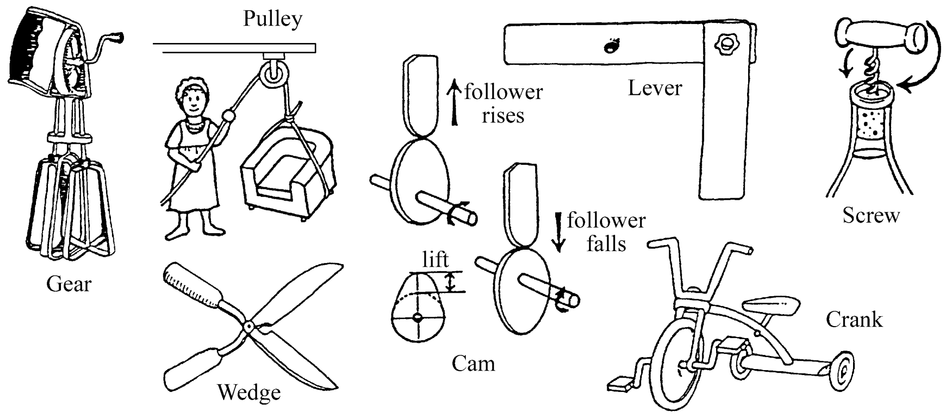
The purpose of a mechanical system is to "make work easier". In a mechanical system, we refer to this capacity to "make work easier" as **mechanical advantage**.

A number of classical components are common to all machines. These are:

- the inclined plane
- the lever
- the wheel and axle (including cams)
- pulleys and gears
- cranks

Complex machinery consists of a combination of these classical mechanical components.

The content of this section covers the way wheels and axles, levers and cranks, cams, gears, and pulleys are used to gain mechanical advantage and transfer movement.



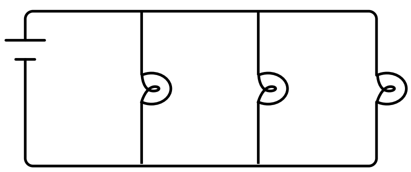
In studying mechanical systems, children will learn to design simple machines that can control the direction and speed of their components. They will also be able to design machines that control mechanical advantage.

Electrical systems always contain control systems. Their components (like cells, lamps, buzzers, and switches) can be classified in terms of:

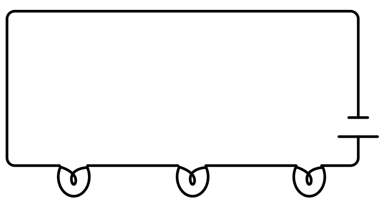
INPUT > CONTROL > OUTPUT

Input components (e.g., cells) provide a source of electrical current in electrical systems while control components (e.g., switches) regulate the flow of the current. Output components (e.g., globes) translate electrical energy into other forms of energy.

By designing simple electrical systems, children will become familiar with electrical circuits and their more basic components.



Globes in parallel.



Globes in series.

Can You Find

Five different kinds of wheels?

1.

2.

3.

4.

5.

Gear wheels in:

- an egg beater?
- a bicycle?

A simple hinge mechanism in:

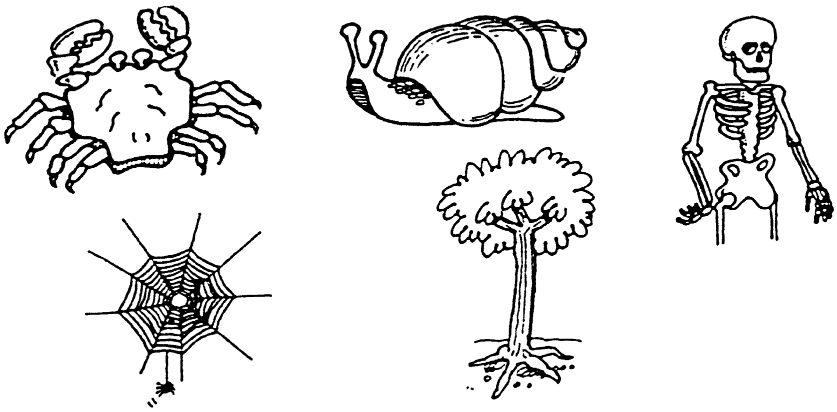
- a lid?
- a door?
- a window?

Structures

Have you ever looked closely at a spider's web or a bee's honey comb or a bird's nest? These are examples of **natural structures**.

Some natural structures offer support from the inside. These are **frame** structures.

Other structures offer support from the outside. These are **shell structures**. Study these natural structures and decide if they are shell or frame structures.

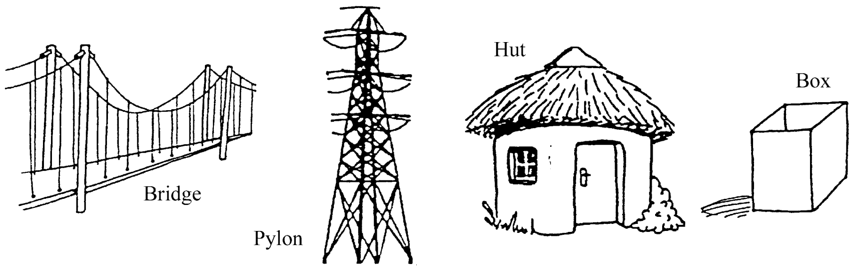


Have you noticed bridges or electric pylons in your community?

They are **constructed** or **manufactured structures** that support a load.

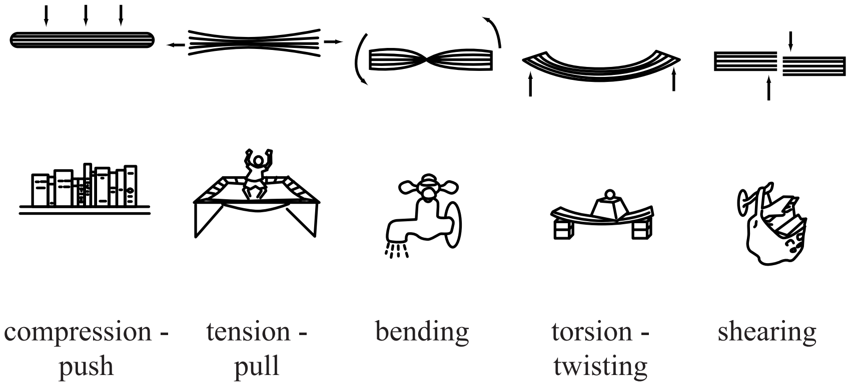
Can you see what load each structure is carrying in the pictures below?

Decide if these are shell or frame structures.



Structures are **stable** or **unstable** and they respond to **forces** that **pull, push, twist,** or **shear**.

Different materials have different characteristics and therefore some are more suited to one function than another. Materials for structures need to be strong enough to support a load. They can be reinforced and strengthened in various ways.



Processing

Raw materials can be processed in different ways to **enhance/improve** the product (e.g., knit wool into a jersey or tie-dye a fabric).

Raw materials can also be processed so that a **new** product results (e.g., making furniture from wood or making maize meal from maize).

Can you give examples of a process that involves:

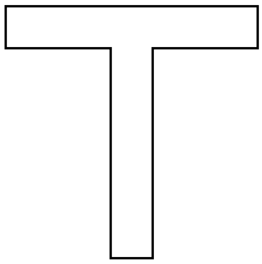
- Combining?
- Preserving?
- Separating?

Communication

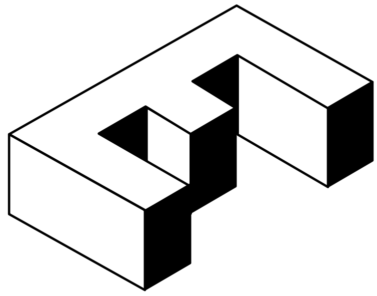
When you plan and design a solution to an identified need or problem, you should be able to communicate your ideas verbally, orally, in writing, and graphically with 2-D (two-dimensional) and 3-D (three-dimensional) drawings.

Two-dimensional means that two dimensions (length and breadth) are shown. An example of this is the drawing of a rectangular shape on the page to represent a rectangular block. If a three-dimensional drawing of a block or brick is needed, the drawing would show three dimensions (length, breadth, and height).

The sketches below illustrate the difference between two-dimensional and three-dimensional drawings.

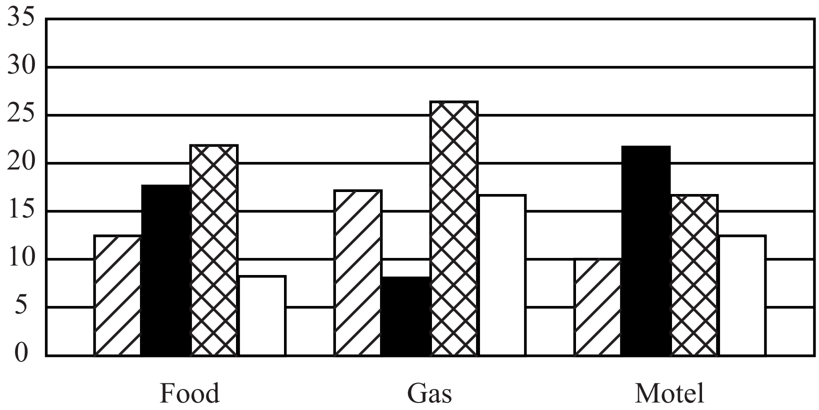


2-D drawing



3-D drawing

You can also present data in a variety of ways, e.g., graphs, flow charts, and tables.



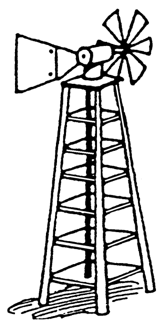
Energy

Energy is the ability to do work, and it is necessary for movement and growth.

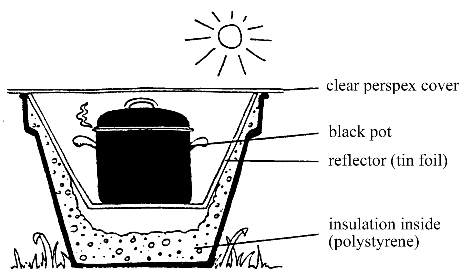
Mechanical systems, even simple ones, can be designed to use the kinetic energy of wind and water to achieve pre-determined mechanical outcomes. For example:

- a sail transfers wind energy to the rest of the boat and drives it through the water
- a water wheel transfers energy to the mechanical components of a mill that, in turn, moves and provides mechanical advantage

Batteries, heat, electricity, and elastic bands are also sources of energy.



Windmill



Solar Cooker

Can you match the object in A with its source of energy in B?

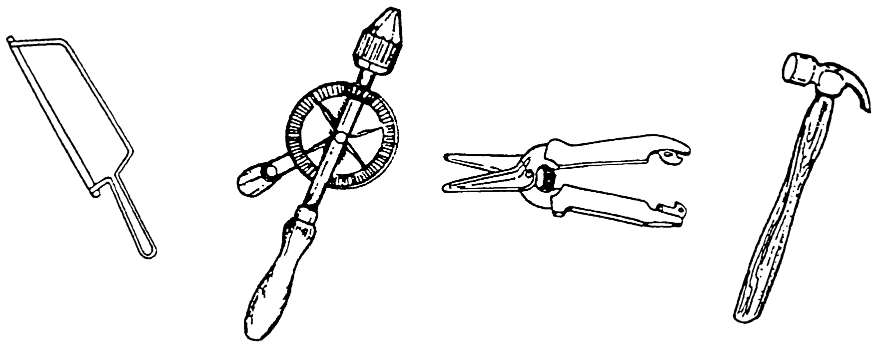
A	yacht	B	wind
	water wheel		sun
	light bulb		wind
	kite		battery
	torch		electricity
	solar heater		water

Materials and Tools

You will already be familiar with a range of materials and tools from Art, Craft, or Handwork classes (e.g., paper and card, clay, wood, and textiles). Children will also use other materials, such as plastic, polystyrene, metal, or laminates in Technology lessons.

Consider using locally available materials from factories, farms, or mills around your school.

Safety must be stressed at all times when tools and equipment are used.



Information

Books, magazines, newspapers, instruction manuals, and even advertisements are possible sources of technology information. In our technological age, children should also learn to gather information electronically, through sources such as the Internet, whenever possible.

Can you interpret the information on a care label on an item of clothing?

Can you use the classified section of the newspaper to find something listed under “machinery and tools” that you would like to buy?

Copy the information in the space below.

Safety

This is listed as a separate content area but is, in fact, a vital aspect that should be taken into account when dealing with each of the content areas. Technology teachers need to be safety conscious at all times—whether we are working with machines, tools, electricity, or any equipment or power source.

Teachers should use news stories and case studies of local accidents and disasters to encourage children to reflect on issues of public safety. For example, a bridge that collapses or buildings that are washed away are real life examples of structures where designers did not pay sufficient attention to safety. In the case of certain natural disasters, such as the great floods of 1999 in Mozambique, many structures will not be able to withstand the force of nature, regardless of their design and construction.

Can you write out two safety rules for working with:

- Hammer

  1.

  2.

- Saw

  1.

  2.

- Scissors

  1.

  2.

Skills

These include:

- **Research skills**
  - exploring and investigating
  - interpreting and predicting
  - appraising and evaluating
  - comparing and classifying
  - making informed choices
  - refining, if necessary
- **Communication skills**
  - drawing
  - painting
  - story telling
  - observing and recording accurately
  - modelling
  - writing
  - role playing

- **Planning skills**
  - organising
  - analysing
  - managing
  - brainstorming
  - coordinating

- **Making skills**
  - cutting
  - sticking
  - stapling
  - sewing
  - weaving
  - baking
  - joining
  - glueing
  - tying
  - knitting
  - cooking

- **Business and economic skills**
  - buying
  - costing
  - making informed decisions
  - estimating
  - selling
  - risk-taking

- **Group and social skills**
  - listening
  - talking
  - compromising
  - negotiating
  - co-operating
  - consensus

- **Design skills**
  - visualisation and modelling
  - generation of ideas
  - representation by drawing
  - adapting and modifying

Values and Attitudes

In teaching Technology, we seek to encourage:

- independence and originality of thought
- a willingness to contribute ideas
- open-mindedness
- consideration of the needs and values of groups and of individuals from a variety of backgrounds when designing
- responsibility
- a systematic approach to tasks
- perseverance
- self-confidence
- self-assessment and honest self-evaluation
- awareness of the potential dangers of misusing materials and tools, in terms of personal health and safety and that of others
- sensitivity for the effects of design and technological activity on the environment
- curiosity, interest, and diligence

Forty Facts from Core Content Areas

Each of the following forty statements can be classified into one or more of the eight content areas. Write the numbers 1-40 and next to each write the letters that corresponds with the appropriate content area(s):

a - Systems and Control	b - Structures
c - Processing	d - Communication
e - Energy	f - Materials and Tools
g - Safety	h - Information

Check your answers with those of a friend and then check them with the answers at the end of the Module.

The first one has been done for you, i.e., a *is Systems and Control*

1. The wheel turns freely around the axle. ___a___
2. A pulley is a simple lifting device. ________
3. Materials used to conduct electricity in electronic circuits are often covered with an insulating material for protective purposes. ________
4. Electrical components can be connected in series or parallel. ______
5. When a force is applied to one piston, the piston in the other cylinder is forced to rise. ________
6. An annotated sketch is a clear sketch with detailed labels. ________
7. A wheel with a groove is called a pulley. ________
8. An eccentric cam is the same as an off-centre cam. ________
9. Energy is the ability to do work. ________
10. An opinion poll or survey elicits the opinions of others. ________
11. Structures that provide support on the inside are called frame structures. ________
12. An isometric drawing is used to show the front corner of an object. ________
13. A gear wheel is a special kind of wheel with evenly spaced teeth. ________
14. Voltage is the potential current between two places and is measured in volts. ________
15. A cam pushes a follower that moves according to the shape of the cam. ________
16. An orthographic projection is a group of 2-D (two-dimensional) drawings that show the product from all sides. ________
17. Raw materials are processed to enhance their value. ________
18. Materials can be worked in various ways, including cutting, sawing, joining, and shaping. ________

19. Special wire and components are made to resist the flow of electricity. This resistance is measured in ohms. ________
20. When one gear wheel meshes with another, it turns in the opposite direction to the gear that is driving it. ________
21. Structures with the support on the outside are called shell structures. ________
22. Some processes that can be applied to food are combining, extracting, preservation, conversion, and distillation. ________
23. Information can be obtained from the Internet. ________
24. A mechanical system consists of various mechanical components working together to produce desired results. ________
25. Mechanical advantage occurs when the output force applied by a machine is greater than that at the system's input. ________
26. Structures are made more stable by widening the base and applying props and buttresses. ________
27. Structures can support loads, protect, and contain. ________
28. Simple mechanisms use the kinetic energy of wind or water to achieve specific mechanical outcomes. ________
29. The working characteristics of materials, such as pliability or rigidity, need to be understood before choosing an appropriate material for design. ________
30. Information can be gained from the library. ________
31. Hydraulic systems use cylinders filled with liquid, usually oil. ________
32. Awareness of safety precautions should occur at all times. ________
33. Different forces act on structures, e.g., tension (pulling force), compression (pushing force), torsion (turning or twisting force), shear (opposing forces causing cutting). ________
34. Learners should be able to administer simple First Aid. ________
35. Technical information (e.g., assembly instructions) can assist the learner. ________
36. The type and direction of movement within a simple mechanical system can be changed. ________
37. Pistons transmit motion and force. ________
38. Information can be accessed, processed, and presented. ________
39. One needs to communicate effectively in order to market a product. ________
40. Lamination is a process that involves joining. ________

Types of Tasks

Use the following Capability Tasks, and the corresponding Case Study and Resource Tasks, to create an **Idea File**.

Capability Tasks

Each Capability Task requires learners to draw on one or more of the content areas. For each content area, identify the Resource Task that will enable your learner to effectively complete the Capability Task.

Capability Task 1

Your five-year-old nephew loves wheeled toys but his parents can't afford to buy them. Design and make a small car that can travel across the room and will be suitable for a child to play with.

Design Brief

- The chassis must be made from wood, neatly cut and joined.
- The axle must be free-turning.
- It can be battery driven, depending on skill level of students and availability of resources.

Capability Task 2

Design and make notepaper and envelopes from handmade paper to sell at a craft fair for raising school funds.

Design Brief

- Include at least three samples of paper.
- Use recycled paper as the basis for your pulp.
- Include grass, bagasse, dung, or anything else that is appropriate for texture.
- It should be possible to write on the paper with ballpoint pen.

Capability Task 3

Design and make a bridge that can span the one-metre distance between two desks.

Design Brief

- The bridge can be constructed from not more than three sheets of newspaper and 30 cm of Sellotape.
- It must hold as great a load as possible.

Capability Task 4

You have a cake of toilet soap to give your aunt for Christmas. You want to make the present look more appealing and special. Design and make a special package from card.

Design Brief

- Clearly draw your design for the package using orthographic techniques.
- The package should be sturdy and functional.
- There should be a small handle and decorative feature.

Capability Task 5

The water trough equipment is old and broken at the local pre-primary school. Design and make a floating object that can move by using wind energy.

Design Brief

- The object should sail for at least two metres.
- The material chosen should be appropriate.
- The structure should be stable and not blow over.

Capability Task 6

The classroom creatures (e.g., snails or silkworms) keep escaping from their old shoe box. Design and make a home for these animals.

Design Brief

- The structure should contain and protect the creatures.
- It should allow air to circulate.
- Learners should be able to see the creatures easily.
- The opening should be big enough to put your hand in, and the door should have a hinge and a catch or a sliding mechanism.

Capability Task 7

Your headmaster has asked you to give recommendations on appropriate and appealing active-wear clothing for 10–15 year olds as their existing sportswear is out of date.

Design Brief

- Interview learners in the 10–15 year age group to identify preferences for colour, style, and design.
- Interview athletes to obtain tips and recommendations.
- Research suitable textiles, such as stretch fabrics or quick drying fabrics.

Capability Task 8

You find that people in the community spend too much money on paraffin for stoves and are not taking advantage of the abundant supply of sunshine for solar energy.

Design Brief

- Design a solar cooker, using recycled/found materials where possible (i.e., it should be affordable for the poor).
- Think about where to use the insulating material and the reflecting material.
- The cooker should be big enough to hold a medium-sized pot.

If you give any of these tasks to your learners, chances are they will have difficulty designing workable solutions because they do not have the necessary background knowledge.

There are two ways we can help learners meet challenges and solve technological problems:

- use **Case Study Tasks** to demonstrate how people in the community solve similar real-life problems
- use appropriate **Resource Tasks** to increase learners' technological knowledge and skills

Case Study Tasks

Case Study Tasks link classroom learning with technology in the real world. Read these case studies and match each one with the appropriate Capability Task:

1. Examine a range of wheeled toys to see how the wheels and axles are fastened to the chassis. Capability Task No. ________
2. Arrange with the manager of a sportswear shop to demonstrate a line of active wear available to young teenagers. Colours, designs, and fabrics are discussed. This can be supplemented by collecting pictures of active wear from supplements in newspapers or magazines and making a classroom frieze or poster. Capability Task No. ________
3. Allow learners to examine a range of papers, e.g., writing paper, newspaper, magazine paper, toilet paper. Check the thickness, texture, and suitability for writing on with a ballpoint pen.
   Capability Task No. ________
4. Examine a range of hinges and fastenings to see what is suitable for opening and closing a box. If you have access to a pet shop, examine containers that were designed to keep small pets safe.
   Capability Task No. ________
5. Collect pictures of bridges from magazines, photos, or library books. If there is a bridge in your area that is easily accessible, whether over a river, a railway line, or even a footbridge over a road, carefully examine the structure. Identify the materials used, the way the deck of the bridge is supported, and the elements used in construction.
   Capability Task No. ________
6. Visit your local supermarket and check the kinds of packaging used for perishables, household items (e.g., milk, soap powder, toiletries). In what ways are they similar? How are they different?
   Capability Task No. ________
7. Collect pictures of sailing vessels (e.g., yachts, dhows, pirogues, or Chinese junks). Note the shape of the hull and how the sails are positioned and fixed. If learners have access to a sailing club or to fishermen with sailing vessels like a dhow or pirogue, a visit could be arranged. Capability Task No. ________
8. Research information on solar power. Approach a local NGO (non-governmental organisation) to find out how solar power can be harnessed simply and effectively. Capability Task No. ________

Check your answers at the end of the Module.

Were you able to match the real life application of Case Study Tasks with the Capability Tasks that challenged you to find a solution to the need or problem? Reflect on the two types of tasks and how you can combine them to help your students solve technological problems.

Resource Tasks

These tasks develop the knowledge and skills learners need to engage in the design problems posed by the Capability Tasks. Resource Tasks should be based on the content areas described above in the Case Study Tasks.

Examples:

- library research
- dialogue with local craftspeople who make similar products

Summary

The following three types of tasks form the basis of Technology Learning Programmes.

Case Study Tasks

These investigations aim to link learning in schools with technological experience in the wider community. They include visits to local businesses and industries, local environment, entrepreneurial activities, indigenous technologies, and a consideration of technologies from other times (e.g., historical implements). These visits provide opportunities to examine social and ethical issues related to the technological development.

Resource Tasks

These short, focussed activities are designed to teach knowledge and skills. They might include practical activities, acquiring information, or examining existing forms of technology.

Capability Tasks

These longer, open-ended tasks require learners to design, make, and evaluate possible solutions to technological problems. These tasks are only meaningful if learners are able to apply the range of knowledge, skills, and experience acquired through Case Study and Resource Tasks.

Can you distinguish between the three types of tasks? In each case below, state the type of task. Compare your answers with those of a friend:

a) Design and make a wheeled vehicle that will travel as far as possible once it reaches the bottom of a ramp. _______________

b) To help you understand the workings of levers and pulleys, use the instructions and diagrams to construct a crane. _______________

c) Visit a bakery to see how bread is made. _______________

d) Demonstrate how juice is extracted from oranges. _______________

e) Design and make a toy robot with flashing eyes. _______________

f) Learners will practise the skill of cutting wood accurately using a Junior hacksaw. _______________

g) Ask a local potter to demonstrate how to mould and fire clay pots. ______________

h) Learners practice drawing orthographic projections. ______________

Check your answers at the end of the Module.

Suggested Project Structure

You now have outlines for eight possible projects. It is suggested that you use the following guidelines to develop the projects, and keep your notes in an "Ideas File".

- problem or need identified in context
- Case Study
- develop the content areas required for successfully completing the Capability Task into several Resource Tasks (see the "Forty Facts" exercise)
- Capability Task

Pictures and articles can be added to the appropriate section in the file.

Classroom Activity

Choose a sample project to try with your learners. Use it to help you understand both the Technological Process and the Technological Content/ Study areas. You will learn how to complete a Technology process assignment and how to manage a class in Technology.

On completion, reflect on the project.

- Would you change or improve any aspect of the project if you use it again?
- What have your students learned?
- Evaluate the efforts of the most successful learner.
- Consider the weakest learner's attempt. How could you assist this student?
- What were some of the questions you used to encourage learners to think about the problem and its solution(s)? What were the responses?

Assessment for this Unit

Have you completed:

- the eight project outlines for your Ideas File?
- the sample project with your class, followed by detailed comments?

Self Evaluation:

- Identify the eight commonly accepted core content areas of Technology.
- Distinguish between Case Studies, Resource Tasks, and Capability Tasks.

Unit 3: Technology and Society

Learning Outcomes for this Unit

On completion of this unit, you will be able to:

- identify features of technology in your community and the broader environment
- design a technology learning experience for the learners using the school as a context for learning
- consider the importance of values in technological literacy
- explain the relationship between science and technology

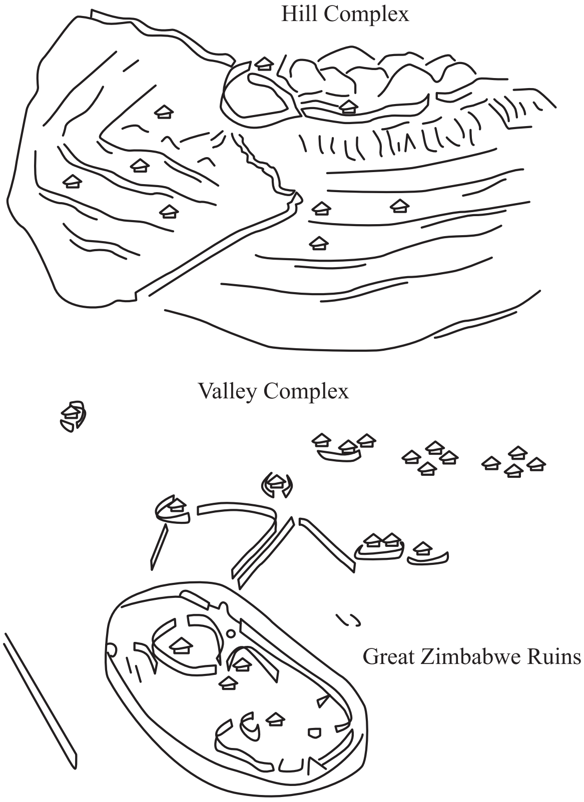
Unit Outline

- Introduction
- Technology in the Home
  - Systems and Control in the Home
  - Structures in the Home
  - Processing in the Home
  - Materials and Equipment in the Home
- Technology in the Community
  - Systems and Control in the Community
  - Structures in the Community
  - Processing in the Community
  - Materials and Equipment in the Community
- Application and Classroom Activity
- Technology Over Time
- Values and Technology
  - Values on a Personal Level
  - Technology and the Natural Environment
- The Relationship Between Science and Technology

Introduction

Participation in a technological society demands an understanding of the complex ways that technology shapes and changes our society. Both the products and the processes of technology represent the culture. We **create** things that we value and think are useful and beautiful. We **design** tools, machines, and systems to help us achieve this.

Consider the excavations at Great Zimbabwe. The enormous stone structures of walls, towers, and enclosures give us a good idea of the technology that the inhabitants applied to their structures.



The ruins of Great Zimbabwe

The great variety of objects found among the ruins show that the inhabitants bought interesting and valuable items by trading with other countries. For instance, the most common ceramics found on the site are shards (broken pieces) of Chinese celadon ware that is a stoneware with a green glaze. Most of this dates from the Ming Dynasty (1368–1644). Porcelain replaced celadon in the sixteenth century but because no shards of porcelain were found on the coast, we can conclude that Great Zimbabwe had lost its role as a key trading partner by that time. Only a few pieces of cooking pottery have been found, but iron-workings and the production of copper and bronze wire ornaments tell us what kind of materials, tools, and technologies were used.

Excavations near Vesuvius, the volcano that erupted near Naples, Italy in AD 79, provide evidence of that society's technology at the time. Wheel ruts in the cobbled streets indicate that some kind of wheeled transport was being used and we also see how roads were built. The remains of wine shops show that processing grapes to produce wine was practised at the time. Even a loaf of bread, baked almost 2000 years ago, exists.

Look around your home and think about the examples of technology that can be found there. Imagine that in 2000 years time, people will want to find out what technology we had.

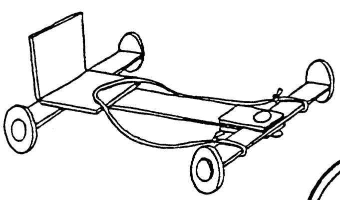
Technology in the Home

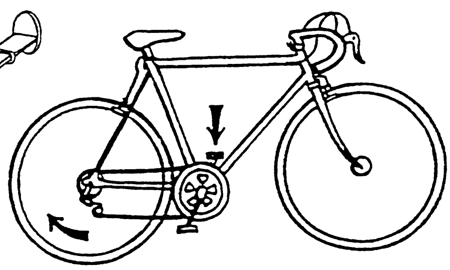
Systems and Control in the Home

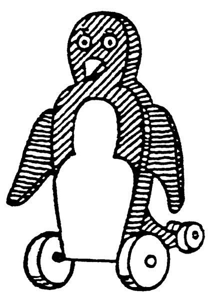
Look around your home and identify all the things that have **wheels**. This makes movement from one place to another easier (e.g., a pushchair for baby, a wheelbarrow, a vacuum cleaner).

What about toys with wheels?

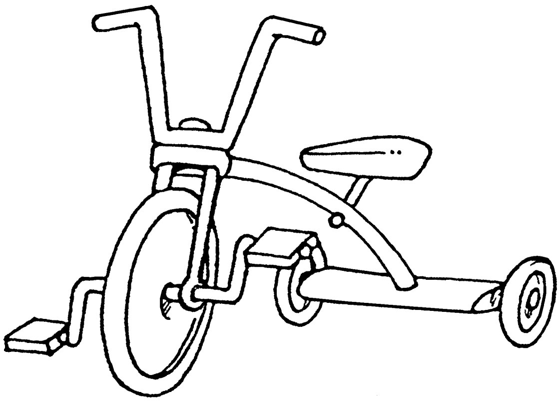
Pull-along toys?	Tricycles?	Go-karts?
Skateboards?	Bicycles?	Toy cars, trucks, etc.?



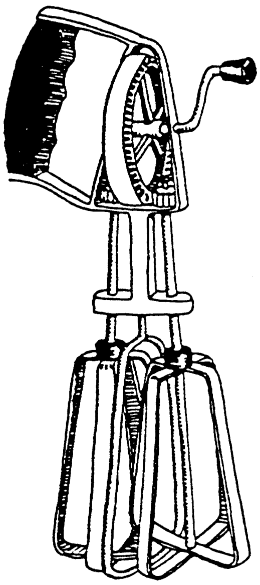




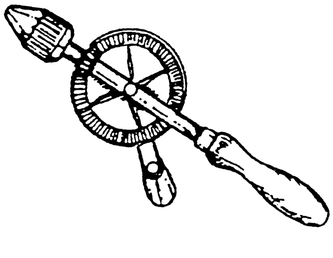
Look at the way the wheels are fastened to the **axles**. Do they turn with the axle or around the axle? What stops the wheels from touching the side of the object so they can move freely? How is the axle fastened to the **chassis** (frame) of the object?

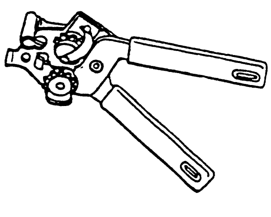


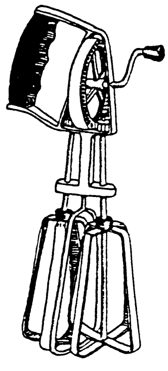
Think about machines that have handles that turn (e.g., egg beater). These probably have simple **gear wheels**.



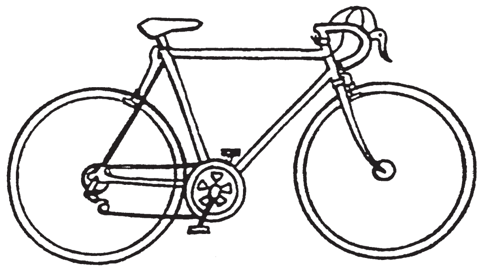
Look at the examples of gear wheels. A gear is a special kind of wheel with teeth on it. When the teeth of two gears interlink, we say they **mesh**.

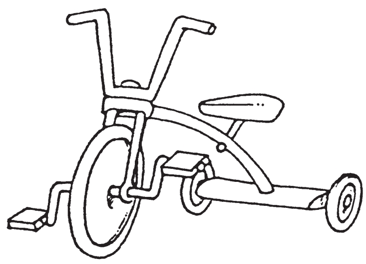




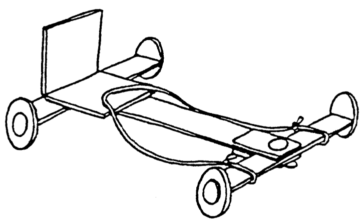


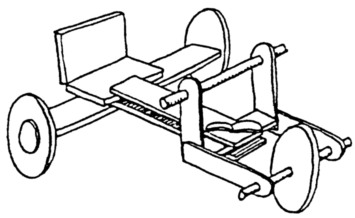
How do we **control** the movement? Can we stop the vehicles with a **braking device**? A bicycle has brakes on the handlebars and the pedals act as a brake if they are moved backwards. Do tricycles have a braking device? How do we **control** a tricycle?

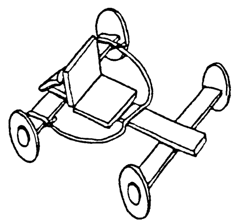




Can we steer all wheeled objects with a **steering device**? Steering is a form of control. Think about the steering wheel of a car. Now think about the piece of rope that you sometimes see fastened to the front axle of a go-kart. Which one has better control? Why do you think so? Talk to a friend about what you think.



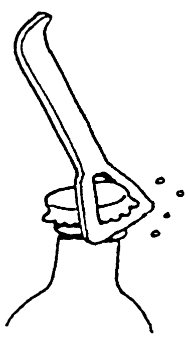




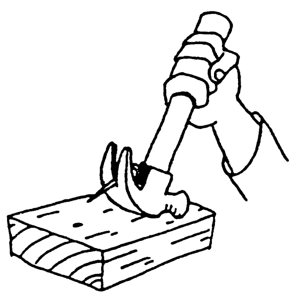
Think about how we control the flow of electrical energy with an **on/off switch**. Where in your home do you have a switch? Think about the light switch, the kettle switch, the switches for the stove, toaster, iron, and any other electrical appliances.

Do we have any **levers** in the home? Levers and linkages give us mechanical advantage.

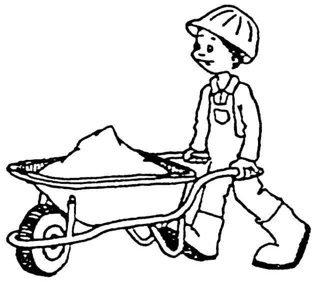
Look carefully at the pictures below. Remember—mechanical advantage means that a greater load can be moved with less effort (e.g., a crowbar is used to move a rock).



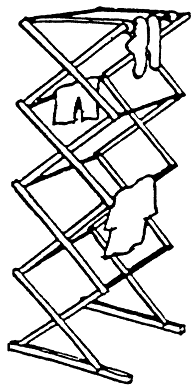
a bottle top opener



a claw hammer



a wheelbarrow



a clothes horse

In each case think about where you would find:

- the fulcrum/pivot point
- the load
- the effort

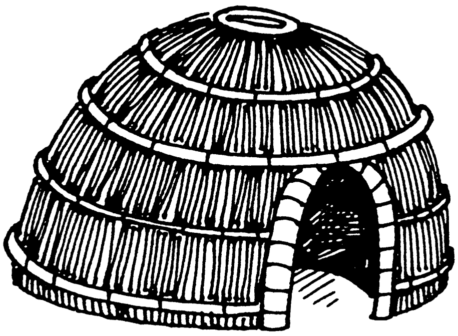
Structures in the Home

There are three main functions of structures:

- support
- contain
- protect

Draw examples of two items in your home that support you when sitting and one that supports you when lying.

For a structure to be stable, it is important that the beams that span the distance are strong. Look at the beams that hold up the roof and the beam that is across (spans) the top of the opening for the door. These are structures that span a distance and must be strong enough to withstand the forces of tension (pulling) and compression (pushing). Also look at shelves in your home. Do they sag in the middle? Can they support the load of books, crockery, etc., without compression? These are structures that support.

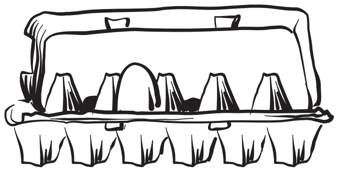


No doubt you have various containers in your home:

- you have suitcases and bags for carrying your clothes
- you may have large grocery packets from carrying groceries from the shops
- you may have tins or plastic jars for storing sugar, tea, or flour

These are all examples of **structures that contain**.

- When you go shopping, look at the packaging. Cardboard or plastic containers protect eggs, and waterproof packaging protects milk from contamination. Can you think of other examples of protective packaging? These are all examples of **structures that protect**.



an egg box

a milk carton

Processing in the Home

There are many examples of processing in the home.
Look carefully at the pictures, then list the letter on the picture next to the correct example:

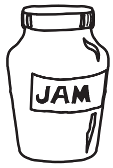
a Combining

b Extraction

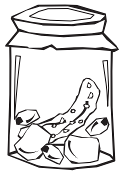
c Preservation

d Conversion

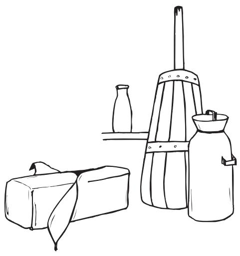
Baking bread



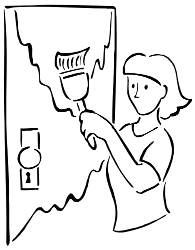
Jam



Pickled vegetables (Atchar)



Making butter



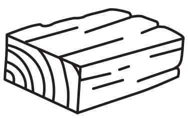
Painting a door

Crushing grain

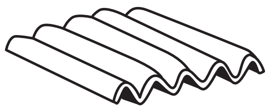
Making soup

Making beer

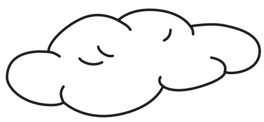
Making bricks



Wood



Metal



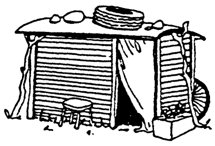
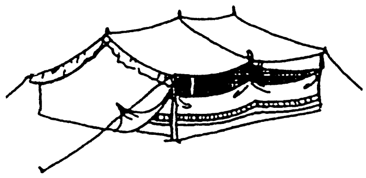
Clay

In each case ask:

- what is being combined? **Combining**
- what is being extracted? **Extraction**
- what is being preserved? **Preservation**
- what new product was made from converting the raw material or original product? **Conversion**

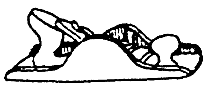
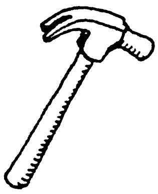
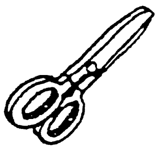
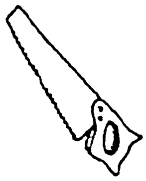
Materials and Tools in the Home

Think about your house itself. What part is made from wood? corrugated iron? clay bricks? cement? plastic? grass? stone? vinyl?

Think about your furniture. What is made from wood? plastic? steel?
Do you have wool, grass, or plastic mats?
What about implements? Do you have metal, plastic, or glass used here?
Textiles are used extensively for curtains, sheets, blankets, tablecloths, or dishcloths.

You might even list all the tools that were used to build your home, e.g., saw, hammer, drill and tools that you use around the home, e.g., knives, scissors, or in the garden, e.g., spade.

Technology in the Community

Look around your community, then answer the following questions. Half a page for each question will be sufficient, but write more if you wish.

- How are wheels and axles used in order to make work easier? Think about wheels and axles used for transport, for machines, or for toys. **(Systems and Control)**
- Choose your favourite basic food. Identify the raw product from which it is derived and determine the process used to produce that food. Include a recipe to describe how you cook and prepare the food. **(Processing/Communication)**
- Describe the home you live in. List all the materials used for the roof, floor, walls, doors, and windows. Where possible, identify the tools used. Identify how this structure is made stable so it will not collapse easily. **(Structures, Materials, and Tools)**

- Record, diagrammatically, how you would make bread. Use clearly labelled diagrams. Compare the process you use to make bread rise (e.g., yeast, baking soda, or yoghurt) with one other method. Compare the energy source you use (e.g., electricity, gas, or open coals) with one other method.
  (Communication/Processing/Energy)
- Write out four safety rules to observe in your home so that your children will not come to any harm.
  (Safety/Information)

Application and Classroom Activity

You now need to design a learning experience for your learners around **Technology in the school**. Consider the following four topics:

- Systems and controls in the school
- Structures in the school
- Processing in the school
- Materials and equipment in the school

You may present your learning experience in any way that is most meaningful to your learners, but here are some points to consider.

Think about

- any simple mechanisms like hinges, opening and closing mechanisms, wheels, or axles, e.g., simple gears as in the classroom pencil sharpener, pulleys, pull-down screen, sash windows, lighting, etc.
- structures that:
  - support
  - contain
  - protect

  There should be plenty of examples for each category.
- processes:
  combining (e.g., sandwiches, mixing paint, glue, paper maché, etc.)
- materials and tools. (things made from wood, paper, plastic, etc.)
- ways to structure the pupils’ experiences:
  - activities
  - written exercises
  - discussions
  - poster presentations
- what questions will you ask to guide the learner’s thinking? Learning experiences must be clearly defined, including:
  - the expected pupil outcomes
  - an outline of the lesson plans/learning experiences
  - a description of how the learners responded

Record any aspects of the learning programme that you would change or improve next time.

Technology Over Time

Historians study the past in an organised and systematic way. We can learn a great deal about the technologies of the past from historians.

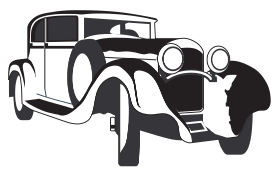
Look at old buildings in your town, or pictures of old buildings in family photos or history books or at the museums. You can record any changes in the use of materials and design. In some cases, some old designs that were replaced by more modern designs are now back in fashion. You can sometimes date a building by the type of material used. For example, in Pietermaritzburg, KwaZulu-Natal, any buildings built with a certain red clay brick are well over 100 years old because the quarry that was dug for the clay was finished well over a hundred years ago.

The city hall (Pietermaritzburg, KwaZulu-Natal, South Africa)

Older buildings may have undergone change of use (e.g., an old school may now be a teacher's resource centre or a warehouse may be turned into a block of flats).

Perhaps you can study such buildings in your locality, looking for clues and thus becoming more sensitive to the past and to the change in the environment.

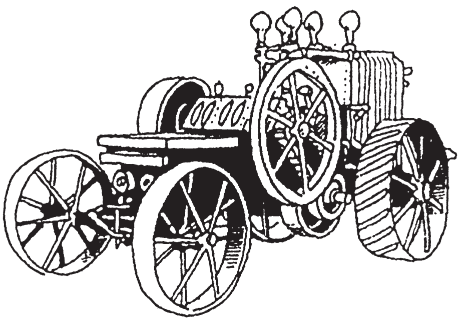
Pupils can have a better understanding of how new inventions present designers with challenges. Look at pictures of old cars. These looked rather like the old horse drawn carriages that they began to replace. Designers seemed to have difficulty breaking away from established ideas. This was also influenced by the fact that the motor car manufacturers relied heavily on the carriage makers for their skills in making the body work.



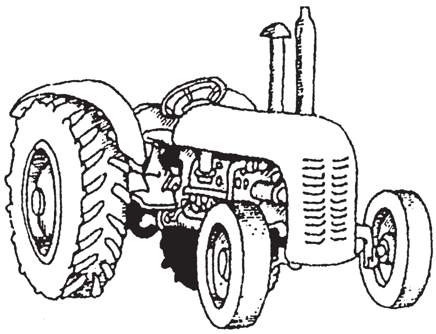
Ordinary everyday artifacts such as clothes, furniture, or appliances can tell a story about their evolution. We can see the changes they underwent over time, in terms of materials used, the needs of the users, and their attitudes and values. For example, having a large, sleek radio that can bring the world into your home expresses the glamour of technology. Similarly, the streamlined shape of a racing car expresses the desire for speed. Change through time is an interesting fact to consider when we look at the design and manufacture of a product or the change in the advertisements of that product.

Studying a range of artifacts can tell us a great deal about the past and this is an important basis for design. The Arts and Crafts Movement, formed by Morris in 1883, turned against the elaborate styles of the nineteenth century. They argued that manufacturers needed the expertise of trained designers to produce good designs for the new methods of industrial production. As a result, both architecture and artifacts changed from intricate, embellished, designs to simpler, cleaner lines.

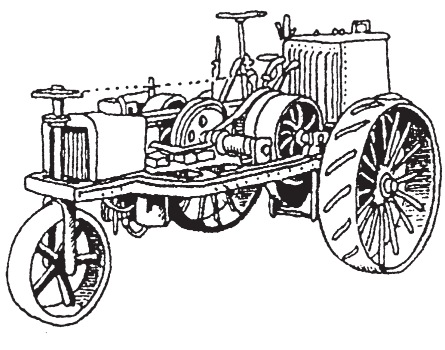
Compare the design of machine-produced and handcrafted artifacts. From the 1750s, mechanisation began to replace the traditional methods of hand production.



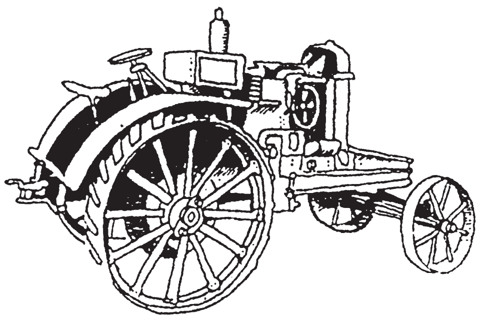
Old No. 1 Hart-Parr Tractor, 1901, 7 hp



Massey-Ferguson, 1955, 50 hp



The Ivel Tractor, 1912, 8 hp

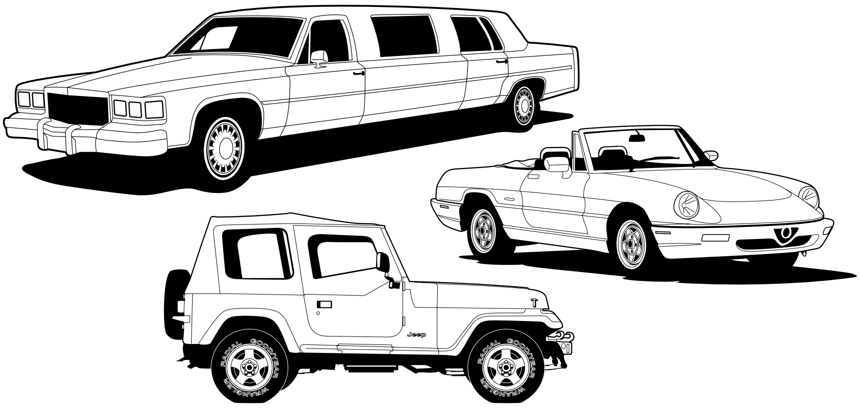


Saunderson Tractor, 1919, 25 hp

Discuss the advantages and disadvantages of these pairs of machine-produced and handcrafted artifacts. Why do you think hand-crafted objects are often more expensive? Why did they use this method of production long ago?

Peoples' needs over time have changed and this has influenced design. Compare the earliest motorcar to modern cars. Cars vary according to the needs of people. For example:

- a limousine
- a multi-purpose vehicle
- a luxury sports car



Design decisions affect all of us and often represent a society's values. For example, designers might bring out a trendy new line of clothes targeting young people, without any thought for the older person.

Circumstances, including materials and techniques available at the time, influence designs. In Victorian England, little boys below the age of two or three were dressed in frilly outfits with lots of tucks and lace. They were not allowed to run around outside and get dirty and were hardly distinguishable from little girls. In modern times, boys wear denim dungarees and tracksuits before they can even walk. In the past, it was also unacceptable for ladies to wear trousers even when horse riding. Nowadays, we use a tough fabric called denim to make jeans that are worn by both men and women. Thus peoples' attitudes affect design and design affects people's attitudes.

Values and Technology

Individual and Social Values

The goal of technology is the improvement of the quality of human life. Our perception of quality of life is based on beliefs, values, and human nature—and there is a reflection of culture in the things we value and find useful or beautiful. Is the good life always dependent on being a fast-paced, high-tech, affluent society?

For many countries, it is important to define **appropriate technology**. Was the technology designed **for** the community, or **by** the community? A sense of self-determination is engendered when technologies are designed by local people to meet local needs. It is in the things we do and create that we define ourselves and reveal our values.

For example, villagers in certain areas tend to gather together to enjoy music and they have the attitude of **one village, one radio**. The wind-up/solarpowered portable radios that were designed as appropriate technology for remote rural communities have not been very successful as they cannot be played loud enough for everyone to hear. Rather than accept the future that others feel is appropriate, it is important to ask “What kind of future do these users want?”

A distinction can be made between **technological capability** and **technological literacy**. A wide range of tasks in the content areas will ensure that our learners develop technological capability. However, technological literacy goes beyond this to include values and attitudes. We need to sensitise our children to the ways in which values influence, and are influenced by, technology in the world and include them in the Case Studies we cover.

A group of Industrial Design students at the Witwatersrand Technikon invented several devices to help blind people cope with difficult or dangerous tasks in the home:

- An egg separator that automatically separates the white from the yolk, so the person only has to pour the egg white from the bottom of the bowl.
- A special jug for the microwave, consisting of a clay jug within another jug so that liquids will never boil over and make a hot sticky mess.
- The prototype for a bath that sets off a warning buzzer if the water temperature is either too hot or too cold. In this way accidents can be avoided.

These products are not available for purchase as it is too expensive to develop them past the prototype stage and the demand for these products is low.

For a classroom project, have your students design new technology that helps people with disabilities. Building the design may be too advanced for upper primary students, but they can report on construction issues, such as cost of materials, ease of manufacture, and the market for their product.

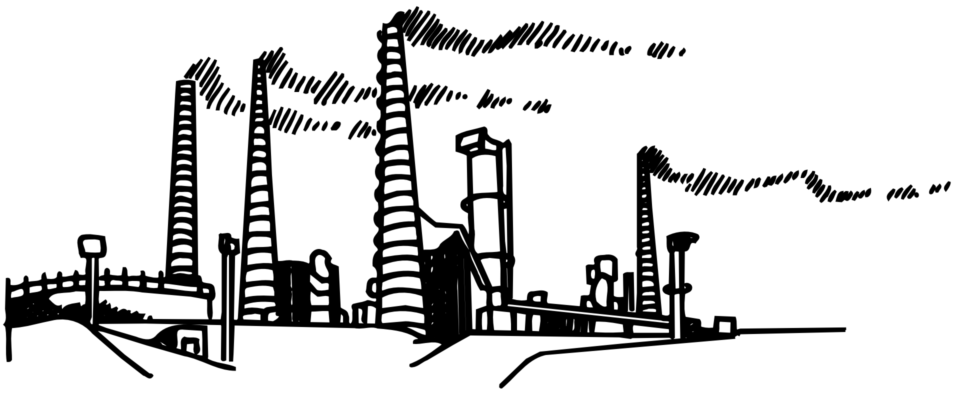
Technology and the Environment

All around us, we see the impact of technology—houses, roads, factories, shopping centres, parks, power stations, etc. Sometimes we even see its effect on the surrounding countryside. Design decisions about the effect of technology on the environment can involve many people, including local councils, town planners, civil engineers, architects, builders, developers, and even central government.

Public enquiries into the construction of motorways, power stations, hydroelectric dams, and major urban projects often reflect the conflicting attitudes of community and business interests. In their studies of technological design, your pupils can draw on the work of environmental scientists, the waste management industry, and government legislation.

Urbanisation

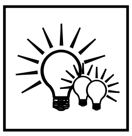
People are becoming increasingly aware of the impact of development and pollution on the environment. The effects of urbanisation encroaching on the surrounding countryside, the depletion of natural resources, and deforestation are taking place around the world, and are often accompanied by pollution, loss of wildlife habitat, etc.



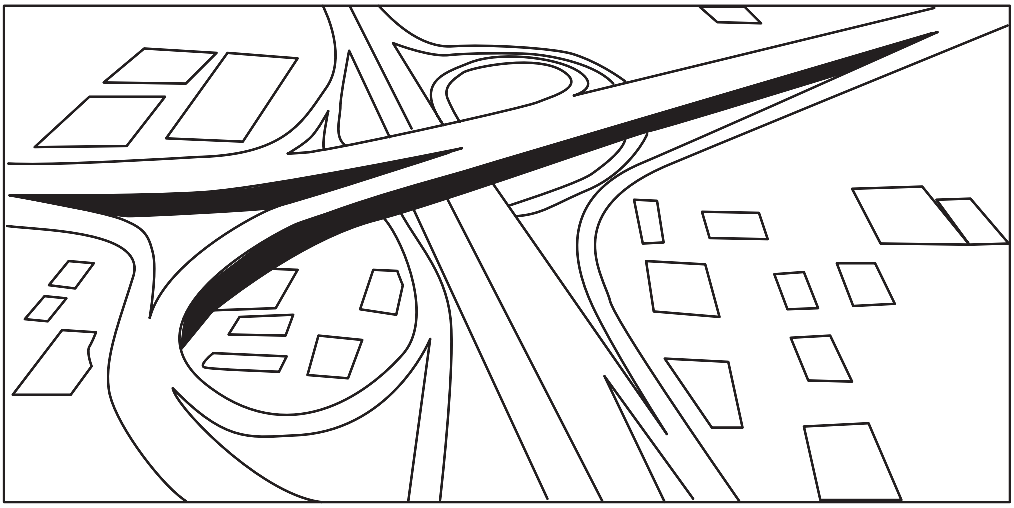
Factories and pollution

The solution to one problem often creates another, and technology that benefits some may bring hardship to others. For example, workers who are exposed to toxic materials can suffer from long-term health problems that might ultimately be fatal. This raises many fundamental questions. Do the positive results of technological advance, such as financial benefits, outweigh the negative effects?

In some parts of the world, the public's tolerance of pollution, and its attitude toward polluters, is changing. At one time, pollution released into the environment was no longer the responsibility of the industry that released it. Industries that release toxic substances into the air, water, or soil now retain ownership of, and responsibility for, those substances and are being held accountable for the effects.



Do you want to teach these topics in your classroom? Perhaps the best way is to choose a technology that is coming to your area, for example, a flood control project or a new road. Then divide your students into four groups for a debate: those "for" the new technology, those "against", some "news reporters" who summarise what has been said in the classroom debate, and some "government officials" who will decide whether the project should proceed. In effect, you turn your classroom into a public enquiry. Set a future date for the class debate so students have time to prepare for it. Activities like this drive home to students both the importance of values to technology, and the *difficulty* of satisfying all the individuals who will be affected by the project.

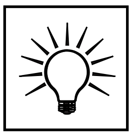


Flyovers

Designers play an important part in both the design and control of technology. Systems designers are experts who may combine computing skills, engineering, and town planning.

Designers can use their influence to overcome the waste of resources and threats to the environment. Together, designers and manufacturers can:

- conserve raw materials
- incorporate recycled and recyclable materials in their products
- design products that will last longer
- design products with greater energy efficiency in mind
- develop products that use natural, renewable energy resources (e.g., devices such as solar cookers and solar water heaters)



Design one lesson plan that instructs your students to find out what your community is doing about one of the following:

- controlling waste management through recycling
- improving the technologies involved in energy conservation (e.g., using solar power or electricity instead of open fires for cooking)
- an environmental concern and its technological solution

Have your students present their findings as a report.

The Relationship Between Science and Technology—and Other Popular Misconceptions

There is a great deal of confusion about the differences and similiarities between Science and Technology. The **know how** of Technology historically preceded the **know why** of Science. Technology and Science work together, yet historically they differ in what they do and in how they do it—and in precedence.

From archaeological excavations, we know that humans have made and used tools for at least two million years. Technology is the result of human skill and ingenuity being used to design and make things from available resources; concepts like crop rotation and metallurgy advanced to a sophisticated level long before any scientific investigation explained why they worked.

Galileo used the telescope to observe the solar system, and it changed our world view. However, few people realise that Galileo's science originated from an improvement to the technology of making eyeglasses. By being able to able make new observations, Galileo was able to ask new questions. Invention, improvement, and the use of a series of instruments were what expanded the reach of science. **Technology was the force that moved science forward. Not the reverse.**

The public image of technology illustrates value judgements, in that different values are attached to different technologies. Even in schools today, the image is still that academic subjects, such as Science require brains, whereas other subjects, such as Technology, require hands, not brains.

Consider the following commonly held viewpoints. If you can, discuss them with colleagues or friends.

"Technology is Applied Science."

If this is so, then scientific understanding should always precede technological invention. What happens when the invention of something precedes scientific understanding? What about the many cases throughout history where people have smelted metals, preserved food, and developed medicines without knowing why the particular technologies worked?

Can the major inventions of the modern era be defined as applied science? For instance, were Henry Ford (who quit school at age 15) and the Wright Brothers (who were bicycle makers), applied scientists? Or skilled and hardworking technologists?

Note—The debate regarding the relationship between Science and Technology is important, not because one is trying to establish which field is dominant, but to understand the real relationship.

"Technology is for males rather than females."

Why is it that the history of invention has tended to be dominated by males? Why do societies tend to encourage boys to identify with more technology based careers, such as engineering?

Can you think of women who have conducted successful careers in technological fields?

What qualities do you think women contribute to technological endeavours that men don't?

Note—Teachers have an enormous influence on children. In what ways can teachers use technology teaching to encourage **all** children's interests in a technological career? Here's a hint: do your classroom technology projects have an innate appeal to both boys and girls? Or just to boys? What classroom projects would you expect to appeal to both?

Assessment for this Unit

For your classroom activity in this unit, you designed a learning experience based on Technology in the School.

- What sort of structure did you use for this activity? Was it effective?
- How did your learners respond to the questions you developed? Were the questions at the appropriate level for your learners?

Keep notes on this activity in your learning journal and record ideas for improving this lesson the next time you teach it.

Self Evaluation

Explain in one or two short paragraphs:

- the core content areas of Technology
- the importance of values in technological literacy
- the relationship between science and technology
- how you would address the males/females dichotomy in your classroom

Unit 4:
Using Drawing to Communicate Technological Ideas

Learning Outcomes for this Unit

On completion of this unit you should be able to:

- print neatly using acceptable printing techniques
- demonstrate an understanding of the basic concepts used in graphic communication (angle, height, length, thickness, isometric and orthographic projection)
- draw well-proportioned "rough sketches" of objects
- use grids to draw freehand isometric (3-dimensional) views of objects
- use grids to draw freehand orthographic drawings of objects
- include simple dimensioning techniques in drawings
- use these skills to clearly and effectively present design ideas

Unit Outline

- Why Learn to Draw as Part of Technology?
- Teaching Objectives
- Basic Concepts of Graphic Communication
- Graphic Communication Equipment
- Learning Graphic Skills

Why Learn to Draw as Part of Technology?

Drawing forms an important part of the skills component of a Technology programme. Solutions to technological problems need to be:

- expressed
- discussed
- refined
- communicated

Technological ideas are often easier to describe in drawings than in words.

Examples of Sketches Used in Famous Designs

Diagram A shows Thomas Edison's original sketch of the "phonograph". This famous **rough sketch** was drawn freehand, without instruments, and yet it helps us understand what the designer was thinking.

- Look carefully at *Diagram A*. This drawing shows how sound can be stored and replayed from an instrument like a gramophone.

  Can you see the gramophone needle?

  What is the needle touching? (a gramophone "record")

  How does the needle move along the "record"?

- Write the answers to these questions. Once you have done that, discuss the different interpretations of the drawing.

It is not important that everyone interprets the drawing in the same way. What is important is that you see how much information can be obtained from a simple "rough sketch". Value your own "rough sketches" and use them to communicate design ideas. When you are engaged in design work, all "rough work" and sketches of this kind should be kept and presented with your completed work.

Some sketches and drawings can contain quite complex drawing, and you should only use them in your lessons if you feel your students can cope with the concept.

Complex drawings can illustrate how much information can be contained in a limited amount of space. Here are sample classroom questions to accompany a drawing or schematic diagram of a gasoline engine:

- How many parts of the engine can you identify?
- Can you explain how these parts work together? Your answers should reinforce the idea that drawings communicate a lot of information in an efficient way.

Diagram A: Sketch of Thomas Edison's Phonograph

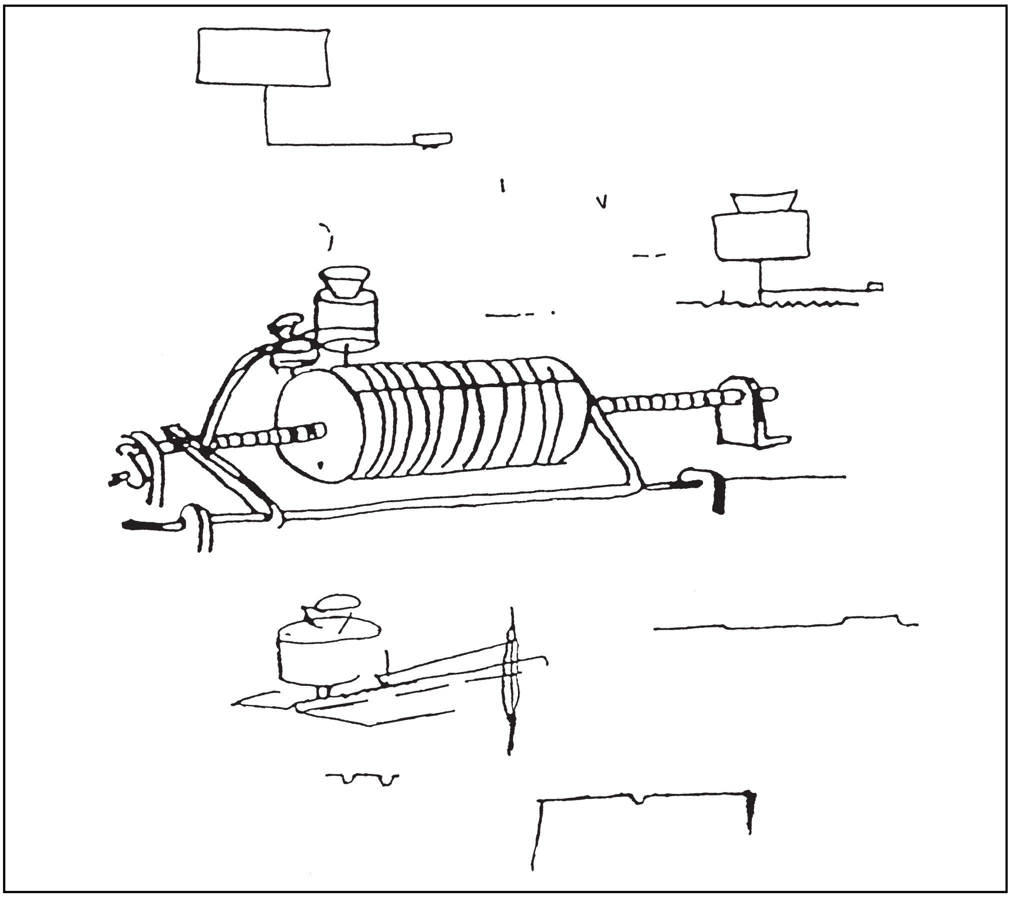
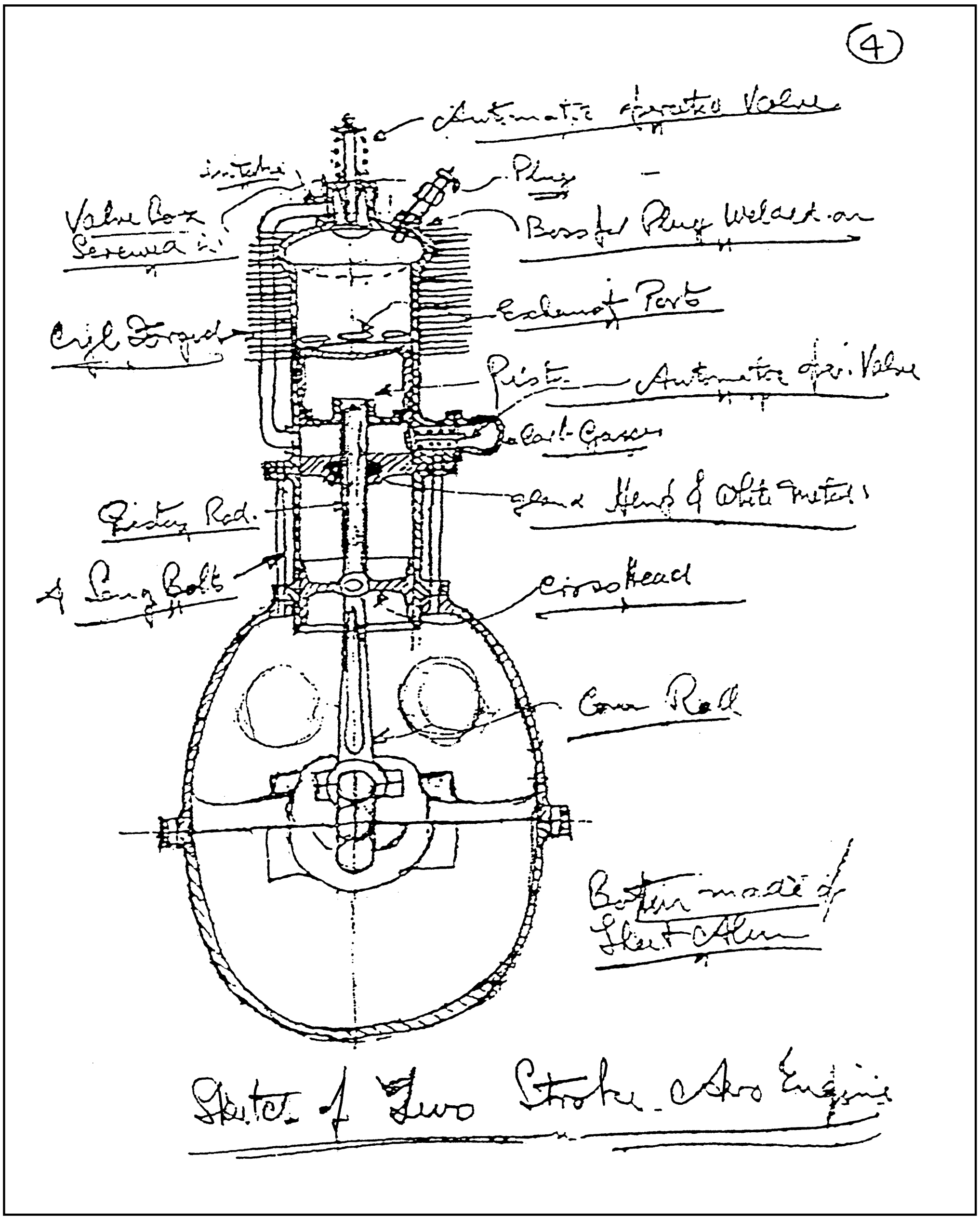


Diagram B: Sketch of H.P. Folland's Two-Stroke Airplane Engine



Teaching Objectives

By the end of **upper primary school (Grade 7)**, learners should be able to:

- demonstrate an understanding of the basic concepts used in graphic communication (angle, height, length, thickness, isometric and orthographic projection)
- make well-proportioned, rough sketches of objects
- draw freehand, isometric (3-dimensional) views of objects, with the aid of grids
- include simple dimensioning techniques in drawings
- use these skills to present design ideas clearly and effectively

Your teaching syllabus may differ from this. As suggested in Unit 1, the way you teach drawing to your students should align with the “circular” model of the technological process.

Basic Concepts of Graphic Communication

Concept 1: Types of Lines

The most common types are:

Construction lines—light, thin lines used to provide a framework for the drawing.

Final lines—clear, dark lines used to indicate the edges of a drawing.

Hidden detail lines—clear, broken lines showing edges of an object that cannot be seen.

(Refer to Task 1–Activity 1—Drawing Lines)

Concept 2: Dimension

In graphic communication the term “dimension” has **two** important applications. The **first** refers to each of **the three universal dimensions** common to all objects:

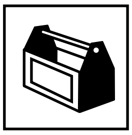
- Height
- Length
- Breadth (Depth)

Two-Dimensional Shapes (2-D Surfaces)
Some drawings show only two dimensions. These shapes (or surfaces) take many forms, but only show two of the universal dimensions. For example, draw any four-sided shape on a piece of paper. This drawing will only have two dimensions (refer to Task 1–Activity 2—Using Lines to Draw 2-Dimensional Shapes).

Three-Dimensional Shapes (3-D Shapes)
Some drawings show all three universal dimensions. These drawings tend to show objects as we would expect to see them—similar to pictures or photographs (refer to Tasks 2 and 3, *Diagram sheets 2–6*—Isometric Drawing).

The **second** use of the term "dimension" refers to methods used to show the exact size of different parts of an object on a drawing (refer to Task 9, *Diagram 32* for examples of some of the methods used to indicate the size of components on a drawing).

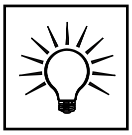
Graphic Communication Equipment



You will need the following equipment for the graphic communication tasks in the next section:

- pencil and sharpener (keep pencils sharp at all times)
- eraser
- ruler
- pencil crayons (red, blue, and yellow)
- glue
- scissors

Note—All the exercises you complete in this unit can be learned by children in the upper primary school.



Learning Graphic Skills

This section sets out a series of tasks and related activities that should be completed sequentially. Some activities can be completed on the diagram sheets included in the text, while other drawings should be done on paper with the aid of the isometric grid (isometric drawings) or the squared paper (orthographic drawings).

Each task develops a particular skill. By following them in sequence you should be able to master all the skills appropriate to the upper primary level. Graphic skills provide children with an important way to communicate their design ideas. Remember that the intention of this section of the course is not to teach graphic skills for their own sake. The intention is rather to increase children's ability to communicate. This should be kept in mind when teaching these skills.

Note—The diagrams needed for these activities are in the Appendix at the end of this module.

Task 1: Drawing lines and printing

Activity 1—Drawing lines

Use paper, the square grid (*Diagram 1A*), and a pencil to complete this exercise.

You have already been introduced to the three types of lines used for graphic communication. Practice these techniques until your drawings become consistent. In this activity, you have an opportunity to practice drawing these lines with the aid of a square grid. Clip the square grid under a piece of A4 paper.

- Using the horizontal lines as a guide, practice drawing ten **construction lines** using your ruler. This exercise might seem simple, however, it requires a great degree of skill to ensure that each line has the same weight. A construction line is very light. Apply very little pressure to the pencil as you draw it across the paper. Each time you draw one of these lines, compare it with the others you have drawn to see if all the lines have a consistently light tone.

- Next, draw ten **final lines**. Final lines are the narrow, dark lines used to indicate the edges of objects. When drawing final lines, make sure your pencil is sharp and that you apply a consistent, firm pressure as you draw it across the paper. After drawing a line, check to see that it has the **consistently dark tone** of the others you've drawn.
- Finally, draw ten **hidden detail lines**. Hidden detail lines are broken lines used to indicate the hidden edges of objects. They should be the same weight as final lines. Each section of a hidden detail line should be equally long (3 mm). The gaps between them are slightly shorter (2 mm). Once again, check that each line has a **consistently dark tone**.

Activity 2—Using lines to draw two-dimensional shapes

Use the square grid (*Diagram 1A*) to complete this exercise.

Clip the square grid under a piece of A4 paper and, using the grid as a guide, copy the two-dimensional shapes shown on *Diagram 27* in the Appendix. Draw the edges of these shapes as **final lines**.

Activity 3—Printing

Using the square grid (*Diagram 1A*) copy the alphabet and the numbers on *Diagram 1*. Make sure that all printing on your drawings conforms to the shape of the letters and numbers in *Diagram 1*.

Printing is always square, and as wide as it is high. The size of the letters can change, however, but printing is never smaller than 3 mm.

Now try printing the alphabet and numbers so they are one block in size.

Task 2:
Drawing three-dimensional views of objects (isometric drawings)

Introduction to Isometric Drawing

Isometric drawings show the three dimensions (height, length, and breadth) of an object and are **easy to read** because they show the object as we are accustomed to seeing it. It is difficult, however, to show a lot of accurate detail in one isometric drawing.

The following activities are intended to introduce you to drawing objects in isometric projection:

Activity 1

Use *Diagram 2* for this activity. *Diagram 2* shows a row of objects (they look like letters of the alphabet) drawn in isometric projection.

Turn the sheet sideways and copy each of the isometric drawings in the space provided below the object. Begin at the corner marked on the drawing and fill in all the edges that can be seen.

The bottom two drawings are to be copied to the right of each object.

Activity 2

Use *Diagram 3* for this activity. *Diagram 3* shows the same objects that were used in *Diagram 2*, however, they are positioned differently.

Copy each of these isometric drawings using the same technique as before. Once again, the drawings should be copied immediately below the object in the top row.

The bottom two drawings are to be copied to the right of each object.

Task 3: Drawing isometric drawings with the aid of an isometric grid

Activity 1

Use *Diagram 4* for this activity (turn sideways). Clip the isometric grid (*Diagram 1B*) behind a piece of A4 paper and copy all the drawings on *Diagram 4*.

Note that objects can be drawn so they appear:

- to go up towards the right (as they do in the top row)
- to go up towards the left (as they do in the middle row)

An object can be drawn showing all details by making a number of isometric drawings.

Activity 2

Use *Diagram 5* for this activity (turn sideways). The drawings on this page are of a more technical nature and include some **non-isometric lines**. These can be seen in the second drawing on the first line and the last two drawings on the third line. **Non-isometric lines** do not lie parallel to any of the axes on the isometric grid.

Some of your design solutions may include shapes with **non-isometric lines**.

Copy the last drawing in each row, starting at the corner that has been highlighted. Then copy the remaining drawings onto A4 paper clipped over an isometric grid (*Diagram 1B*).

Activity 3

Use *Diagram 6* for this activity (turn sideways). The drawings on this page show how a solid object (block) can be turned into a hollow object (box) by simply adding or removing a line or lines.

Once again, some of your design solutions may include shapes similar to these. For example, the second drawing from the left in the top row could be used to show **the body of a simple vehicle**. Detail of an axle or crank could be added to the underside of the body.

The drawings (boxes) with missing sides could, for example, be used to show details of how the parts of a similar vehicle might be assembled. By removing the side, the detail is easy to see.

Copy all the drawings onto A4 paper clipped over an isometric grid (*Diagram 1B*).

Task 4: Drawing isometric circles

Activity 1

Use *Diagram 7* for this activity. It is difficult to draw isometric circles without instruments. For example, if you look at the isometric drawings of the three cylinders on the page, you will see that the circles at the end of the cylinders are elliptical in shape. These **isometric circles** appear to be on the **right side**, on the **left side**, or on the **top** of the object being drawn. Look at the three cylinders in order to understand this point.

Because **isometric circles** are quite difficult to draw freehand, it is suggested that the ellipses (isometric circles) on this page be **used as a template** that can be placed under your drawing page so that the circle, which may be a wheel on a vehicle, for example, can be traced.

Task 5: Drawing two-dimensional views of objects (orthographic drawings)

Unlike **isometric drawings** which show three dimensions in one drawing, **orthographic drawings** show the three dimensions of the object being drawn in a number of two-dimensional views.

Most drawings of machines, buildings, and other complex objects are drawn using orthographic projection because it is easier to show a lot of detail without the drawing becoming cluttered and difficult to read.

A draughtsperson may draw many orthographic views of an object but in these activities, we will work with only three views—the **front** view, **top** view, and the **left** view.

(Diagram 8 and 9—These two pages go together)
To illustrate how a draughtsperson would draw orthographic views of an object, make use of *Diagrams 8 and 9*.

Activity 1

Use *Diagram 8* for this activity. First colour the parts of the drawings on *Diagram 8* (blue, yellow, and red) as instructed. Then **cut out and assemble the cube**.

Cut out the model of walls and floor, then fold along the dotted lines. This gives you a miniature model of **the floor** (blue), the **front wall** (red), and the **side wall** (yellow).

Stand this model on the desk, but do not glue the side wall to the floor. Place the cube on the floor so the blue square of the cube is above the blue square of the floor. **Now go to *Diagram 9* (Activity 2)**.

Activity 2

Use *Diagram 9* for this activity. Colour the parts of the drawing on *Diagram 9* as indicated. The use of colour makes the drawing easier for you to explain and easier for your students to understand.

Imagine the arrows are rays of light from a torch shining onto the cube—from the front, top, and side. In other words **the arrows indicate the direction we are looking from when drawing the three views**.

When you shine a light from the **front** (red arrow), the light strikes the front (red surface) of the cube and the shadow of this surface falls immediately behind the cube, on the front wall. This is called the **"front view"**.

When you shine a light from the **top** (blue arrow), the light strikes the top (blue surface) of the cube and the shadow of this surface falls immediately below, on the floor. This is called the **"top view"**.

When you shine the light from the **left** (yellow arrow), the light strikes the left (yellow surface) of the cube and the shadow of this surface falls immediately behind, on the side wall. This is called the **"left view"**.

Use the model of your cube and floor and walls now.

Remove the cube from your model of the floor and walls.

Flatten the floor and side wall so the model lies flat on the table. You can now see how a draughtsperson draws a three dimensional object showing length, breadth, and height on a flat sheet of paper.

Look carefully at the position of the three views—the **left view** lies to the right of the **front view** and the **top view** lies below the **front view**.

You can see why the three views are positioned the way they are and that each view shows two dimensions:

- the **front view** shows height and length
- the **top view** shows length and breadth
- the **left view** shows breadth and height

Activity 3

Use *Diagram 10* for this activity.

This is an opportunity for you to draw an orthographic projection of the cube.

Copy the orthographic views shown in the top right-hand drawing in the space below it. Begin each view at the corner indicated.

Diagrams 11–20

The following activities make use of:

- a cube, **number 1** (each edge of the cube is one grid-unit long)
- a second block, **number 2**, that has a square end and a length of two grid-units

Activity 4

Use *Diagram 11* for this activity.

Drawing 1

Drawing 1 shows a cube (one grid-unit). It also shows the three views and the three arrows indicating the position from which the object is being viewed (i.e., as described in *Diagram 9*).

Notice the end with the number 1 on it is seen when looking from above and will appear on the floor (in the top view).

Drawing 2

Drawing 2 shows a block two grid-units high. The dotted line in the middle shows the two units. It also shows the three views and the three arrows indicating the position from which the object is being viewed.

Drawing 3

Drawing 3 shows a cube and a block two grid-units high. It also shows the three views and the three arrows indicating the position from which the object is being viewed.

Drawing 4

Drawing 4 shows a cube and a block two grid-units high. It also shows the three views and the three arrows indicating the position from which the object is being viewed. Notice that when you look from the left side, you are unable to see the cube (block 1) as it is hidden from view by the bigger block (block 2).

In the left view, this hidden block (block 1) is seen as a broken (hidden detail) line.

Drawing 5

Drawing 5 shows a block two grid-units long. It also shows the three views and three arrows indicating the position from which the object is being viewed. The square end of the block (with the number 2 on it) can be seen when you look from the left side, and the square end is then seen in the left view.

Unlike drawings 1–4 where the square ends are seen in the top view, the square end is seen in the left view in drawing 5.

Drawing 6

Drawing 6 shows a block with a breadth of two grid-units. It also shows three views, and the arrows indicate the position from which the object is being viewed. The block is lying so that the square end (with the number 2 on it) is seen when looking from the front and the square end is therefore seen in the Front View.

Task 6: Drawing orthographic views from isometric drawings (square blocks)

Diagram 12

The five isometric drawings in *Diagram 12* show the same cube and the block used in *Diagram 11*.

The **top view**, showing each block/blocks viewed from the top, is shown in each of the five orthographic drawings on the bottom half of the page.

The number 1 and 2 shown on the square end is a reminder of the height or length of the block.

Activity 1

Use *Diagram 12* for this activity.

Project the front and left views of each of the block/blocks, using the square grid as an aid. The fifth drawing shows the top view of the number 2 block that is lying on the floor. You cannot see the square end with the number 2 on the top view and that is why there is no number in this view. Look at Drawing 5 on *Diagram 11* if you have difficulty visualising this.

Diagram 13

These are the **model answers** of the five drawings on *Diagram 12*.

Check your drawings to make sure they are correct.

Diagram 14

The following exercises make use of:

- a cube, number 1
- a second block, number 2, which has a square end and is two grid-units high
- a third block, number 3, which has a square end and is three grid-units high

The six isometric drawings show the three blocks arranged in different ways. In each case the front, top, and side view of the arranged blocks is also shown.

Notice the broken lines (referred to as hidden detail) in drawings 2–6.
The next exercise on *Diagram 15* will make use of these combinations.

Activity 2

Use *Diagram 15* for this activity. The five isometric drawings at the top of the page show the different arrangements of blocks 1, 2, and 3. The blocks are the same as those on *Diagram 14*. The top view of each group of blocks is given in the five orthographic drawings. The numbers 1, 2, and 3 shown on the square ends indicate the height of the blocks. Project the front and left views using the square grid as an aid. Show the hidden detail on the views you draw.

Diagram 16

These are the **model answers** of the six drawings on *Diagram 15*.
Check your drawings to make sure they are correct.

Activity 3

Use *Diagram 17* for this activity. The incomplete orthographic drawings of the three blocks grouped together in different combinations are shown on this page. Draw the missing front view and left view on each drawing.

Diagram 18

These are the **model answers** for the drawings on *Diagram 17*.
Check your drawings to make sure they are correct.

Activity 4

Use *Diagram 19* for this activity. Incomplete orthographic drawings of three blocks grouped together in different combinations are shown on this page. Draw the missing front and left views on each drawing.

Task 7: Drawing orthographic views from isometric drawings (letters and numbers)

The activities described in *Diagrams 21–23* refer to the isometric drawings of different shaped blocks on *Diagram 20*.

Diagram 20

(You used these same blocks in Task 3, Activity 1 on *Diagram 4*.)

A number of shaped blocks are drawn in isometric projection.

Colour the surfaces of each block in the following way:

- the surface that will be seen in the **front view: Red**
- the surface that will be seen in the **top view: Blue**
- the surface that will be seen in the **side view: Yellow**

Using colour helps visualise the surface you will see in each view.

Activity 1

Use *Diagrams 21–23* for this activity. These diagrams provide examples of what drawings numbered 1, 2, and 8 in *Diagram 20* will look like in orthographic projection. Compete the three views in the space provided on each page.

Task 8: Drawing orthographic views from isometric drawings (machined objects)

The activities described in *Diagrams 25–27* refer to the isometric drawings of different shaped blocks on *Diagram 24*.

Diagram 24

You used these blocks in Task 2, Activity 2 on *Diagram 5*—isometric exercise.

A number of shaped blocks are drawn in "isometric". Colour the surfaces of each block in the following way:

- the surface that will be seen in the **front view: Red**
- the surface that will be seen in the **top view: Blue**
- the surface that will be seen in the **side view: Yellow**

Using colour helps visualise the surface you will see in each view.

Activity 1

Use *Diagram 25* for this activity. On this diagram sheet, you are given the front view of each block. Complete the drawings by projecting the top view and left view. Pay attention to the hidden detail.

Activity 2

Use *Diagram 26* for this activity. The three views of each block are given. Complete the views by drawing the hidden detail lines.

Diagram 27

These are the **model answers** of the drawings on *Diagrams 25 and 26*. Check your drawings to make sure they are correct.

Activity 3

Use *Diagram 28* for this activity. Isometric drawings of two houses are shown in the diagram. With the assistance of the square grid provided (*Diagram 1A*), project a front, top, and side view of each house on A4 paper. Clip the square grid behind your paper.

Diagram 29

Diagram 29 provides the **model answer** for the drawings on *Diagram 28*. Check your drawings to make sure they are correct.

Activity 4

Use *Diagram 30* for this activity. An isometric drawing of a house and a dog kennel is shown on the diagram. Use the square grid (*Diagram 1A*) to project a front, top, and side view of the house and kennel on A4 paper. Clip the square grid behind your paper.

Diagram 31

Diagram 31 provides the **model answer** of the drawings on *Diagram 30.* Check your drawing to make sure it is correct.

Task 9: Dimensioning

Dimensions indicate the sizes (length, breadth, and height) of the various parts of an object. They also show the position of such important features as holes, grooves, etc.

Imagine you are an architect and you draw the “plans” of a house without indicating any sizes or dimensions. You then give the drawings to a builder so he can build the house. Without **dimensions**, the builder will not be able to build the house as he will not know how big it is, exactly where the windows and doors should be placed, and how much material will be needed.

Dimensions must always be shown clearly. To ensure that they are shown clearly and correctly, a “code of practice” explains how dimensions must be placed on a drawing. This code is accepted around the world.

Diagram 32

The isometric and orthographic drawings show the dimensions (length, breadth, and height) of the object. They also show the position of holes and other features.

Note the following:

- dimensions are placed above the dimension line
- arrowheads are shown as a **sight thickening** of the line and end on the limit line
- there is a gap between the limit line and the object
- the dimension is read from the front or from the right in the orthographic drawing

Activity 1

Use the drawings you completed on *Diagrams 21–23* for this activity. Use the information you have been given on dimensioning to dimension these drawings on Diagram 32.

Assessment for this Unit

Consider the paper tower (icebreaker) activity you completed in Unit 1 of Module 1.

Use a combination of isometric and orthographic techniques to describe the ideas your pupils developed as they worked to find a solution to the problem.

The presentation should show the group's initial ideas and the changes that took place as the idea was tested and refined. The drawings should be combined with text (notes and information) and set out so that the sequence of the development is clear.

Answers to Activities

Answers to Forty Facts from Core Content Areas (Unit 2)

1) a	11) b	21) b	31) a
2) a	12) d	22) c	32) g
3) g	13) a	23) h	33) e
4) a	14) e	24) a	34) g
5) e	15) a	25) e	35) h
6) d	16) d	26) b	36) e
7) a	17) f	27) b	37) e
8) a	18) c	28) a	38) h
9) e	19) e	29) f	39) d
10) h	20) a	30) h	40) c

Case Study Tasks (Unit 2)

1) Capability Task 1
2) Capability Task 7
3) Capability Task 2
4) Capability Task 6
5) Capability Task 3
6) Capability Task 4
7) Capability Task 5
8) Capability Task 8

Summary Questions (Unit 2)

a) Capability Task
b) Resource Task
c) Case Study Task
d) Resource Task
e) Capability Task
f) Resource Task
g) Case Study Task
h) Resource Task

Appendix

Diagram 1: Square Grid – Technical Printing

Copy the alphabet - Always use this printing on your drawings.

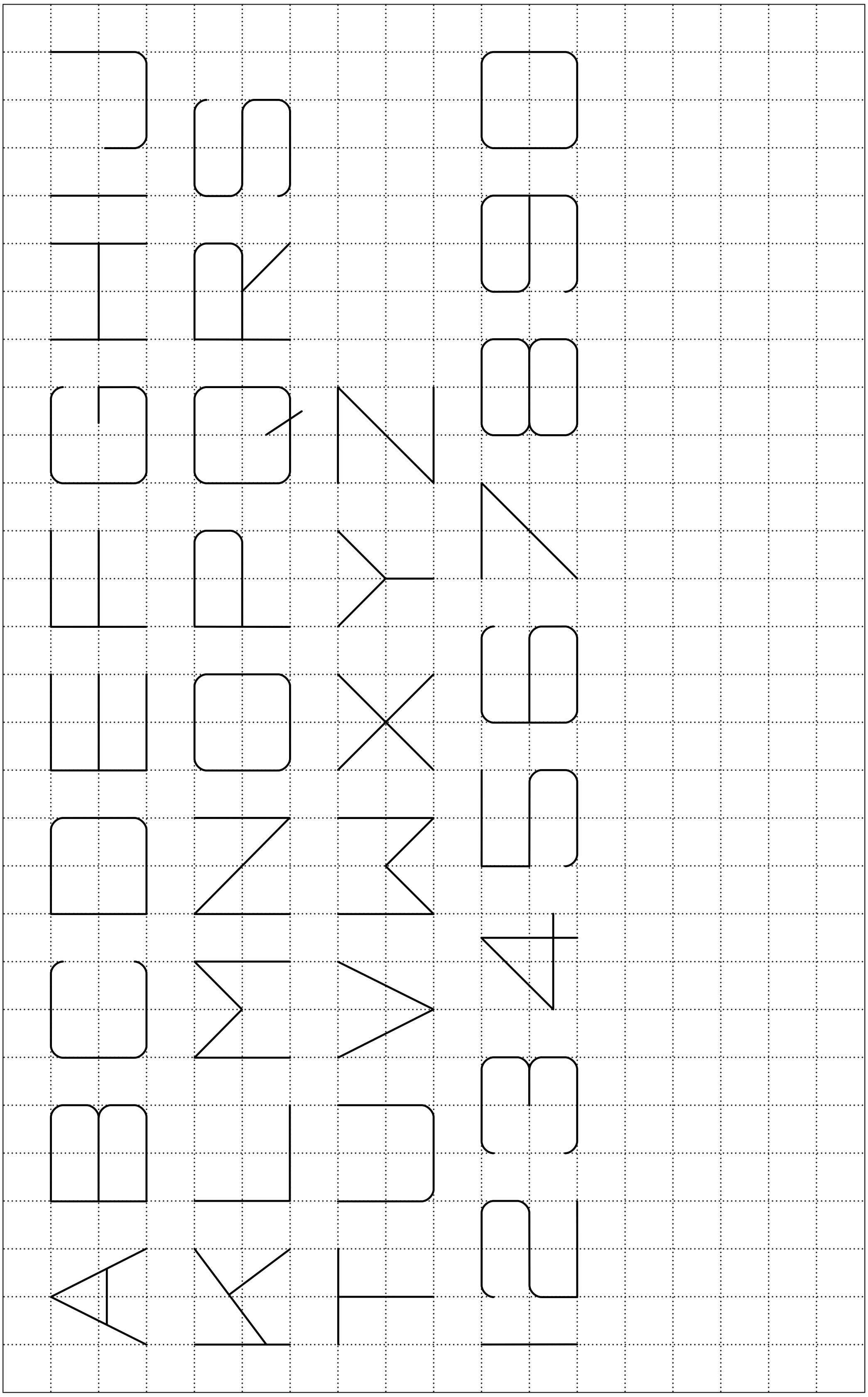


Diagram 1A: Squared Grid

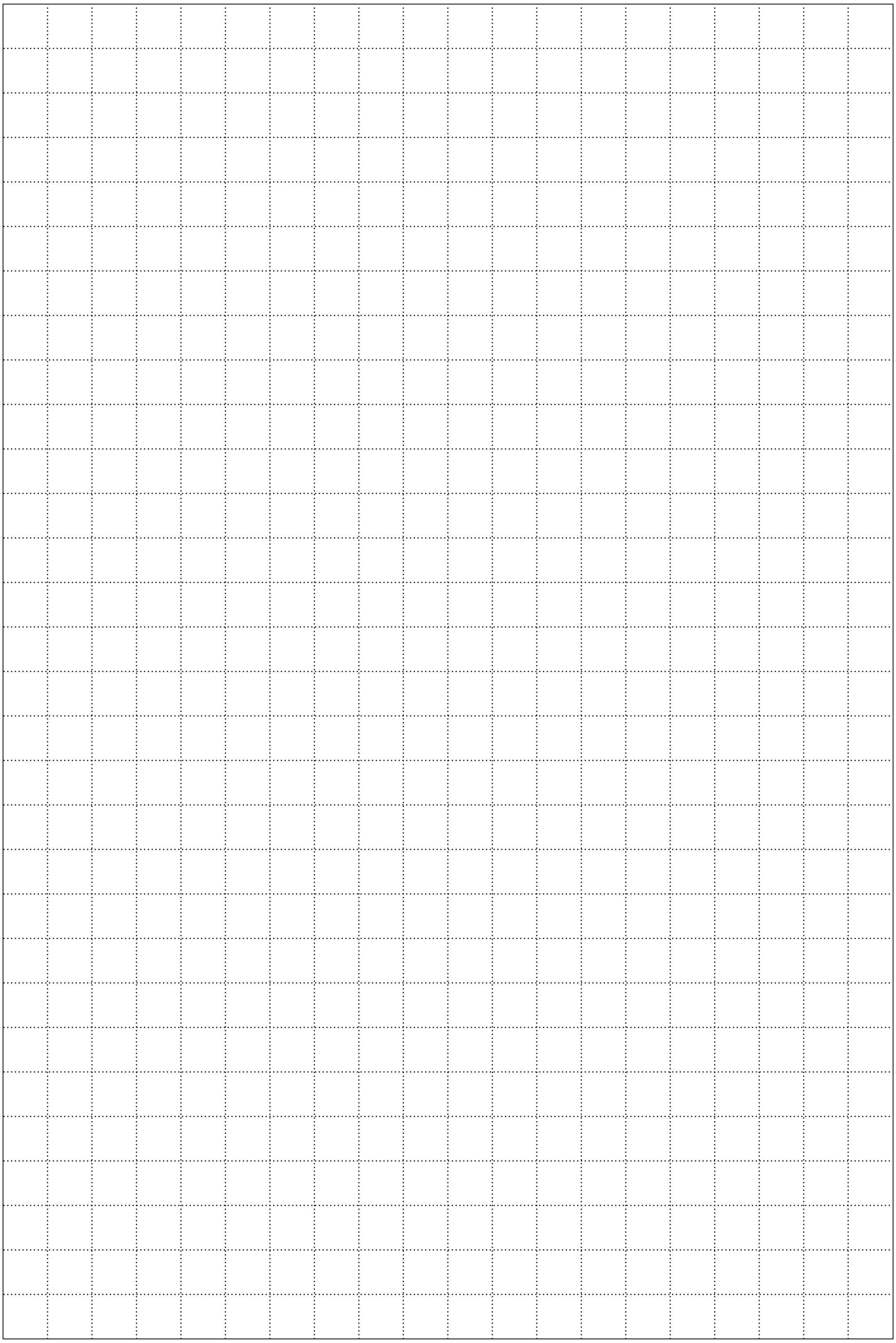


Diagram 1B: Isometric Grid

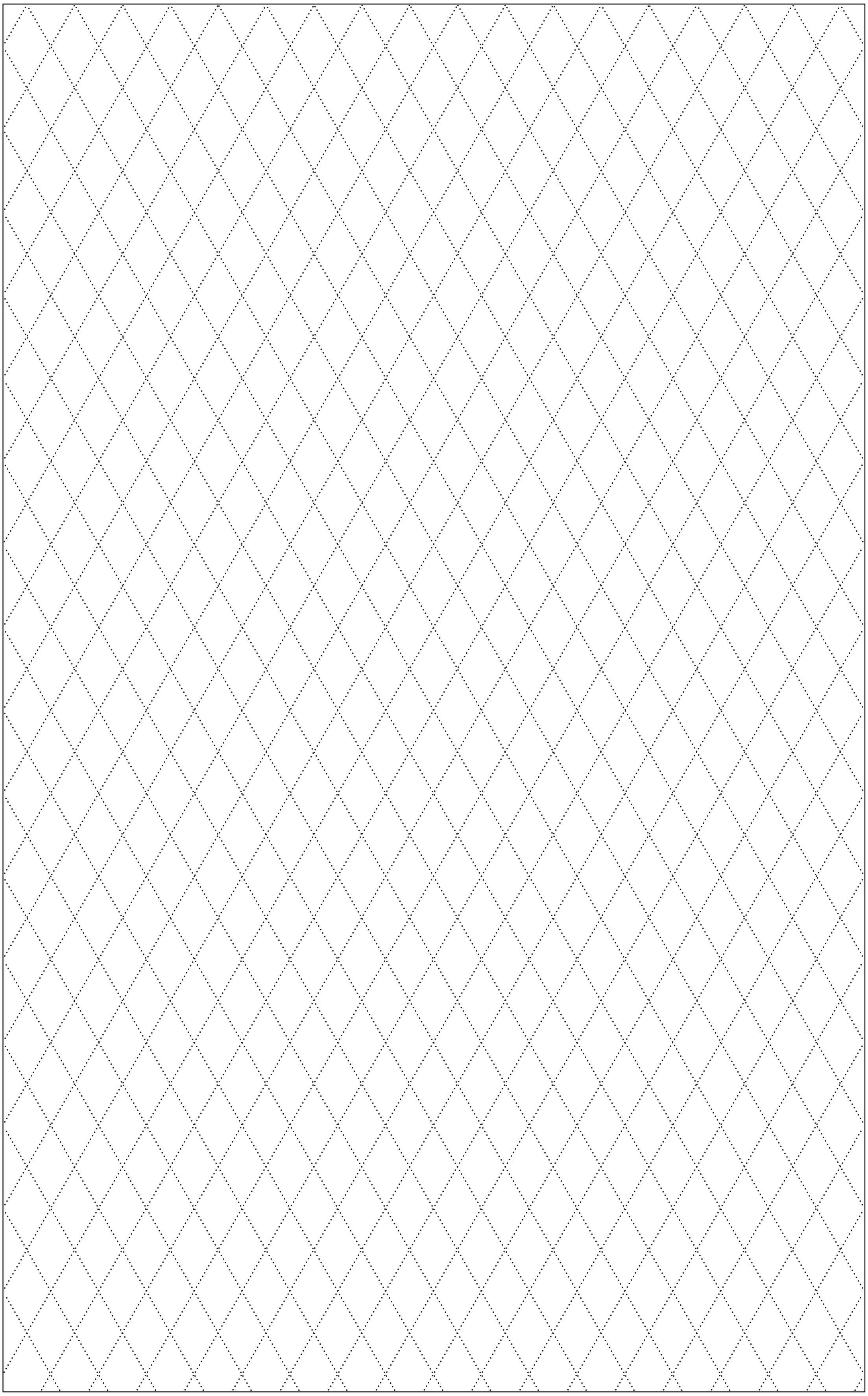


Diagram 2: Isometric Drawing

Copy the given drawings.

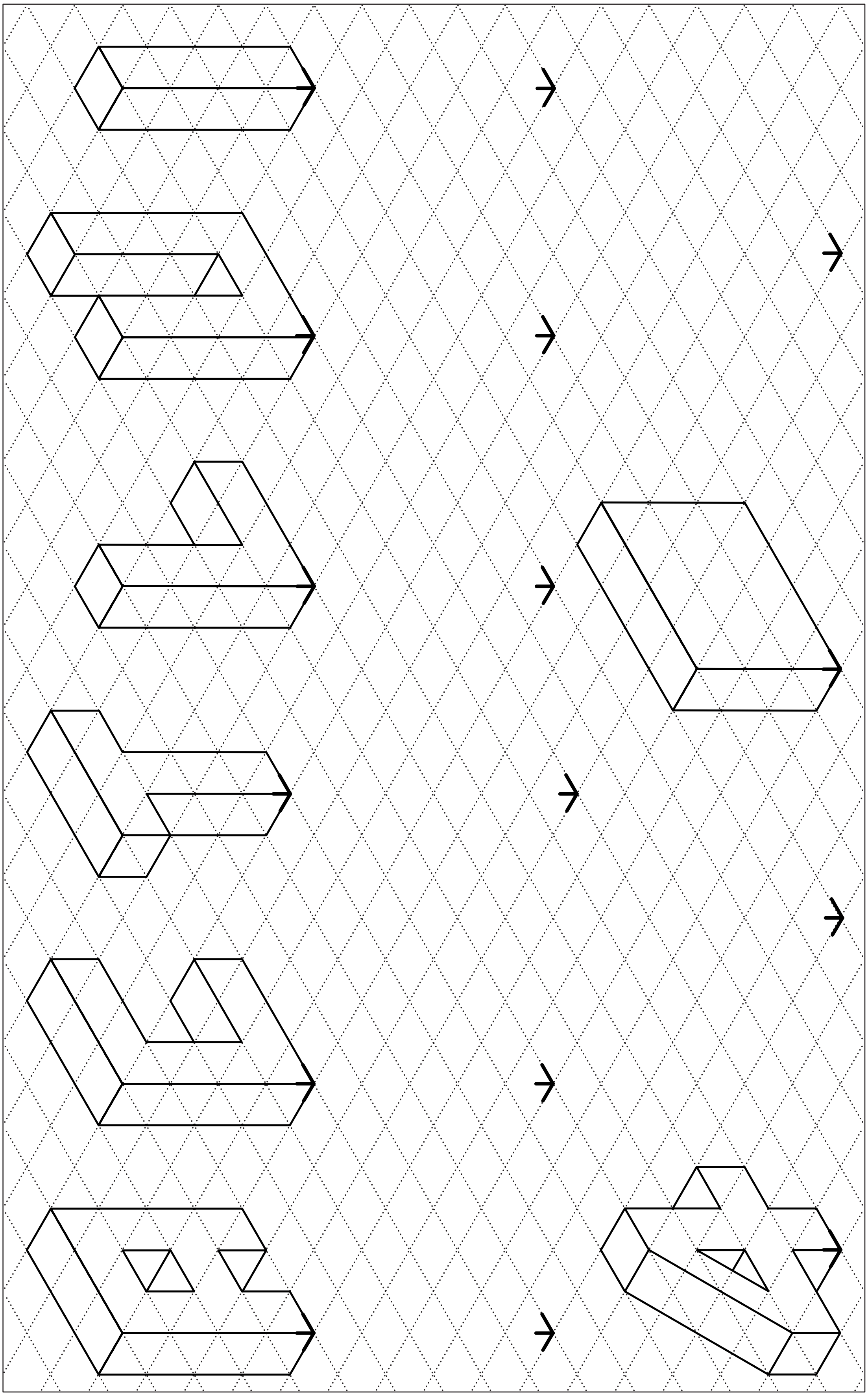


Diagram 3: Isometric Drawing

Copy the given drawings.

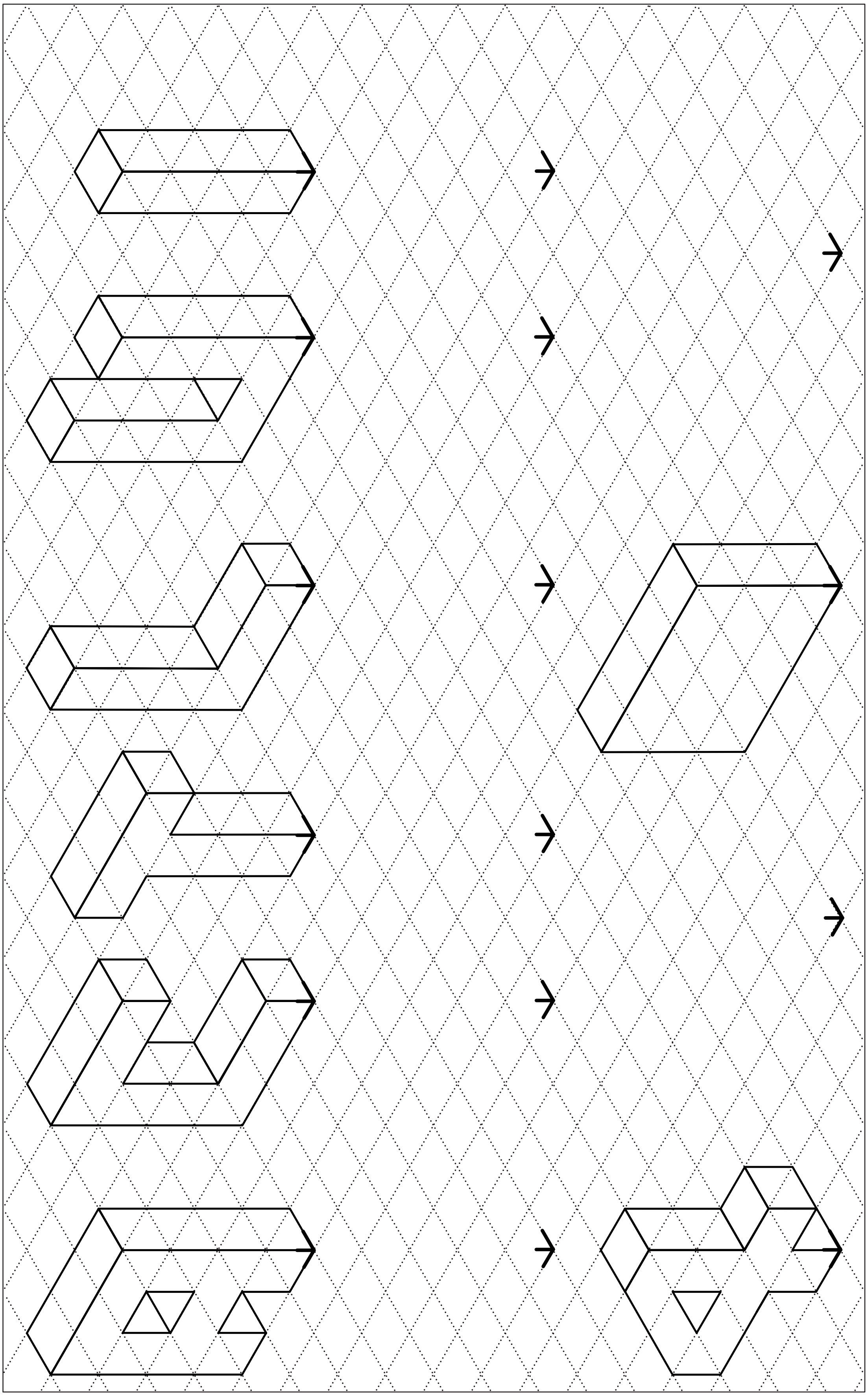


Diagram 4: Isometric Drawing

Using the isometric grid, copy the given drawings.

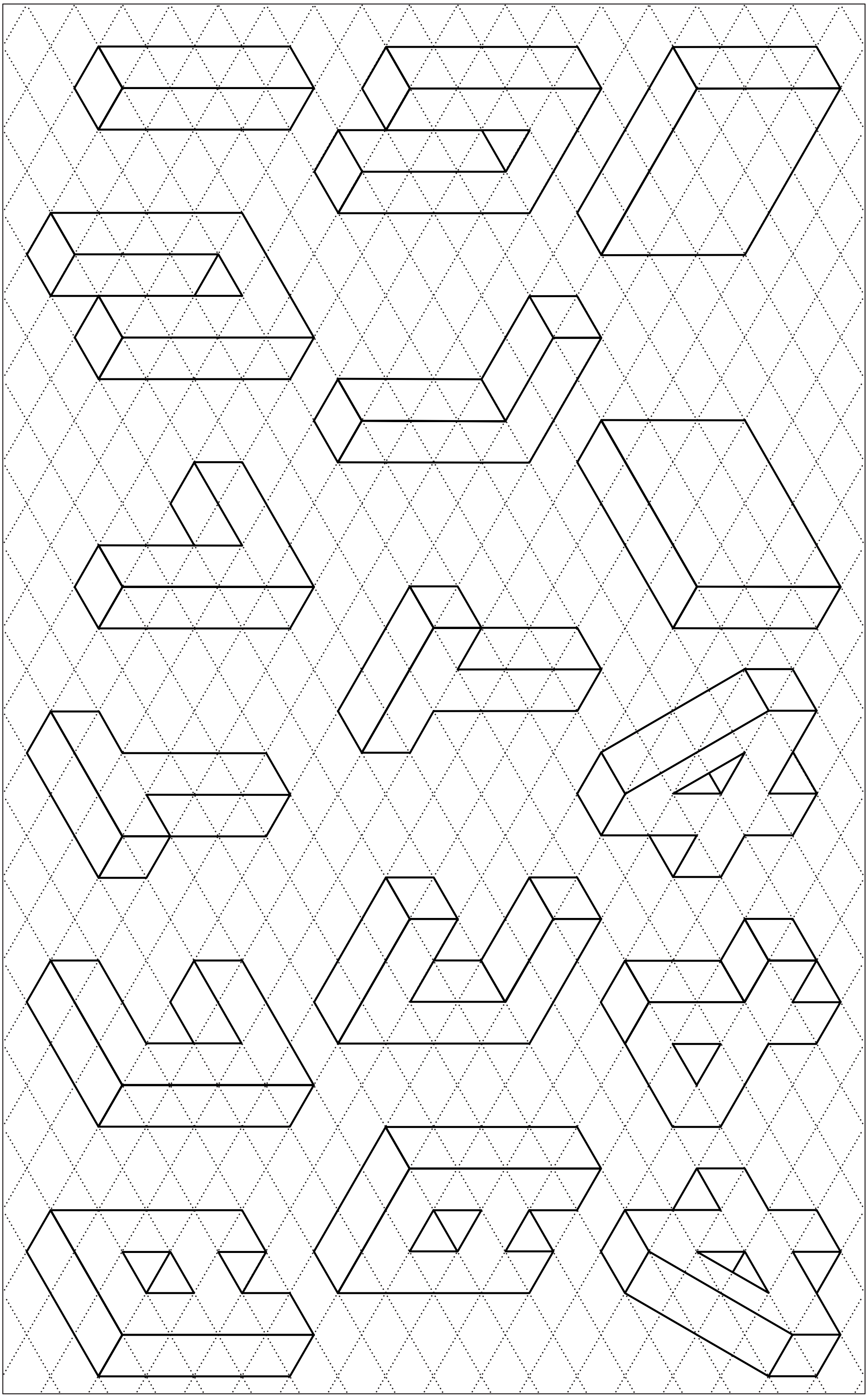


Diagram 5: Isometric Drawing

Copy the last drawing in each row, starting at the corner point given. Copy the other drawings using the isometric grid.

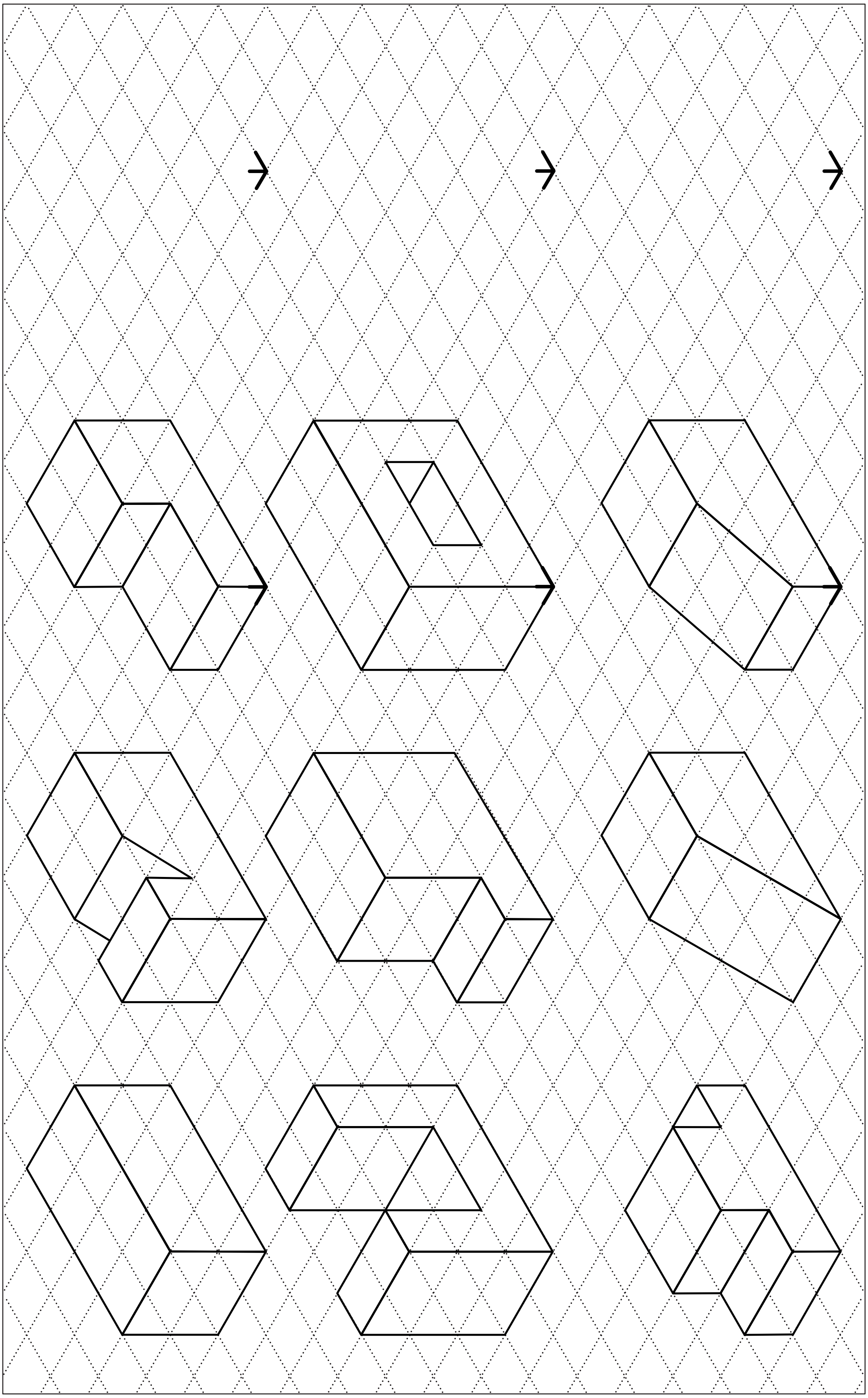


Diagram 6: Isometric Drawing

Copy the given drawing on the isometric grid.

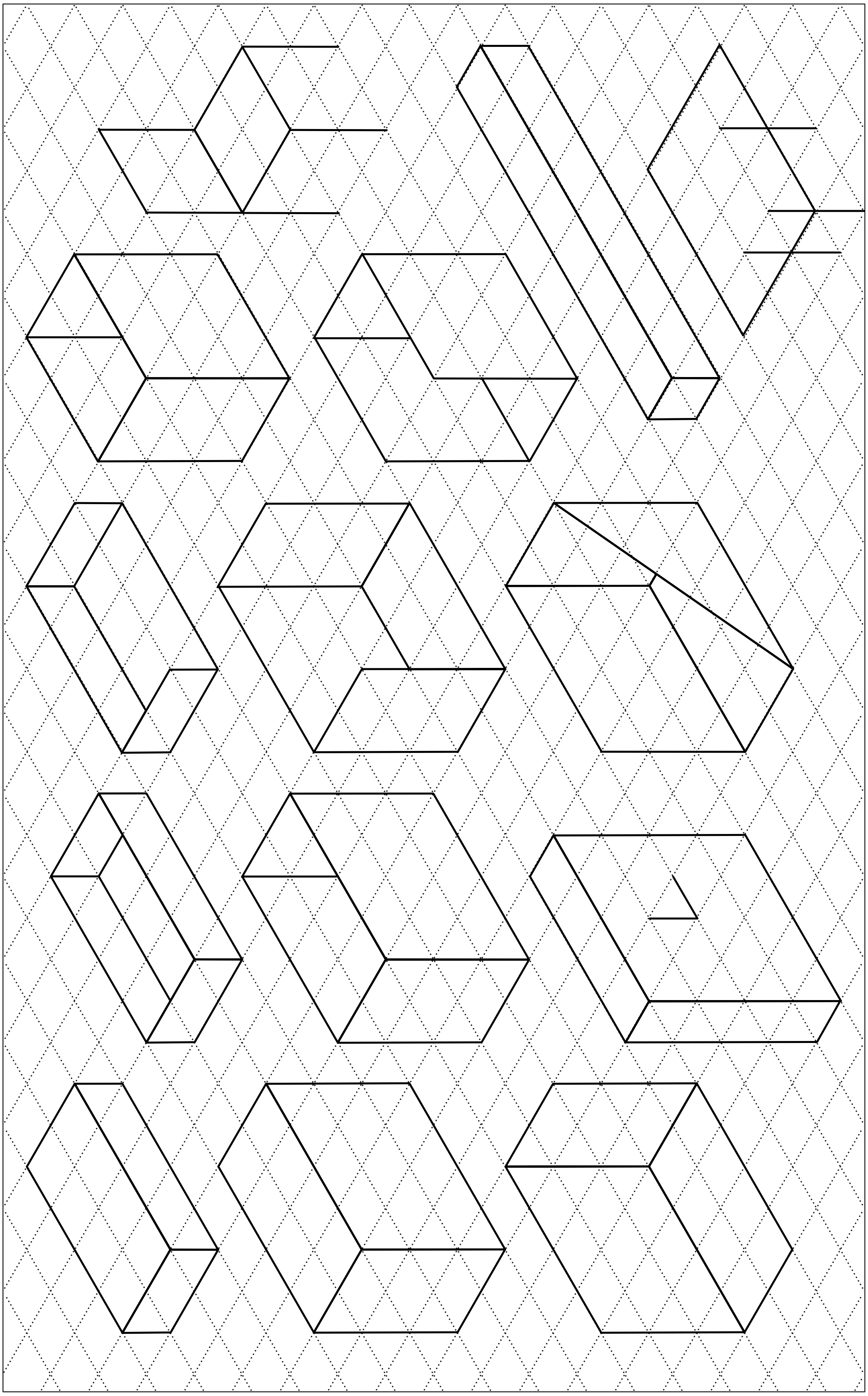


Diagram 7: Isometric Circles

When you need to draw isometric circles such as wheels, trace the circle you need by placing this sheet under your drawing.

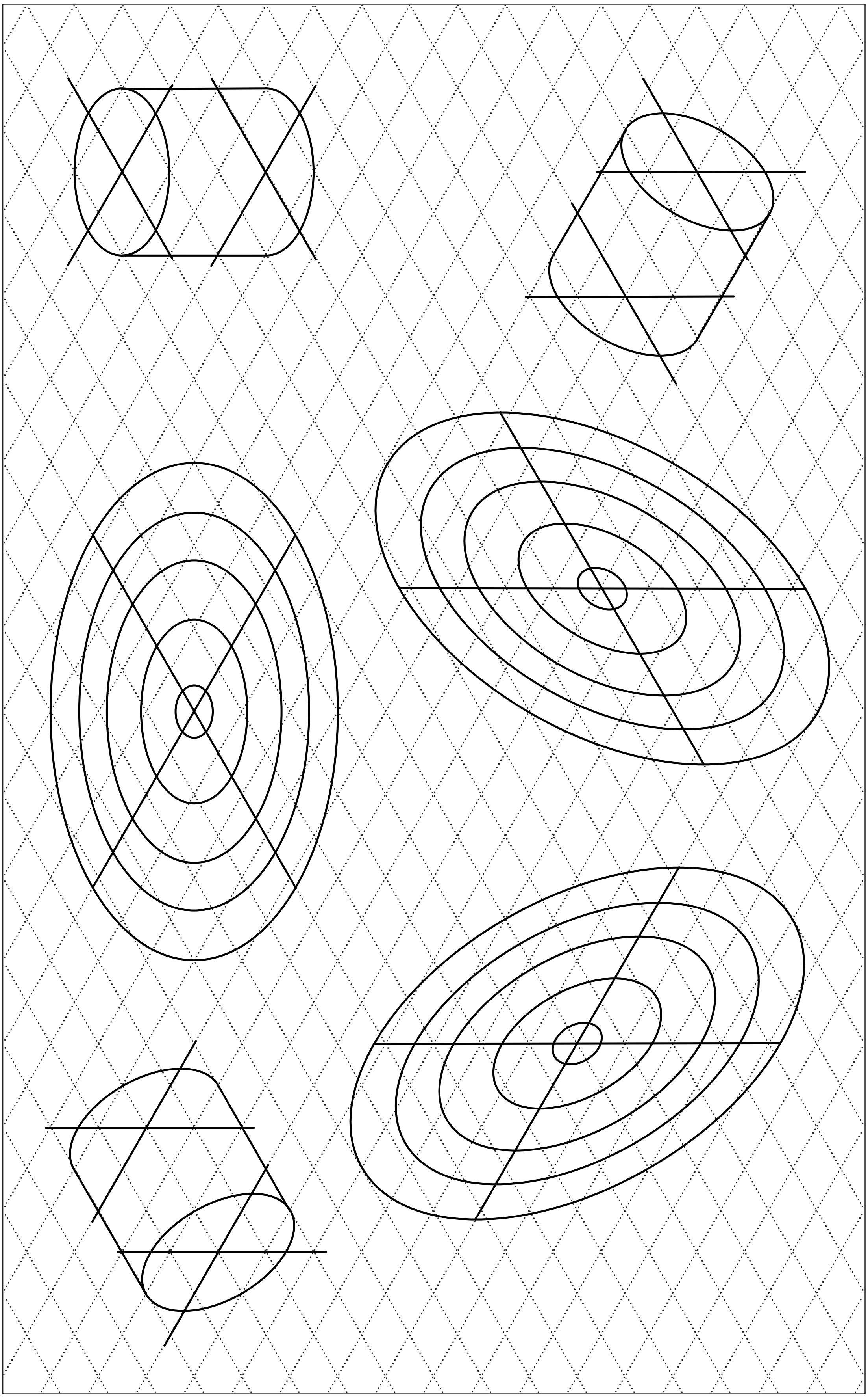


Diagram 8: Making a Cube

Cut on solid line; fold on dashed line.

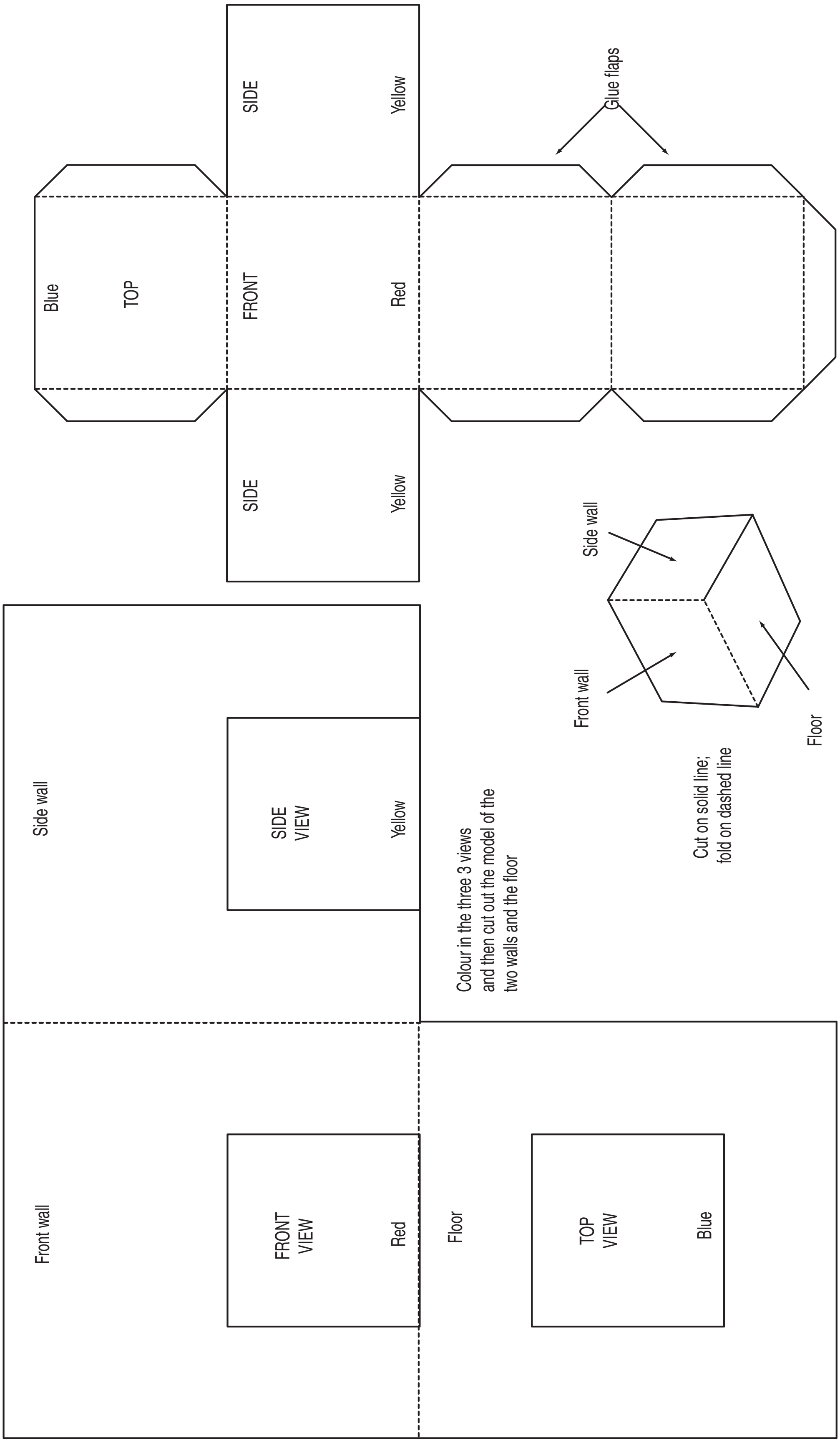
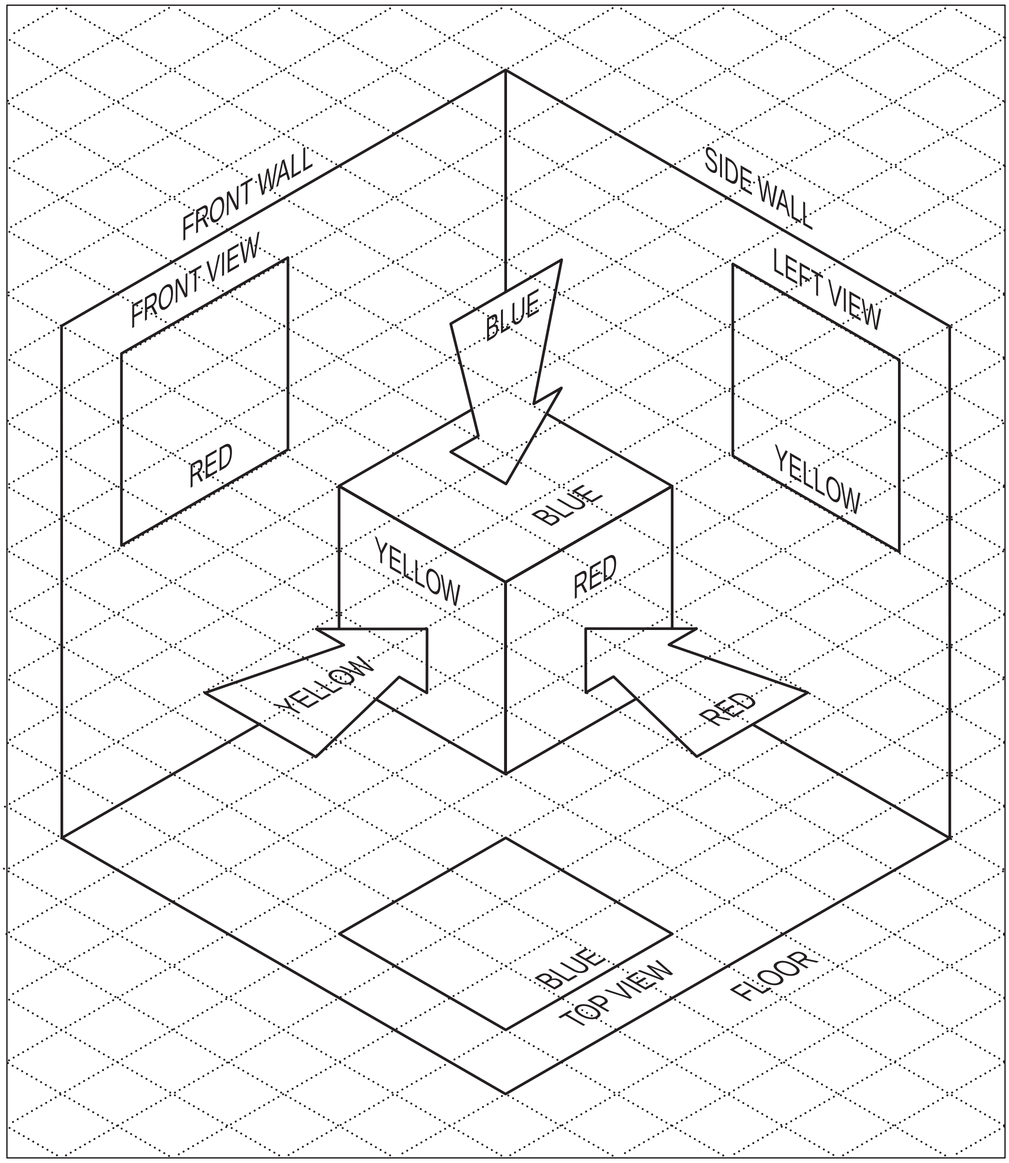


Diagram 9: Orthographic Projection

Colour the front arrow RED
Colour the top arrow BLUE
Colour the left arrow YELLOW

Colour the front of the cube RED
Colour the top of the cube BLUE
Colour the left side of the cube YELLOW

Colour the front view RED
Colour the top view BLUE
Colour the left view YELLOW



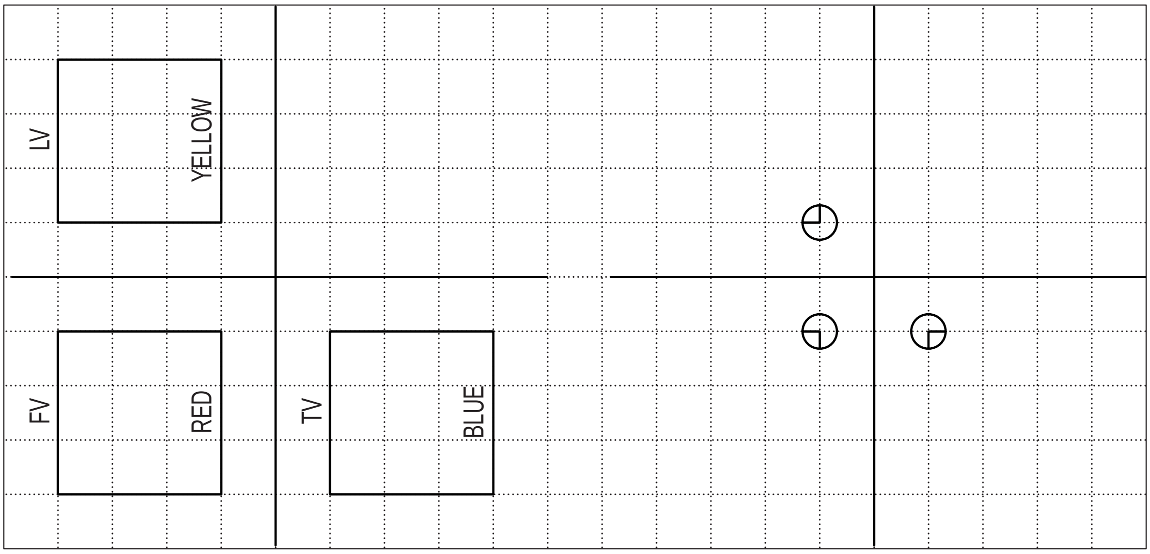
When you look along the Red arrow you will see the front RED face of the cube and this is what you will draw in the ***front view*** - (Red square on front wall.)

When you look along the BLUE arrow you will see the top BLUE face of the cube and this is what you will draw in the ***top view*** - (Blue square on floor.)

When you look along the YELLOW arrow you will see the side YELLOW face of the cube and this is what you will draw in the ***left view*** - (Yellow square on side wall.)

Diagram 10: Isometric Drawing and Orthographic Projection

Copy the front view, top view and left view of the cube. Begin each view at the point indicated by the circle.



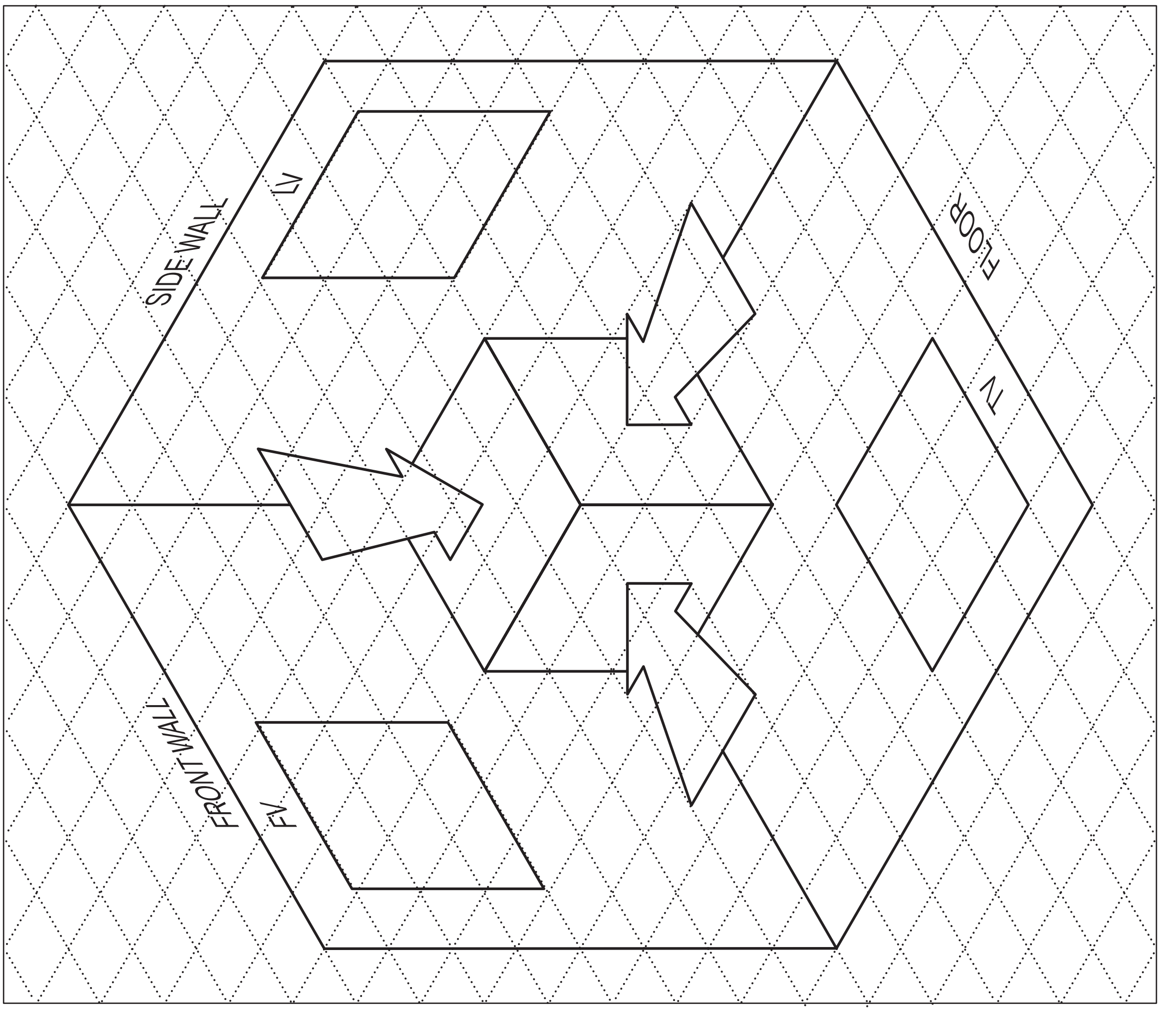


Diagram 11: Orthographic Projection

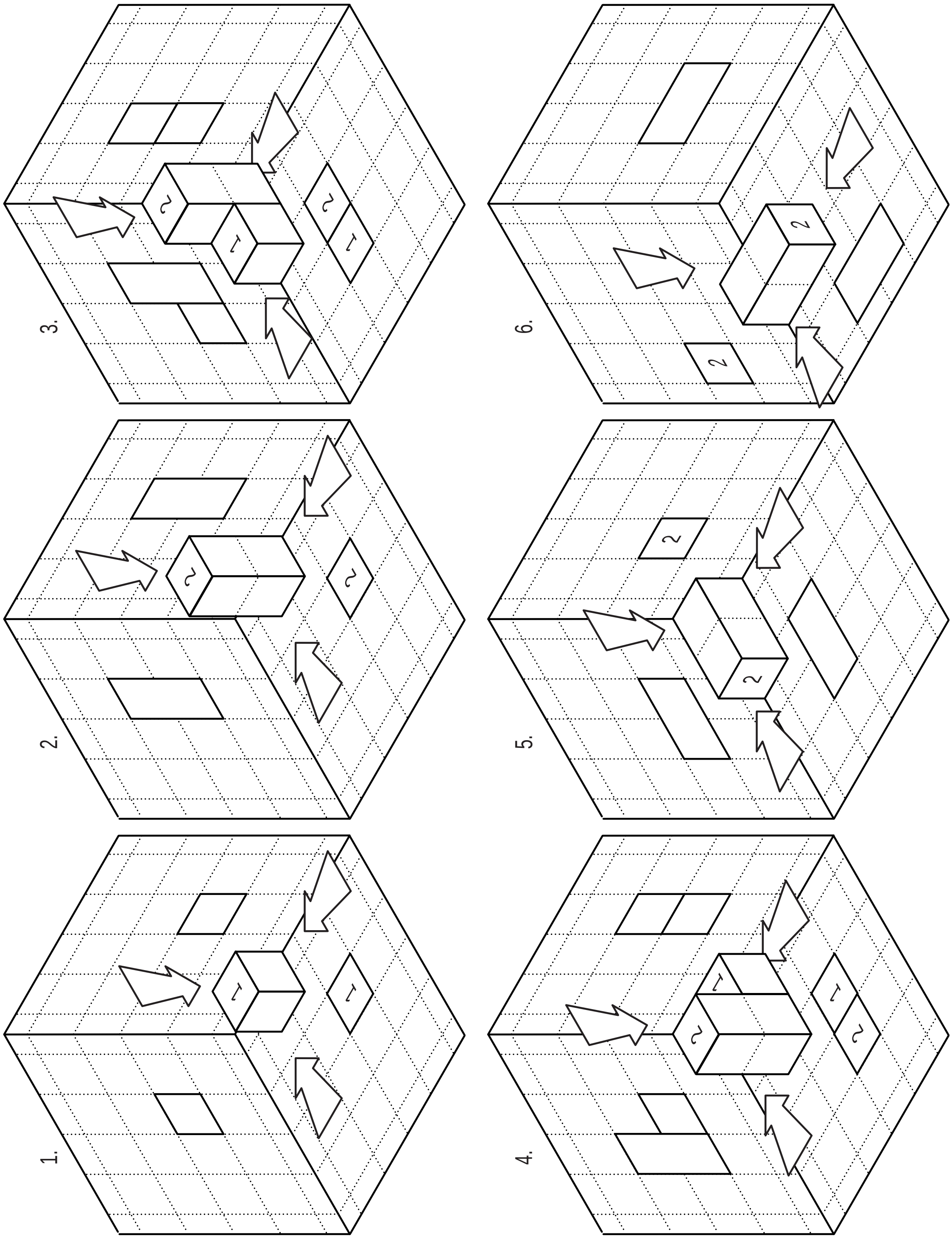


Diagram 12: Orthographic Projection

Project the front view and left view from the given top view in each example.

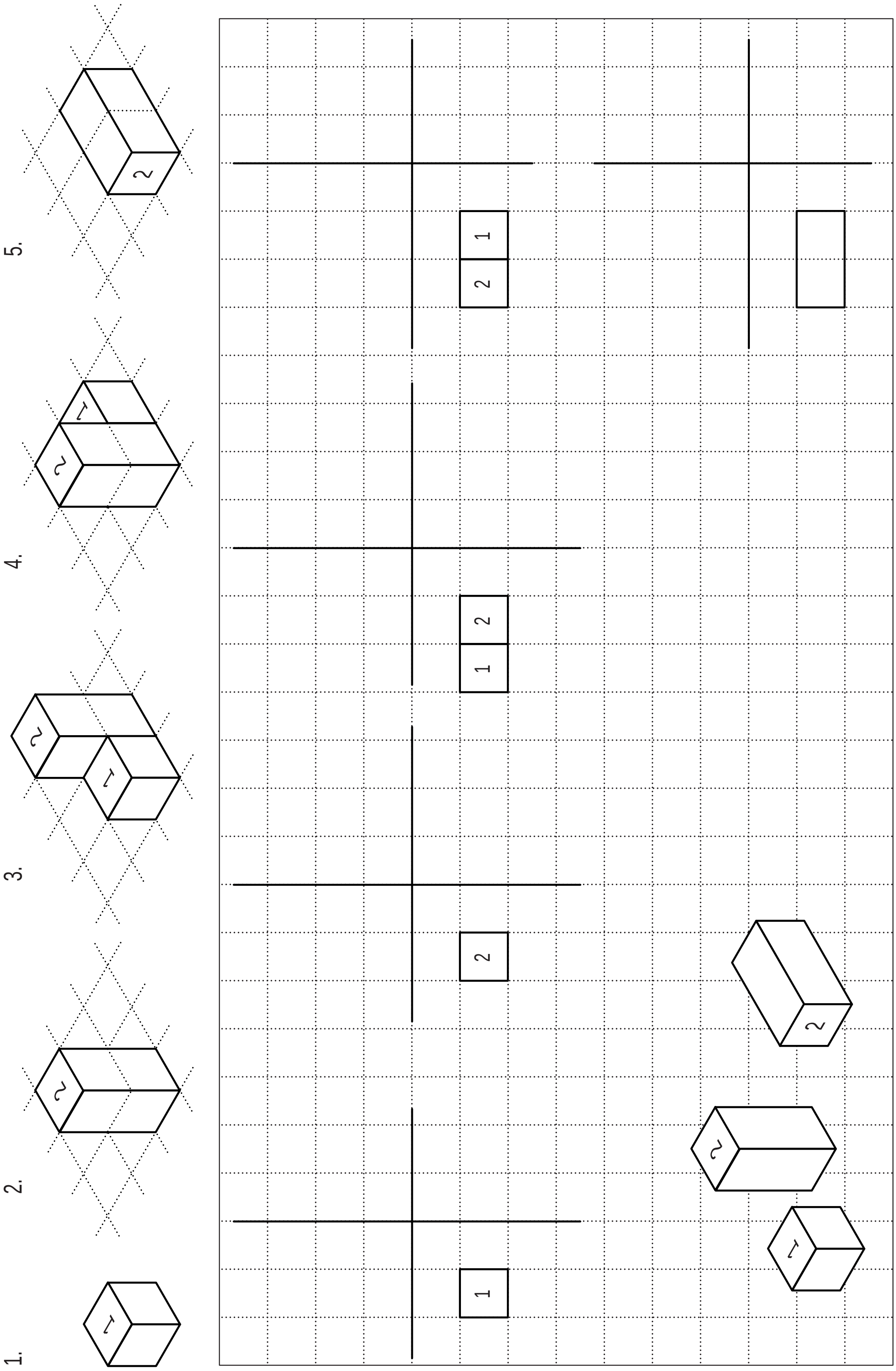


Diagram 13: Orthographic Projection

Model Answers

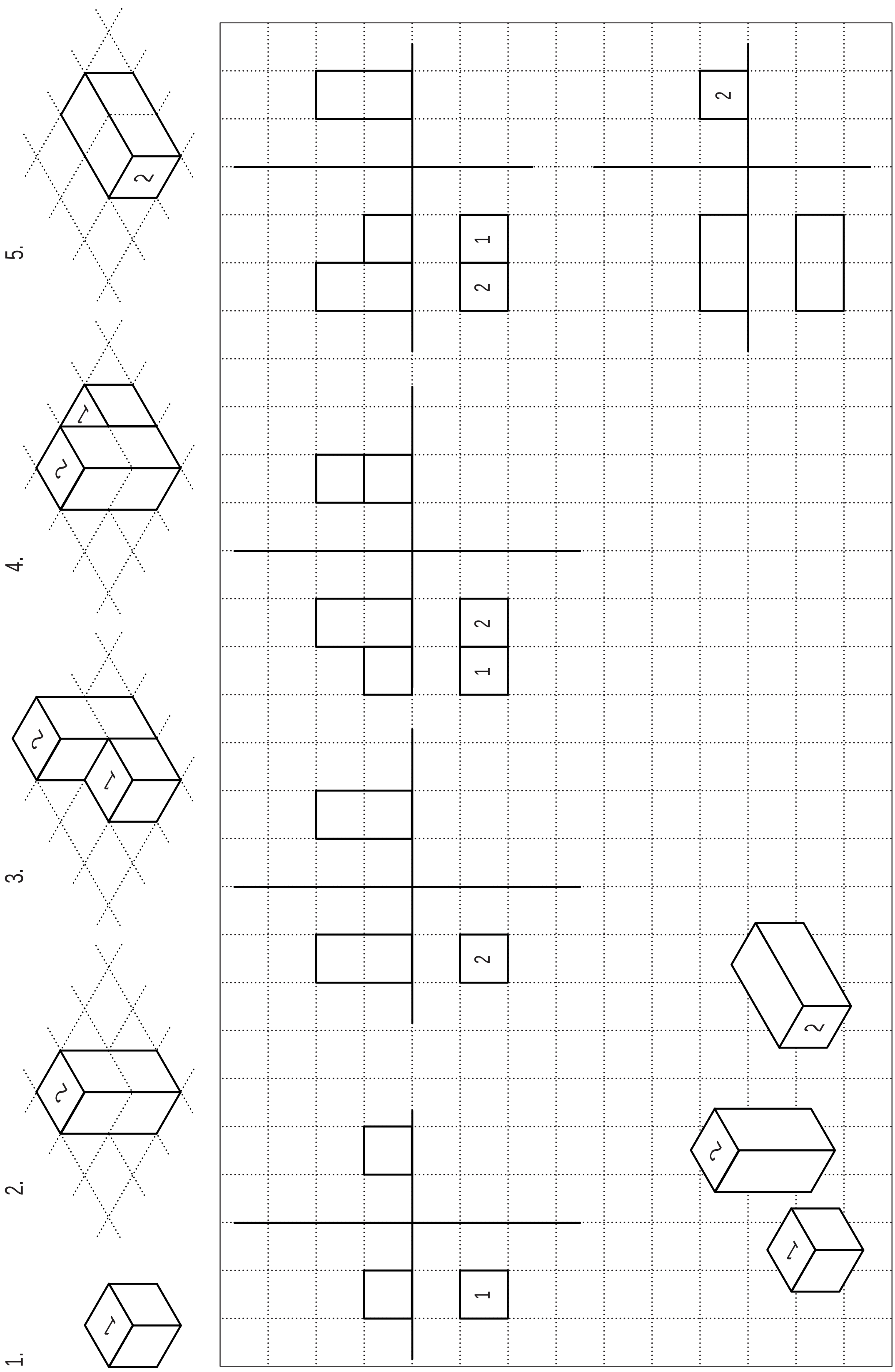


Diagram 14: Orthographic Projection

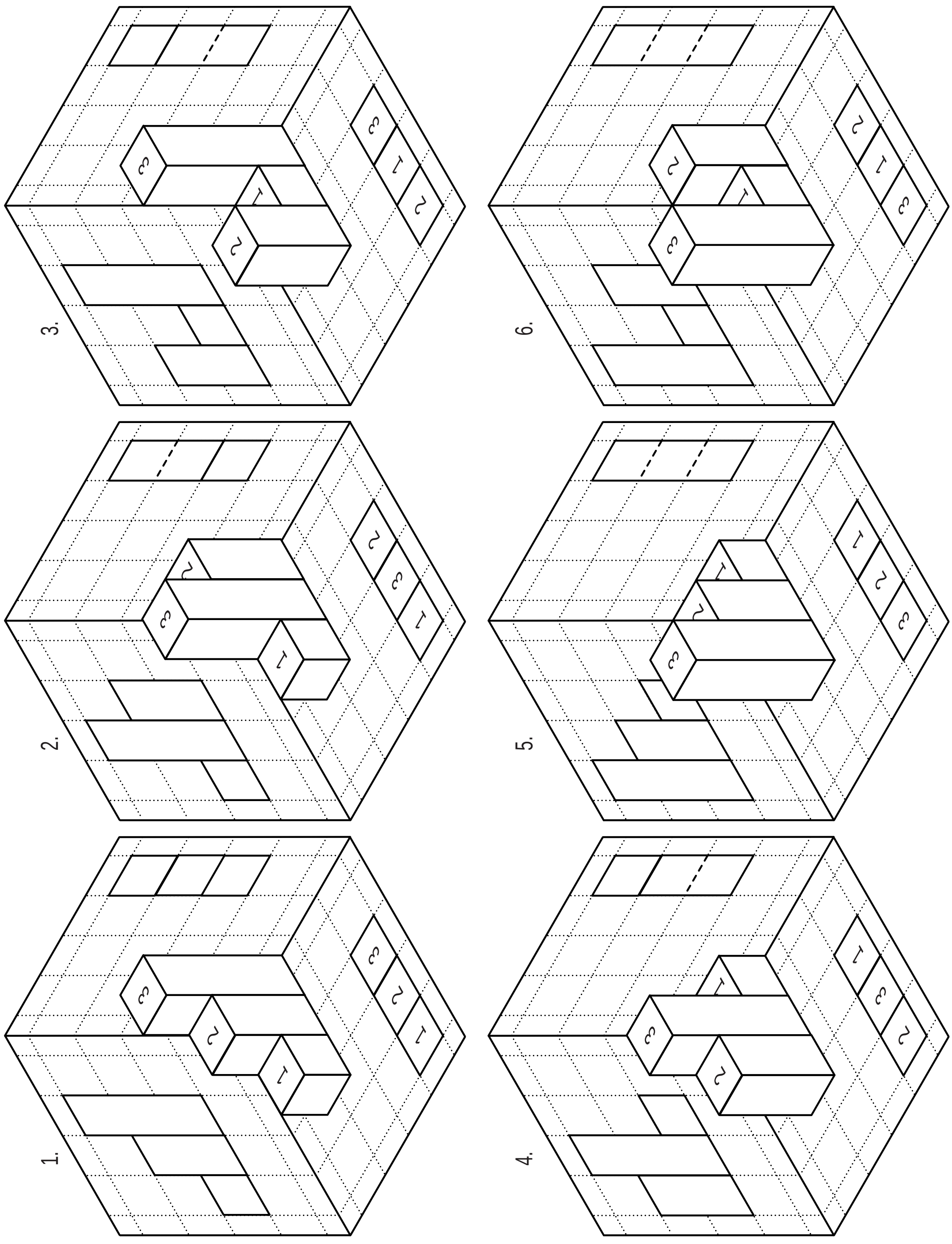


Diagram 15: Orthographic Projection

Project the front view and left view from the given top view in each example.

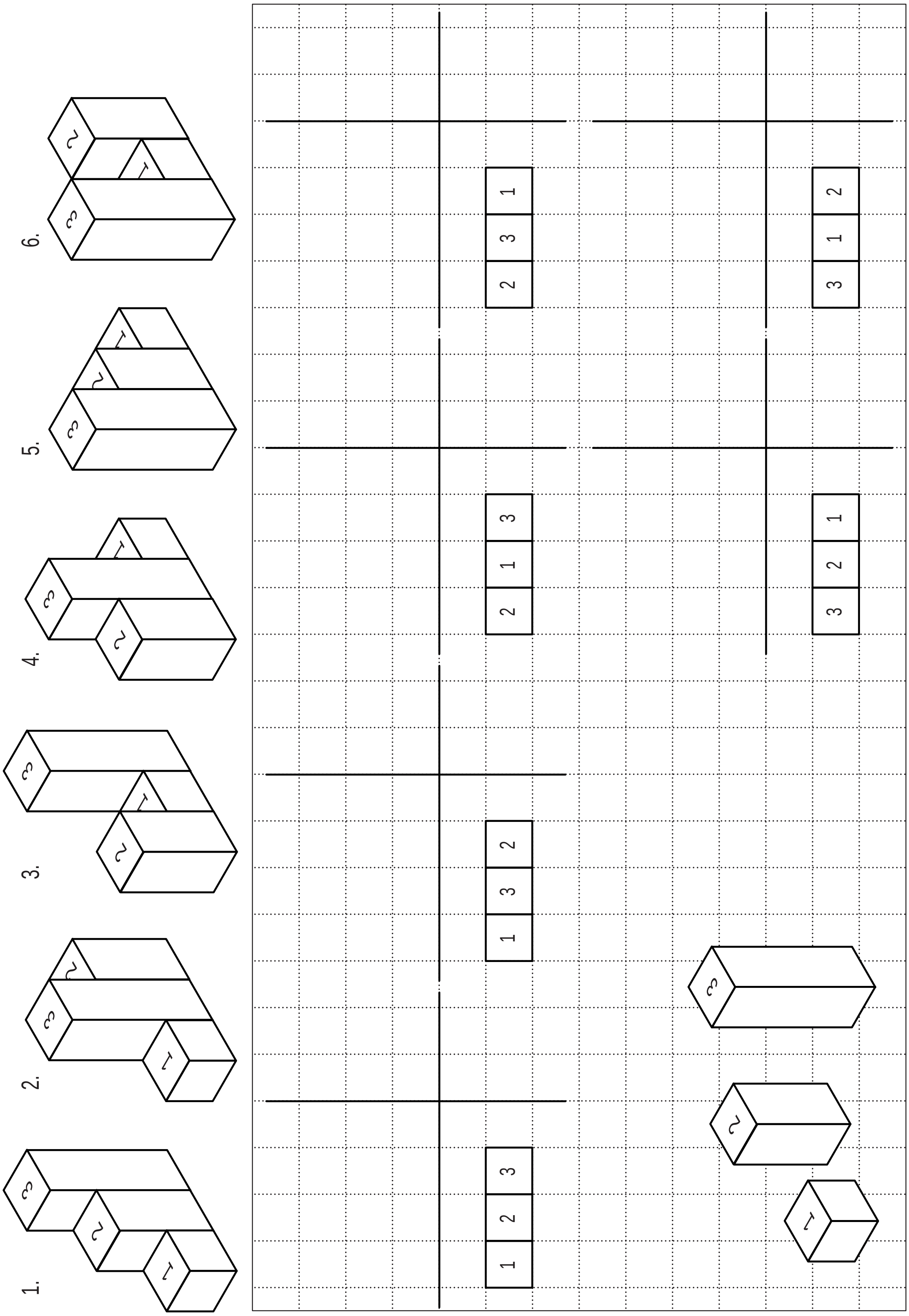


Diagram 16: Orthographic Projection

Model Answers

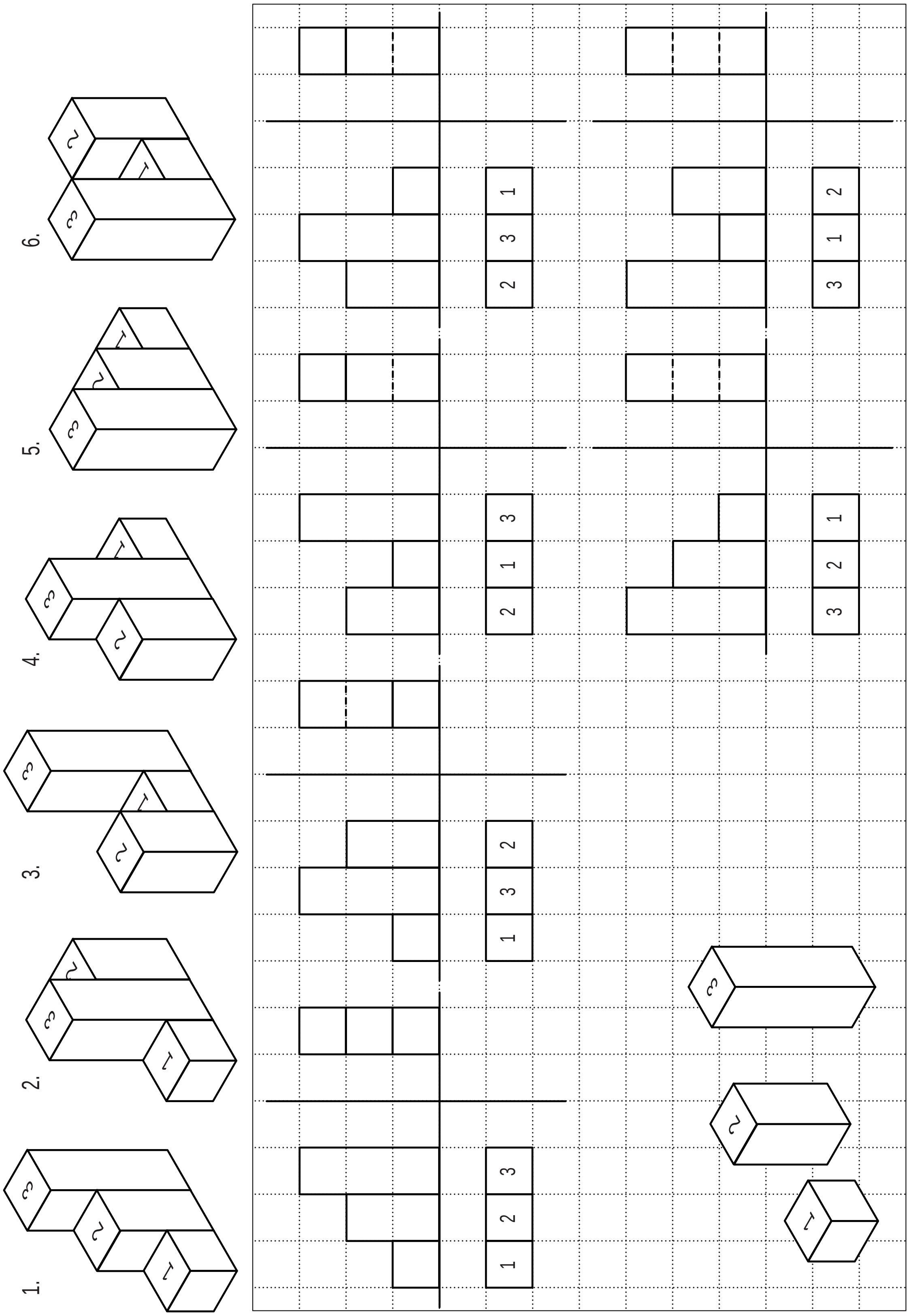


Diagram 17: Orthographic Projection

Project the front view and left view from the given top view in each example.

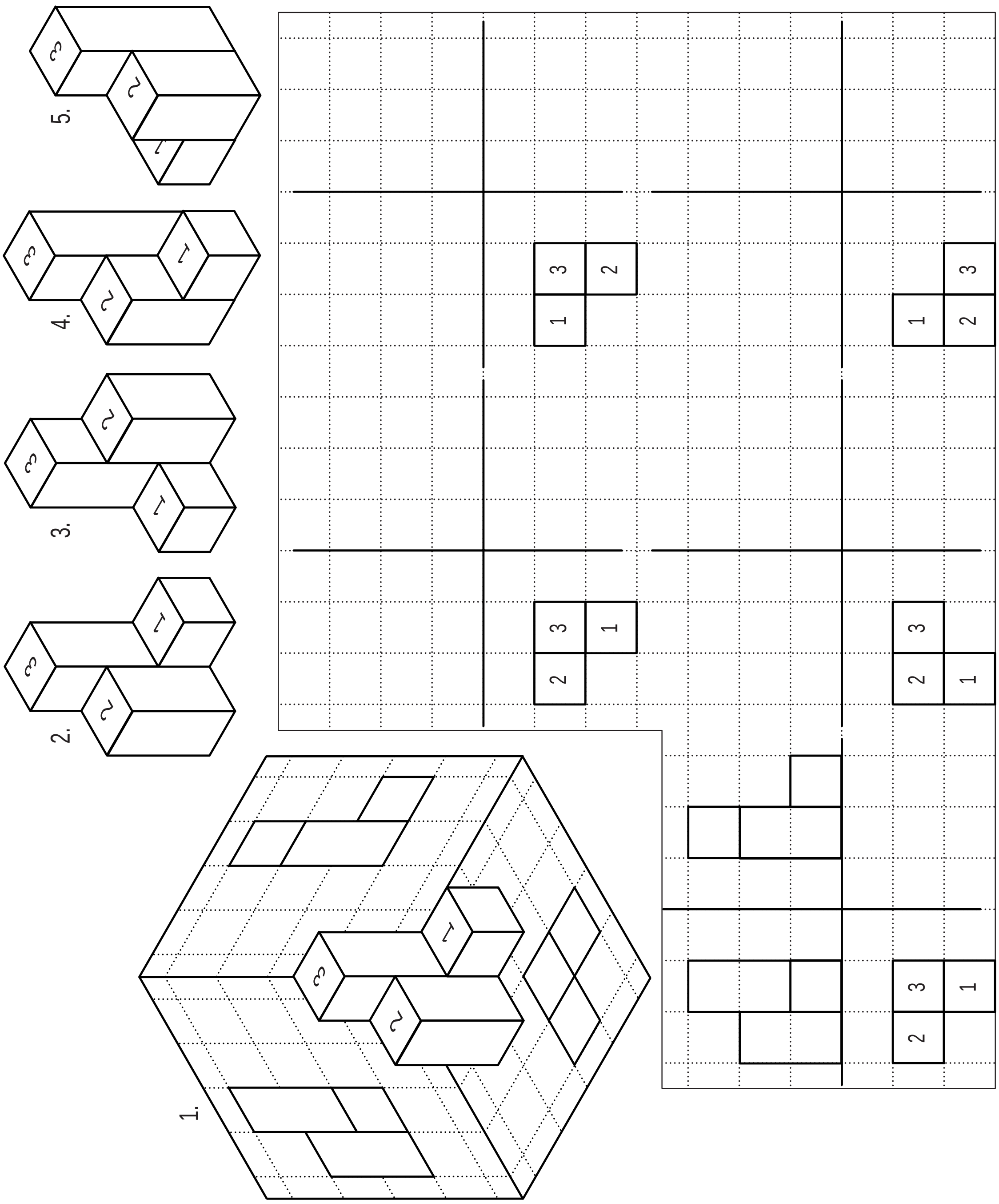


Diagram 18: Orthographic Projection

Model Answers

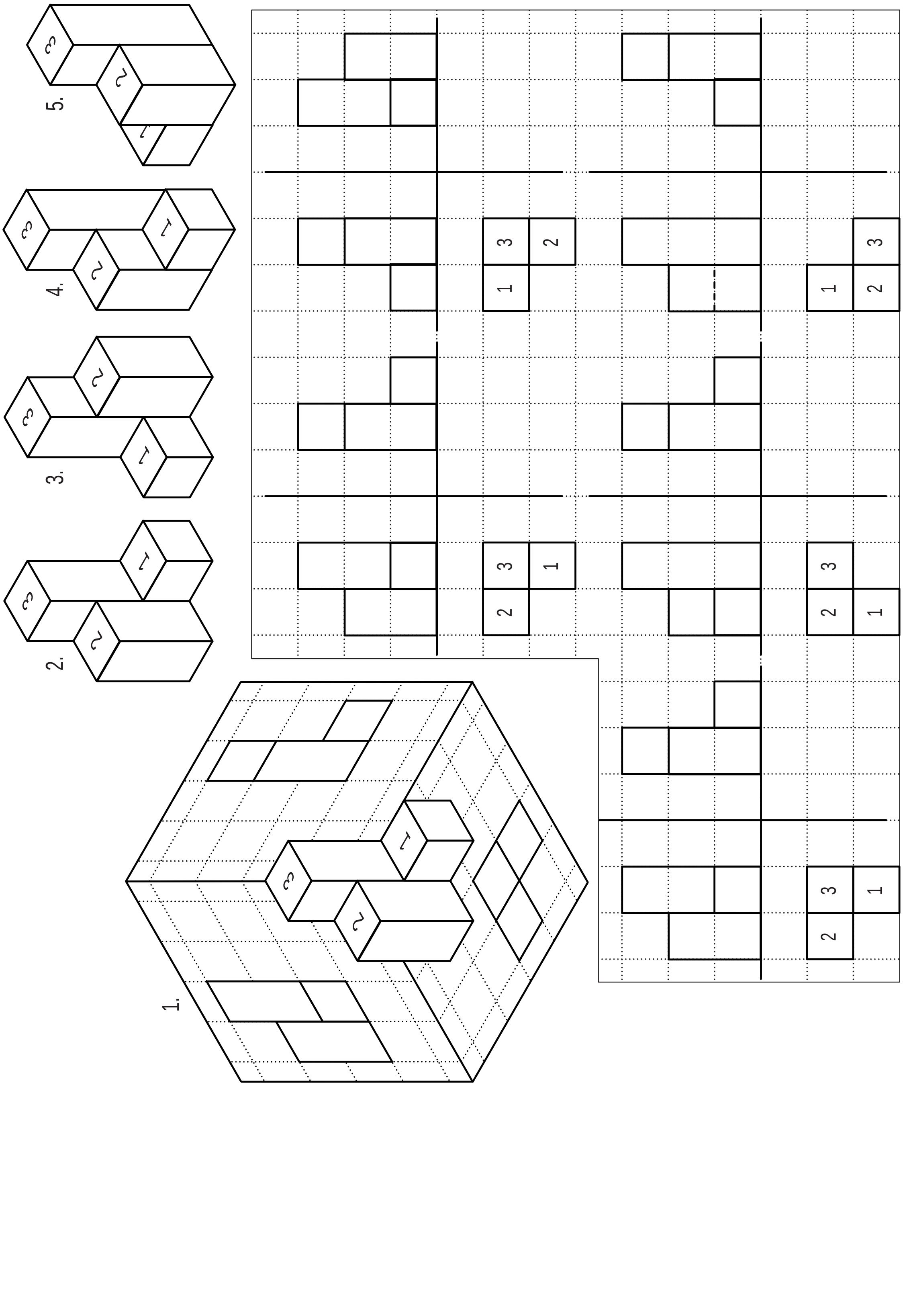


Diagram 19: Orthographic Projection

Project the top view and left view from the given front view in each example.

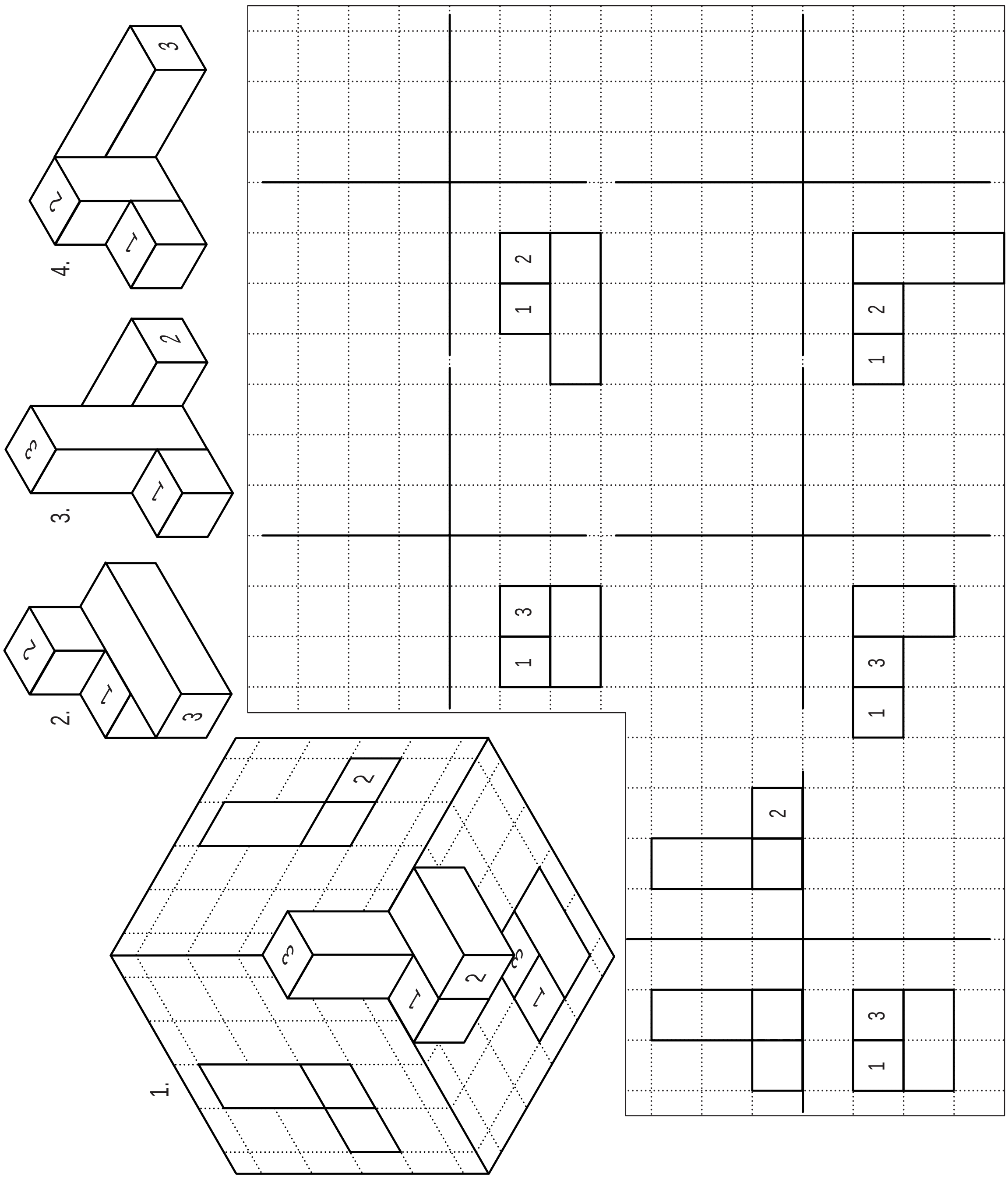


Diagram 20: Orthographic Projection

Using the square grid, draw the front view, top view and left view of the blocks numbered 1-9.

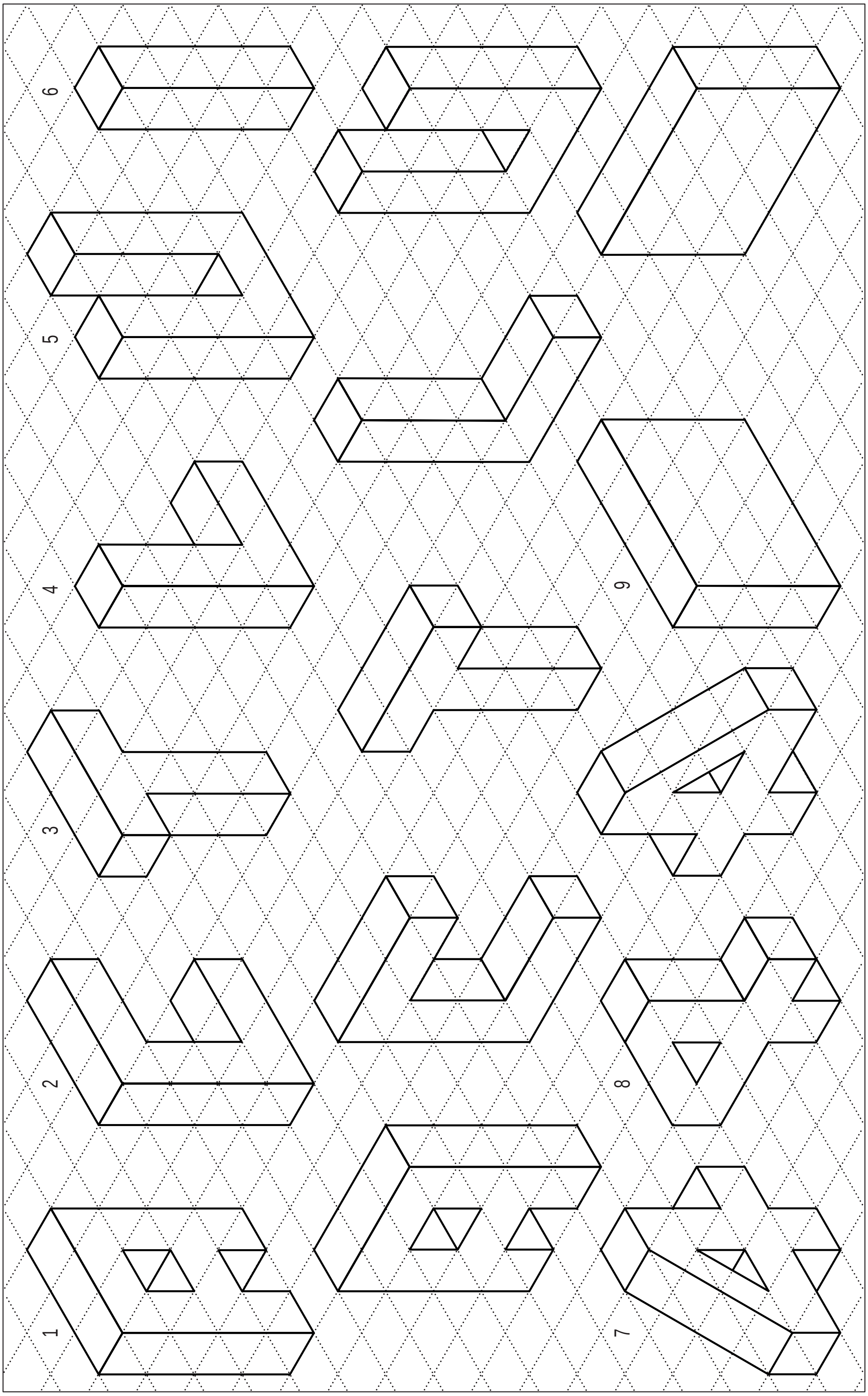
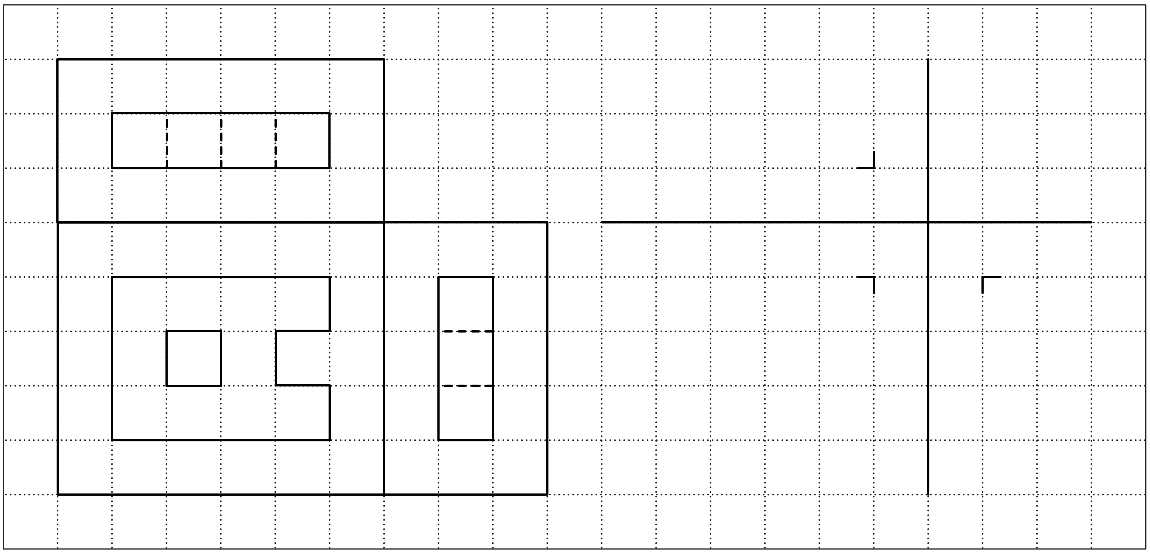


Diagram 21: Orthographic Projection

Draw the front view, top view and left view.



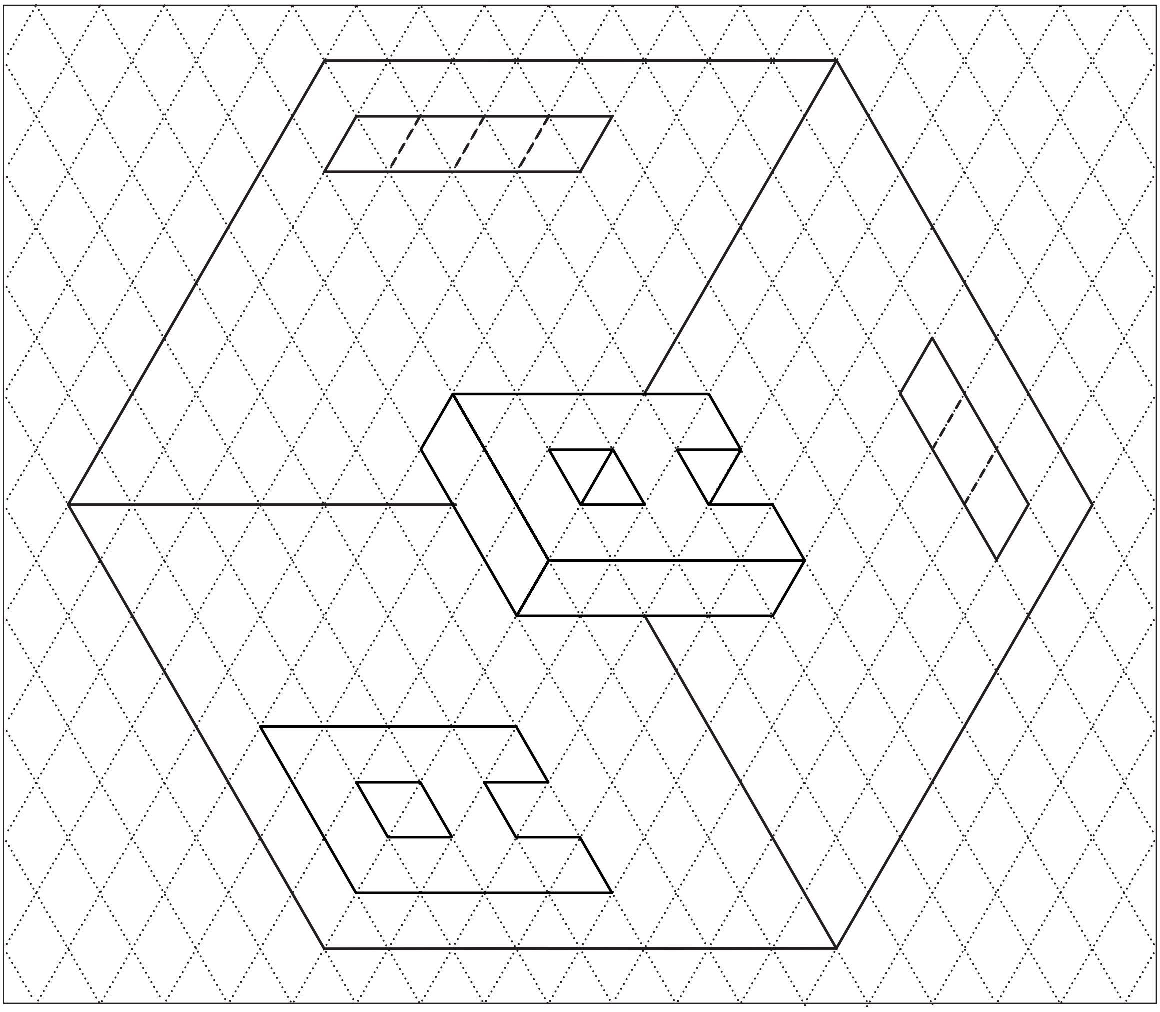
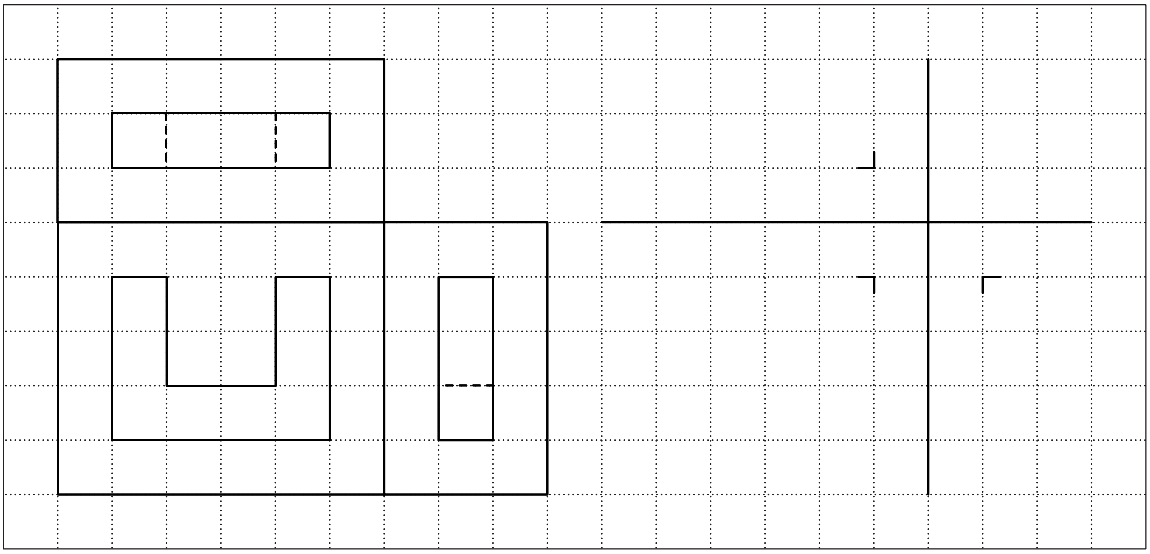


Diagram 22: Orthographic Projection

Draw the front view, top view and left view.



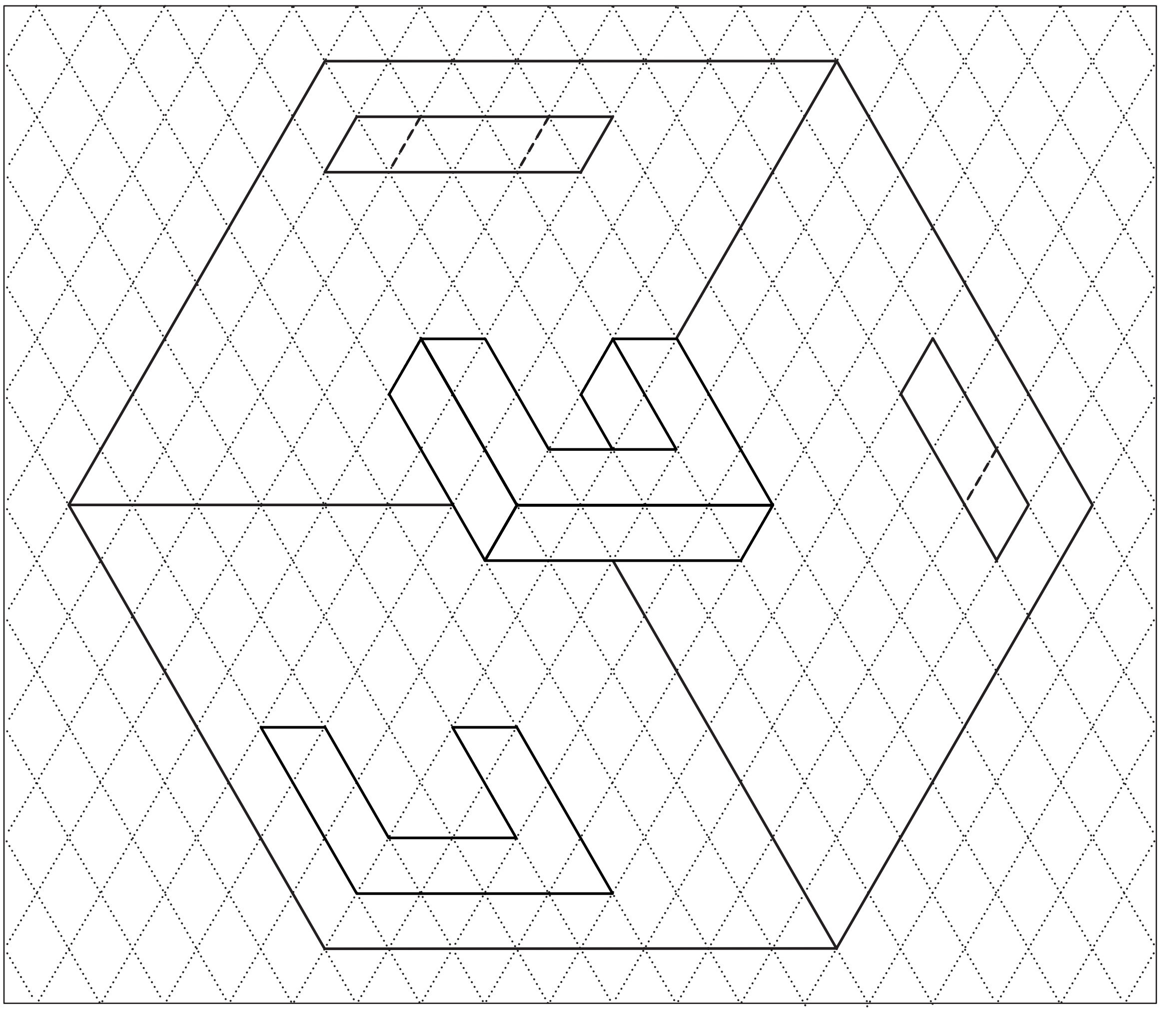
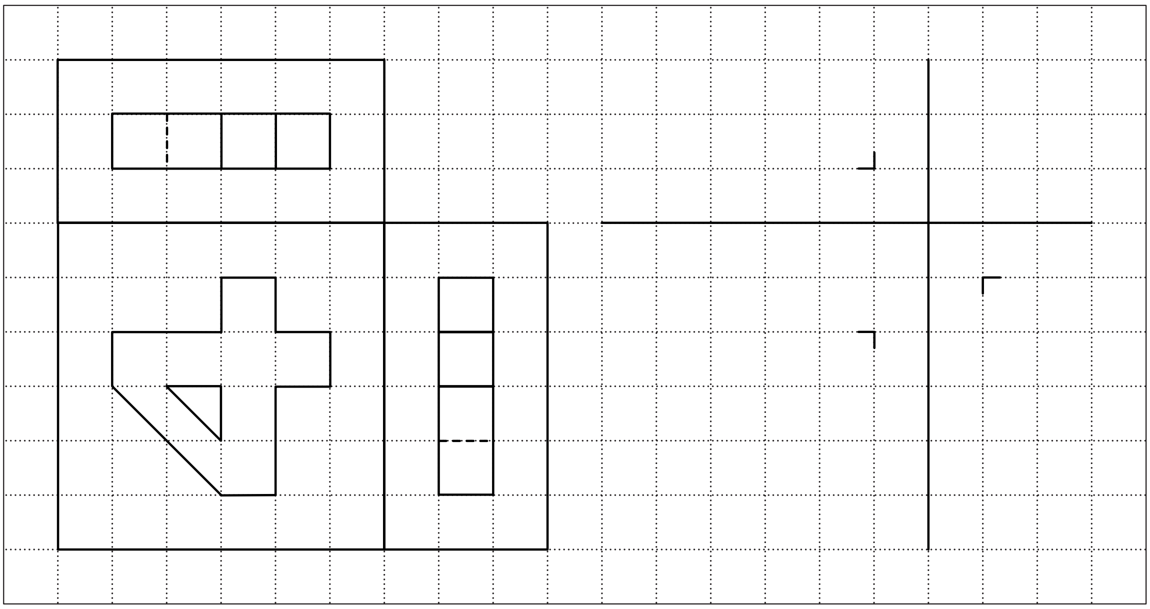


Diagram 23: Orthographic Projection

Draw the front view, top view and left view.



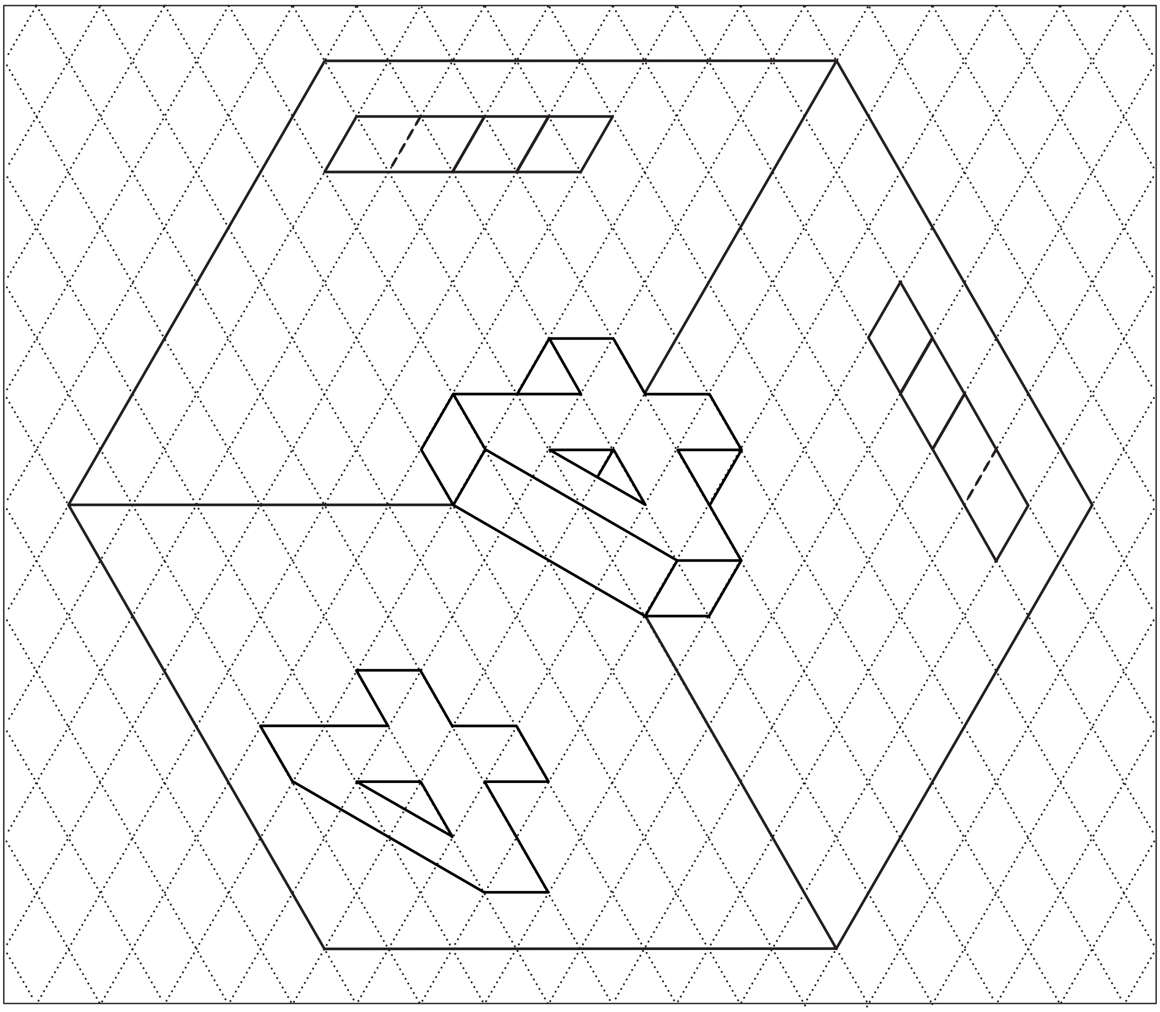


Diagram 24: Orthographic Projection

Draw the front view, top view and left view.

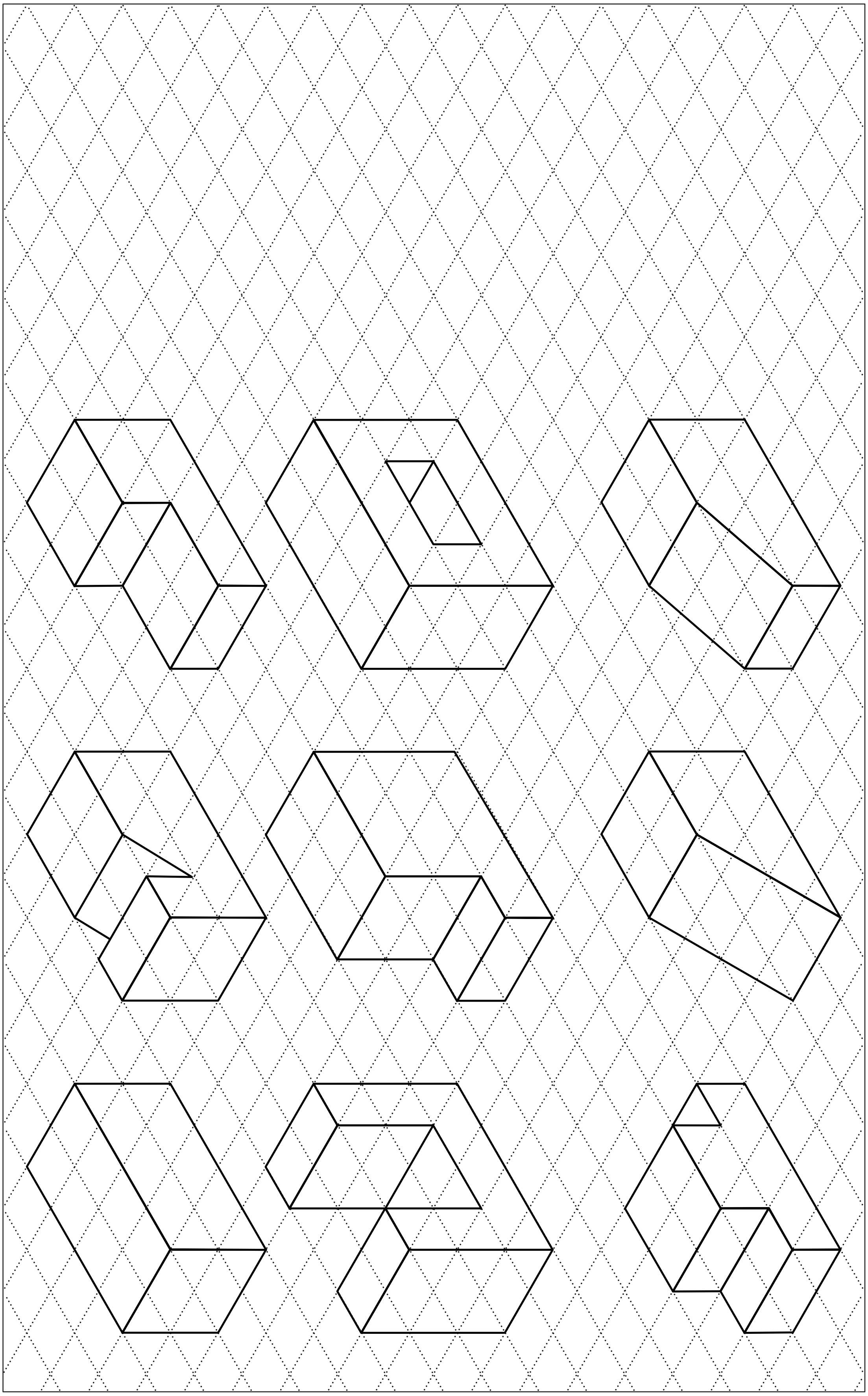


Diagram 25: Orthographic Projection

Project the top view and left view from the given front view in each example..

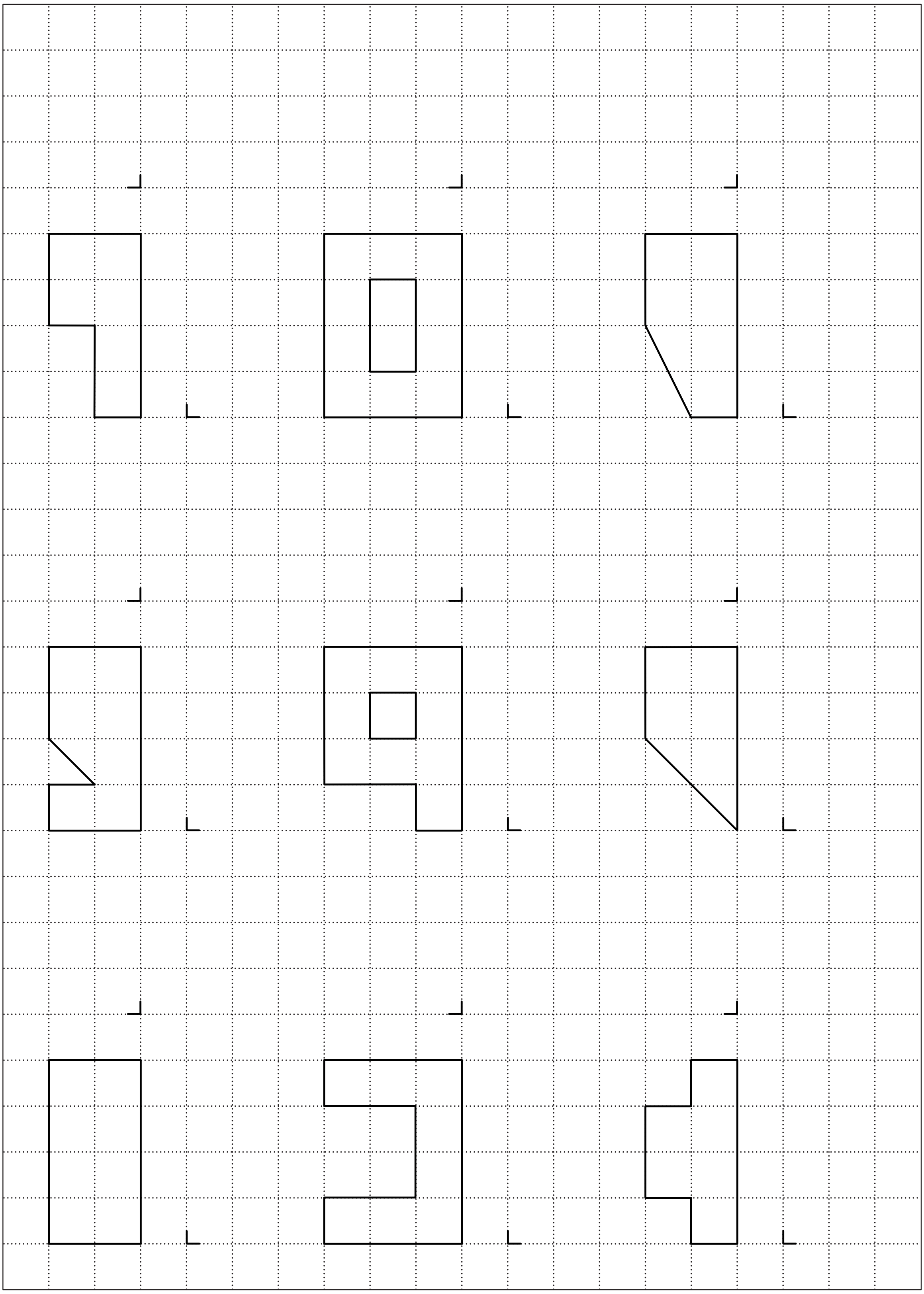


Diagram 26: Orthographic Projection

Complete the views by drawing the hidden detail.

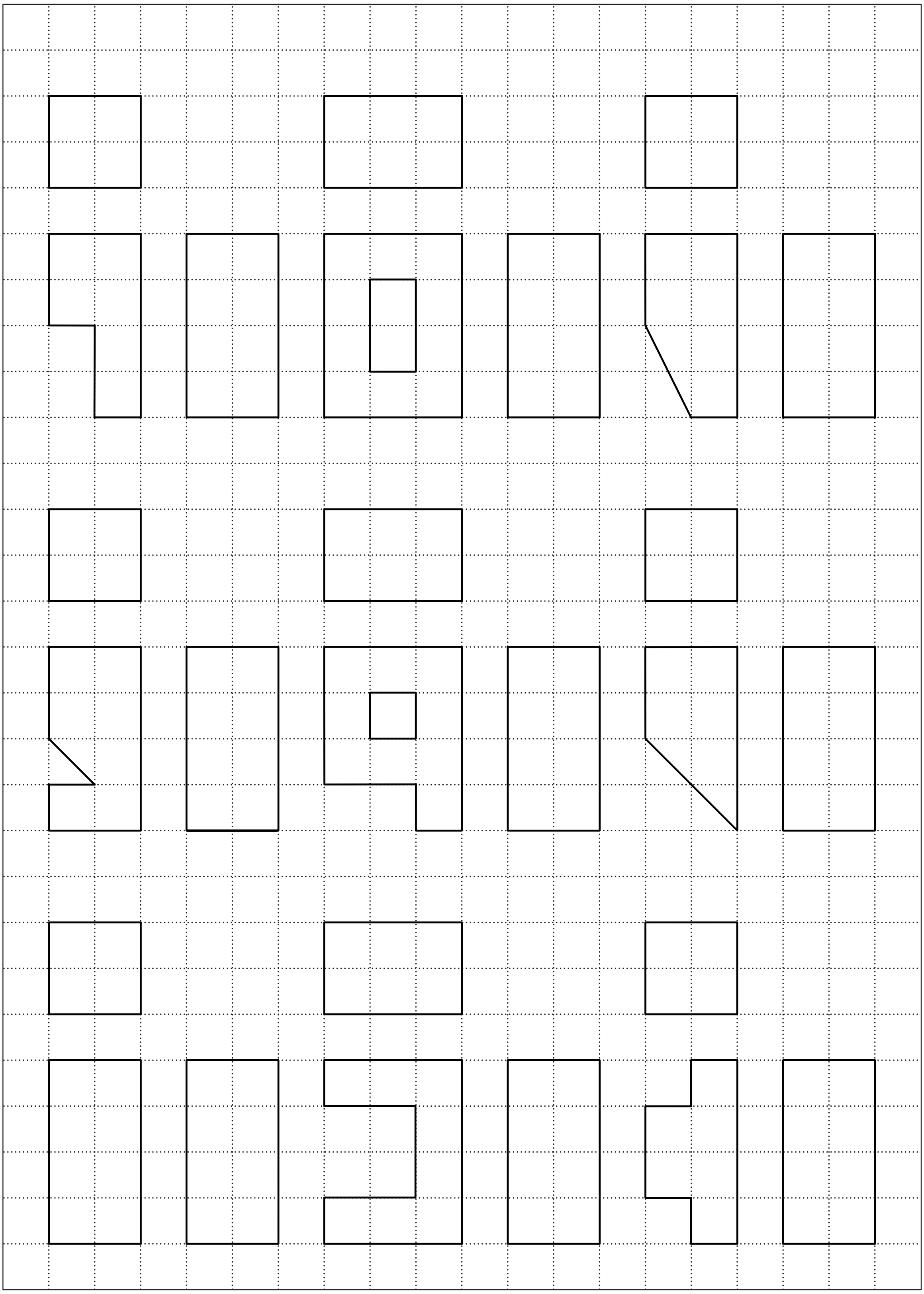


Diagram 27: Orthographic Projection

Model answers.

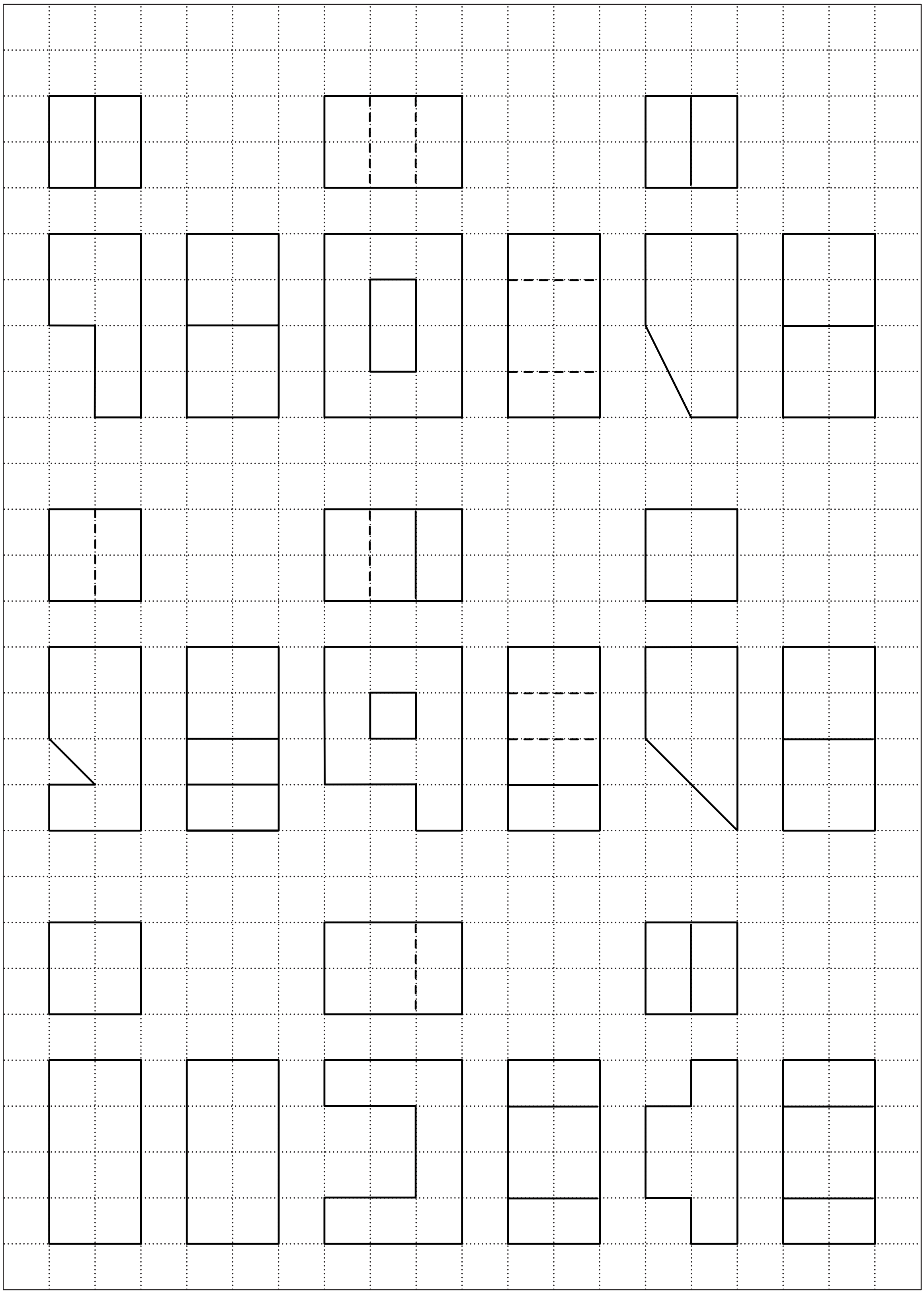


Diagram 28: Orthographic Projection

Draw the front view, top view and left view of the houses. (Use the square grid.)

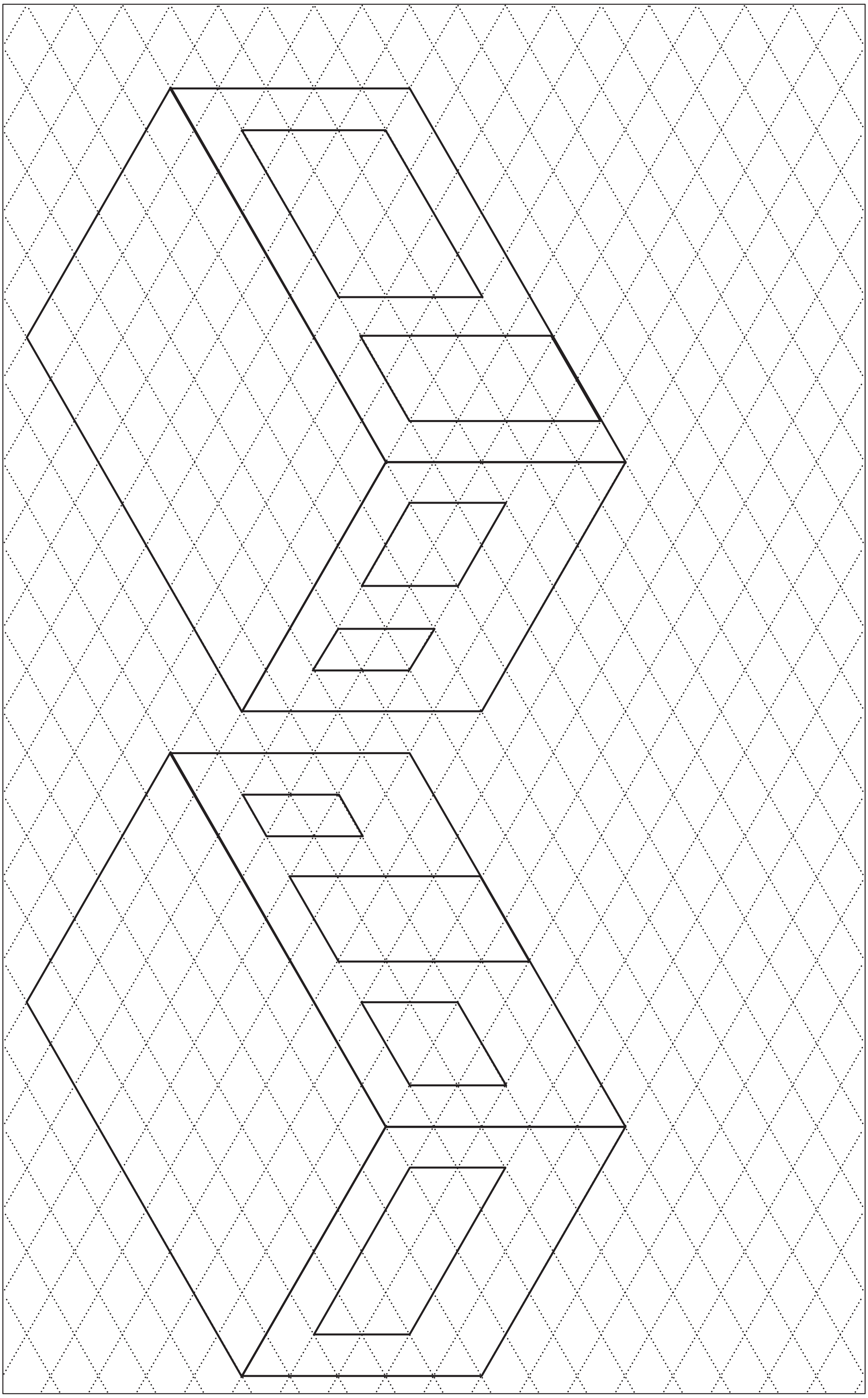


Diagram 29: Orthographic Projection

Model answers.

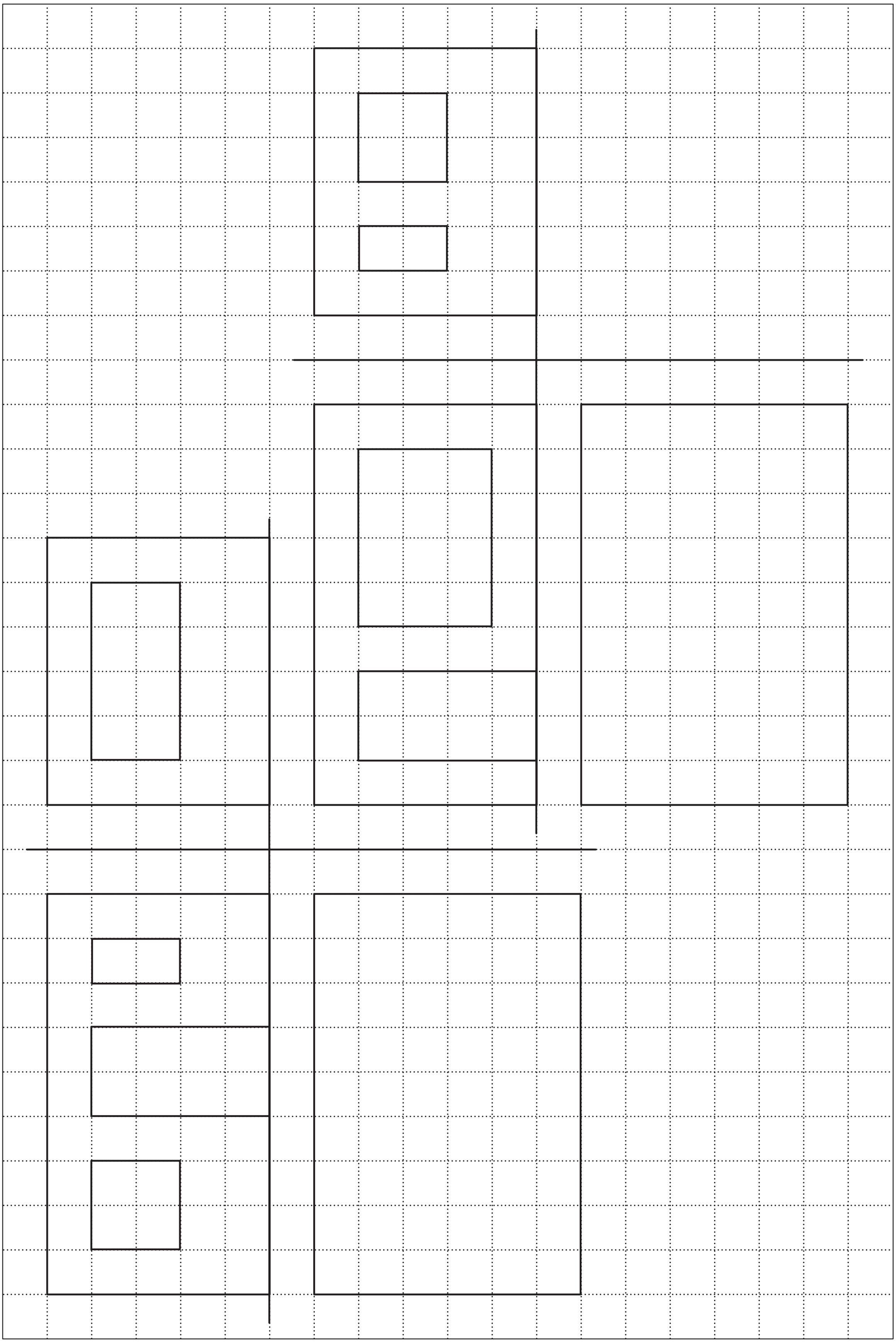


Diagram 30: Orthographic Projection

Draw the front view, top view and left view of the house. (Use the square grid.)

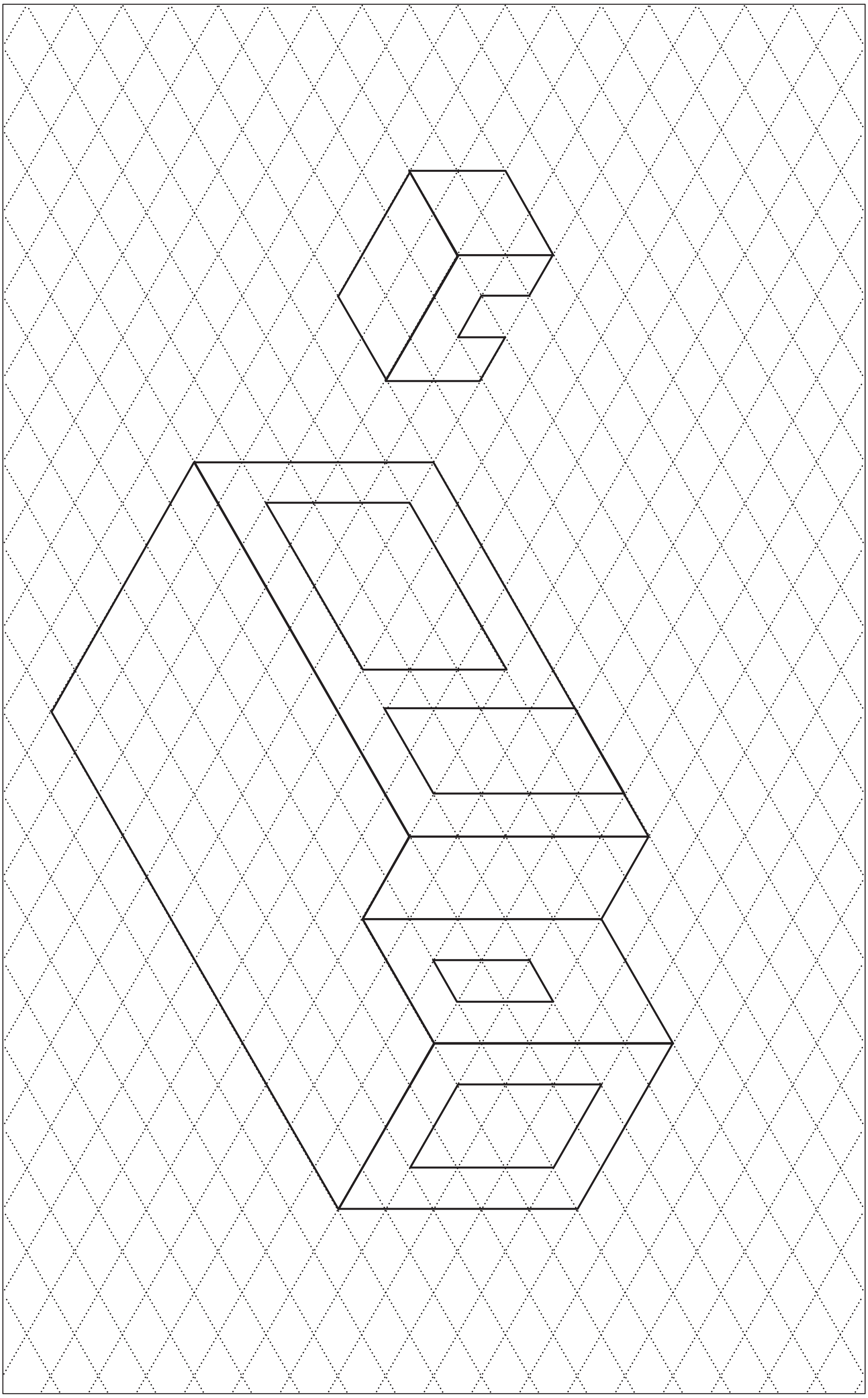


Diagram 31: Orthographic Projection

Model answer.

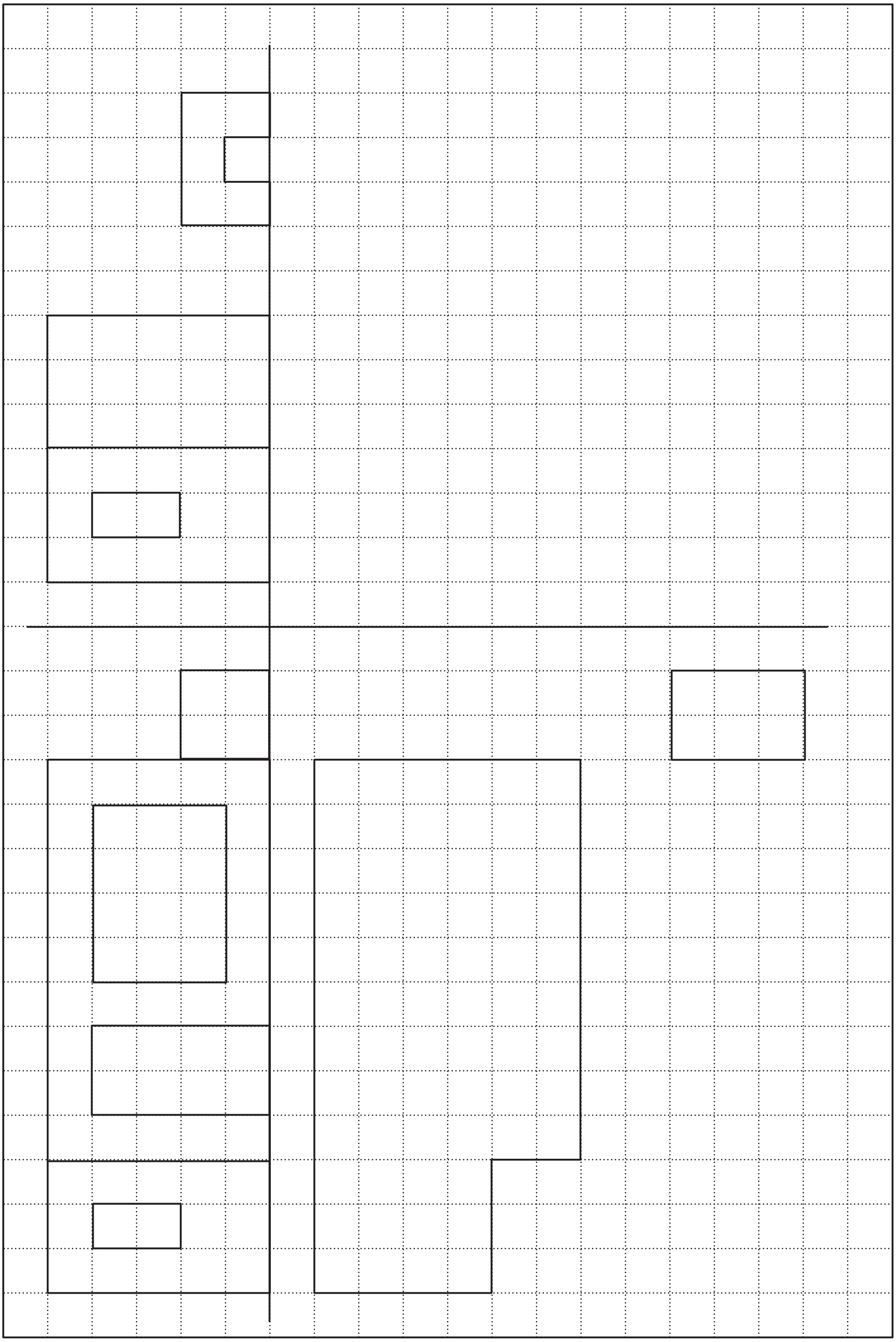


Diagram 32: Dimensioning