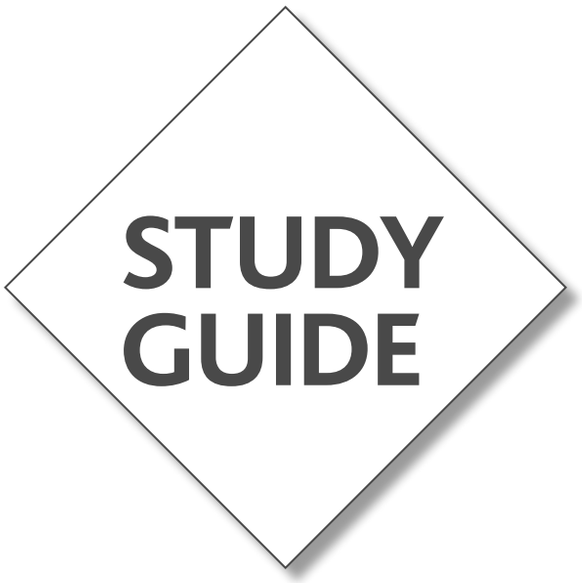


Design and Technology

Upper Secondary

Peter Stensel

HODDER EDUCATION
AN HACHETTE SINGAPORE COMPANY

CONTENTS

INTRODUCTION

Your Design and Technology syllabus will engage you in designing and making products through the application of technology. You will build on your experiences of lower secondary design and technology to learn how to identify design opportunities in everyday life. Through your designing and making projects, you will develop your creative and critical thinking skills as well as your practical drawing and problem solving skills.

HOW YOU WILL BE ASSESSED FOR YOUR COURSE

There are two parts to your assessment:

- **Paper 1 Written Examination (2 hours)**
  This paper accounts for 40% of your total mark for the subject. The questions will require you to apply your design skills and you will be expected to answer all of the questions. Question 1 will be worth 26 marks and will test your knowledge application of Design. Questions 2 to 4 will be worth a total of 54 marks and will test your knowledge application of technology (electronics, mechanisms and structures). Paper 1 is marked out of a total of 80 marks.

- **Paper 2 Design Project (22 weeks)**
  Your Design Project will run over a 22-week period and will account for 60% of your total mark for the subject. You will be required to identify a design opportunity within a given theme and to design and make a prototype based on the design opportunity identified. As part of the design project, you will need to complete a design journal and a presentation board. These are explained in more detail in chapter 1.

THE FORMAT OF THIS WORKBOOK

This workbook is divided into two main sections:

Section A — Design

The chapters in this section are intended to help develop your knowledge and understanding of design and will help to guide you through your design project. The chapters are organised according to the mark scheme for the design project and the marking criteria are included in each case.

Section B — Technology

This section covers the theory of electronics, mechanisms and structures. It also looks at the properties and applications of different materials and highlights a wide range of workshop processes.

When you see this icon, go to Annexes to see a larger presentation of the image.

Managing Your Project Work

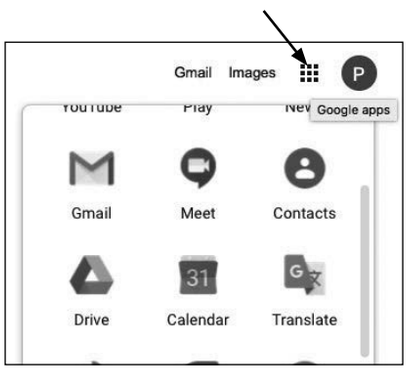
As you embark on your Design Project, you will need to decide how you are going to manage your work. You are required to work to an A3 size format so you will need some good quality A3 paper or an A3 sketchpad. It is also advisable to have a folder to prevent your work becoming creased or damaged. If you are going to work entirely on paper then an A3 presentation display folder with individual clear pockets for your A3 sheets is a good option. Alternatively, you may choose to manage your work digitally using a free online service such as Google Drive to store your work. To use Google Drive, you will need to have a Google account.

A Google account will give you access to a range of very useful apps, including *Docs* for creating documents, *Slides* for creating presentations and *Forms* for creating and organising questionnaires and surveys. Work is automatically saved to Google Drive, though it is also possible to download files to your own computer if needed. Working digitally in this way means your work will be safe and you will be able to access it from anywhere with an internet connection.

Creating a Digital Design Folder Using Google Slides and Sharing it With Your Teacher

To create your digital design folder, sign in to your Google account, click on the *Slides* app, choose 'Start a new presentation' then select 'Blank'.

Sign in to your Google account, then click here to access the Google apps.



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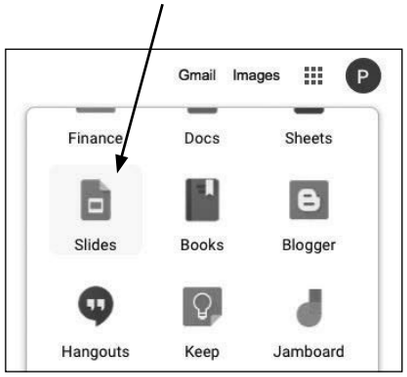

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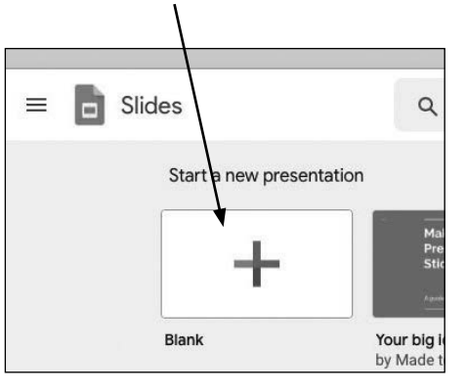

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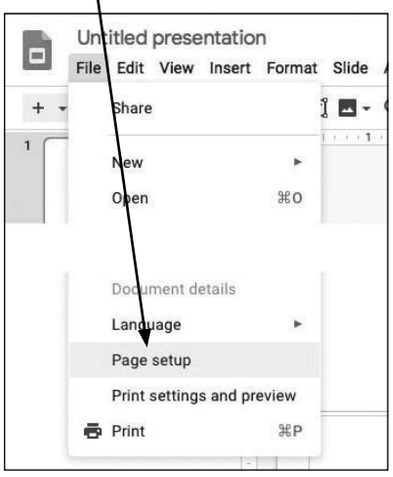
Select File > Page setup



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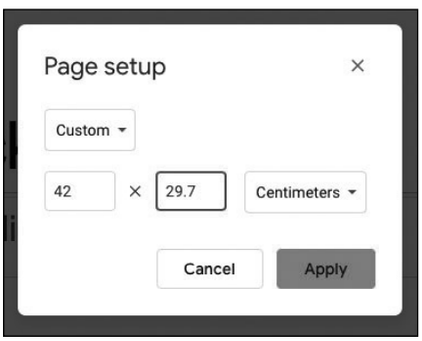

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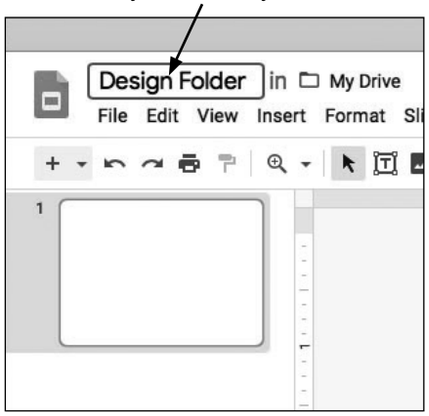


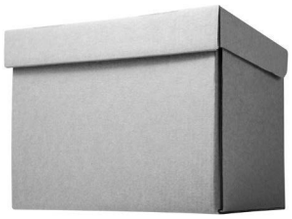
7 STRUCTURES

Structures in Everyday Lives

Structures come in all shapes and sizes, from small running shoes to the tallest building. Running shoes must **resist forces** during use, while **containing** and **protecting** the runner's feet. A tall building must be strong enough to **support** its own weight, as well as resisting the forces of wind, rain, fire and earthquakes. Have a look at the structures below. What do you think are their functions?

umbrella

postal box



child's stool

When designing structures, it is important to think carefully about the choice of materials and the methods used to join materials together. Many products today include **composite materials**, which can be lightweight but very strong. Another important factor when designing structures is the environment in which the structure will be used. Structures for outside use will need to be weatherproof, so the surface finish may be an important consideration.

QUESTION

Look at the bus shelter in the image below. Can you list **four important design considerations** the designer would have considered when designing the shelter structure?

Consideration One _____

Consideration Two _____

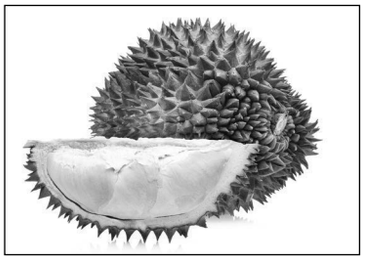
Consideration Three _____

Consideration Four _____

Natural and Man-made Structures

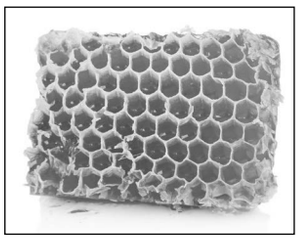
Structures in nature have evolved over millions of years to carry out their tasks as efficiently as possible. A leaf, for example, requires a large surface area to gather the maximum amount of sunlight. To do this, a leaf has a strong midrib that tapers from the base to the tip. Veins taper from the midrib to the edge of the leaf in a regular pattern.

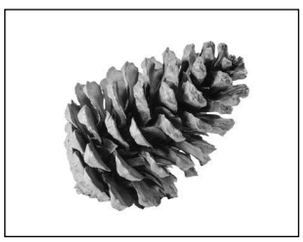
Using ideas from nature to help solve human design problems is called **biomimicry** (see page 35).



The Esplanade performing arts centre in Singapore is known locally as The Durian because its design resembles the spiky skin of the durian fruit. The aluminium shields that cover the building are like a living skin as they open and close automatically to shield the strong sunlight.

The Beijing National Stadium, designed for the 2008 summer Olympics, evolved from the study of Chinese ceramics. Commonly known as the Bird's Nest, it has a concrete supporting structure and a curved steel frame.





DESIGN TASK

Taking inspiration from one of the natural structures shown, sketch an idea for a piece of furniture such as a shelving system, a chair or a table.

Frame and Shell Structures

Man-made structures can be classified into two main groups: **frame structures** and **shell structures**.

A frame structure consists of a framework of **beams** and **columns** (called **members**) that provide the main support for the structure. The frame acts as a skeleton for the structure to ensure that it is rigid and stable and strong enough to support other materials attached to it.

A shell structure achieves its main strength and integrity from a continuous outer surface or 'shell'. The shell is self-supporting, though other materials may be attached to it.

Examples of frame structures include frameworks for buildings, bridges and rollercoasters, display stands, playground slides, etc.

Examples of shell structures include moulded chairs, helmets, suitcases, footballs, card boxes, buckets, etc.

RESEARCH TASK

Plastic bottles are shell structures usually made by **extrusion blow moulding**. Draw a diagram to explain how the process works.

RESEARCH TASK

From what type of material is the shell of a cycle helmet made? Why do you think this material is used?

Material: _____

Reasons for use:

_____

_____

_____

_____

_____

_____

_____

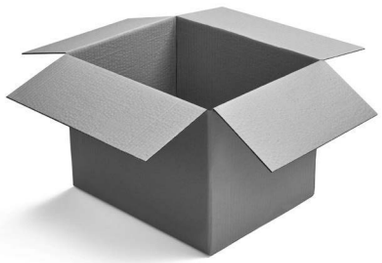
_____

Functions of a Structure

A structure provides one or more of four main functions. These include:

- supporting
- spanning
- containing
- protecting

A chair is designed to **support** the weight of a person sitting on it. The structures should be strong enough to hold together, even if the person tilts back while sitting on it.



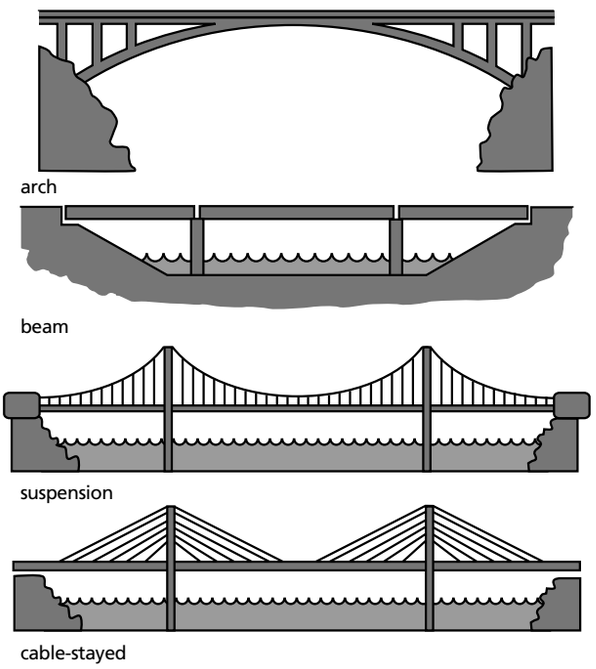
Corrugated card cartons are widely used to **protect** products during transportation. The flaps help to strengthen the carton while the corrugation absorbs small knocks and bumps.

A pedestrian bridge **spans** between two or more points. The bridge must be strong enough to withstand the weight of a large crowd and the force of strong winds. Designers must also consider the users of the bridge, allowing access for wheelchairs, buggies and other mobility aids.

Food and drinks are **contained** in many different types of packaging. The packaging may need to be watertight, greaseproof or have good thermal insulation properties to keep the contents hot or cold.

QUESTION

Four common types of bridges are shown on the right. Paste a photograph below of a bridge in your local area. State the type and location of the bridge.



Loads and Forces

Structures are designed to withstand different types of force:

external forces — forces that act on a structure
internal forces — forces that act within a structure

Forces act in many different ways. Weight is a force arising from gravity. A structure must be strong enough to support its own weight and any other forces acting on it.

Wind force is useful for moving boats and turning the blades of wind turbines but it also has the potential to destroy buildings, uproot trees and overturn large vehicles.

Structures must be able to resist the forces of sudden impacts. Sports bats and rackets, toys, fizzy drink bottles and many other products are carefully designed to withstand impact forces. Vehicles are designed with crumple zones to absorb the energy of an impact, thereby protecting passengers in the event of an accident.

Forces that act on or within a structure are called **loads**. What are the loads acting on the Marina Bay Sands hotel shown above?

_____

_____

_____

_____

_____

_____

STATIC AND DYNAMIC LOADS

A force on or within a structure that has a constant size, position and direction is called a **static load**. Examples of static loads include a book on a bookshelf or a vase of flowers on a table. A force on a structure that changes size, position or direction is called a **dynamic load**. A child on a moving swing is a dynamic load on the frame of the swing.

QUESTION

Label the image below to show the static and dynamic loads acting on the structures.

Design Challenge

Smartphones and tablets can be difficult to position properly while making videos or during video chats. In a situation like this, a stand is needed that can be used to hold a device in place.

Question 1a

What type of research would you carry out to give yourself a better understanding of the product requirements?

Question 1b

List three specification points you think would be important in the design of a stand for a device.

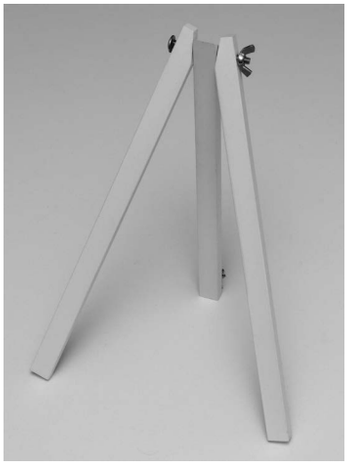
1. _____

2. _____

3. _____

Question 1c

The photograph below shows a framework for a desktop easel.



In the space below, design an attachment for the framework so that it can be used to hold a device such as a tablet or smartphone. Annotate your sketches clearly.

Question 2a

The image below shows a winners' podium for use at sporting events. The podium has been designed to be flat-packed so that it is portable.

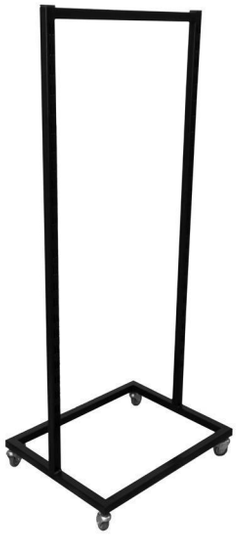
What force(s) would be acting on the podium when it is in use? Explain your answer.

Question 2b

Suggest a suitable material from which the podium could be made. Give reasons for your answer.

Question 3a

The image below shows a clothes rail made from tubular steel. Add labels to the image to show which parts would be subject to bending, torsion and compression forces when in use.



Question 3b

The manufacturer wishes to modify the design so that the height of the rail can be adjusted. Sketch an idea below to show how you would modify the design.