UNDERSTANDING STRUCTURES

PDF & DIGITAL FORMATS

2 Peas and a Dog

Middle School Teaching Resources

RESOURCE INCLUDES

- ✓ Ontario Curriculum Aligned
- ✓ Detailed Lesson Plans
- ✓ Readings, Videos, Graphic Organizers, Group Work, Projects, Rubrics
- ✓ Hands-On Science Labs
- ✓ MP3 Audio Files
- ✓ Answer Keys
- ✓ Quizzes & Unit Test
- ✓ Print & Digital Formats

INCLUDED LESSONS

- Introduction - Science Safety
- Unit Vocabulary
- Unit Introduction: Structures and Form
- Classifying Structures
- Bill Nye Video
- Centre of Gravity & Stability
- Force
- Structures Show and Tell Assignment
- Classifying Structures Quiz
- Internal and External Forces
- Card Pyramid Activity
- Symmetry in Structures
- Structural Failure
- Manufacturing Factors
- Loads
- Ensuring Structural Safety
- Factors in Designing & Building Structures
- Ergonomic Design
- Lab - Take-Out Containers
- Lab - Egg House Structure
- Unit Review
- Unit Test

UNIT ORGANIZATION

GRADE 7 STRUCTURES
ONTARIO CURRICULUM ALIGNMENT

Lesson	2007 Curriculum	2022 Curriculum
1. Safety Rules & Vocabulary	2.1, 2.6	A1.4, A1.5
2. Classifying Structures	3.1	D2.1
3. Bill Nye Video	3.1	D2.1
4. Centre of Gravity and Stability	3.2	D2.2
5. Force	3.3	D2.3
6. Show and Tell Assignment	3.1	D2.1
7. Quiz	3.1	D2.1
8. Internal and External Forces	3.4	Not Included
9. Card Pyramid Activity	2.2, 3.1, 3.2, 3.4	A1.3, D2.1, D2.2
10. Symmetry in Structures	3.5	D2.4
11. Structure Failure	3.6	D2.5
12. Manufacturing Factors	3.7	D2.6
13. Loads	2.3	Not Included
14. Structural Safety	2.5	D2.7
15. Design Factors	1.1	D1.1
16. Ergonomic Design	1.2	A1.2, D1.2

CURRICULUM ALIGNMENT

LESSON OVERVIEW

Lesson	Activity Type	Name	Suggested Time
Intro #1A #1B	Class Discussion	Safety Lesson, Unit Vocabulary, Unit Introduction	2 – 3 Classes
	QR Code Scavenger Hunt		
	Whole Class Reading		
#2	Whole Class Readings & Classification Activity	Classifying Structures	1 – 2 Classes
#3	Whole Class Video & Fill in the Blanks Activity	Bill Nye Video	1 Class
#4	Whole Class Reading & Video	Centre of Gravity & Stability	1 – 2 Classes
#5	Whole Class Reading & Explanation	Force	0.5 Class
#6	Presentations	Show and Tell Assignment	Whole Unit

UNIT PLAN

LESSON #1B

Unit Introduction: Structures and Form

Lesson Overview:
Students will work on understanding what is a structure and what is form.

Materials Needed:
- Photocopy a class set or use the provided Google Slides version of:
  1. Structures and Forms article
  2. Structures Search activity (photocopied for pairs or individual work)

Teacher Instructions:
1. As a class, read through Structures and Forms article. Have students highlight important information.
2. Then hand out the Structures Search activity.
3. Divide the class up into pairs or have the students complete the activity individually.
4. Explain the instructions of the activity. Look around the classroom and select several different structures. Explain each structure's form and function on the provided sheet.
5. At the end, have a class discussion about the structures they hav

LESSON PLANS

WHAT'S INSIDE?

METHODS USED BY ENGINEERS TO ENSURE STRUCTURAL SAFETY

Most people usually do not enjoy taking a test. Engineers, however, must use them regularly to ensure the safety of the structures they build. As it is impossible to design a structure to be 100% failure proof, performance testing and risk management are technical requirements.

In orde ues should b ten need to run lo already been conducted.

ARTICLES

Performance testing is the evaluation process that ensures that a product meets the level of quality to be sold to the public. It is an absolute necessity, since the regulations and standards for a product to be sold to the public are usually very high.

Engineers also use **risk management** techniques to reduce the possibility of structural failure. Risks are often considered in one of three ways: ignore the risk, avoid the risk, or design for the risk. When engineers design for the risk, they will primarily look at one of three categories as their main method of measurement. They can design for loads, design for safety, or design for efficiency.

SCIENCE VOCABULARY WORD #1

Using a phone or a tablet, scan the QR code below the hidden word.

ENGAGING ACTIVITIES

STRUCTURES SEARCH

Look around the classroom and select several different structures. Explain each structure's form and function.

Structure	Description of Form	Description of Function
Binder	Made from plastic, cardboard, and metal. Its shape is a rectangle covered in plastic.	Used to hold papers given out in class.
	Made from Its shape is	
	Made from Its shape is	

WHAT'S INSIDE?

ANSWER KEY

Input the following examples into the correct category of force:

1. A pear falls to the ground fr
2. You twist your body to put s
3. When you sit in a chair, your
4. When you blink, your eyes cl
5. The wind blows the leaves a
6. Stretching your hand up in t

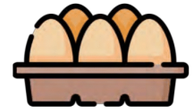
EXTERNAL
A pear falls to the ground from a pear tree due to gravity. The wi around

ANSWER KEY

The effect gravity has on a structure.	A. LOAD
The overall weight of the object on	B. DYNAMIC LOAD
	C. TRIANGLE
The sum of the static load and dynamic load combined.	D. DEAD LOAD
A load that changes due to the forces that act on it (e.g., water, winds).	E. STATIC LOAD
The object's weight.	F. ARCHES, BEAMS, COLUMNS
A very strong and rigid shape, often used in structures because it does not bend easily.	G. LIVE LOAD

ANSWER KEYS

EGG HOUSE STRUCTURE LAB



Task: To create an environmentally-friendly (no purchasing of materials) v egg to be dropped from a predetermined ucture must land on its base, and have easy rted and removed.

ment.

for your design. Look over the note Elements e you.

r the teacher to check and approve along with . Label all the key features needed for the aterials used, and all tentative measurements.

roject plan are approved you are ready to

remember to be safe with all tools used.

n by answering the questions below.

cture hold up against the forces it (why or why not?).

ucture easy to build with the materials you de a list of all your materials.

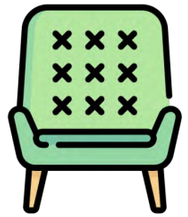
table and/or symmetrical? Why or why not?

isually pleasing? Explain.

complete, please complete a Final Design

r structure will be

MANUFACTURING FACTORS



Imagine two chairs, one made of tissue paper and one made of bricks. A tissue paper chair would be too weak and would not be able to be used for its purpose, thus not being very functional.

A chair made of bricks would be uncomfortable, and too heavy to move around. This is why it is important to choose the right materials when designing and building consumer structures.

When selecting materials for the design of consumer structures there are a number of key things to consider, including but not limited

1.
2.
3.
4.
5.
6.
7. Aesthetics
8. Life of the material
9. Handling and storage
10. Skills required

LABS & CASE STUDIES

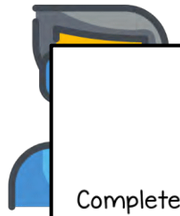
TEACHER FEEDBACK

"This resource included AWESOME hands on activities. My class loved building the egg house and are looking forward to the Transformers Video analysis. Great application- will definitely use again!" - Angela D.

"Fantastic resource! No prep and easy to post on Google Classroom. Readings are student friendly and easy to follow along." - Andrea Ward

INTRODUCTION

SCIENCE SAFETY RULES



1. LISTEN
- ✓ To ALL the teacher's ins
- ✓ Know the location of the

2. ATTIRE
- ✓ Wear safety goggles ar
- ✓ Tie-up any loose items
- ✓ Wear closed toe, comfo

3. READ CAREFULLY
- ✓ Any lab
symbo
- ✓ The procedure of your e

4. TOOLS
- ✓ Handle all tools with care
- ✓ Inform the teacher if a
there is a spill.
- ✓ Do not taste test any ite

5. CLEAN-UP
- ✓ Thoroughly wash all used
- ✓ Wash hands with soap a

SAFETY RULES QUIZ

Complete the following true/false questions on safety:

1. When you clean-up, wash your hands with water.	T	F
2. Before you begin, you must listen to ALL the teacher's instructions.	T	F
3. Remember to tie-up any loose items (e.g. hair, clothing, jewelry, etc.).	T	F
4. Feel free to taste test items in the science room.	T	F
5.	T	F
6. Do not bother reading your procedure, just make it up as you go!	T	F
7. Handle all tools with care, especially sharp objects.	T	F
8. Wear open toe shoes, and use gloves/goggles as needed.	T	F
9. Read labels on chemicals used carefully (e.g., WHMIS symbols).	T	F
10. Do not tell the teacher if there is a spill or if an item is broken/faulty.	T	F

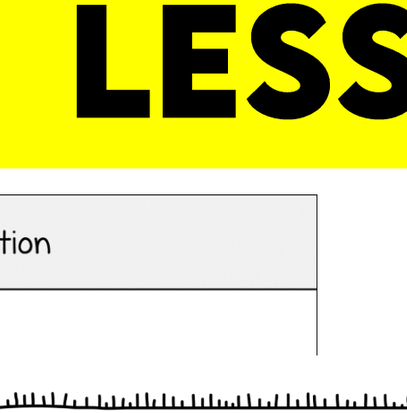
SCIENCE SAFETY

LESSON 1A & 1B

Vocabulary Word	Definition
#1	
#2	
#3	
#4	
#5	
#6	
#7	
#8	

SCIENCE VOCABULARY WORD #17

Using a phone or a tablet, scan the QR code below to find the hidden word.



UNIT VOCABULARY

STRUCTURES AND FORM

see and touch, which can be ronment. Your body, for ber and a tree. Each led the form, as well as a

d or oad is he ke the

e can he and

sort them by the ly whether they are natural naturally in the tain, both being mass Manufactured structures ures, however they are am.

g.com

STRUCTURES SEARCH

Look around the classroom and select several different structures. Explain each structure's form and function.

Structure	Description of Form	Description of Function
Binder	Made from plastic. Its shape is	Used to hold papers given out in
	Made from Its shape is	

UNIT INTRODUCTION: STRUCTURES AND FORM

LESSON 2 & 3

STRUCTURAL FORMS

Frame structures are composed of a framework of parts that fastened together to provid strength. These structural components (or parts), are together to create either a 2-dimensional or 3-dimensi form that can be either lef frame or covered by a coati

Some examples of simple f (natural) and a tennis racke (manufactured) and a bat's covered by another material

Shell structures material for thei strength of these structur holds the whole object toge mug (manufactured) and a examples of shell structure of two or more types of st using solid structures (boar These **combined structures** especially if a product needs or wrapped in plastic.

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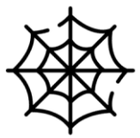
STRUCTURAL FORMS ACTIVITY

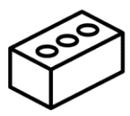
Classify the following images as a solid, frame, shell or combination structure.



_____

_____

_____



_____

_____

_____

_____

_____

_____

_____

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CLASSIFYING STRUCTURES

BILL NYE: STRUCTURES VIDEO

Use the word bank below to answer the following fill in the blank questions, as you watch the Bill Nye video.

❑ form	❑ function
❑ egg	❑ domes
❑ flexible	❑ bridge
❑ tension	❑ structures
❑ adobe	❑ compression

1. This is r s

f_____

2. The internal pulling on an object is called _____.

3. The internal pushing on an object is called _____.

4. This structure was used to hold up a textbook: _____.

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BILL NYE VIDEO

LESSON 4 & 5

STRUCTURAL STABILITY

The **centre of gravity** is the ima
concentrated. Where the centre
its stability. This means that th
gravity is, the m
ground, the mo
race car has a
rapidly without

Size also matte
you will make it
chair, the base
this design is b
especially when

The centre of g
either. Our bodies for example,
of gravity. Where you may assu
actually higher than your waist
more weight than the bottom h

Explain what the centre of gr

CENTRE OF GRAVITY INVESTIGATION

Go through your pencil case or the classroom and find **three** different structures (e.g. markers, eraser, pencil, etc.). Sketch the objects below
ch. Make sure to label where
row.

Object 2	
Object 3	

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CENTRE OF GRAVITY & STABILITY

FORCE

on an object, causing it to
ct of a force on a structure is
he direction of the force and

s being put on an object. When
to the weight and size of an
nple, a gentle breeze will cause
nd will make that same flag

ed the **direction**. The direction
f stress. For
ake it more difficult
you, you will notice

point of application and the
e the force meets the
fic location where the force
pplication is the side of the
revious example of the wind,
e wind is affecting the
e or just a part of it? Where
ock you over, the wind
down the area that it is

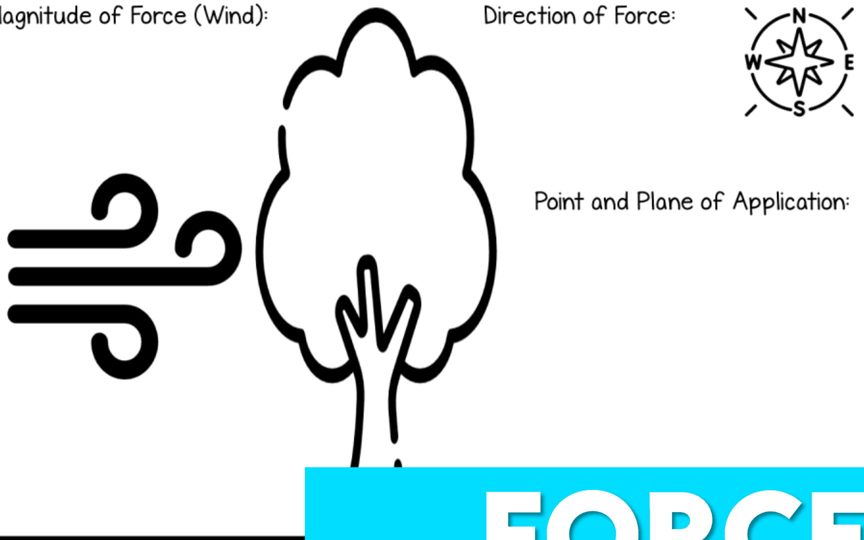
g.com

FORCE ACTIVITY

Magnitude of Force (Wind):

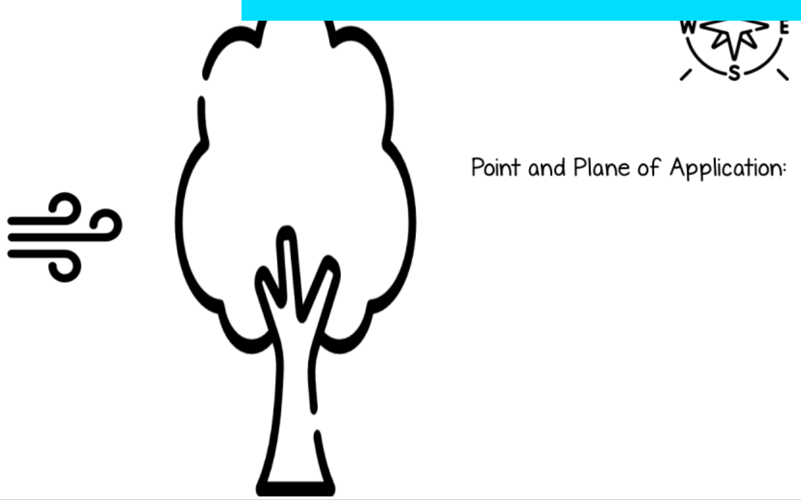
Direction of Force:

Point and Plane of Application:



Magnitude of Force (Wind):

Point and Plane of Application:



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FORCE

LESSON 6 & 7

LESSON #6

Structures Sho

Lesson Overview:
Students will bring an object to
the class.

Materials Needed:
- Photo

Teacher
1. Hand
2. Have
3. I wa
4. Explo
   maxi
5. Start

SHOW AND TELL ASSIGNMENT

Task: Bring in an interesting object to class or take a digital photo of
nd classify its:

ination)

		Met ctations	Exceeds Expectations
Presentation Content Object form, function, materials, classification are explained.			
Oral Presentation Skills Eye contact, voice level, opening and closing statements.			

STRUCTURES SHOW AND TELL ASSIGNMENT

LESSON #7

tures Quiz

structures with this quiz.

their own

CLASSIFYING STRUCTURES QUIZ

Name: _____ /5

Classify each structure by circling the correct answer for each question.

	a. Solid b. Shell c. Frame d. Combination
	a. Solid b. Shell c. Frame d. Combination
	a. Solid b. Shell c. Frame d. Combination
	a. Solid b. Shell c. Frame d. Combination
	a. Solid b. Shell c. Frame d. Combination

CLASSIFYING STRUCTURES QUIZ

LESSON 8 & 9

EXTERNAL AND INTERNAL FORCES

Every structure must be desig
that it may encounter. The forc
either an external force or an ir
happen to a structure and can

An **external force** will act upon
Naturally occurring examples of
natural force of attraction betv
external force on all structures
the centre of the Earth.

An **internal force** is when one p
the same st
within buildi
structures.
that adapts

There are f
size of a str
tension, she
cause a def
deformation
structural f

Compression happens when a f
within an object. An example of
found in the mattress on your
stretching or pulling apart an ob
a rubber band being pulled. A **sh**
opposite directions from one ar
cut your hair. Lastly, turning a k
torsion force, which is the act o

© htt

EXTERNAL AND INTERNAL FORCES

Input the following examples into the correct category of force:

1. A pear falls to the ground from a pear tree due to gravity.
2. You twist your body to put something on the table.
3. When you sit in a chair, your bottom pushes down on the seat.
4. When you blink, your eyes close and open in opposite directions.
5. The wind blows the leaves around in many directions.
6. Stretching your hand up in the air to ask a question in class.

	SHEAR	
	TORSION	

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INTERNAL AND EXTERNAL FORCES

LESSON #9

Card Pyramid Activity

Lesson Overview:
Students will work on understanding frame structures by building a card tower.

Materials Needed:
- Video: How to Build a Tower of Cards
- Deck of cards (1 per pair, triad or group of students)
-

T
1

2 y

3. Demonstrate how to start. This may be difficult, but that is the point, to show that building a structure is not easy and requires good balance and stability at the base.
4. Allow students to try and make their own card towers. See who can get the biggest card pyramid constructed. Be mindful when you or the students walk around the classroom. Cards could tip over due to vibrations from walking on the floor and the air movement when passing by.
5. This activity is a good consolidation discussion on the forces that could affect structures.

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CARD PYRAMID ACTIVITY

LESSON 10 & 11

SYMMETRY IN STRUCTURES

If an object is symmetrical,
equal parts that are identica
that divides the structure ir
This means that the force c

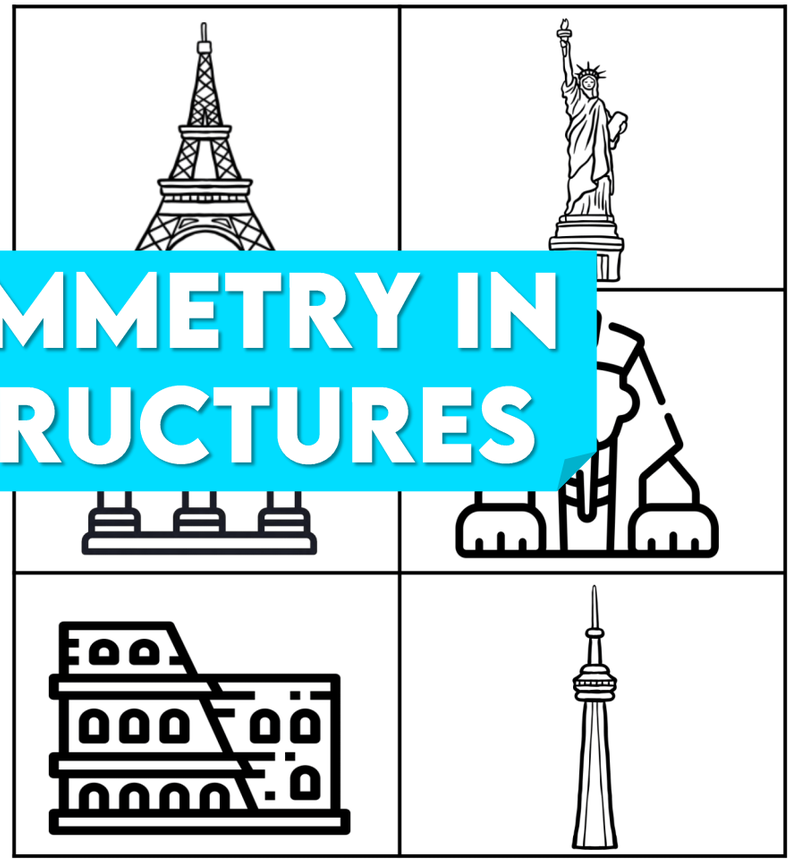
Symmetrical obje
the load of mass
excellent exampl
found in being ab

When engineers
symmetry is oft
only does it increase structu
overall **aesthetic** of a struct

An object that is symmetric
the most appealing to the e
world, aesthetics are almos
product works).

SYMMETRY IN STRUCTURES

Draw the line of symmetry (if possible) in these famous structures.



SYMMETRY IN STRUCTURES

STRUCTURAL FAILURE

STRUCTURAL FAILURE QUESTIONS

1. What are the two main causes of structural failure? Give an example of each.

2. How can th
working on i

3. How does time affect structural failure?

4. How can the load on a structure cause failure? Give at least one example.

STRUCTURAL FAILURE

ctured flaw or a
times. A few of the
ion failure, faulty
ay also occur due to a
flood, earthquake or fire.
tural failures are primarily

ifferent professionals involved
oremen, etc.) poor
ne of the most common
sign can look great on paper,
communicated. Another
be due to a lack of experience
dividual could miscalculate or
ng in catastrophic results.

the chances that it may not be
ed upon it increase. **Time** is

LESSON 12 & 13

MANUFACTURING FACTORS

Imagine two chairs, one m
bricks. A tissue paper chair
able to be used for its pur

A chai
move
materi

When
there
limited to:

1. Cost
2. Availability
3. Ability to manufact
4. Strength and durab
5. Sustainability
6. Climate
7. Aesthetics
8. Life of the materia
9. Handling and storag
10. Skills required

MANUFACTURING FACTORS

List the 10 different manufacturing factors that companies must think about before creating their products.

1.	
2.	
5.	
6.	
7.	
8.	
9.	
10.	

MANUFACTURING FACTORS

LOADS ON A STRUCTURE

a roof structure.

needs to support a load.
ernal forces that are placed
table and risk structural

static loads combined. A
ucture. There are two types
ive load (the overall
l is the force that
xample, moving

hapes that are used in its
ng and rigid shape that can be
However, rectangles and
y do bend easily. Circles are
d, and will bulge outwards

to support a load are arches,
ly because of the strength
dings that contain an arch, for
evenly through both halves of
ing. A set of columns acts in a
t.

LOADS ON A STRUCTURE MATCHING SHEET

Match the statements/definitions on the left to the terms on the right.

The effect gravity has on a structure.	A. LOAD
The overall weight of the object on the structure.	B. DYNAMIC LOAD
Most often used 3D s structures.	
The sum of the static load and dynamic load combined.	D. DEAD LOAD
A load that changes due to the forces that act on it (e.g., water, winds).	E. STATIC LOAD
The object's weight.	F. ARCHES, BEAMS, COLUMNS
A very strong and rigid shape, often used in structures because it does not bend easily.	G. LIVE LOAD

LOADS

LESSON 14 & 15

METHODS USED BY ENGINEERS TO ENSURE STRUCTURAL SAFETY

Most people usually do not e
must use them regularly to
they build. As it is impossible
failure proof, performance
technical requirements.

In order to de
should be used
to run lots of t
been conducte

Performance testing is the
product meets the level of
absolute necessity, since th
product to be sold to the pu

Engineers also use **risk man**
possibility of structural failu
three ways: ignore the risk,
When engineers design for
of three categories as their
can design for loads, design

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ENSURING STRUCTURAL SAFETY GRAPHIC ORGANIZER

Please fill in the following information on each definition using the article as a reference.

Ensuring Structural Safety

- Performance Testing
- Risk Management
- sign for Loads
- Design for Safety
- Design for Efficiency

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STRUCTURAL SAFETY

FACTORS IN DESIGNING & BUILDING STRUCTURES

FACTORS IN DESIGNING & BUILDING STRUCTURES

Take point form notes on the important information from the article.

How Form Fits Fu	
Dete Consur	
Economy and the Environment	

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e same form).

building a

is quite easy
r example, a
books will have

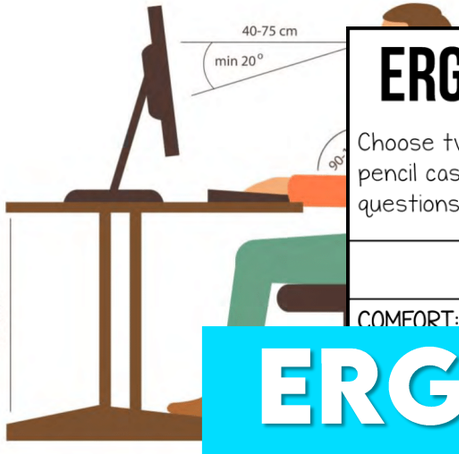
unction with
es much more
llow people to cross water,
vell as other environmental
on. This means that
tructure) remains the
things like climate, weather

om

FACTORS IN DESIGNING & BUILDING STRUCTURES

LESSON 16 & 17

ERGONOMIC DESIGN



Ergonomics is about the

How does a desig
they design a pr
people use that
it? For how long? In what p
over and over again? They
in their research so that th
the human body and help p

Products that are not ergon
repetitive stress injuries (R
tunnel (wrist pain), neck or
who work with technology
types of injuries. Since mos
staring at a computer scre
chair, desk and even the co
hurt them if they are not e

ERGONOMIC DESIGN INVESTIGATION

Choose two **different** structures in the same category (e.g., 2 pencils, 2 pencil cases, 2 backpacks, 2 chairs, etc.). Complete the investigation questions for the two items you chose.

ITEM #1	ITEM#2
COMFORT: How comfortable is it to	**COMFORT:** How comfortable is it to
	fe is it?
EASE OF USE: Is it easy to use?	**EASE OF USE:** Is it easy to use?
ENJOYMENT: Do you enjoy using it?	**ENJOYMENT:** Do you enjoy using it?

ERGONOMIC DESIGN

TAKE-OUT CONTAINER LAB

t food) containers to find
aging.

ntainers Links" page
ze at least 3 different
uestions.
ifferent links,
nvironmentally–
s. Write up your
with the 3 inquiry

completed

om

TAKE-OUT CONTAINER INQUIRY

Environmental Questions	
1. Are the materials used environmentally –f Ex	
2. Co co re co Ex	
3. Do ca or repurposed? Provide suggestions.	

LAB TAKE-OUT CONTAINERS

LESSON 18, 19, & 20

EGG HOUSE STRUCTURE LAB

Task: To create an environmer
structure that will allow a raw
height and not break. This stru
access for the egg to be inser

Procedure:

1. This is a group work assignm
2. Start brainstorming ideas fo
of a Good Design to help guide
3. Complete a Project Plan for
a rou
stru
Once
cons
4. Co
5. Co
C. Is your structure st
D. Is your structure vis
6. When your structure is co
sketch with all the parts la
7. Make sure you have review
evaluated.

LAB WRITE UP REQUIREMENTS

Requirements

- ❑ Typed Up
- ❑ Font Requirements: Size 12, black ink, readable
- ❑ Includes all of the information below

LAB
EGG HOUSE
STRUCTURE

ocess

ppen in the experiment?)

2. MATERIALS: (List the items used)

3. PROCEDURE: (List and number the steps in order used during this lab.)

4. COLLECT & ANALYZE DATA: (Use a table, chart, or graph – what does your data tell you?)

5. RESULTS: (This is the final summary of what happened and what you learned from doing this lab. Was your hypothesis correct?)

UNIT TEST /20

Name: Class:

Please circle your response for each of the following questions.

1. A structure is _____
A. Something that is only available in the Southern Hemisphere.
B. Something that can be seen and touched.
C. Something that is designed to hold very few objects.
D. Something that can rotate and transform to better serve people.

UNIT REVIEW & TEST

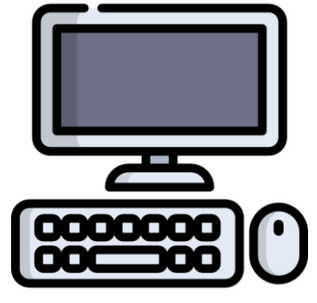
3. What is another way to classify structures?
A. Manmade or plastic
B. Natural or manufactured
C. Heavy or weak
D. Solid or forced

4. A structure that uses more than one classification is called:
A. Combination
B. Frame
C. Solid
D. Shell

LESSON FORMATS

PDF

✓ Individual & Whole Unit



DIGITAL

✓ Google Slides

RESOURCE CAN BE USED IN-PERSON OR ONLINE