BIOMIMICRY AND ENVIRONMENTAL ENGINEERS

Year 5

STUDENT DESIGN WORKBOOK

Name: _____

Other group members: _____

_____

_____

Group Number: _____ Class: _____

THINKING SPACE

… drawings, diagrams, observations, notes, reflections …

PART 2A

INTRODUCTION TO ENVIRONMENTAL ENGINEERS

1. **Watch** the video "Life as an Environmental Engineer" (Tamar).

2. While watching, see if you can **find answers** to these questions about Environmental Engineers.

a. **What** is the main area of the environment that Tamar works in?

_____

b. **Complete this sentence**: A good Environmental Engineer has a strong interest in

_____ and _____

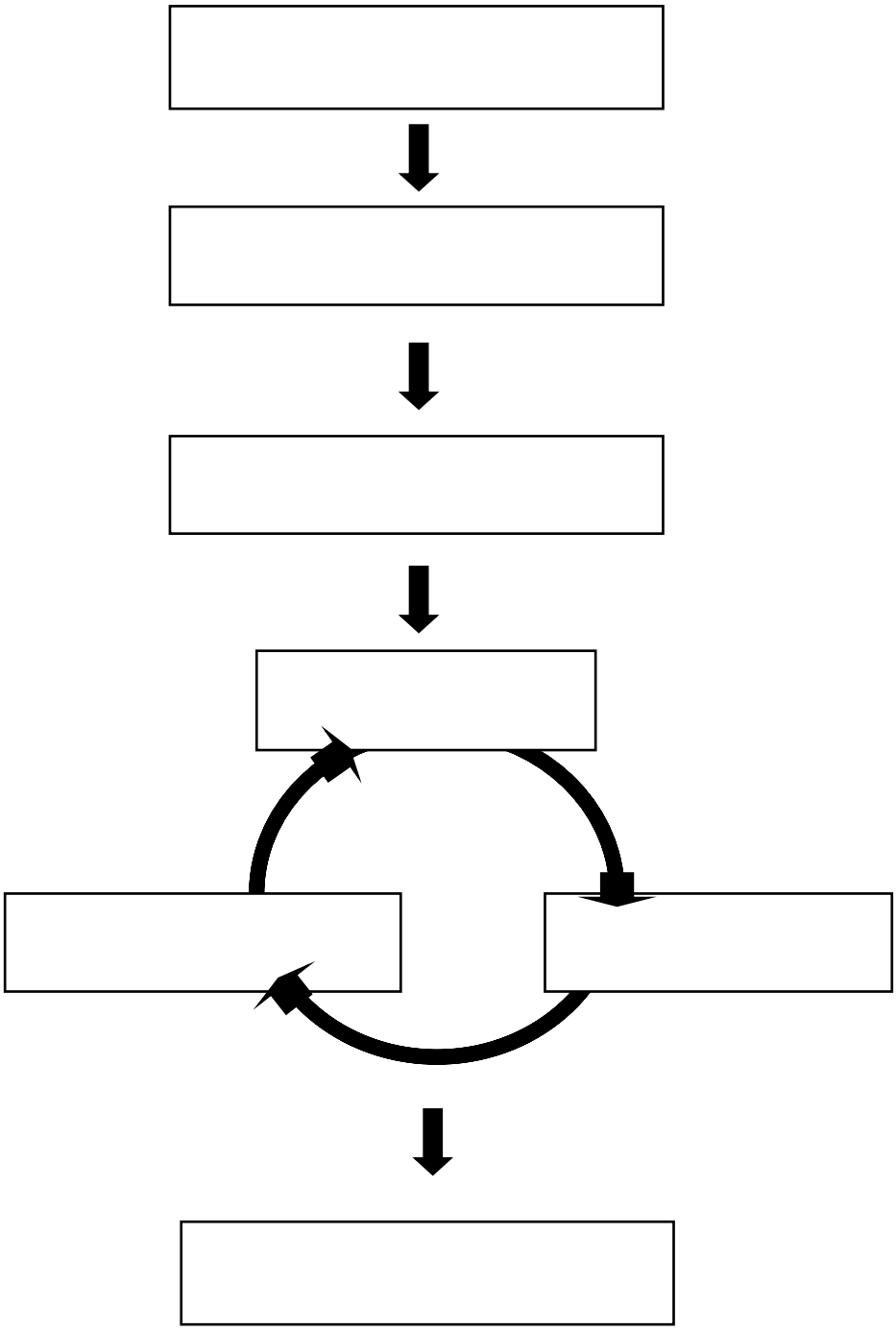
and _____.

THINKING SPACE

… drawings, diagrams, observations, notes, reflections …

3. **Complete** the engineering design model below.

ENGINEERING DESIGN MODEL



Model adapted from pbs.org model

THINKING SPACE

… drawings, diagrams, observations, notes, reflections …

4. **What** is an environment?

5. **What** is an ecosystem?

6. **Read** the information about environments.

There are two types of environments that exist:

a) the *natural* environment, and
b) the *human-made* environment.

The **natural environment** is split into two parts: living things, which we call *biotic*, such as plants and animals; and non-living things, which we call *abiotic*, such as water, soil, air and sunlight.

There are a lot of **interactions** between living (*biotic*) and non-living (*abiotic*) things in the environment.

An interaction is when one thing has a relationship with something else. For example, a flower needs to use water to live, so the flower and water interact so that the flower lives.

THINKING SPACE

… drawings, diagrams, observations, notes, reflections …

7. **Think** back to your visit to Mt Coot-tha Botanical Gardens to help you answer the following questions.

a. **List** the *natural things* in the environment at Mt Coot-tha you visited?

NATURAL THINGS

b. **List** the *human-made things* in the environment at Mt Coot-tha you visited?

HUMAN-MADE THINGS

8. **Why** should you care about the environment?

THINKING SPACE

… drawings, diagrams, observations, notes, reflections …

PART 2B

ENVIRONMENTAL INTERACTIONS ACTIVITY

Listen carefully to the teacher's instructions for this activity.
You will be placed in groups by the teacher and given a card with the name of something from the environment written on it. One group member will be the scribe and be responsible for the web tally sheet.

1. **Construct** a table of living (biotic) and non-living (abiotic) things from your group's cards.

Biotic	Abiotic

2. **Work with your group** to create an *interaction web*.

- All members of the group sit or stand in a circle, except the scribe.
- One member of the group starts with a ball of wool. He/she holds the end of the wool and passes the ball to another member of the group to whom he/she is related, based on their card identification (e.g., a 'fish' passes the ball to the 'water' because a fish needs water to live).
- The group member who passed the ball of wool must explain his/her 'relationship' with the next student (e.g., 'a fish needs water to swim in and help it breathe').
- The next student continues in the same fashion (e.g., the 'water' holds the ball of wool and passes it to a 'flower' and then explains their relationship i.e., water is what allows a flower to grow and survive).
- Continue passing the ball of wool around the group, showing and explaining the interactions.
- The wool may be passed to you more than once. Make sure you DO NOT let go of the wool.
- Each group member counts how many connections they have.
- The scribe records the number of connections for each group member on the web tally sheet.

THINKING SPACE

… drawings, diagrams, observations, notes, reflections …

3. **Record** the number of interactions for your group on the *web tally sheet* below. You can get the information for this from your group's scribe.

Environmental Thing	Number of Connections - Tally Marks	TOTAL
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		

THINKING SPACE

… drawings, diagrams, observations, notes, reflections …

4. Use the information from your *web tally sheet* to **graph** your results.

Environmental Interactions

THINKING SPACE

… drawings, diagrams, observations, notes, reflections …

5. **Record** answers to the following questions about the *Environmental Interactions Activity*

a. What things had the **most interactions or connections**?

_____

b. Think about the connections to water and air from the activity. **Why** are there so many?

_____

_____

_____

THINKING SPACE

… drawings, diagrams, observations, notes, reflections …

PART 3A

ADAPTATIONS AND BIOMIMICRY

1. **Read** the information about adaptations.

Compared to many animals and plants, humans are not very physically adapted to the environments in which they live. We comfortably tolerate only a small temperature range, between 17 and 37° Celsius. As a result, humans tend to adapt our environment to our needs rather than doing much adapting ourselves.

Engineers can study the way nature has approached solutions to these challenges to improve their own designs.

Plants and animals adapt in response to the environment they live in. Adaptation is a characteristic of a plant or animal that increases the chance of their survival. Camouflage is an important adaptation.

2. **Watch** the online slide show "Animal Camouflage Pictures" and see if you can spot the camouflaged animals.

3. **Read** the online book "Animal Adaptations".

THINKING SPACE

… drawings, diagrams, observations, notes, reflections …

4. **List** both *structural (physical)* and *behavioural* adaptations of animals from the book.

Animal	Structural Adaptation	Behavioural Adaptation
Sea Horse		
Shark		
Fish		

5. **Watch** the video "Nature is Smarter Than Us".

6. **Write** a definition for biomimicry.

THINKING SPACE

… drawings, diagrams, observations, notes, reflections …

7. Your group will be given an example of a *biomimicry invention* and a *magnifying glass*. The design for this invention came from something in nature. **Examine** the invention with the magnifying glass and **discuss** it with your group.

8. **Write** answers to the following questions.

a. **Where** in nature do you think the design came from? **Why** do you think this?

b. Do you **use** this invention anywhere at home or at school? If so, give an **example** of where you use it.

c. **Why** is this invention better than other kinds of attachment mechanisms?

THINKING SPACE

… drawings, diagrams, observations, notes, reflections …

9. **Watch** the video "Infamous Inventors" to see where this invention came from.

10. **Play** the *Biomimicry Matching Game*. Your teacher will guide you.

11. Can you think of any other examples of *biomimicry*? **Write** about them below.

_____

_____

_____

_____

_____

12. **Read** the information below about *biomimicry*.

Biomimicry is an approach to problem-solving and design and impacts on the way engineers design products and systems. We are discovering that for every human challenge, nature has a time-tested solution. All things in the environment (nature) have a purpose.

THINKING SPACE

… drawings, diagrams, observations, notes, reflections …

PART 3B

ENGINEERING DESIGN CHALLENGE: DESIGN A WIND SEED MODEL

1. Introduction:

a. Not all seeds have burs or prickles so they attach to passing animals or humans and spread to other places. **List** some other ways seeds can spread that you may have seen or know of.

_____

_____

_____

_____

b. **Watch** the videos "Seed Aviation" and "Dispersal of Seeds".

2. Scenario:

Your **small engineering team** (group of three or four students) has been invited to work with genetic plant scientists to design a **new seed shape** for a drought tolerant crop. The aim is to produce food for livestock in drought affected areas of Australia. The plant scientists have asked for your help in designing a model seed shape for the plant that can be dispersed by wind. Wind dispersal was seen as the best option because seeds only need to be spread on top of the soil for them to germinate. This will also reduce the use of labour and machinery on farms and will help farmers survive changing climates.

3. Challenge:

Your challenge is to **design** a new seed model to be spread by wind. You will design and make seed models to investigate dispersal by wind. You will look at the relationship between the shape of the seed and its ability to be spread by the wind.

4. Problem:

Your team will design a seed shape model based on biomimicry and **measure** two important qualities that improve spreading by wind:

- distance travelled and
- time in the air.

Remember to follow the **Engineering Design Model**.

THINKING SPACE

… drawings, diagrams, observations, notes, reflections …

5. Materials:

- design supplies to construct artificial seed models (tape, scissors, glue, pipe cleaners, feathers, tissue paper, cotton wool balls, toothpicks, straws, post-it notes, thread, rubber bands, paperclips)
- small fan
- tape measure
- stop watch
- marker

6. Brainstorming and Design Thinking:

- **How** can you make your seed model **light**?

_____

_____

- **How** can you make your seed model **aerodynamic**?

_____

_____

- **How** should you **weight** your seed model to ensure it goes a long way and stays in the air for a long time?

_____

_____

- **Draw** and **label** some draft designs in the 'Thinking Space' on page 28.

Your group will be given a bag of seed samples to **examine**. Take notice of the shape, size and weight of each seed.

Discuss the following questions with your group:

- How do you think each of the seeds might be dispersed? Why?
- Which seed do you think is the best? Why?

THINKING SPACE

… drawings, diagrams, observations, notes, reflections …

7. Experimenting and Designing:

- **Draw** and **label** your first design.
- Experiment and think about how to design your seed model to allow it to be spread by wind. Focus on what shape and size and material used will allow your model to travel the farthest and stay in the air for the longest amount of time.

THINKING SPACE

… drawings, diagrams, observations, notes, reflections …

8. Construction:

Build your model seed using any materials supplied.

9. Testing:

a. Set up the fan on a table blowing horizontally across the room.
b. Establish a standard drop height above the fan and set up a tape measure along the floor beneath the fan.
c. Each seed model should be **dropped at least three times** from the same point above the fan. Experiment with your set-up to find the best height, and then use that height consistently for all trials.

10. Recording Your Results:

Record the **time** in the air and the **distance** travelled for each trial in the table below (Model #1).

Optional: Calculate the average time in air and distance travelled.

Seed Dispersal Data Table					
		Time in Air (s)	**Distance Travelled (cm)**	**Average Time in Air (s)**	**Average Distance Travelled (cm)**
Model #1	Trial #1				
	Trial #2				
	Trial #3				
Model #2	Trial #1				
	Trial #2				
	Trial #3				

THINKING SPACE

… drawings, diagrams, observations, notes, reflections …

11. **Redesigning:**

- **Design** another prototype of a flying seed model to **improve** on your first design. **Draw** and **label** your design below.

THINKING SPACE

… drawings, diagrams, observations, notes, reflections …

Record **how** you changed your seed model and **why**.

_____

_____

_____

_____

_____

12. Construction:

Build your new improved seed model.

13. Retesting:

Retest your second seed model using the same procedure as the first.

14. Recording Your Results:

Record your results on the table on page 33 (Model #2).

THINKING SPACE

… drawings, diagrams, observations, notes, reflections …

15. **Reflecting:**

Write answers to the following questions.

a. **Which** was your best design and **why**?

b. **What** would you do to **improve** your design?

c. **Re-read** the Environmental Engineers Card and **think** about what you have learned about Environmental Engineers. **What** are Environmental Engineers interested in?

THINKING SPACE

… drawings, diagrams, observations, notes, reflections …

BIOMIMICRY CHALLENGE FEEDBACK

Please **colour in the face** to show how you felt about the different parts of the *Biomimicry Challenge*.

Did you like:	**Did not like it**	**Not sure**	**Liked it**
1. ... the activity about Biomimicry?			
2. ... having a real problem to solve?			
3. ... watching the videos?			
4. ... designing a seed model?			
5. ... making the seed models?			
6. ... testing your seed models?			
7. ... recording the results of your seed model?			
8. ... thinking about how to make your seed model better?			

Next time I would like to:

_____

_____

_____

_____

