

# STUDENT WORKBOOK

## Year 6

Name: \_\_\_\_\_

Other group members: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

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Group Number: \_\_\_\_\_

Class: \_\_\_\_\_

School: \_\_\_\_\_



## **THINKING SPACE**

... drawings, diagrams, observations, notes, reflections ...

# DESIGNING AN EARTHQUAKE RESISTANT BUILDING

## 1. PROBLEM

Your team has been asked by AusAid, an organization that manages projects for countries in need, to **design a building that can withstand an earthquake** in the Philippines. Acting like structural engineers, you will design, build and test a structure that can withstand an earthquake simulated by a shaker table constructed by a QUT engineer. Since the Earth has limited resources, so too do engineers. For this reason you will need to **work within a budget**.

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

## 2. Materials and Equipment

- toothpicks (\$0.30 each)
- skewers (\$1.00 each)
- plasticine (\$1.00 per stick)
- scissors
- shaker table

## 3. Challenge

Using the materials listed, you will **design a building with the following constraints**:

- a. The building must be **at least 12cm (two storeys) high**
- b. The building must contain **at least one triangle**
- c. The building must contain **at least one square**
- d. There must be **evidence of cross-bracing** to reinforce the structure
- e. You may use **whole toothpicks or skewers cut to size**
- f. You have a **budget of \$40.00** (maximum) to spend

**The group whose final design does not fall over and remains in the exact shape it was before testing is the winner of the Engineering Challenge. If more than one group achieves this, the highest and/or least expensive structure will win.**






## **THINKING SPACE**

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#### 4. BRAINSTORM



Discuss the questions below with your group. **Record** your answers in the box.

<ul style="list-style-type: none"><li>• <b>What shapes</b> will you use for your building?</li></ul> <hr/> <hr/> 
<ul style="list-style-type: none"><li>• <b>How tall</b> will your building be? _____</li><li>• <b>Where</b> will you use either <b>cross-bracing, base isolation or tapered geometry</b>?</li></ul> <hr/> <hr/> <hr/> <hr/>
<ul style="list-style-type: none"><li>• <b>How</b> will you make it <b>strong</b>?</li></ul> <hr/> <hr/> <hr/>
<ul style="list-style-type: none"><li>• <b>Draw and label</b> some <b>draft designs</b> in the ‘Thinking Space’ on page 4.</li></ul>

#### 5. EXPERIMENT



- You will be given **50 toothpicks, 10 skewers and a stick of plasticine** to start with.
- If you wish, you can work with the materials and **experiment** with different **construction methods**.
- If you need to **cut a skewer**, you will have to **measure the required length** and **mark it** on the skewer. An **adult** will then **cut the skewer** at the mark.
- **Discuss** possible **designs** with your group, taking into account the **cost** of materials.

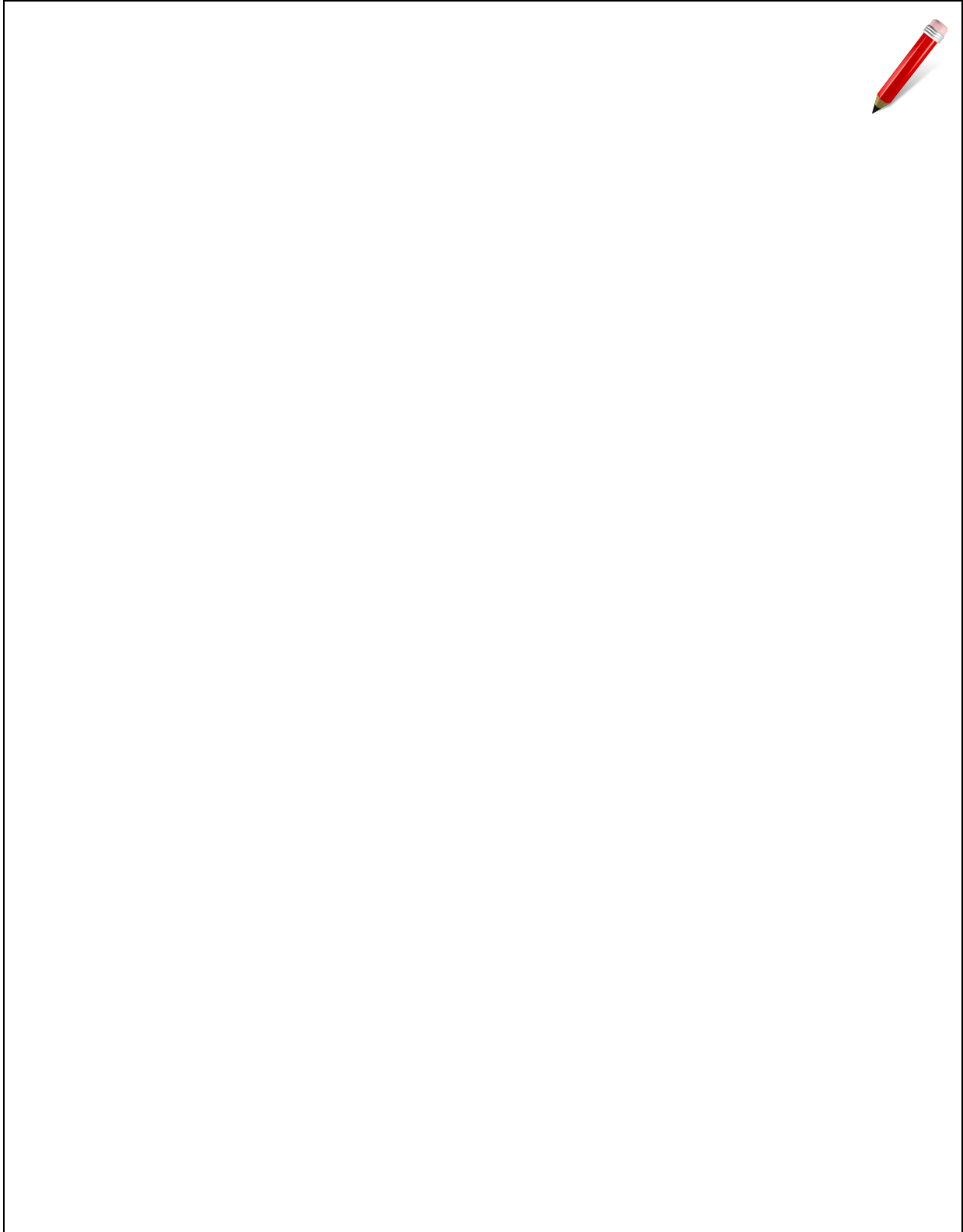


## **THINKING SPACE**

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## 6. DESIGN

- **Draw and label** your first design.
- Make sure you **label the shapes** you used with the correct names.
- **Remember** to put **measurements** on the design.
- **Note the amount of materials** you use.





## **THINKING SPACE**

... drawings, diagrams, observations, notes, reflections ...



## 7. BUILD



**Build** your structure using the materials supplied.



**Calculate** the cost of your building. **Record** the cost in the table below.

Materials	Cost	No. Used	Total
Toothpicks	\$0.30 each		
Skewers	\$1.00 each		
Plasticine sticks	\$1.00 each		
<b>GRAND TOTAL</b>			

## 8. TEST



**Write** answers to the following questions.

- a. **Place** your structure on the shaker table. **Pull the tab** on the shaker table to represent an earthquake of **Richter Scale 4**. **Describe** what happened.

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- b. **Repeat** at **Richter Scale 8**. **Describe** what happened.

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- c. **What** did you **learn** about your building from the test (including any **maths** and **science** that you used)?

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## **THINKING SPACE**

... drawings, diagrams, observations, notes, reflections ...

## 9. EXPERIMENT AND REDESIGN



Write answers to the following questions.

a. **What** can you **change** to improve your design?

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b. **How** will these changes make your structure **better**?

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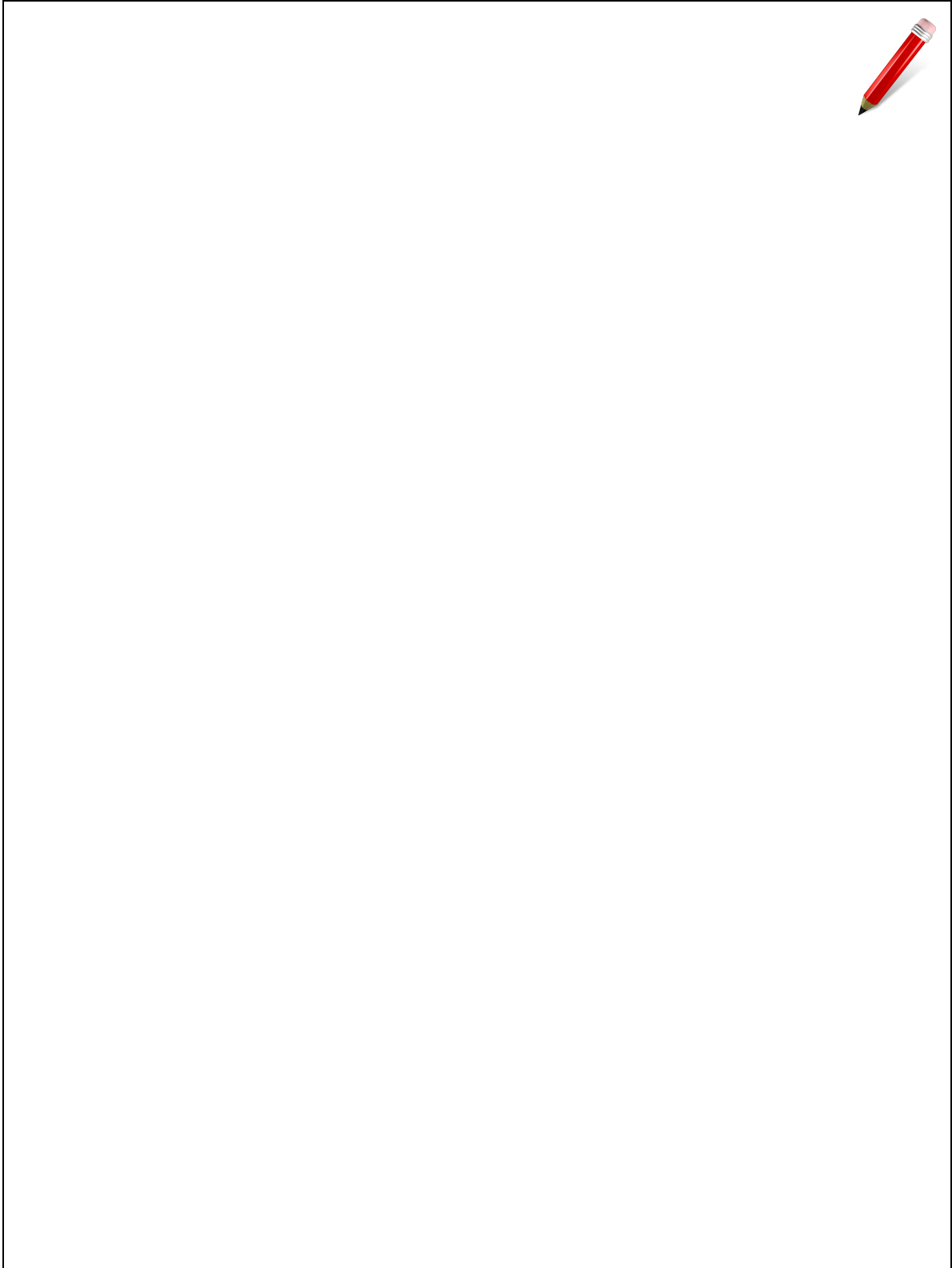
*Building models, created by student teams for a design contest, combine structural and cost-benefit considerations to ensure both safety and economic performance.*



## **THINKING SPACE**

... drawings, diagrams, observations, notes, reflections ...

- **Draw and label** your improved design below.





## **THINKING SPACE**

... drawings, diagrams, observations, notes, reflections ...

### 10. REBUILD



**Rebuild** your new and improved structure.



**Calculate** the cost of your new building. **Record** the cost in the table below.

Materials	Cost	No. Used	Total
Toothpicks	\$0.30 each		
Skewers	\$1.00 each		
Plasticine sticks	\$1.00 each		
<b>GRAND TOTAL</b>			

### 11. RETEST



**Write** answers to the following questions.

- a. **Place** your structure on the shaker table. **Pull the tab** on the shaker table to represent an earthquake of **Richter Scale 4**. **Describe** what happened.

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- b. **Repeat** at **Richter Scale 8**. **Describe** what happened.

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- c. **What** did you **learn** about your new building from the test (including any **maths** and **science** that you used)?

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## **THINKING SPACE**

... drawings, diagrams, observations, notes, reflections ...

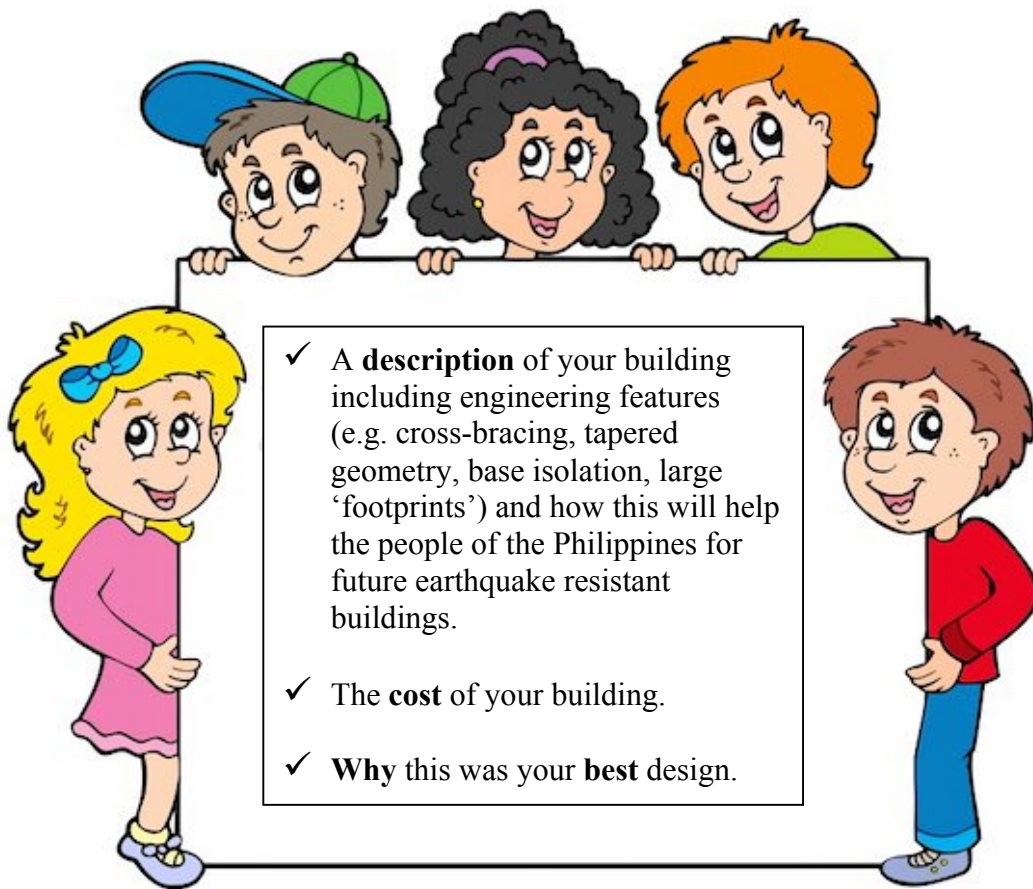


## 12. Presentation



**Present** your best design to the class.

- Use the ‘Thinking Space’ on page 16 to **plan your presentation**.
- **Include the following points** in your presentation.





## **THINKING SPACE**

... drawings, diagrams, observations, notes, reflections ...

### 13. Reflecting



Write answers to the following questions.

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

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

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c. In what ways were you **working like an earthquake engineer** today?

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d. Write down everything about **how you were using mathematics** today for the design of your building. You can use diagrams in your explanation.





























## **THINKING SPACE**

... drawings, diagrams, observations, notes, reflections ...

# EARTHQUAKE ENGINEERING CHALLENGE FEEDBACK

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

Did you like:	Did not like it	Not sure	Liked it
1. ... the activities about earthquakes?			
2. ... having a real problem to solve?			
3. ... designing a model of an earthquake resistant building?			
4. ... making a model of an earthquake resistant building?			
5. ... testing your model of an earthquake resistant building?			
6. ... recording the results of the test of your model of an earthquake resistant building?			
7. ... doing a presentation about your model of an earthquake resistant building?			
8. ... thinking about how to make your model of an earthquake resistant building better?			

**Next time I would like to:**

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