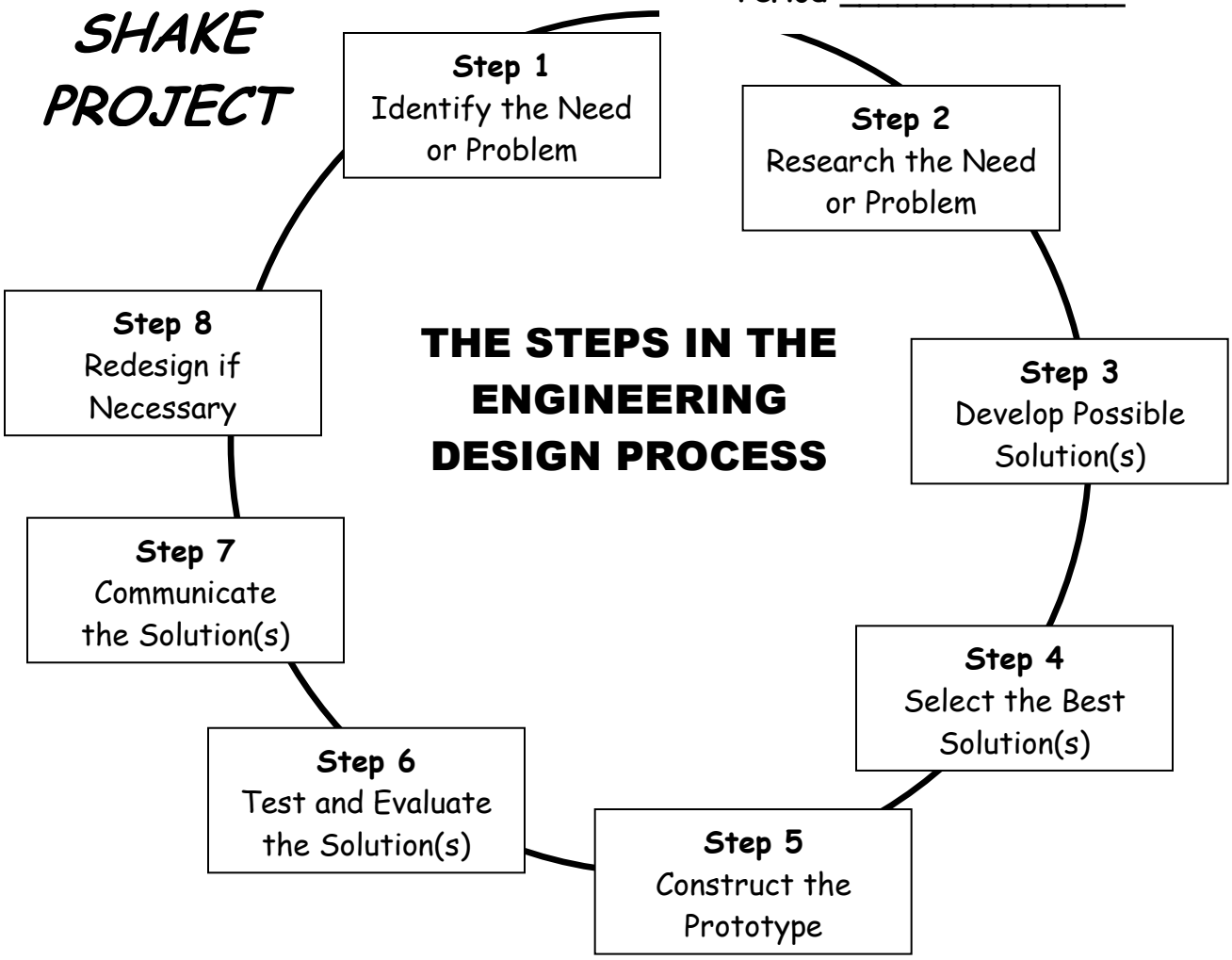
Name _____

Period _____

EARTHQUAKE SHAKE PROJECT



1. **Identify the need or problem.**
2. **Research the need or problem.**
   - examine current solutions
   - explore other options via the Internet, library, interviews, videos, etc.
3. **Develop possible solution(s).**
   - brainstorm possible solutions
   - use your knowledge of science and math
   - present the solutions using "thumbnail sketches", "rough sketches", and "working drawings"
4. **Select the best possible solution(s).**
5. **Construct the Prototype. Will it work as a final design?**
6. **Test and evaluate the Prototype. Submit final design & test final design.**
   - does it work?
   - does it meet the original design constraints?
7. **Communicate the solution(s).**
   - publish description and results of your research in a journal.
8. **Redesign (if necessary).**
   - Overhaul the solution(s) based on information gathered during the tests and presentation

EARTHQUAKE SHAKE PROJECT

STEP 1 – IDENTIFY THE NEED OR PROBLEM

Design and build a minimum of a four-floor structure that is self-supporting, free-standing, sits within a standard lot, and can withstand a moderate earthquake. Your grade will be based on the completion of this packet and upon the performance of your structure. A few materials will be provided and you need to make the best usage of what you are given.

You will research, design, test, evaluate, and present your findings following the steps in the Engineering Design Process found in this packet.

1. **FOLLOW ALL SAFETY RULES!!! ABSOLUTELY NO HORSEPLAY!!! If you do not follow this rule you may be asked to spend the remainder of the project away from the rest of the class, possibly in the office.**
2. Each group will design, construct, test, and evaluate their earthquake-resistant structure.
3. Plan your earthquake-resistant design so that it will maintain the greatest degree of stability and strength as possible (while being as *lightweight* as possible).
4. Students will design an earthquake-resistant structure using the steps of the Engineering Design Process.
5. Students will make mental notes of their progress each day. This will help students to write a short essay on the last day of the project.
6. At a "**TEACHER CHECKPOINT ___** ", students will have their work approved by their teacher before beginning the next section.
7. Each student group will receive 50 straws, 12 pop sickle sticks, 225 cm^2 of brown paper, 10 cm of masking tape, 10 construction pins, and 5 rubber bands.

8. Plans must be approved by the instructor before the earthquake-resistant structure prototype is constructed.
9. The instructor has the final decision as to the appropriateness of any additional items that might be used in the construction of the earthquake-resistant structure or over any other rulings not previously addressed.
10. You may do research away from class and bring materials from home (upon the approval of the instructor), but **all construction will take place in class. You may come in and work on your earthquake-resistant structure before school (7:30-8:00) or after school (2:30-3:00), but you <u>may not</u> take the earthquake-resistant structure home.**
11. Schedule for final test dates and completion of project will be announced.
12. Questions? Just ask your friendly, neighborhood earth science teacher! ☺

Design Requirements

Design Requirement	Description	Disqualifications
Height	The structure must be no higher than 50 cm tall, the height of the tallest structure (City Hall) in Earth City.	***Your structure will be disqualified if it is shorter than 40 cm tall.***
Area	The area of the base of the building must be at least 225 cm^2. However, the base should not be any larger than 324 cm^2.	***Your structure will be disqualified if its base has an area smaller than 196 cm^2***
Number of Floors	There must be at least a total of 4 floors, Each floor must be a minimum of 10 centimeters in height.	
Function	The top floor will be an open air parking garage. The top floor must be able to hold 250 grams of mass, even during an earthquake. Only the first and top floors need to have actual floors.	
Flag	A city flag must fly on top of the building. The city flag should fly at exactly 50 cm in height.	
Weight	Your structure must be constructed in a manner to make it as lightweight as possible.	

EARTHQUAKE SHAKE PROJECT

STEP 2A – RESEARCH THE NEED OR PROBLEM

THEORY

Before we can design an earthquake-resistant structure, we need to understand the science behind earthquakes, how earthquakes cause destruction, how engineers build structures to withstand earthquakes, and what types of designs you should consider when planning your structure. To answer the following questions, refer to the Internet or the links listed two pages ahead.

1. <u>What is an earthquake?</u>

2. <u>What causes earthquakes?</u>

3. <u>What are the three types of seismic waves</u>? <u>Next to each wave, sketch a diagram of how it operates</u>.

A. _____ - Waves

B. _____ - Waves

C. _____ - Waves

4. List and explain three types of destruction which earthquake waves cause.

A.

B.

C.

5. What types of buildings are very susceptible to collapsing due to earthquake waves? Explain.

6. What can engineers do to help to prevent structures from collapsing during earthquakes? List and explain at least three different things.

A.

B.

C.

7. What are seismic dampers and why are they important?

8. What is a truss? Why are trusses important which building structures?

9. Using the right type of trusses in your earthquake-resistant structure could help you to meet the design challenge by increasing the strength of the framework. Draw three truss designs which you may consider using for your earthquake-resistant structure:

TRUSS 1

TRUSS 2

TRUSS 3

INTERNET SOURCES

You may want to use the following web sites to do research needed for your earthquake-resistant structure. There are others that you may find by searching the Internet.

http://earthquake.usgs.gov/learn/kids/eqscience.php

http://www.eduweb.com/portfolio/bridgetoclassroom/engineeringfor.html

http://rooftrussblog.com/types-of-roof-trusses/

http://www.pre-engineering.com/resources/trusses.htm

http://www.contractorstruss.com/trusses.htm

http://www.camelbackdisplays.com/Truss-brief-history.htm

http://www.daviddarling.info/childrens_encyclopedia/structures_Chapter2.html

http://www.taylordevices.com/dampers-seismic-protection.html

http://bit.ly/HNIswF

http://www.homelandsecuritynewswire.com/shock-absorbers-making-buildings-earthquake-proof

http://www.popsci.com/scitech/article/2009-09/new-earthquake-resistant-design-keeps-buildings-standing-during-violent-quakes

TEACHER CHECKPOINT _____

STEP 2B – LOCATE RESOURCES

Material Type	Maximum Allowed	Mass (to be measured by student groups)
Straws	50	grams per straw
Pop Sickle Sticks	12	grams per stick
Brown Paper	225 cm^2	grams per cm^2
Masking Tape	10 cm	grams per cm
Construction Pins	10	grams per pin
Rubber Bands	5	grams per band

EARTHQUAKE SHAKE PROJECT

STEP 3 – DEVELOP POSSIBLE SOLUTIONS

Remember that the main goal of this challenge is to build a structure that is self-supporting, free-standing, sits within a standard lot, and can withstand a moderate earthquake. From your research (and from previous knowledge) make a list of things that are important (and you plan to use) to make your structure meet these goals!

1.
2.
3.
4.

What are the key aspects of building an earthquake-resistant structure? Check out the following article: http://www.ehow.com/how_2239227_build-earthquake-resistant-housing.html

Produce (at least) two possible design ideas for your earthquake-resistant structure. Sketch your design ideas for your earthquake-resistant structure in the spaces below.

Design 1

Design 2

TEACHER CHECKPOINT _____

EARTHQUAKE SHAKE PROJECT

STEP 4 – SELECT THE BEST SOLUTION(S)

Brainstorm with other group members and decide which design will work the best. Draw the plans for the earthquake-resistant structure your group will build in the box below. You may want to look at plans from the other "INTERNET SOURCES" to help you decide.

EARTHQUAKE-RESISTANT STRUCTURE PLANS

DRAW BASIC SHAPE OF THE EARTHQUAKE-RESISTANT STRUCTURE:	CUT PIECES (AS NEEDED):

TEACHER CHECKPOINT _____

EARTHQUAKE SHAKE PROJECT

STEP 5 – CONSTRUCT THE PROTOTYPE

Build a real-life model of your earthquake-resistant structure to make sure the pieces will fit together as planned. You will be allowed to modify your prototype once you have it put together. Building a prototype typically allows an engineer to resolve potential construction, materials, and performance issues before building the final product.

TEACHER CHECKPOINT _____

You may want (or need) to make changes based on your experiences in building the real-life model. In the space below, list the materials you will use. On the next page, provide detailed plans for your earthquake-resistant structure. When this plan has been approved, you may receive the Ziploc bag of materials from your instructor and begin construction of your project.

PROVIDED MATERIALS

Material Type	Number Available	You Plan to Use
Straws	50	
Pop Sickle Sticks	12	
Brown Paper	225 cm^2	
Masking Tape	10 cm	
Construction Pins	10	
Rubber Bands	5	

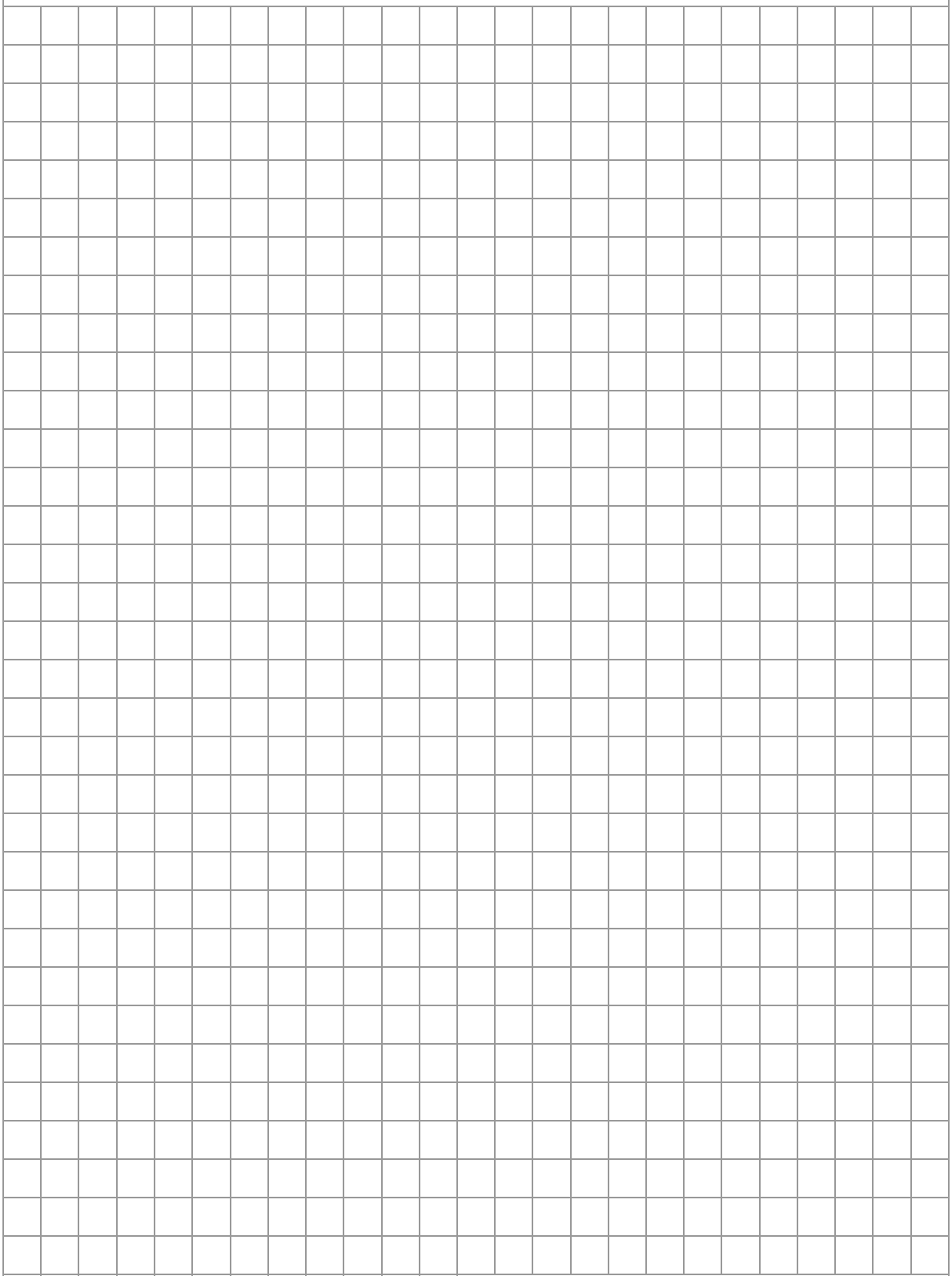
EARTHQUAKE-RESISTANT STRUCTURE FINAL PLANS

BASIC SHAPE OF THE EARTHQUAKE-RESISTANT STRUCTURE

STRAWS (OR OTHER PIECES) NEEDED – DRAW THEM

(Each square represents 2 cm x 2 cm)

STRAWS (OR OTHER PIECES) NEEDED (CONTINUED) – DRAW THEM TO SCALE



(Each square represents 2 cm x 2 cm)

TEACHER CHECKPOINT _____

EARTHQUAKE SHAKE PROJECT

STEP 6 – TEST AND EVALUATE THE SOLUTION

PROBLEMS/SOLUTIONS

You will encounter difficulties when working on this engineering design challenge. What were your three biggest problems constructing the earthquake-resistant structure and how did you solve them? Please use complete sentences.

1. PROBLEM:

SOLUTION:

2. PROBLEM:

SOLUTION:

3. PROBLEM:

SOLUTION:

TEACHER CHECKPOINT _____

EARTHQUAKE SHAKE PROJECT

EARTHQUAKE-RESISTANCE STRUCTURE TO BE TESTED

1. Mass (in grams) _____

2. Height (in cm) _____

3. Area of Base (in cm^2) _____

TEACHER CHECKPOINT _____

THE EARTHQUAKE SHAKE!!! FINAL CHECKS AND TESTS!!!

Your group will have two minutes to arrive at the earthquake shake table after you are called forward. Remember, your earthquake-resistance structure must withstand a **moderate** earthquake to receive all of the points!

4. Was your earthquake-resistant structure free-standing and self-supporting?

_____

5. Did your earthquake-resistant structure withstand a *light* earthquake? _____

6. Did your earthquake-resistant structure withstand a *moderate* earthquake? _____

TEACHER CHECKPOINT _____

EARTHQUAKE SHAKE PROJECT

STEP 7 – COMMUNICATE SOLUTION(S)

Write an article to be published in the fictional MVCTC Times newspaper about your experiences making and testing your self-supporting, free-standing, earthquake-resistant structure. The article should be between 150-200 words long. Include successes and failures you had in building and testing your earthquake-resistant structure. You may want to use your project packet and fellow team members as references when writing your article. *Your article must be in your own words*.

TITLE: _____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

TEACHER CHECKPOINT _____

EARTHQUAKE SHAKE PROJECT

STEP 8 – REDESIGN REFLECTION

1. Did your earthquake-resistant structure work properly when you tested it? Explain.

2. What could you do to your earthquake-resistant structure to improve its performance? Explain.

3. If you were starting over, what would you do differently? Explain.

4. How do you rate the attitude/cooperation of the members in your group?

	1	2	3	4	5	6	7	8	9	10
Not so good									Great!	

5. Would you want to work with the same group for the next project?

_____ Please explain why or why not.

TEACHER CHECKPOINT _____

EARTHQUAKE SHAKE PROJECT

GRADING

Day of Completion	Category	Possible Points	Points Earned
DAY 1	Step 2 - Research the Need or Problem	10 points	
DAY 2	Step 3 – Develop Possible Solutions	5 points	
DAY 2-3	Step 4 – Select the Best Solution	5 points	
DAYS 3-5	Step 5 - Construct the Prototype (Life-Size Model which will be modified)	15 points	
	Materials/Final Plans	15 points	
DAYS 4-5	Step 6 – Test and Evaluate the Solution	5 points	
DAYS 7-8	Structure To Be Tested ·Meets 0 specs ·Meets 2 specs ·Meets 4 specs ·Meets all 6 specs	0 points 3 points 6 points 10 points	
DAYS 7-8	Structure Performance ·Self-supporting – does not withstand *light* earthquake. ·Self-supporting – does withstand *light* earthquake ·Self-supporting – does withstand *moderate* earthquake	3 points 5 points 10 points	
DAY 9	Step 7 - Communicate Solution	10 points	
DAY 9-10	Step 8 – Redesign if Necessary	10 points	
ALL DAYS	Attitude/Cooperation within your Group.	5 points	
	Points DEDUCTED for leaving a messy work area	**MINUS**	-
	Total for Project	**100**	
	Withstands a severe earthquake!!!	10 points extra credit	+
	Lightest weight to withstand a *moderate* earthquake!!!	10 points extra credit	+