Home Connection:

Solar House Design Challenge

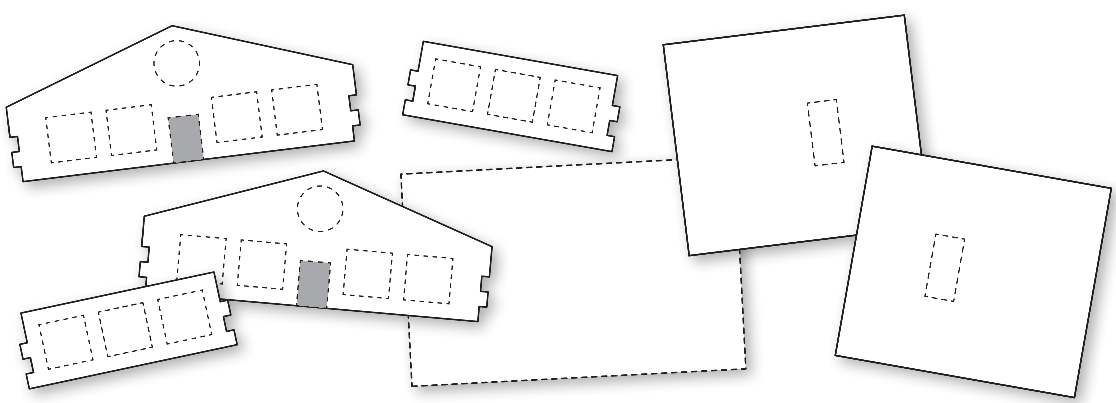
Dear Family,
During the last few days, the students designed a house that captured as much solar energy as possible. They acted just like engineers! They

- identified and learned about a problem
- planned ways to solve the problem
- made and tested a model
- revised their design to make it better

In this challenge, students developed understanding about radiant energy, engineering design, calculating area, and adhering to a budget. They also practiced skills, such as developing and using models, making claims based on evidence, and communicating technical information.

Let your child tell you in his or her own words about what the team did in this engineering effort and how the team used the model pieces and tools shown in the pictures. Prompt your child if he or she needs help.

- What was the problem you were solving?
- What were the criteria (goals or conditions) that your design had to meet?
- What constraints (limits) to cost and materials did you have to work with?
- How did you measure the success of your design?
- How did you improve your design? What information did you learn that led to your improvements?



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On the back of this sheet, work with your child to extend his or her work in the challenge.

Home Connection:

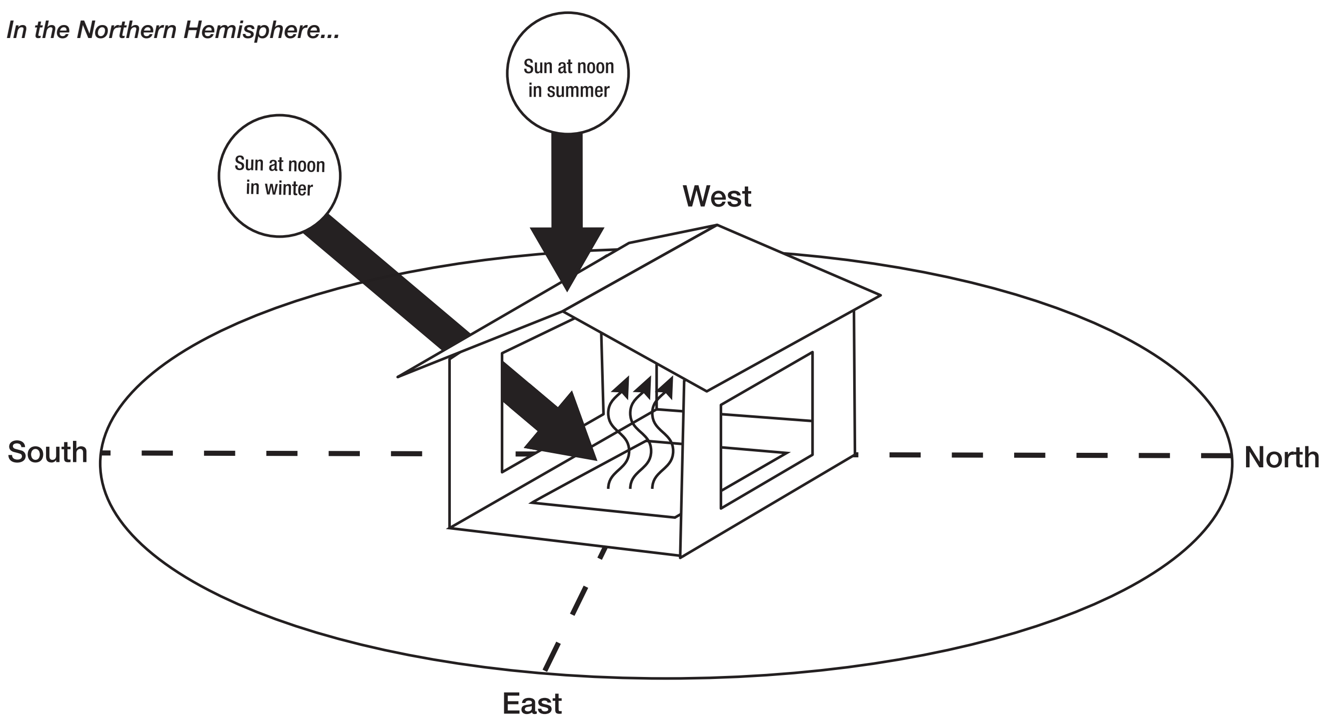
Solar House Design Challenge

Have your child use the diagram to tell you about the position of the sun in the sky during winter and summer, and why the sun's position is important to using passive solar energy. He or she will note that in most of the United States, the sun is always in the southern part of the sky, so southern exposures let in more solar energy.

Try it!

Conduct a survey of your home for its potential to use passive solar energy to help warm it. Help your child identify the direction each side of your home faces. Then help him or her measure the size and number of the windows that face in each direction. Work with your child to calculate how much open space faces in each direction. Then ask your child to draw conclusions about how much you might be able to depend on solar energy to help warm your home. Prompt your child, if needed.

- From which direction does the sun shine in most of the United States?
- How much open space do we have that faces in each direction?
- Do you think it is possible for us to use passive solar energy to warm our home? Why or why not?
- Could we rely on passive solar energy during part of the year or part of the day? Why or why not?



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Compare Flooring Materials

Name ______________________________

Follow these steps.

1. **Observe** the flooring materials under the lamps at the testing stations.
2. **Listen** for the starting temperature from each thermometer probe. Record the temperatures in the chart.
3. Watch as your teacher turns on the lamps. Then, wait 15 minutes.
4. **Listen** for the ending temperature from each thermometer probe. Record the temperatures in the chart.
5. **Calculate** the difference between the starting and ending temperatures.

Compare Flooring Materials			
Material	Starting Temperature (°C)	Ending Temperature (°C)	Difference (°C)
Brick			
Light Tile			
Slate			

TIP

When adding or subtracting decimals, line up the decimal points. It will help you match up numerals with the same place value. For example:

$$\begin{array}{r} 2.5 \\ +3.5 \\ \hline 6.0 \end{array}$$

Use the results of the test to answer these questions.

1. Rank the flooring materials from warmest to coolest at the end of 15 minutes.

   Warmest ⟷ Coolest

   ____

2. Which material might keep the floor the warmest? ______________________________

   Explain why you think so. ______________________________

   ____

   ____

   ____

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Solar Energy and House Design

Name ________________________________

Read pages 4 and 5 and think about the information.

Use your own words to define the following terms.

radiant energy: ____

____

reflect: ____

____

absorb: ____

____

Look back at your problem. Then, finish these sentences.

1. **Analyze** To solve our problem, we need to capture __________________ because

   ____

   ____

2. **Evaluate** The materials we use for our house might make a difference because

   ____

   ____

   ____

3. **Evaluate** The side of the house that faces south might make a difference because

   ____

   ____

   ____

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Passive Solar House Design Plan

Name ________________________________

Follow these steps.

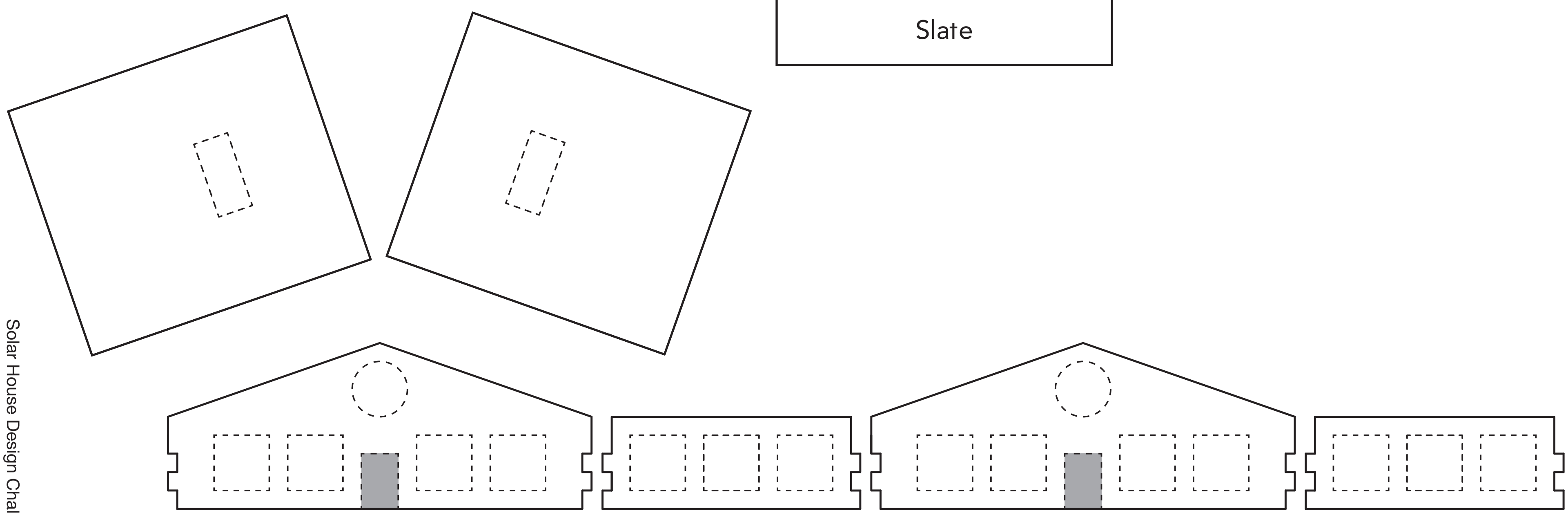
1. Circle one:

   My Design Plan   Team Design Plan

2. Use pencil to trace the dotted lines on each **House Side** and **Roof Side** to show where you want windows and skylights.
3. The doors are shaded. Decide if you will keep them open or closed.
4. Circle your choice of flooring material.
5. Place an ***S*** for ***South*** on the side of the house that will face the lamp (sun) during testing.

Flooring Materials (circle your choice)
Brick
Light tile
Slate

Roof Side 1   Roof Side 2



House Side 1   House Side 2   House Side 3   House Side 4

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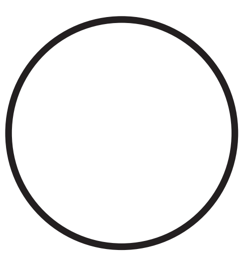
Materials Budget

Name ______________________________

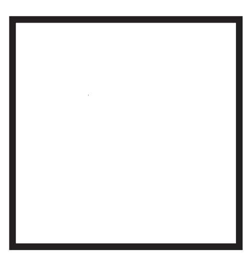
Follow these steps.

1. **Estimate** Look at the drawings of the square window and skylight. Estimate how many square centimeters each one covers. Write your estimates in the chart.
2. **Measure** The round window has been measured and the area has been calculated for you. Use a centimeter ruler to measure the length and the width of each square window and skylight. Write the length and width on the drawing.
3. **Compare** your estimate to the measured area.
4. **Calculate** the area of the square window and skylight. Multiply the length by the width.
5. **Calculate** the cost of one window of each kind. Multiply the area by the cost per square unit.

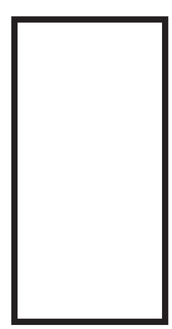
Window Type	Estimated Area in Square Centimeters	Area in Square Centimeters	Cost per Square Unit	Total Cost of One Window
Round window		7 square centimeters	$300	
Square window			$200	
Skylight			$400	



Round window



Square window



Skylight

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Calculating Total Cost

Name ________________________________

Follow these steps.

1. For windows and skylights, record the total cost for one item using calculations from the **Materials Budget** page.
2. Record how much of each material you will need to build your house in the *Quantity* column.
3. **Calculate** the total cost of each item. Multiply the cost per item by the quantity.
4. Only part of your total costs are spent on windows, skylights, and flooring. All other costs for building the house total $80,000. Add the total costs of each to find the total house cost.

Item	Cost per Item	Quantity	Total Cost
Square windows	$		
Skylights	$		
Round windows	$		
Flooring: brick	$6,000		
Flooring: light tile	$4,000		
Flooring: slate	$8,000		
All other costs for the house			$80,000
		Total House Cost	

5. **Compare** your total house cost to the cost constraint. Use the place value boxes to help you.

Cost Constraint $ 1 2 0 , 0 0 0

Our Total Cost $ ☐☐☐ , ☐☐☐

☐ Our total cost is $120,000 or less. We are ready to build.

☐ Our cost is more than $120,000. We need to make changes such as...

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Model Test Data

Name ________________________________

Follow these steps and record your data in the charts.

1. **Record** the starting temperature with the lamp off.
   Starting Temperature: ______ °C
2. The lamp is turned on. **Record** the temperature inside your model at 10 and 20 minutes.
3. The lamp is turned off when the timer reaches 20 minutes.
4. Wait 10 minutes, record the temperature inside your model. Repeat after 20 minutes.
5. **Calculate** the difference between the starting temperature and each temperature you measure. Record that difference in the chart.

Temperature Inside with Lamp On (Sun)		
Time (minutes)	**Temperature (°C)**	**Degrees above Starting Temperature**
10		
20		

Temperature Inside with Lamp Off (No Sun)		
Time (minutes)	**Temperature (°C)**	**Degrees above Starting Temperature**
10		
20		

6. **Evaluate** the success of your design plan. Recall that a successful design must:

☐ Increase the inside temperature of the house by at least 4°C above the starting temperature in 20 minutes with the lamp on.

How successful was your design? Explain. ________________________________

____

☐ After 20 minutes with the lamp off, have a final temperature of at least 1°C above the starting temperature.

How successful was your design? Explain. ________________________________

____

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Area of Open Space

Name ________________________________

Follow these steps.

1. Determine the direction that each side of the house and the roof faced. Circle the direction in the chart. Notice that Roof Sides will face the same direction as House Sides 2 and 4.

2. Get "area for one" information from the **Materials Budget** page.

3. **Calculate** the open area of each face of the house. To do this, multiply the area for one by the number of windows open.

Side	Which direction does it face? Circle one.	Square Windows and Skylights			Round Windows			Total Open Area
		Area for one	Number of windows or skylights open	Total open area	Area for one	Number of windows open	Total open area	
House Side 1	N S E W							
House Side 2	N S E W							
House Side 3	N S E W							
House Side 4	N S E W							
Roof Side 1	N S E W							
Roof Side 2	N S E W							

4. **Calculate** the total area of windows and skylights open to sunlight from each direction. To do this, add the total area of the skylights facing each direction to the total area of the windows facing each direction.

   Total open area of side facing:

   North ______ South ______ East ______ West ______

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Reflect On It

Name ________________________________

Use your design plan, model, and test results to finish these sentences.

Design Plan

1. We chose our flooring because ____

   ____

2. We decided to use the type of windows we did because ______________________

   ____

3. We placed the windows where we did so that ______________________________

   ____

4. We set the house so House Side _____ would face south because ______________

   ____

Model

5. Our model met these criteria: ____

   ____

6. Our model met these constraints: ____

   ____

7. One feature of our model that worked very well was__________________ because

   ____

8. One feature of our model that did not work very well was _____________ because

   ____

Compare Models

9. We compared our models to Team _____. I observed that ____________________

   ____

10. The most successful design was in Team _____. It might have been most successful because ____

   ____

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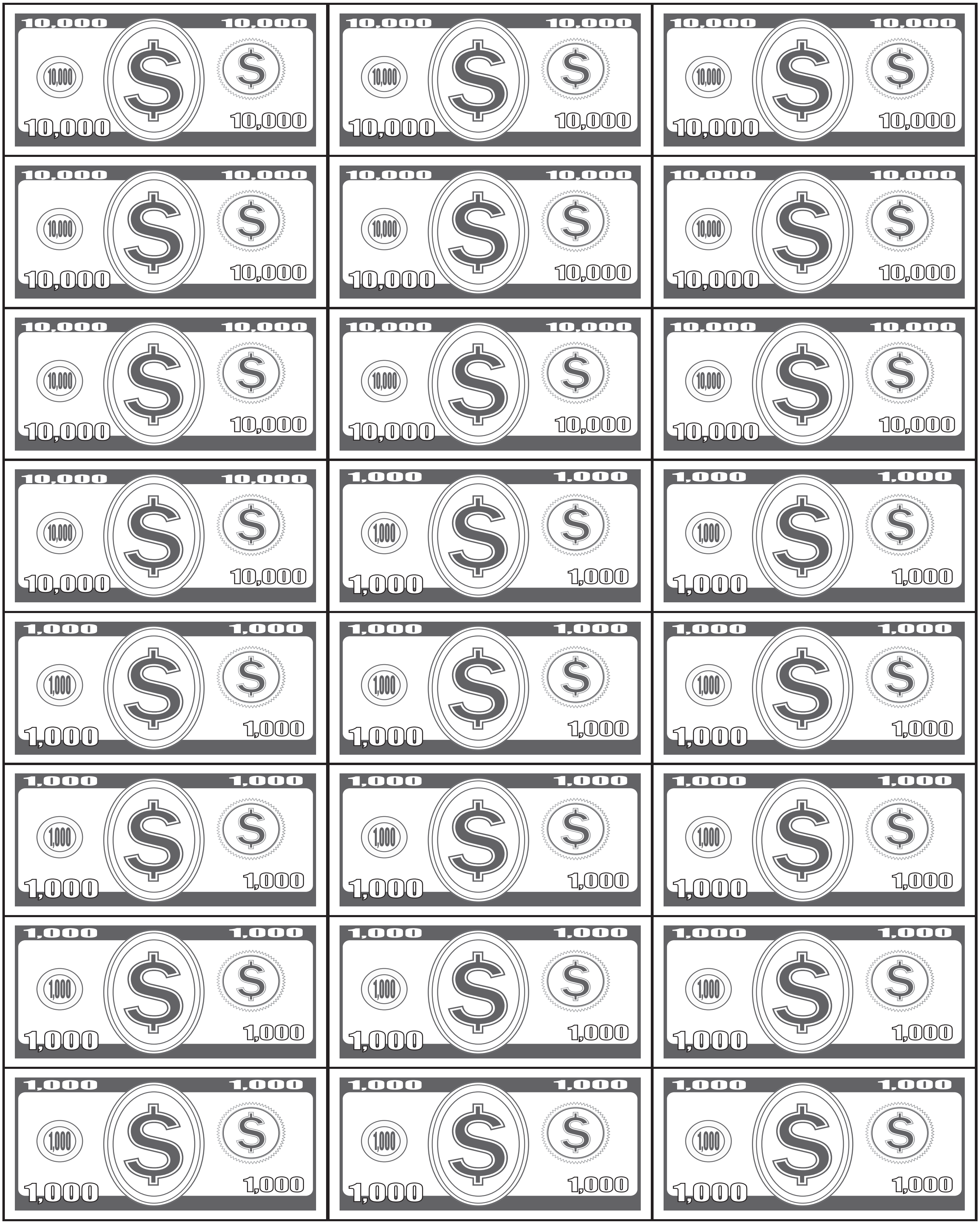
Spending Money



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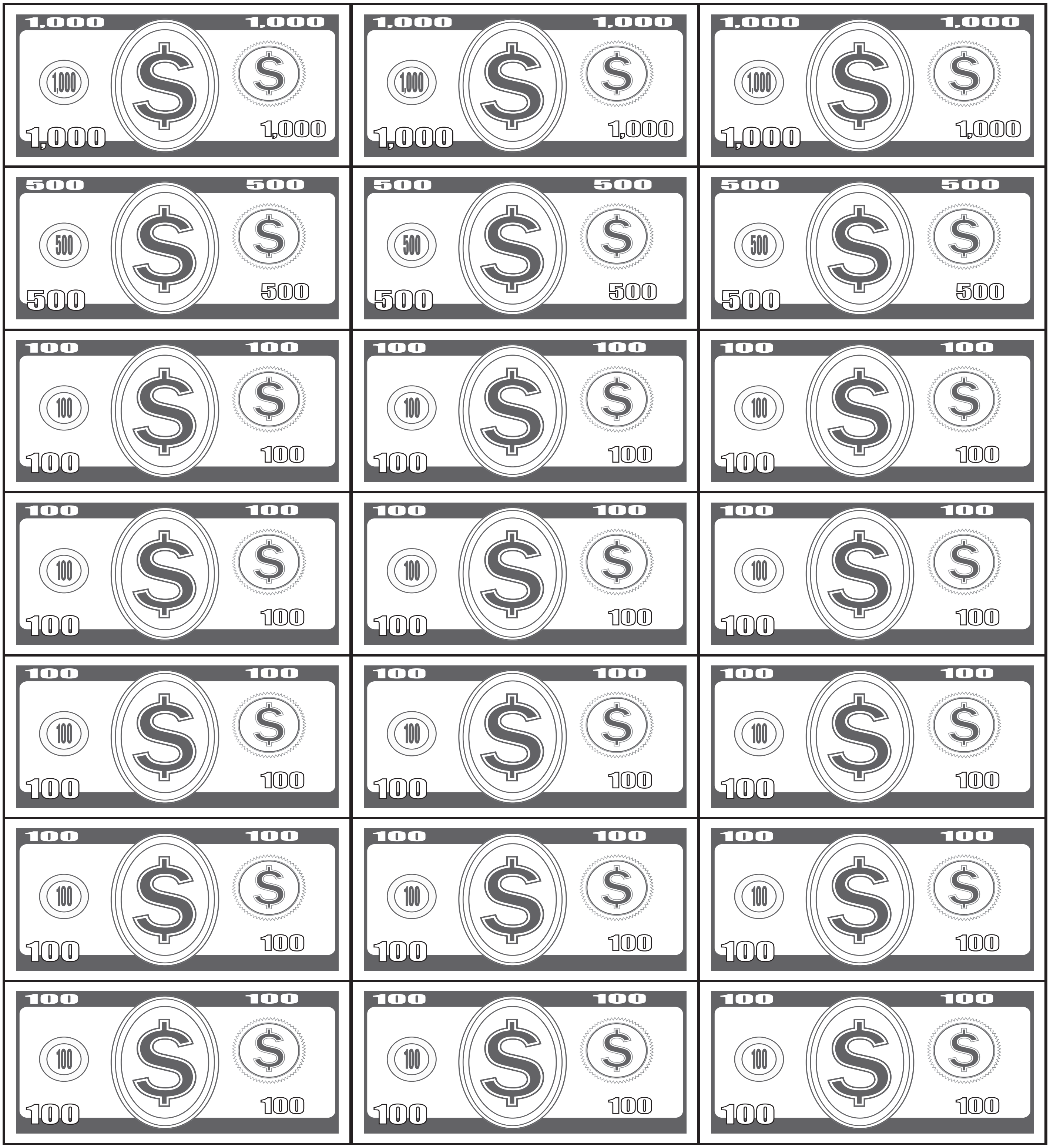
Spending Money



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