# Probing Under the Surface
## Task Information

**Grade:**    8th grade

**Content:**

- Middle Level Block D - IF3  Topographic Maps
- MST Framework Standard 2 Systems Modeling (Descriptive Modeling)

**Format:**    Manipulative

**Purpose:**

- To use a simple instrument to measure, record, and draw inferences about a hidden surface.

**Skills:**

**Primary:**    Observing, measuring, generalizing/inferring
**Secondary:**   Interpreting data, predicting

**Time:**    20 minutes

**Materials:**

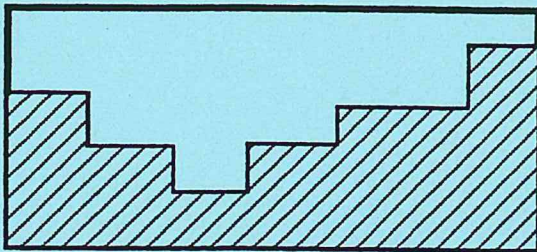**per Student:**
- measuring stick
- mystery box

**Preparation:**

- **Measuring Stick:**
  - use a small wooden dowel 1/8" - 1/4" in diameter and at least 5 cm longer than the box height.
  - marked off  in centimeters and label 0 - 15.
  - mark the dowel with a fine line permanent marker
- **Mystery Box:**
  - use a regular size shoe box.
  - cut and/or shape Styrofoam blocks to different levels.  A handy knife or coarse file will do this.  See diagrams below.
  - boxes must be all the same **or** labeled to match student papers with an answer key.
  - glue Styrofoam blocks at 3 or 4 different levels inside the bottom of the box
  - cover the tops of the Styrofoam blocks with tag board (duct tape).  This keeps the measuring stick from poking into the Styrofoam.
  - the depth between hole three (3) and hole five (5) should show significant changes.
  - on the top of the box, place a row of 10 (ten) equally distant dots.
  - number the dots 1 - 10

- use a drill or sharp pair of scissors to poke holes through the top of the box on the **odd numbered dots**.
- Be sure that the holes are large enough for the measuring stick to fit through. but not so large that you can see into the box.
- Seal the edges of the box top on the box with clear packing tape.
- The students should not be able to see inside the box at all during the experiment.
- measure and record the actual depth reading of each box to serve as the answer key.

### Sample Mystery Box Diagram:

(side view - inside of shoe box)                    (top view)
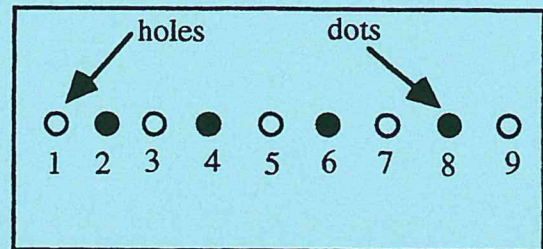


**Extensions/Modifications:**
- Students may wish to design their own hidden surfaces.

**Safety:**
- Watch that the students don't push the probe down too hard, causing the base to puncture or split.

**Credit/Source:** Project Aims Activities in integrating math and science

# Probing Under the Surface

**Task:** At this station, you will be using a measuring stick to determine the shape of the inside bottom of a box.
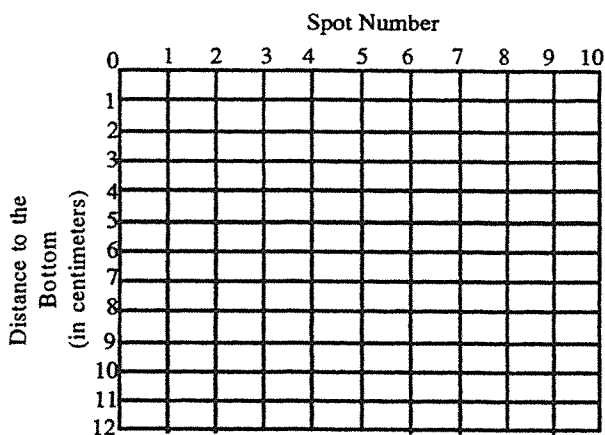
## Materials:

- 1  measuring stick
- 1  mystery box

## Directions:

1. Slide the measuring stick straight down into each spot marked on the box lid.
2. Measure the distance to the inside bottom of the box from each spot.
3. Record your measurements on the data table.
4. Place points on the graph representing the distance to the inside bottom of the box.
5. Connect the dots to make a line graph.

| Spot Number | Distance to the Bottom of the Box (in centimeters) |
|:---:|:---:|
| 1 | |
| 3 | |
| 5 | |
| 7 | |
| 9 | |

6. What does the graph indicate about the shape of the inside bottom of the box?

_____

_____

7. Based on your graph, predict what the depth is to the inside bottom of the box at spot 4.

_____

In the space below, explain the reason for your answer.

_____

_____

**Please Continue on the Next Page**

8. In the space below, make a drawing of what you think the inside bottom of the box looks like.
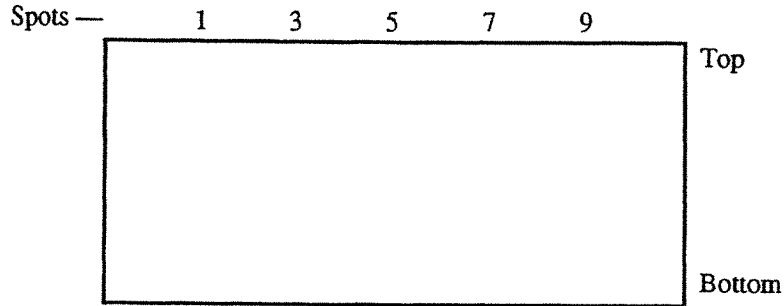
Spots —     1     3     5     7     9

Top

Bottom

9. Below is a set of observations made on **another box**. Which of the drawings <u>could</u> represent the shape of the inside bottom of the box? (Circle the letters of as many choices that could be possible.)

Spot Number

Distance to the Bottom (in centimeters)

A.

B.

C.

D.
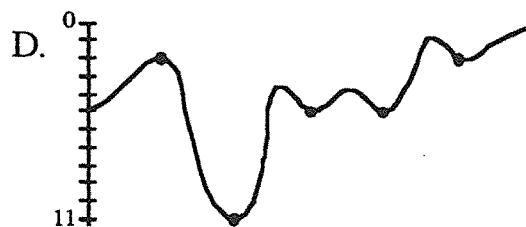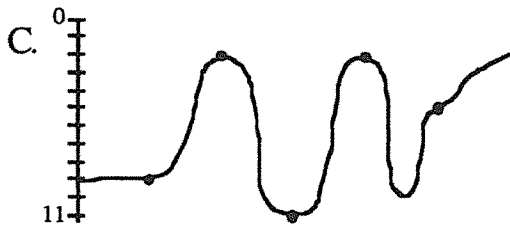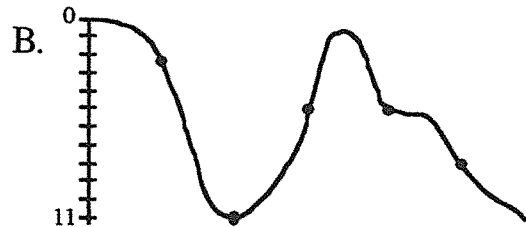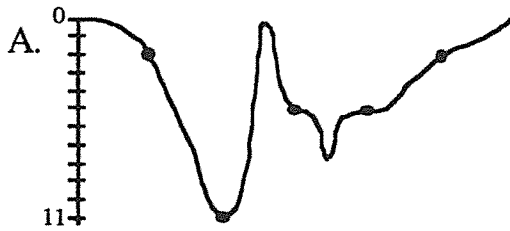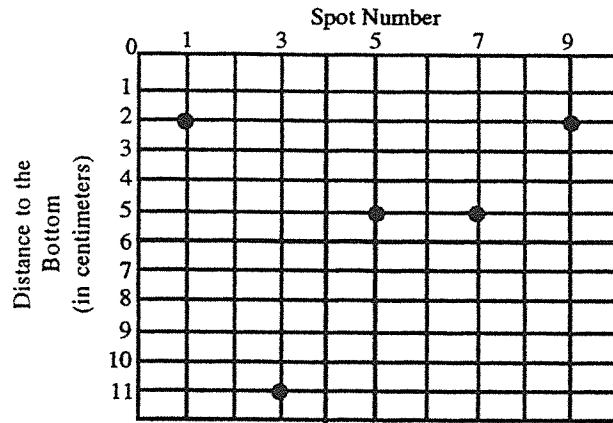
Please Continue on the Next Page

10. Two students performed a similar activity with the same mystery box that you used. Roberto used a probe that was 4 cm long and Susan used a probe that was 8 cm long. Compare the results that Susan and Roberto would have obtained about the shape of the inside bottom of the box.

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_____

_____

_____

_____

_____

# Probing Under The Surface - Scoring Rubric
## Maximum Score 24 points

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## Tasks 1 & 2 - Directions　　No credit

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## Task 3. Data Table　　7 points total

Standard: The student will measure the distance to the bottom of the box and record these data accurately and precisely in a data table.

Criteria

    A. 1 point for **each** of the five correct measurements (+/- 1.0 cm. of teacher's value)

    B. 1 point if **all** measurements are rounded to the nearest tenth of a centimeter.

    C. 1 point if **all** of the measurements are labeled with the correct units.

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## 4 & 5 Graph　　6 points total

Standard: The student will use the data from his/her table to draw a graph representing a profile of the surface of the bottom of the box.

Criteria

    A. Allow 1 point for **each** of the five correctly plotted points

    B. 1 point if the line is correctly drawn.
    Dot to dot **or** best fit curve may be acceptable.

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## Question 6　Shape description　　2 points total

Standard: The student will describe the shape of the bottom of the box using his/her data to draw inferences about the profile of an unobservable surface.

Criteria

    • 2 points if the statement is descriptive and is generally consistent with the table and graph.

    • 1 point if the statement is partially correct.

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## Question 7　Estimation　　4 points total

Standard: The student will predict the elevation of an unknown value between two known values, and justify that prediction. The prediction should be based on the student's graph

Criteria

    A. 2 points for correctly estimating the value and unit at spot four (4), based on their line graph - +/- 0.1 cm
    1 point for correct value +/- 0.2 cm.

    B. 2 points for a reasonable explanation for their prediction.
    1 point for a partial explanation of prediction.

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## Question 8    Model drawing                    1 point total

Standard:   The student will draw a two dimensional representation of the bottom
            of the box based on their data.

Criteria
- 1 point for a drawing which matches the graph in #3.

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## Question 9    Select drawing                   2 points total

Standard:   The student will interpret the data from the graph to make an
            accurate inference.

Criteria
- 2 points if both and only graphs A & D are selected.
- 1 point if only graph A or D is selected, with no incorrect selections.
- 1 point if both graphs A or D are selected, and one additional incorrect
  selection is made.
- 0 points if 2 incorrect graphs are selected.

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## Question 10    Explanation of limited stick      2 points total

Standard:   The student will explain the results of the limits of measurement

Criteria
- 2 points if a logical explanation is given that the graph would reflect the
  lack of data below the limits of the measuring stick.
- 1 point for a partial explanation.

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### Highest possible score - 24 points

**Student ID** _____ **Scoring Form - Probing Under the Surface**

**Male or Female (circle one)**

Circle the student's score for each question. Add the points for each question and write the total score at the bottom of the scoring form.

**1. & 2.    No credit**

**3.  Data table**

| | | | | | | |
|---|---|---|---|---|---|---|
| A. Recorded each correct measurement | 0 | 1 | 2 | 3 | 4 | 5 |
| B. Record all measurements to the nearest tenth of a centimeter | 0 | 1 | | | | |
| C. Labeled all measurements with correct units | 0 | 1 | | | | |

**4. & 5.    Graph**

| | | | | | | |
|---|---|---|---|---|---|---|
| A. Points correctly plotted | 0 | 1 | 2 | 3 | 4 | 5 |
| B. Line correctly drawn | 0 | 1 | | | | |

**6.  Shape Description**        0    1    2

**7.  Estimation**

| | | | |
|---|---|---|---|
| A. Value of depth and units | 0 | 1 | 2 |
| B. Reasonable explanation | 0 | 1 | 2 |

**8.  Model Drawing**        0    1

**9.  Select Drawing**        0    1    2

**10. Explanation of Limited Stick**        0    1    2

**Total Score** _____

Total possible score - 24

# Probing Under the Surface

Task:   At this station, you will be using a measuring stick to determine the shape of the
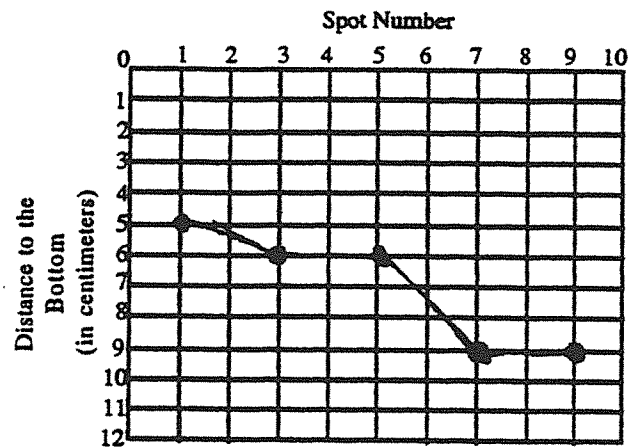inside bottom of a box.

MATERIALS
    1   measuring stick
    1   mystery box

DIRECTIONS

1.   Slide the measuring stick straight down into each spot marked on the box lid.

2.   Measure the distance to the inside bottom of the box from each spot.

3.   Record your measurements on the data table.

4.   Place points on the graph representing the distance to the inside bottom of the box.

5.   Connect the dots to make a line graph.

| Spot Number | Distance to the Bottom of the Box (in centimeters) |
|---|---|
| 1 | 5 cm |
| 3 | 6 cm |
| 5 | 6 cm |
| 7 | 9 cm |
| 9 | 9 cm |

6.   What does the graph indicate about the shape of the inside bottom of the box?

It indicates that as you move down
the box it gets deeper or it stays
the same.

#1

7. Based on your graph, predict what the depth is to the inside bottom of the box at spot 4.
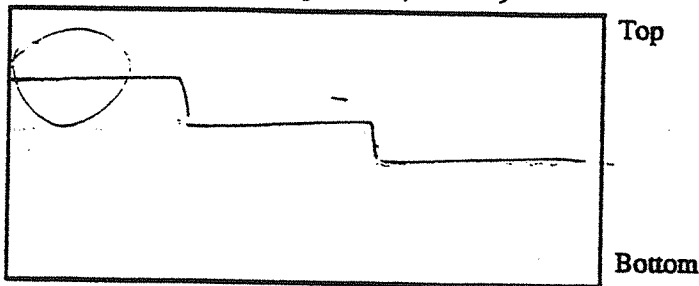
__6 cm__          Explain how you got your answer in the space below.

I got this answer because the graph shows that the box gets deeper or stays the same so I think it would stay the or the depth of the box would be lower
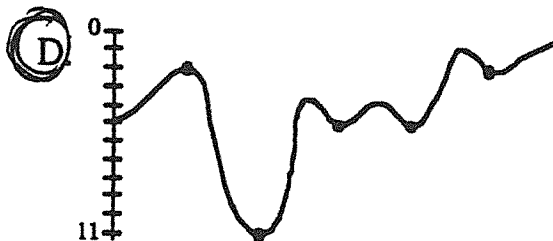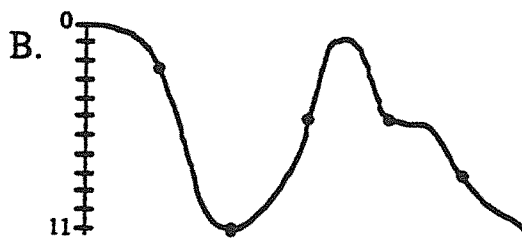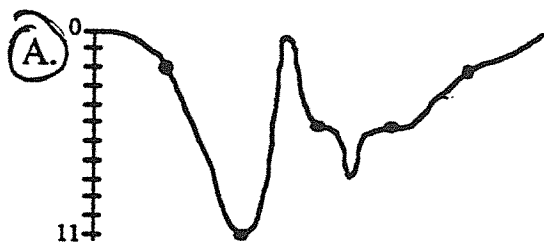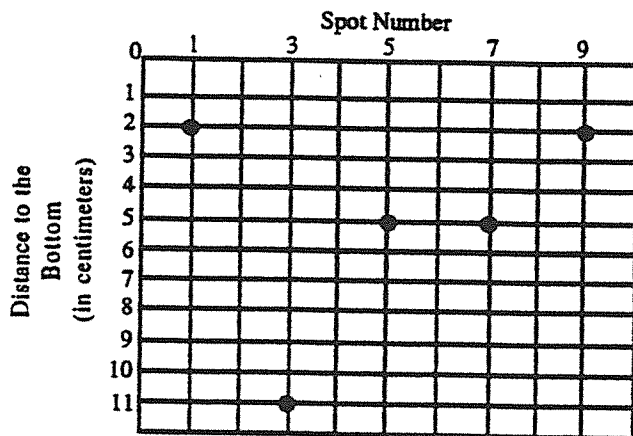
8. In the space below, make a drawing of what you think the bottom of the box looks like.

Spots —          1    3    5    7    9

Top

Bottom

9. Below is a set of observations made on another box. Which of the drawings could represent the shape of the inside bottom of the box? (Circle the letters of as many choices that could be possible.)

Spot Number

Distance to the Bottom (in centimeters)

A.

B.

C.

D.

10. Two students performed a similar activity with the same mystery box that you used. Roberto used a probe that was 4 cm long and Susan used a probe that was 8 cm long. Compare the results that Susan and Roberto would have obtained about the shape of the inside bottom of the box.

Susan's box was deeper and Roberto's was swallower.

Student ID ___6755-61___ Scoring Form - Probing Under the Surface

(Male) or Female (circle one)

Circle the student's score for each question. Add the points for each question and write the total score at the bottom of the scoring form.

**1. & 2.**   No credit

**3. Data table**

   A. Recorded each correct measurement     0    1    2    3    4    (5)

   B. Record all measurements to the
      nearest tenth of a centimeter     0    (1)

   C. Labeled all measurements with
      correct units     0    (1)

**4. & 5.**   Graph

   A. Points correctly plotted     0    1    2    3    4    (5)

   B. Line correctly drawn     0    (1)

**6. Shape Description**     0    1    (2)

**7. Estimation**

   A. Value of depth and units     0    1    (2)

   B. Reasonable explanation     0    1    (2)

**8. Model Drawing**     0    (1)

**9. Select Drawing**     0    (1)    2

**10. Explanation of Limited Stick**     (0)    1    2 → didn't see or do

Total Score ___21___

Total possible score - 24

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## DIRECTIONS

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5.   Connect the dots to make a line graph.

| Spot Number | Distance to the Bottom of the Box  (in centimeters) |
|---|---|
| 1 | 4 cm |
| 3 | $5\frac{1}{2}$ cm |
| 5 | $5\frac{1}{2}$ cm |
| 7 | 8 cm |
| 9 | 11 cm. |
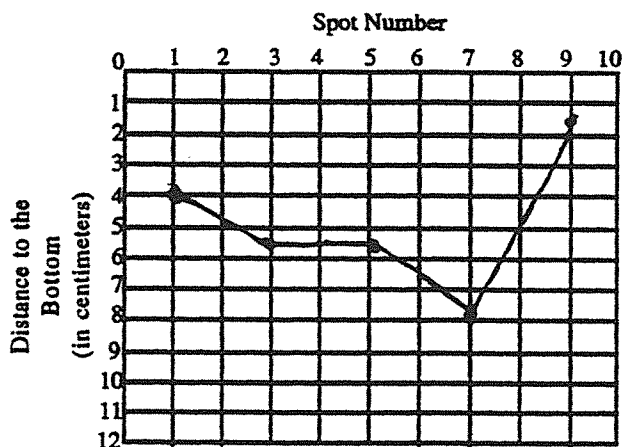


6.   What does the graph indicate about the shape of the inside bottom of the box?

The graph indicates that the shape of the box inside is no all even the front is higher than the middle the end is very high.