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MANEUVERS ON A GEO-BOARD.

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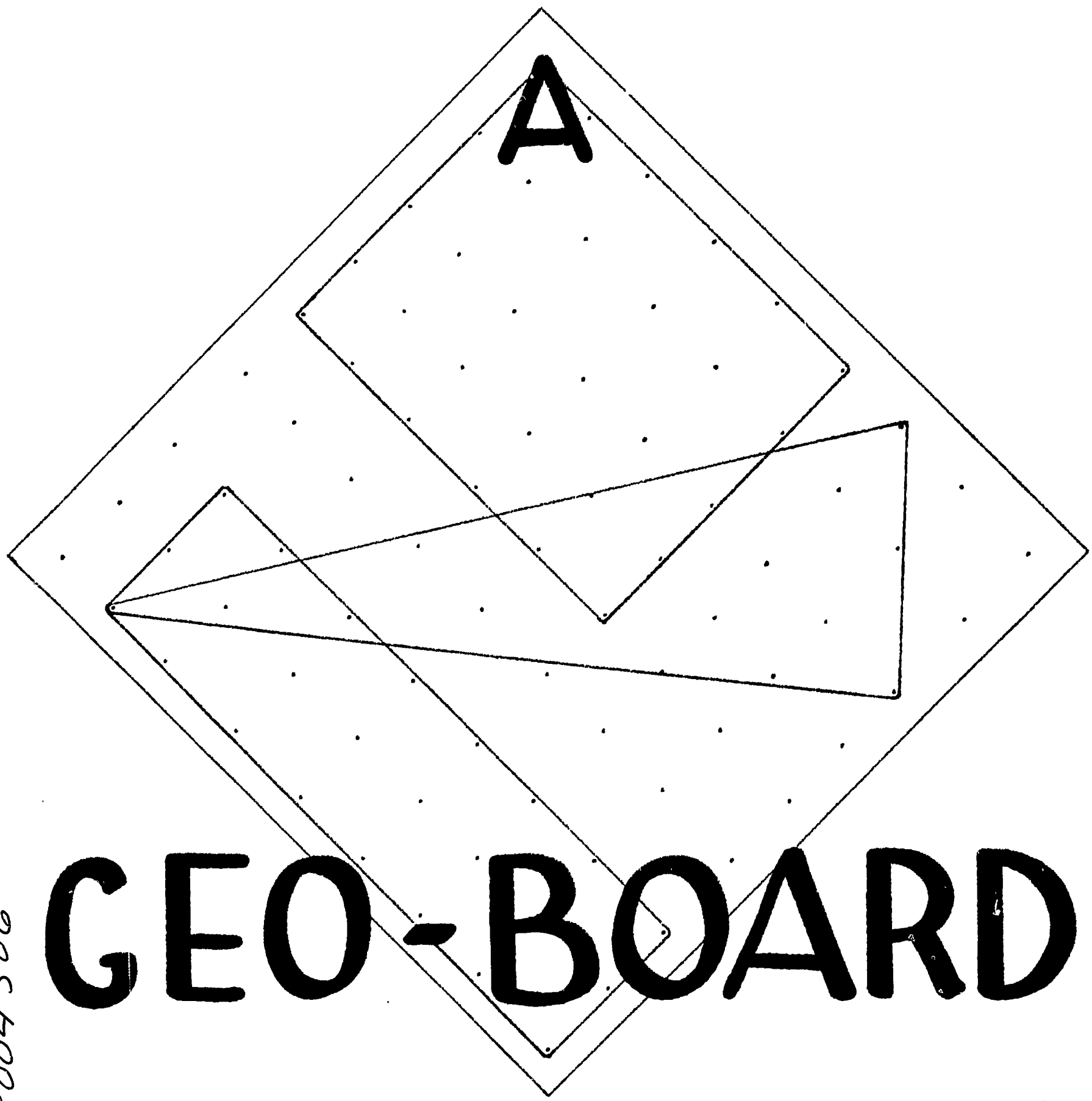
THIS BOOKLET, ONE OF A SERIES, HAS BEEN DEVELOPED FOR THE PROJECT, A PROGRAM FOR MATHEMATICALLY UNDERDEVELOPED PUPILS. A PROJECT TEAM, INCLUDING INSERVICE TEACHERS, IS BEING USED TO WRITE AND DEVELOP THE MATERIALS FOR THIS PROGRAM. THE MATERIALS DEVELOPED IN THIS BOOKLET INCLUDE ACTIVITIES ON (1) CONSTRUCTION OF SQUARES, RECTANGLES, TRIANGLES, AND PARALLELOGRAMS HAVING A GIVEN INDICATED AREA, (2) DISCOVERING RELATIONSHIPS BETWEEN PERIMETER, LENGTH, WIDTH, AND AREA OF GEOMETRICAL CONSTRUCTIONS, AND (3) CONSTRUCTING NETWORKS. ACCOMPANYING THESE BOOKLETS WILL BE A "TEACHING STRATEGY BOOKLET" WHICH WILL INCLUDE A DESCRIPTION OF TEACHER TECHNIQUES, METHODS, SUGGESTED SEQUENCES, ACADEMIC GAMES, AND SUGGESTED VISUAL MATERIALS. (RP)

MANEUVERS

ON



GEO-BOARD

ESEA TITLE III

PROJECT MATHEMATICS

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November 1967

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1. Construct a square which encloses an area of 9 square inches.

2. Construct a rectangle which encloses an area of 12 square inches.

   Record the results of activities 3 - 6 in table 1.

3. Construct a square which encloses an area of 4 square inches.
   What is the perimeter of the square? _____
   What are the length and width of the square? _____

4. Construct a rectangle (not a square) which encloses an area of 4 square units. What is the perimeter of the rectangle? _____ What is the length and width of the rectangle? _____

5. Construct a square which encloses an area of 16 square inches.
   What is the perimeter of the square? _____
   What are the length and width of the square? _____

6. Construct a non-square rectangle which encloses an area of 16 square inches. What is the perimeter of the rectangle? _____
   What are the length and width of the rectangle? _____

Table 1

Activity	Perimeter	Length	Width	Area Measure
3.	_____	_____	_____	4 square inches
4.	_____	_____	_____	4 square inches
5.	_____	_____	_____	16 square inches
6.	_____	_____	_____	16 square inches

Discussion: If a square and a rectangle have the same area measure, do they have the same perimeter? _____ Which will have the least perimeter for the same amount of area?

_____

7. Construct a rectangle which encloses an area of: 15 square inches, 18 square inches, 20 square inches, and 24 square inches. Record the results in Table 2.

Table 2

Rectangle	Perimeter	Length	Width	Area Measure
1.	_____	_____	_____	15 square inches
2.	_____	_____	_____	18 square inches
3.	_____	_____	_____	20 square inches
4.	_____	_____	_____	24 square inches

Look at your table: Compare the length and width to the area. If you know the length and width of a rectangle, how can you easily find the area? _____

8. Construct each of the following triangles:
   a. Scalene - The three sides have unequal lengths.
   b. Isosceles - Exactly two sides are equal.
   c. Equilateral - All three sides are equal.

Record the results of activities 9 - 12 in Table 3.

9. Construct a right triangle which encloses an area of 2 square inches. (Hint: Divide a square of 4 square inches into 2 right triangles.) What is the measure of the base and height of the triangle?

10. Construct an isosceles triangle which encloses an area of 3 square inches. What is the measure of the base and height of the triangle?

11. Construct an isosceles triangle which encloses an area of 2 square inches. What is the length of the base and height of the triangle?

12. Construct a scalene triangle which encloses an area of 1 square inch. What is the measure of the base and height of the triangle?

Table 3

Activity	Base	Height	Area
9.	_____	_____	2 square inches
10.	_____	_____	3 square inches
11.	_____	_____	2 square inches
12.	_____	_____	1 square inch

Discussion: Compare the base and height to the measure of the area of each triangle. Do you see a quick way to find the measure of a triangle if you are given the measure of the base and height?

Record your results of activities 13 - 16 in table 4.

13. Construct a parallelogram which encloses an area of 6 square inches (Opposite sides parallel--but not a rectangle). What is the measure of the base and height of the parallelogram?

Construct each of the following parallelograms (not rectangles). Record the measure of the base and height of each parallelogram.

14. Enclose an area of 8 square inches.

15. Enclose an area of 10 square inches.

16. Enclose an area of 15 square inches.

Table 4

Activity	Base	Height	Area
13.	_____	_____	6 square inches
14.	_____	_____	8 square inches
15.	_____	_____	10 square inches
16.	_____	_____	15 square inches

Look at your table: If you were given the measure of the base and height of a parallelogram could you give a quick way to find the measure of area?

The following activities 17 - 23 will involve counting border points (nails the rubber band is touching) and interior points (nails in the interior of the geometric figure--but not touching the rubber band). Record your results for each activity in table 5. (Number 17 is filled in as an example.)

17. Construct a square which encloses an area of 36 square inches. What is the number of border points? What is the number of interior points?

18. Construct a triangle which encloses an area of 6 square inches. Give the number of border and interior points.

19. Construct a rectangle which encloses an area of 30 square inches. Give the number of border and interior points.

For activities 20 - 23, the area is not given. List in table 5 the border and interior points for each figure and then if you can "guess" the area.

20. Construct a 4-sided geometric figure (quadrilateral) such that no 2 sides have equal measures. (Don't let the rubber band cross itself.) Give the number of border and interior points.

21. Construct a 5-sided geometric figure (pentagon). Give the number of border and interior points.

22. Construct a 6-sided geometric figure. Give the number of border and interior points.

23. Construct a geometric figure of your choice. (Don't let the rubber band cross itself.) Give the number of border and interior points.

Table 5

Activity	I Exterior Points	II One-half of Exterior Points	III Interior Points	Columns II + III	Area
17. (square)					
18. (triangle)					
19. (rectangle)					
20. (4-sided)					
21. (5-sided)					
22. (6-sided)					
23. (choice)					

Discussion: Can you give a relationship between border points, interior points and area? If you were given the number of border points and interior point of a geometric shape (made up of straight line segments), could you "guess" the measure of the area?

24. Construct each of the figures shown in table 6. Use the information to do a construction, and complete the table. ("omit"--leave these out.)

Table 6

Shape	Length (Base)	Width (Height)	Perimeter	Area
A. Right Triangle	2 inches	2 inches	"omit"	_____
B. Isosceles Triangle	3 inches	2 inches	"omit"	_____
C. Isosceles Triangle	_____	4 inches	"omit"	8 sq. in.
D. Square	5 inches	_____	_____	_____
E. Rectangle	5 inches	_____	_____	40 sq. in.
F. Right Triangle	_____	_____	"omit"	4 sq. in.
G. Rectangle	_____	3	20	_____
H. Square	_____	_____	40	_____

25. Construct each triangle below with the given measures. Fill in the missing values.

Table 7

Shape	Base	Height	Area
A. Isosceles Triangle	3 in.	2 in.	_____
B. Isosceles Triangle	2 in.	3 in.	_____
C. Right Triangle	4 in.	3 in.	_____
D. Right Triangle	3 in.	4 in.	_____
E. Scalene Triangle	_____	4 in.	10 sq. in.
F. Scalene Triangle	4 in.	_____	10 sq. in.

26. Construct a 4-sided figure. Use a second rubber band to connect to 2 corners of the quadrilateral so that it is divided into 2 triangles.

27. Construct a 5-sided figure. Use 2 rubber bands connected to corner points so that it is divided into 3 triangles.

28. Construct a 6-sided, 7-sided, and an 8-sided figure. What is the least number of rubber bands needed to divide each figure into triangles?

Fill in the values below:

Table 8

Shape	(least no.) Rubber Bands	No. of Triangles
4-sided	1	2
5-sided	_____	_____
6-sided	_____	_____
7-sided	_____	_____
8-sided	_____	_____

29. Construct a square which encloses 36 square inches of area. Using border points on the square, construct the largest (most area measure) triangle possible inside the square. What type triangle is this?

a) scalene b) equilateral c) isosceles

30. If you had to fence off 100 square units of area (4-sided), which dimensions would you use for the least amount of fencing?

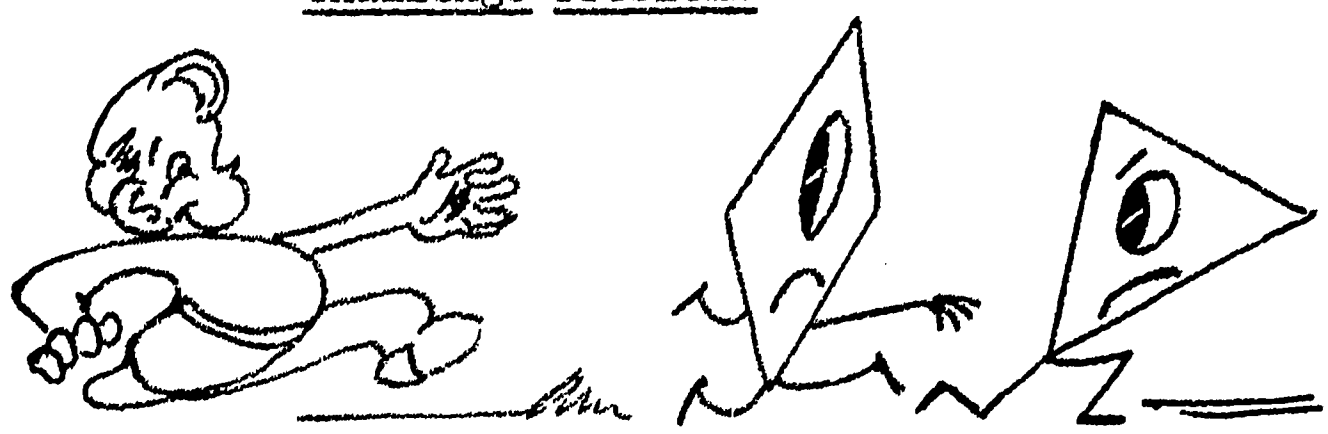
a) 4 by 25 rectangle

b) 2 by 50 rectangle

c) 10 by 10 rectangle (square)

d) Another 4-sided figure. Show an illustration (drawing) of your figure.

Challenge Problems



1. Construct a triangle with an area of:
   a. 6 square inches
   b. 8 square inches

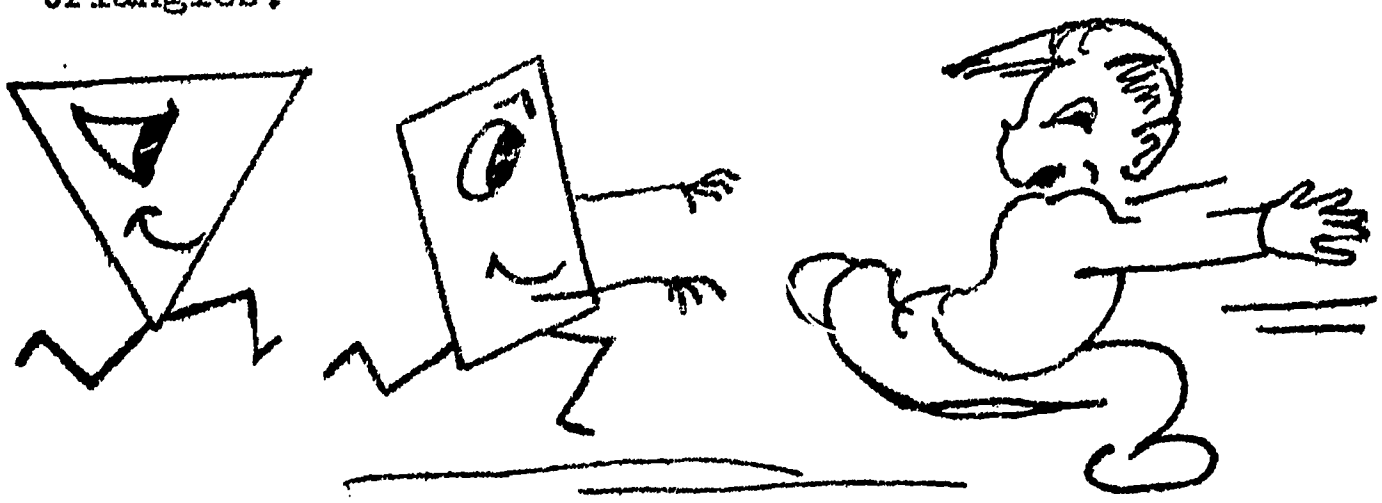
2. Construct a trapezoid with an area of 4 square inches. Base _____ Height _____

3. Construct a trapezoid with an area of 25 square inches. Base _____ Height _____

4. Construct a pentagon with an area of:
   a. 3 square inches
   b. 4 square inches
   c. 12 square inches

5. Construct a square with an area of:
   a. 2 square inches
   b. 8 square inches

6. Construct an isosceles triangle. Using another rubber band, construct another isosceles triangle inside the original so that the larger triangle is divided into 4 equal isosceles triangles.



7. Construct a 6-sided figure so that, if one line segment is constructed, 2 equal trapezoids result.

* 8. Construct an isosceles triangle with an area of 1 square inch. Perimeter _____

* 9. Construct a right triangle with a base of 1 inch and a height of 4 inches. Area _____ Perimeter _____

* 10. Construct an isosceles triangle with an area of 1 $\frac{1}{2}$ inches. Base = $\sqrt{2}$. Perimeter is _____.

* 11. Construct an isosceles triangle with an area of 6 square inches. Base = $\sqrt{8}$.

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* Must know Pythagorean theorem.

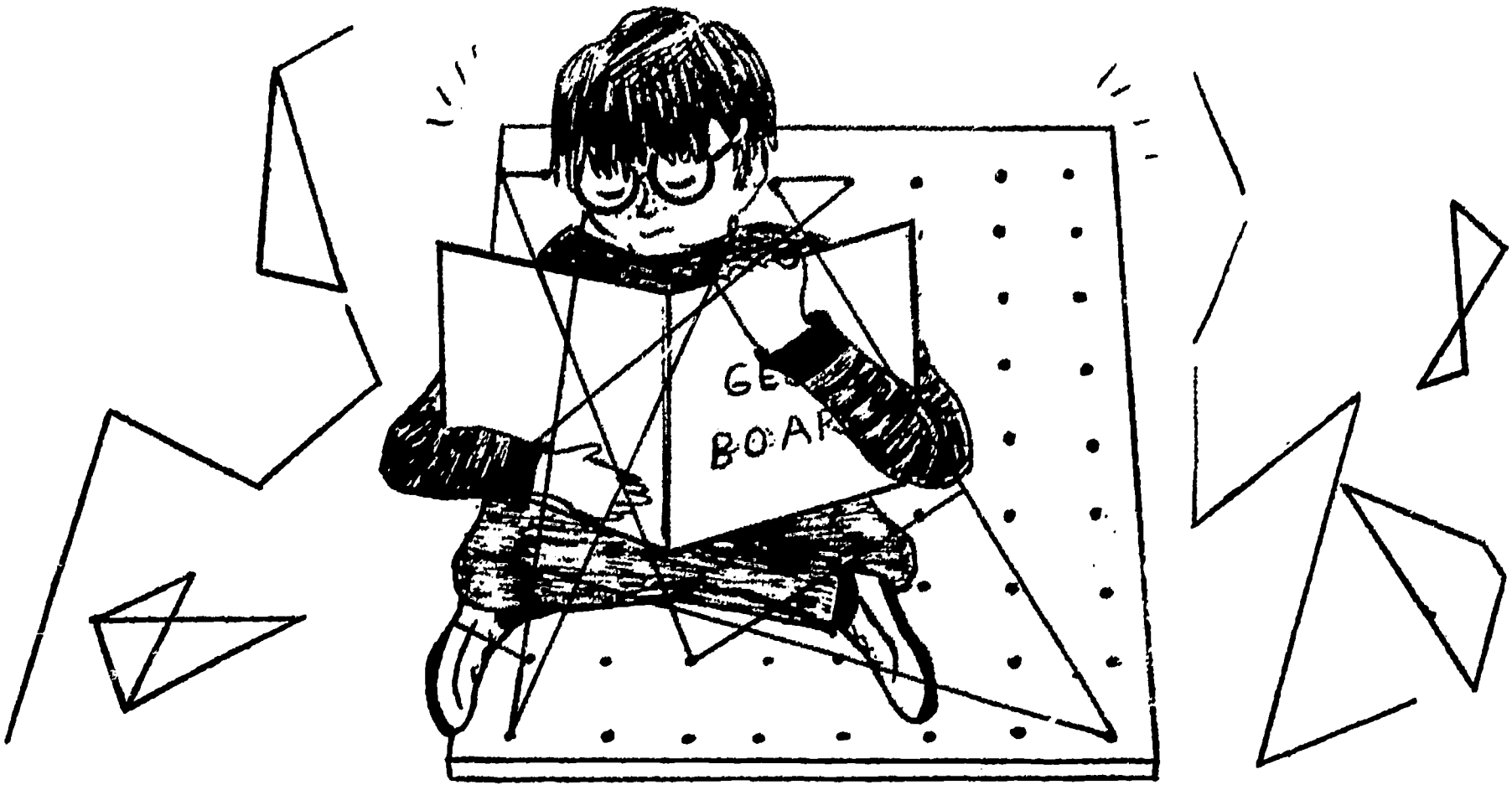
Challenge Table

Construct each figure and fill in the table.

Figure	Base	Height	Perimeter	Area
A) Parallelogram	____	7 inches	____	42 sq.in.
B) Scalene Triangle	____	____	____	3 sq.in.
C) Acute Triangle	3	2	____	____
D) Obtuse Triangle	____	____	____	3 sq.in.
E) Right Triangle	4	____	____	10 sq.in.
F) Isosceles Triangle	____	5	____	15 sq.in.

NETWORKS

(Read Carefully)



The next six activities are constructing "networks." These six networks are made up of straight line segments--pictured by rubber bands.

Points where line segments meet are called "vertices." A vertex is <u>even</u> if an even number of <u>paths</u> lead into the vertex. If not, the vertex is <u>odd</u>.

For each network: count the total number of vertices, the number that are "odd" and the number that are "even."

In the "example" network, the vertices are ringed. An E or O is placed in each ring for odd or even.

<u>Remember</u>, the paths are the number of different ways that lead into the vertex. This number will also be placed in each ringed vertex.

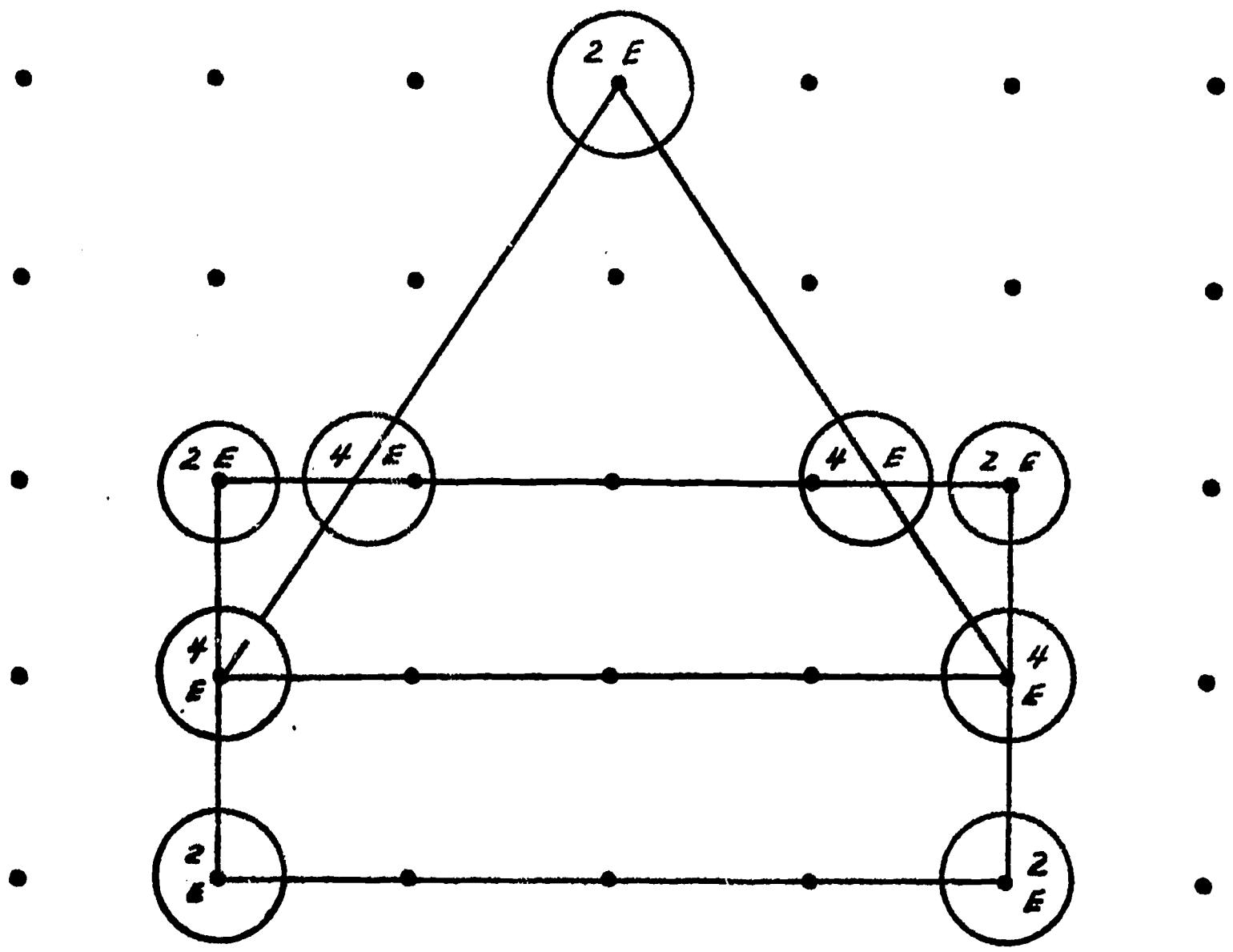
The results for each network will be listed in a table at the end of the six activities.

(The number of odd vertices are a clue for your answer.)

Construct the networks using rubber bands. Use more than one rubber band.

Can you travel this network without retracing?

Example Network



Number of Vertices

Total	Odd	Even
9	0	9

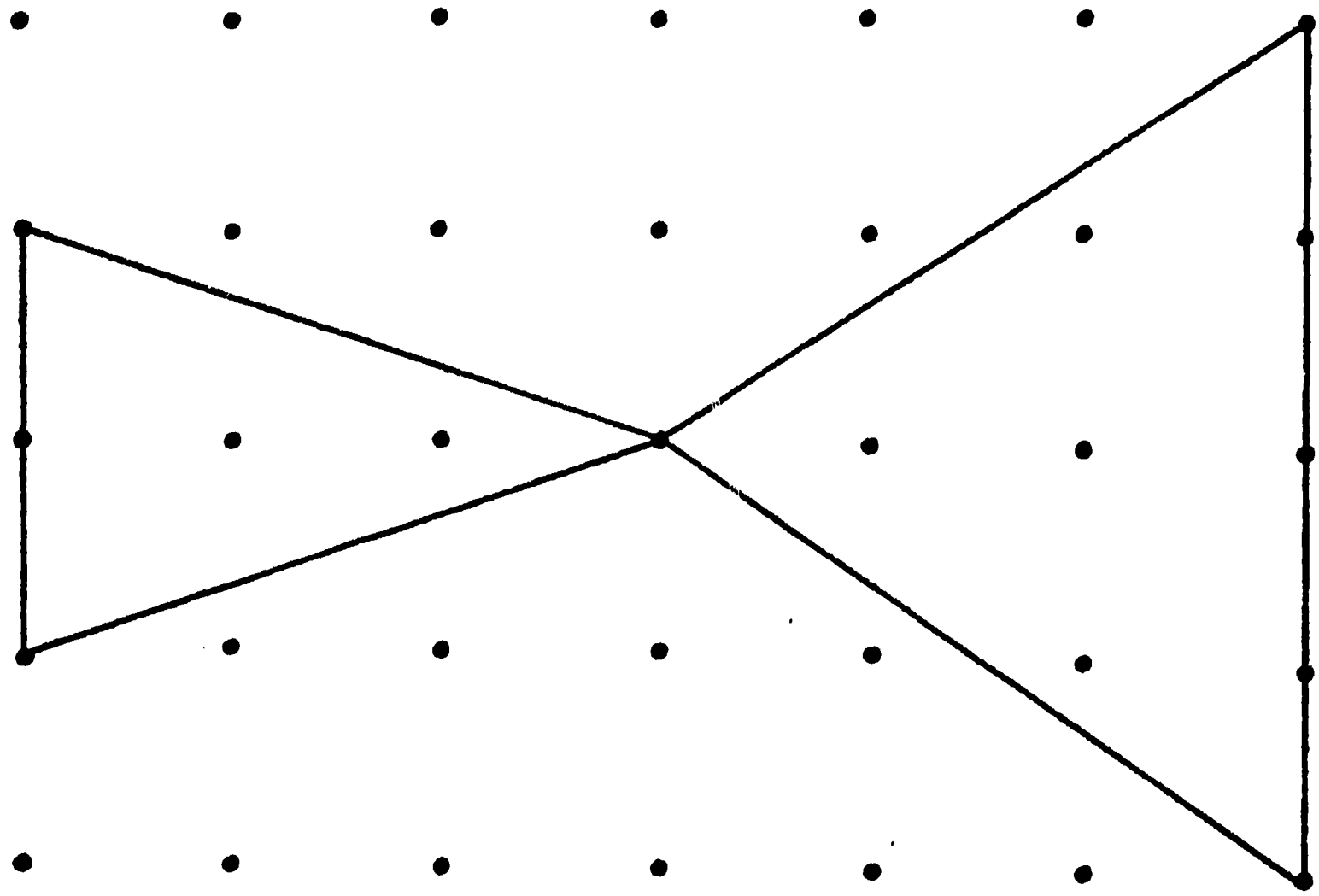
Travel without retracing?
(check one)

Yes _____ No _____

Construct each network using rubber bands. More than one rubber band is needed.

Can you travel these networks without retracing?

Network 1

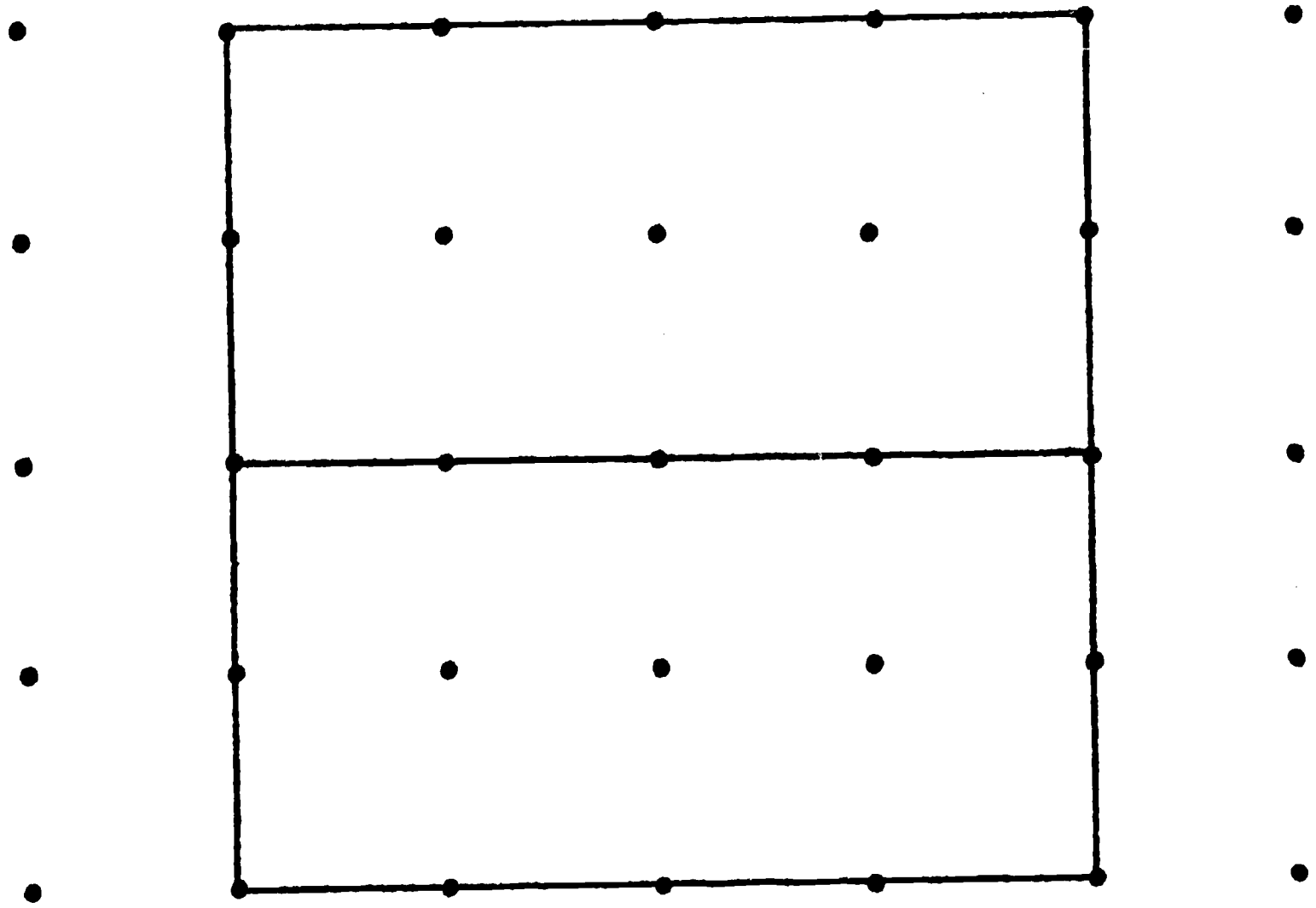


Number of Vertices		
Total	Odd	Even
____	____	____

Travel without retracing?
(check one)

Yes ____ No ____

Network 2

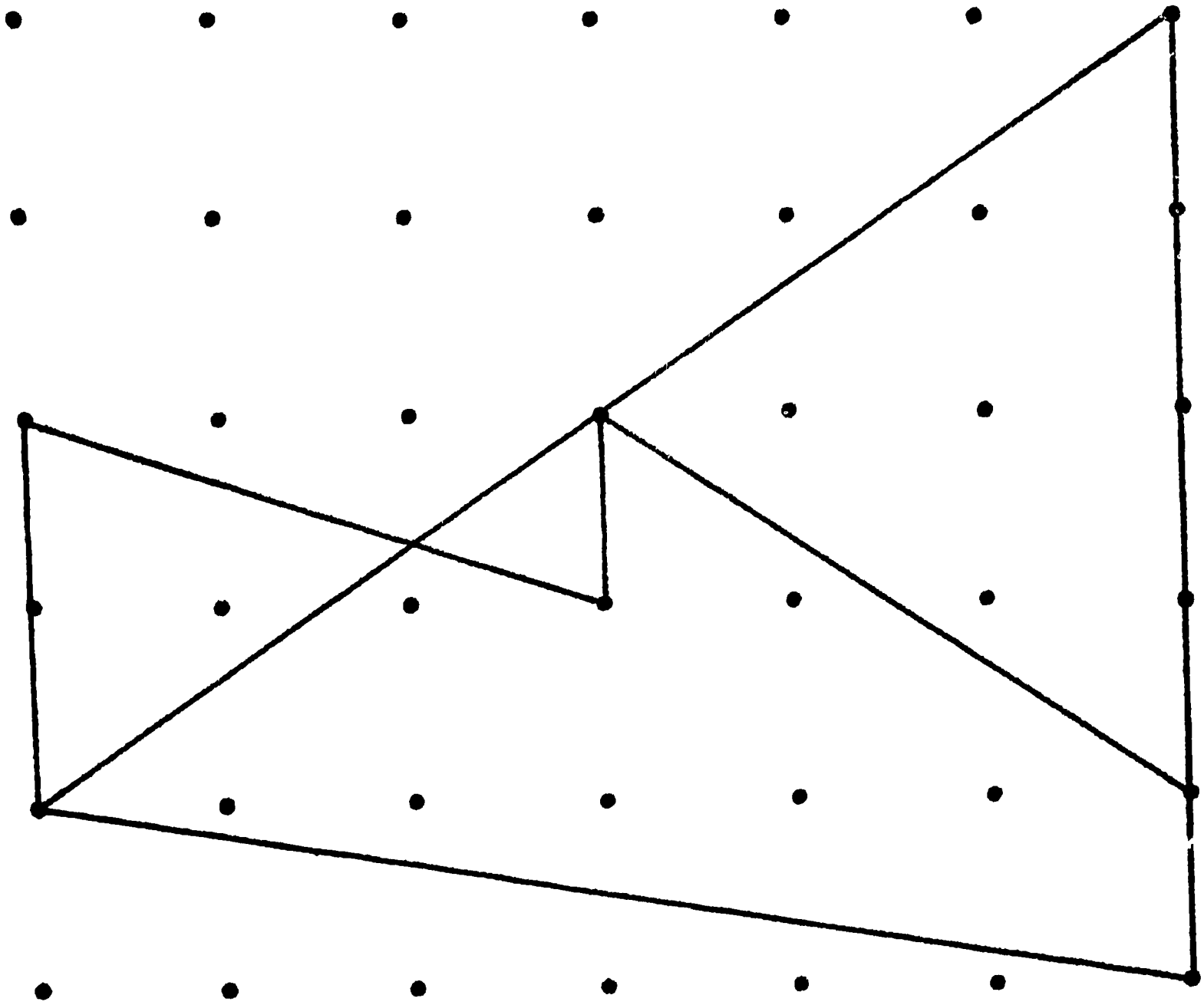


Number of Vertices		
Total	Odd	Even
____	____	____

Travel without retracing?
(check one)

Yes _____ No _____

Network 3

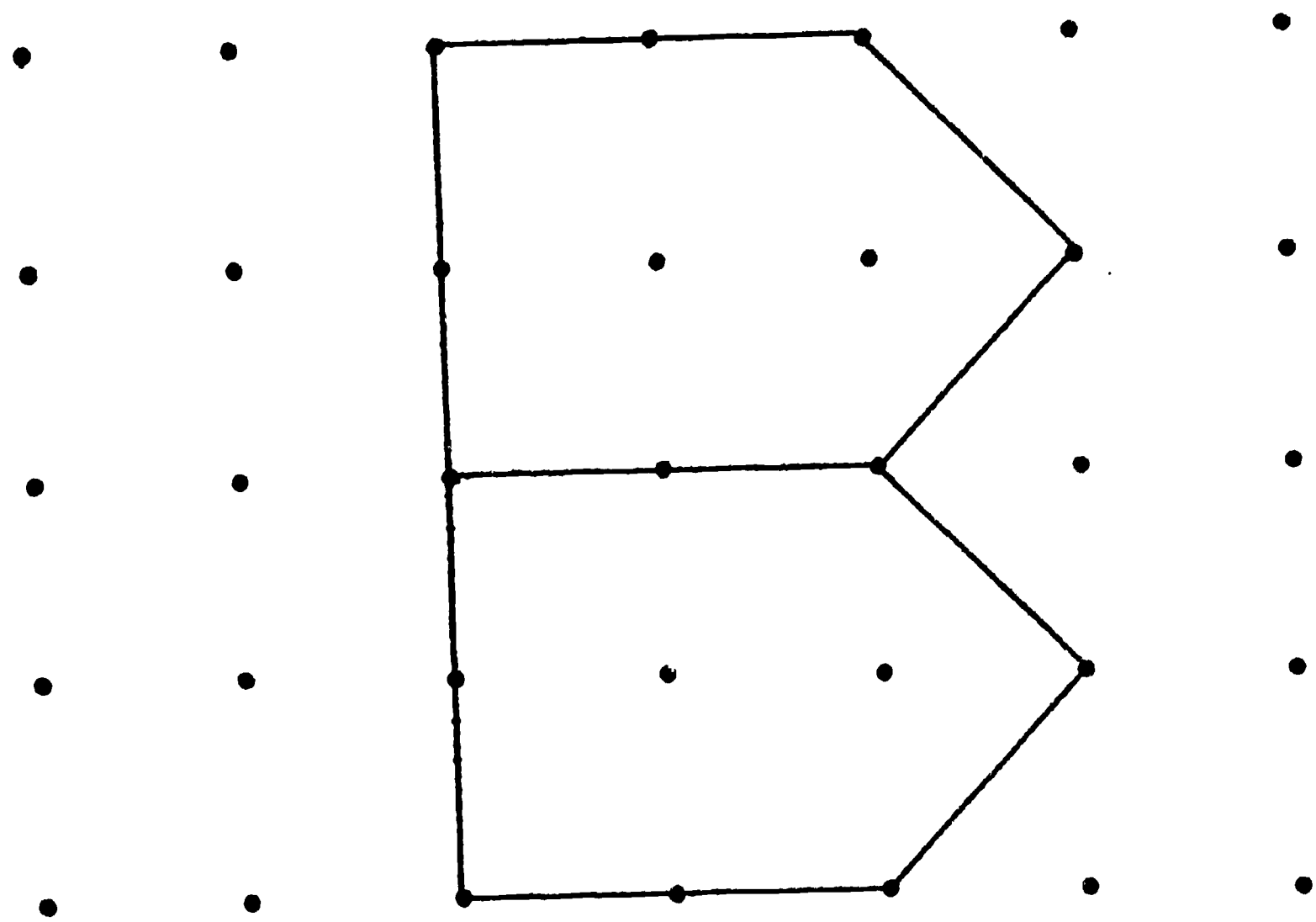


Number of Vertices		
Total	Odd	Even
____	____	____

Travel without retracing?
(check one)

Yes _____ No _____

Network 4



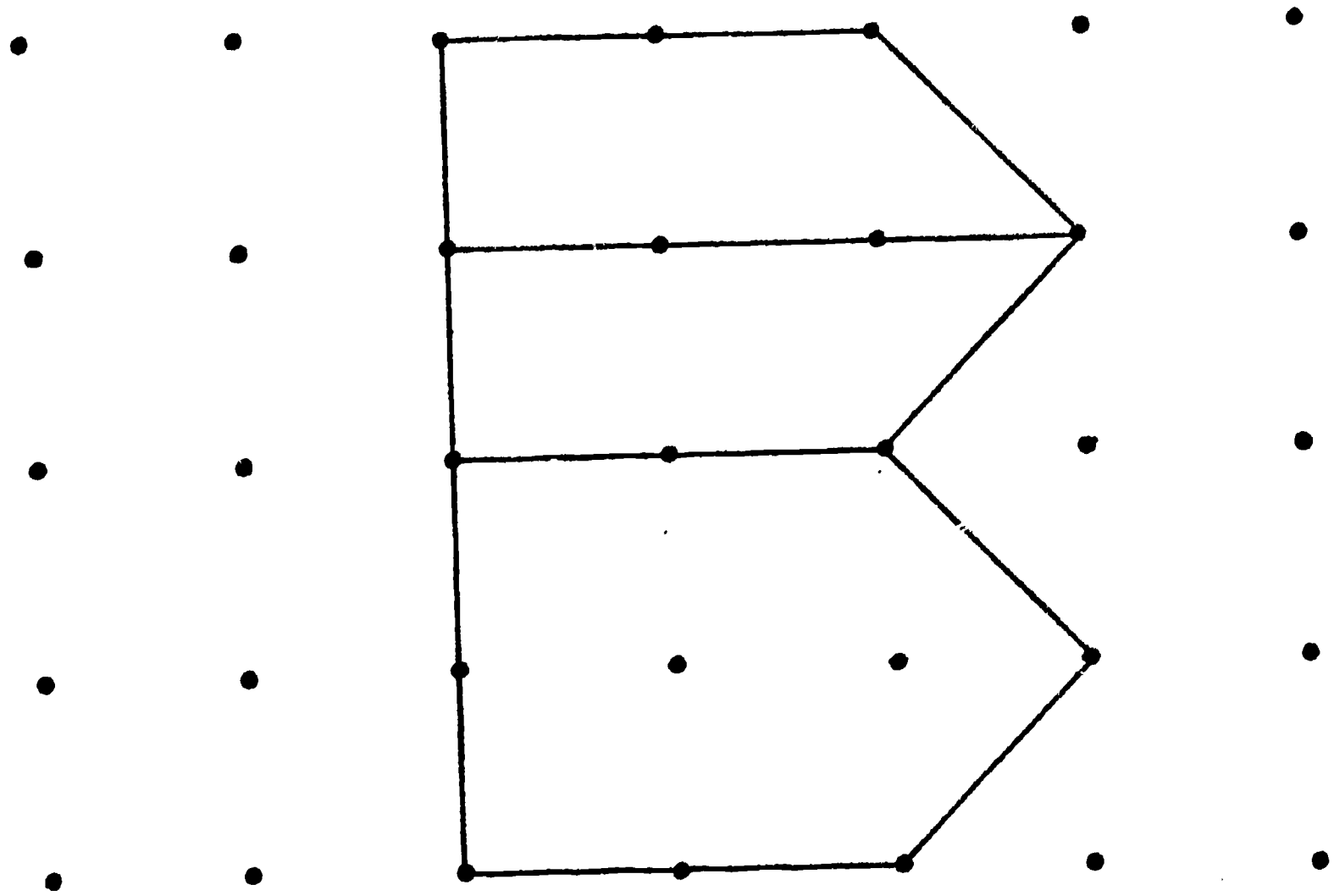
Number of Vertices

Total	Odd	Even
____	____	____

Travel without retracing?
(Check one)

Yes _____ No _____

Network 5



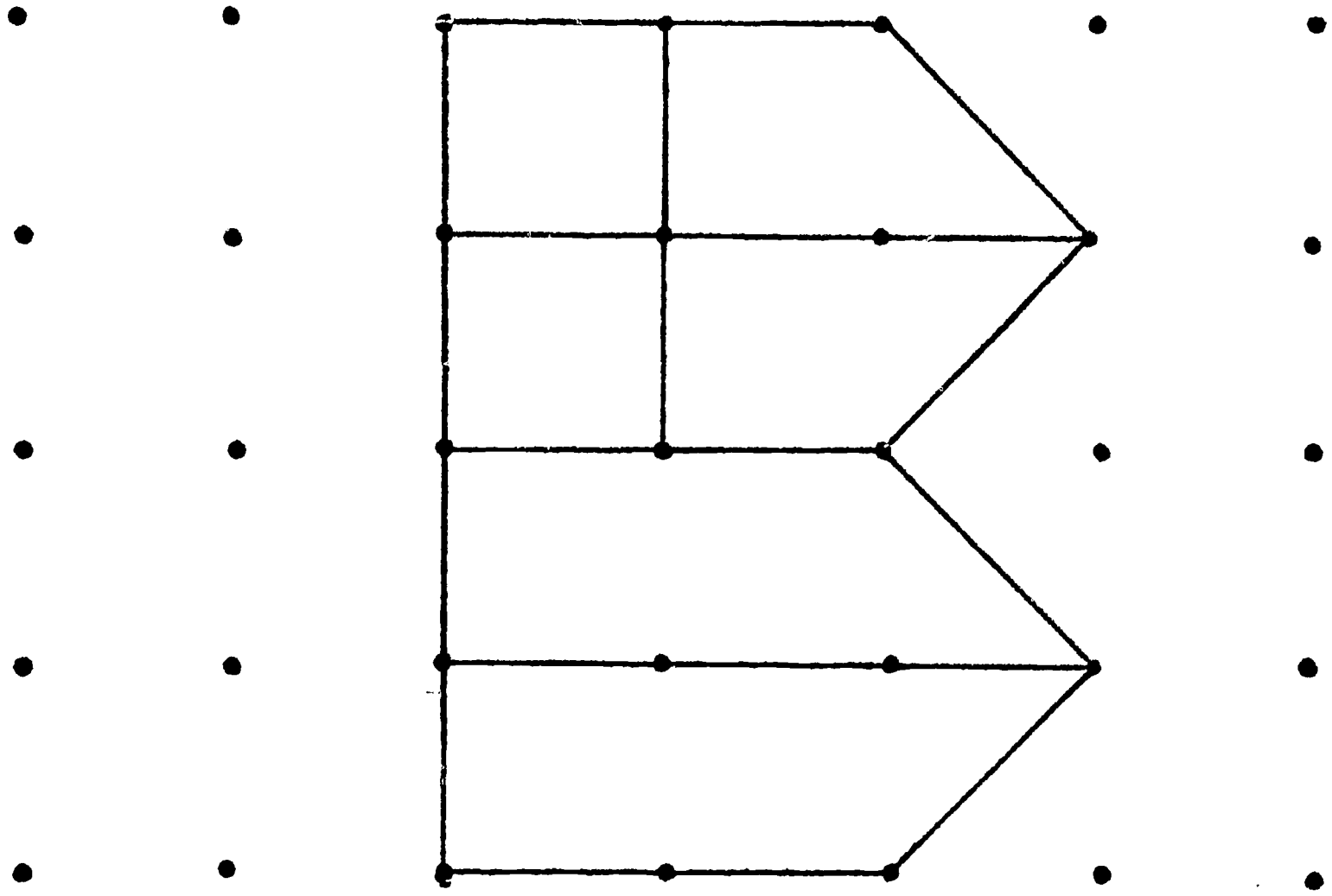
Number of Vertices

Total	Odd	Even
____	____	____

Travel without retracing?
(Check one)

Yes _____ No _____

Network 6



Number of Vertices

Total	Odd	Even
____	____	____

Travel without retracing?
(Check one)

Yes _____ No _____

Network Summary Table

Network	Number of Vertices			Travel?	
	Total	Odd	Even	Yes	No
Example	9	0	9		
1					
2					
3					
4					
5					
6					

Check the ideas below against your work.

Idea I: If a network has all even vertices, you can start at any vertex and travel the network without retracing a path and return to your starting point.

Idea II: If a network has exactly two odd vertices, to travel without retracing, you must start at one odd vertex and you'll end at the other. (You can't return to a starting point.)

Idea III: Unless a network has <u>all</u> even or <u>exactly two</u> odd vertices, it "cannot" be traveled without retracing.

Soooo! Construct some networks of your own and try out these ideas.