

## Chapter 11

### MG1 Golden

1. The area of the base of a golden pyramid is four units.
2. The cosine of 36 degrees is equal to one half of  $f$ .
3. The next term in this sequence is  $8f + 13$ . The ratio of any term over its previous term is phi.
4. Possible answers include the following: the golden ratio occurs in nature because it provides the best arrangement of items while minimizing wasted space.

### MG1 Puzzle

1. graph of the "Cheat" puzzle:

```

1  2  3  4
5  6  7  8
9 10 11 12
13 15 14 B
    
```

2. First two levels of the "Cheat" puzzle:

```

1  2  3  4
5  6  7  8
9 10 11 12
13 15 14 B
    
```

```

1  2  3  4      1  2  3  4
5  6  7  8      5  6  7  8
9 10 11 B      9 10 11 12
13 15 14 12    13 15 B 14
    
```

When you try to correctly order the bottom row of the "Cheat" puzzle, the third row becomes out of order.

3. We know that 9 of the people each shook hands with a different number of people. Since they couldn't shake hands with their spouse or themselves, we know that each of them shook hands with 0, 1, 2, 3, 4, 5, 6, 7, or 8 others. In creating a graph for this solution, we end up with one couple, each of whom

shook hands with 4 others. Since Prof. Cohen asked everyone but himself, this couple must be the Cohens. So Lois shook hands with 4 others.

### MG1 Topology

1. By joining two mobius strips on their boundaries (note that each mobius strip has only one boundary), you can create a Klein bottle.
2. The grapes reappear at the bottom of the screen.
3. The grapes reappear at the bottom of the screen, in the other column.

### MG1 Poincaré

1. In hyperbolic geometry, the parallel axiom states that given a line  $L$  and a point  $p$  not on the line, there are an infinite number of lines through  $p$  and parallel to  $L$ .
2. The Poincaré disc has a radius of 6. A point 2 units from the center would be mapped to a point 18 units from the center. A point 0.1 units from the center would be mapped to a point 360 units from the center.
3. Asymptotically parallel lines meet only at the boundary of the model, not on the interior. Divergently parallel lines do not meet at the interior or the boundary of the model.
4. As objects move from the center to the edge, they get smaller in size.

### MG1 Fractals

1. Sample answer: The Sierpinski hexagon and the pattern created by the “Chaos Game” are both fractals. In the “Chaos Game,” we used a three-sided figure to create a repeating pattern of three small figures surrounding a larger figure of the same shape. In the Sierpinski hexagon, we used a six-sided figure to create a repeating pattern of six small figures surrounding a larger figure of the same shape.
2. Four copies of level 4 are required to make level 6. Eight copies of level 3 are required to make level 6. Thirty-two copies of level 2 are required to create level 7. Following the same pattern,  $2^{n-1}$  copies of level 1 are needed to create level  $n$ .