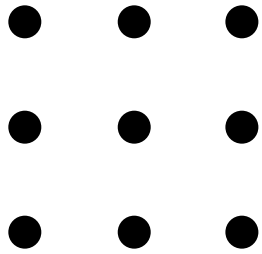
Ask a Scientist Holiday Puzzle Party!

December 20, 2005

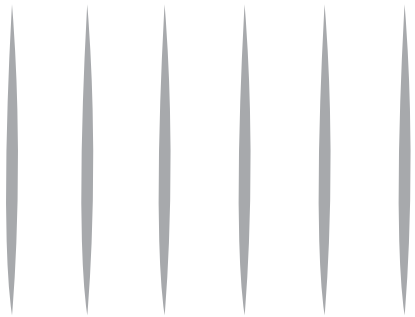
Host: Juliana Gallin
Puzzle Master: Steven Bodovitz

Solutions are on p.3

Warm-up puzzle #1:
Connect all nine dots with four straight lines without lifting your pencil (or pen) off of the page.



Warm-up puzzle #2:
Using six toothpicks, make four identical equilateral triangles and nothing else. (In other words you can't make six equilateral triangles, or four triangles and a diamond, etc.)



PUZZLE #1: MARBLES IN BOXES

You have three boxes: one with two black marbles, one with two white marbles, and one with a black marble and a white marble. The boxes are labeled (BB, WW, BW) but each box is labeled incorrectly. You are allowed to take one marble at a time from any box, without looking inside the box, and by this process of sampling you must determine the contents of all three boxes. What is the smallest number of drawings needed to determine the contents?

PUZZLE #2: PENNIES

A table has an unknown quantity of pennies lying on it. Exactly 10 of the pennies are heads up and the rest are tails up. You are blindfolded and wearing mittens so that there is NO way that you can determine precisely which pennies are heads up and which are tails up. You may however pick the pennies up, move them around, and flip them over. Explain how you can separate the pennies into two groups so that each group has exactly the same number of pennies with heads up.

Notes: The solution does not in any way involve identifying specifically which pennies are heads up vs. tails up. The fundamental assumption is that this is impossible. And no, it does not matter how many pennies in total are on the table—only that ten of them are heads and the rest are tails.

PUZZLE #3: THE MANGO TREE

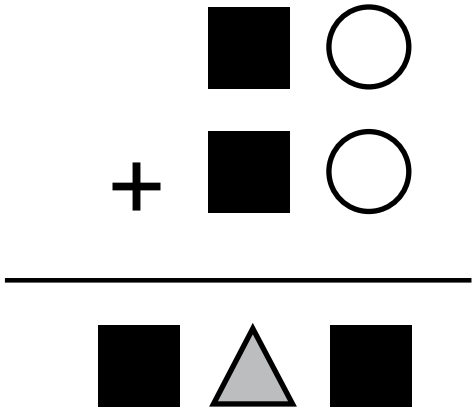
Far away in Puzzle Land was a mango tree whose owner was very protective of his mangoes. In order to protect his fruit the owner erected a series of seven fences around the tree. Concentric, circular fences. Each fence had a gate with a guard. So to get to the tree, a person had to pass through seven gates guarded by seven guards. One day a man approaches the guard at the outermost gate and says, “If you let me pass through, when I come back I will give you half the mangoes I have. But then you must give me one back.” The guard agrees and lets the man go through the gate. The man proceeds to make the same deal with the other six guards, eventually reaching the prized mango tree.

How many mangoes did the man have to collect to pass back through the seven gates, giving half of his stash to each guard, and the guard giving one back? Note: he is not allowed to cut any mangoes in half, and he must wind up with at least one mango at the end.

PUZZLE #4: VENUSIAN ARITHMETIC

Suppose a space probe to Venus sends back an addition sum scratched on a wall. Assuming that the Venusians use a positional notation like ours and a number base corresponding to the fingers on one Venusian hand, how many fingers are on that hand?

Note: the square must not equal zero.



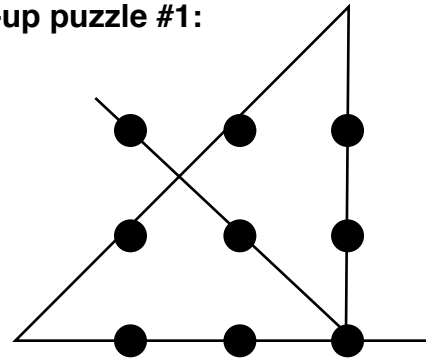
PUZZLE #5: THE FIVE PRISONERS

A generous warden gives five prisoners the chance to get out of jail early. He tells them that he will line them up, one behind the other, and put either a red hat or a blue hat on each of their heads. They will be able to see the colors of the hats in front of them, but not behind them and certainly not the color of the hat on their own head. Then, one at a time, in any order they choose, each prisoner gets to say to the entire group, in a normal voice without any intonation, either “red” or “blue,” but nothing else and is not allowed to communicate in any other way. Any prisoner who says the color of his hat correctly gets out of jail early. The prisoners have the night before to figure out their strategy. What is the best strategy to get the most prisoners out early?

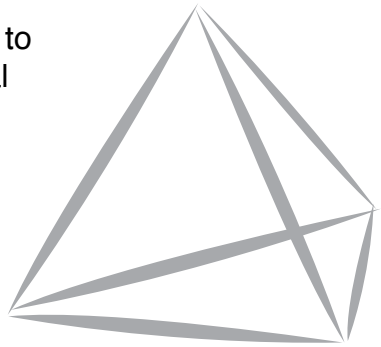
Solutions are on p.3 ⟶

SOLUTIONS

Warm-up puzzle #1:



Warm-up puzzle #2:
Use the six toothpicks to create a 3-dimensional tetrahedron.



MARBLES:
You can determine the contents of all three boxes by pulling out just one marble from the box labeled BW. Since the boxes are all mislabeled, if you pull out a white marble you know that two white marbles are in that box. The two black marbles must then be in the box labeled WW (since they can't be in the box labeled BB) and that leaves the mixed pair in the box labeled WW.

PENNIES:
Simply choose any ten pennies at random, move them into their own group, and flip them over. This new group will have exactly as many heads up as does the main group. Think about it: Let's say you randomly choose ten pennies that have three heads up. This leaves seven heads behind in the main group. And when you flip the ten pennies with the three heads, you'll have seven heads up in that group as well. Try it!

MANGO TREE:
Classic answer: He only has to collect two mangoes!
There are also alternate answers, if you feel like doing a little math. If he collects 130 mangoes from the tree he will wind up with three at the end. If he collects 258 mangoes he winds up with four at the end. And so on, limited only by the number of mangoes on the tree and the man's mango-carrying ability.

VENUSIAN ARITHMETIC:
The Venusian has three fingers. 12 + 12 = 101 in base 3.

PRISONERS:
The last prisoner in the row uses his guess as a code. He says "red" if he sees an even number of hats of one color—four of one color or two of each color—in front of him. He says "blue" if he sees an odd number of hats—three of one color and one of the other. From this information, the prisoner in the fourth position can figure out his hat color. If he hears "red," for example, and sees one blue and two reds in front of him, then he must be wearing a blue hat. Once the third prisoner hears the fourth prisoner's answer, he can figure out his hat, and so forth up to the prisoner in front. Under this scenario, four prisoners get out early, and the prisoner in the 5th position has a 50-50 chance.