

Science Club Questions

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1. Introduction

Friday afternoons often finds the members of the Computer Architecture Group gathering in the 6th floor lounge of LCS for beer, chips, and lively discussion in a meeting fondly called *Science Club*. The discussion usually centers around a *Question of the Week*, a brain teaser sufficiently difficult that ten or so beer-drinking academicians have some trouble ferreting out the answer. The best of these questions have been collected in this memo; no answers are given since, in the best tradition of Science Club, old questions are often resurrected for continued discussion.

2. Questions

Here are the (currently) 22 Science Club questions that we, as a group, can recall. As more questions are remembered, they will be added to the list.

Q1: Monty Hall

Suppose you're a contestant on The Price is Right, and Monty Hall shows you three doors, only one of which conceals a prize. You select a door. Monty opens one of the other doors, and shows you it is empty (he can always select such a door since Monty knows where the prize is). He then offers you the choice of staying with your current selection, or changing to the remaining door. What do you do?

Q2: The N-Condoms Problem

There is an island with a large number of people living there (the exact number does not matter as long as it is large). They have been deprived of having sex for years because they lack condoms and fear sexually-transmitted diseases. One day, a box containing n condoms is air-dropped onto the island. What is the maximum number of people who can safely have heterosexual intercourse free from fear of disease? (Hint: the answer is larger than n .)

Q3: The Spouse's Handshake Problem

You and your spouse go to a party where people greet each other by shaking hands subject to the rule that no one shakes another person's hand more than once, and no one shakes their spouse's hand. There are 12 couples at the party. At the end of the evening, everyone has shaken a different number of hands. How many hands did your spouse shake?

Q4: The Sailboat Problem

Sailboats can sail into the wind by pulling their main sail in close and heading slightly away from the apparent source of the wind. This is called *tacking*, and normally involves an oscillatory motion: for a while the boat is aimed to the left of the wind, a *left tack*, then to the right, a *right tack*. The overall motion is towards the wind, although instantaneously, the boat is moving to the left or right of the wind. Switching between tacks is called *coming about*.

Part 1: Simple version

Why does this work?

Part 2: Complex version

Can a sailboat go down a river *faster* than the current with no power assistance in still air (no wind)?

Q5: The Triangles Problem

Consider an arbitrary triangle with unit area. Beginning with one vertex of the triangle, proceed clockwise around the triangle marking a point $\frac{2}{3}$ of the way along each edge. Now draw three line segments, one from each of the points just marked to the opposite vertex. What is the area of the triangle bounded by the three line segments just drawn?

Q6: Gender Balance: Infanticide

In an island community, families kill all female infants until the first male infant is born, insuring that their first child is a male. Afterwards, they have children normally. How does this affect the balance of gender in the population? Assume that without infanticide, the balance would be 50 percent male, 50 percent female.

Q7: Gender Balance: Single Male Child Families

A similar island community has children until the first male child is born and then ceases to have children. Thus, each family has exactly one male child who has zero or more older sisters. How does this affect the balance of gender in the population?

Q8: The Hangman's Dilemma

A prisoner has been sentenced to death. He has been told that his execution will occur at dawn sometime in the next week, but the day will be kept secret so that the execution will be a surprise. The prisoner quickly reasons that the day of execution cannot possibly be a surprise; what is his reasoning? Why is he wrong?

Q9: The Building Wiring Problem

A new building has a large trunk of n unlabeled identical wires running from the first floor to the roof. With only a battery, clip leads, a light bulb, pen and masking tape, you are to uniquely identify each end of each wire. How many trips to the roof must you make?

Q10: The Four-Color Penny Problem

Can you lay down some number of pennies flat on a table in such a way that, were you to color them so that no two touching pennies were the same color, you would need no fewer than four colors to do so?

Q11: The Cars And Roads Problem

There are two cities **A** and **B** with two roads connecting them. There is a way for two cars connected by a rope of length l to drive simultaneously from **A** to **B**, one on each road, without breaking the rope. Can the cars then drive (without the rope), one from **A** to **B** on one road, the other from **B** to **A** on the other road, without *ever* being within l of each other?

Q12: Universal Logic

A binary NOR gate is called a universal logic element because it can be used to construct any arbitrary binary function.

Part 1: Ternary Logic

Is there an equivalent universal gate for ternary logic?

Part 2: n -ary Logic

Let n describe the number of states in a logic family (for example, $n = 2$ for binary logic, $n = 3$ for ternary logic). Is there a universal gate for all n -ary logic families?

Part 3: Continuous Logic

Let n range to infinity; the resultant logic family has continuous rather than discrete values. Does this family have a universal logic element?

Q13: Why Is It Dark At Night?

The sun lights up the sky during the day. At night, the earth shields us from the sun, and the sky is dark even though there is the light from many stars shining on the earth. Why isn't the night sky bright? If the universe were infinitely large, and therefore would hold infinitely many stars, would the night sky be infinitely bright?

Q14: Why Are Manholes Round?

Manholes, and their covers, are round for a very specific reason; what is it? (Hint: maneuvering ease of the covers is not the underlying reason.)

Q15: Multiway Light Switches

A hall light is wired with two identical SPDT switches, one at each end of the hall, so that either switch can independently turn the light on or off. What is the wiring diagram? Can you generalize this to more than two switches, each of which controls the light?

Q16: Betting on Red

A dealer has a normal deck of 52 playing cards which he deals, face up, one at a time until they are all dealt. You must at some point in the process place a bet on the next card being red. Let n be the card number before which you choose to place your bet. Is there a heuristic for selecting an n which increase your chances above 50 percent?