

Jain Mathematics Tournament

Season Three



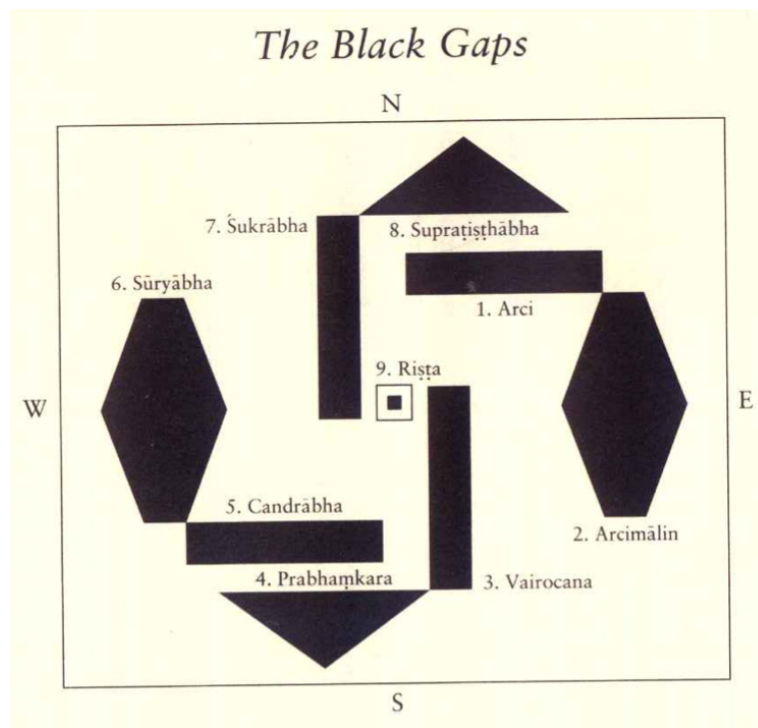
A Young Jains of America Initiative

If anything in these problems has offended you or gone against the teachings of Bhagwan Mahavir, we sincerely ask for forgiveness. Micchami Dukkadam.

Problem 1

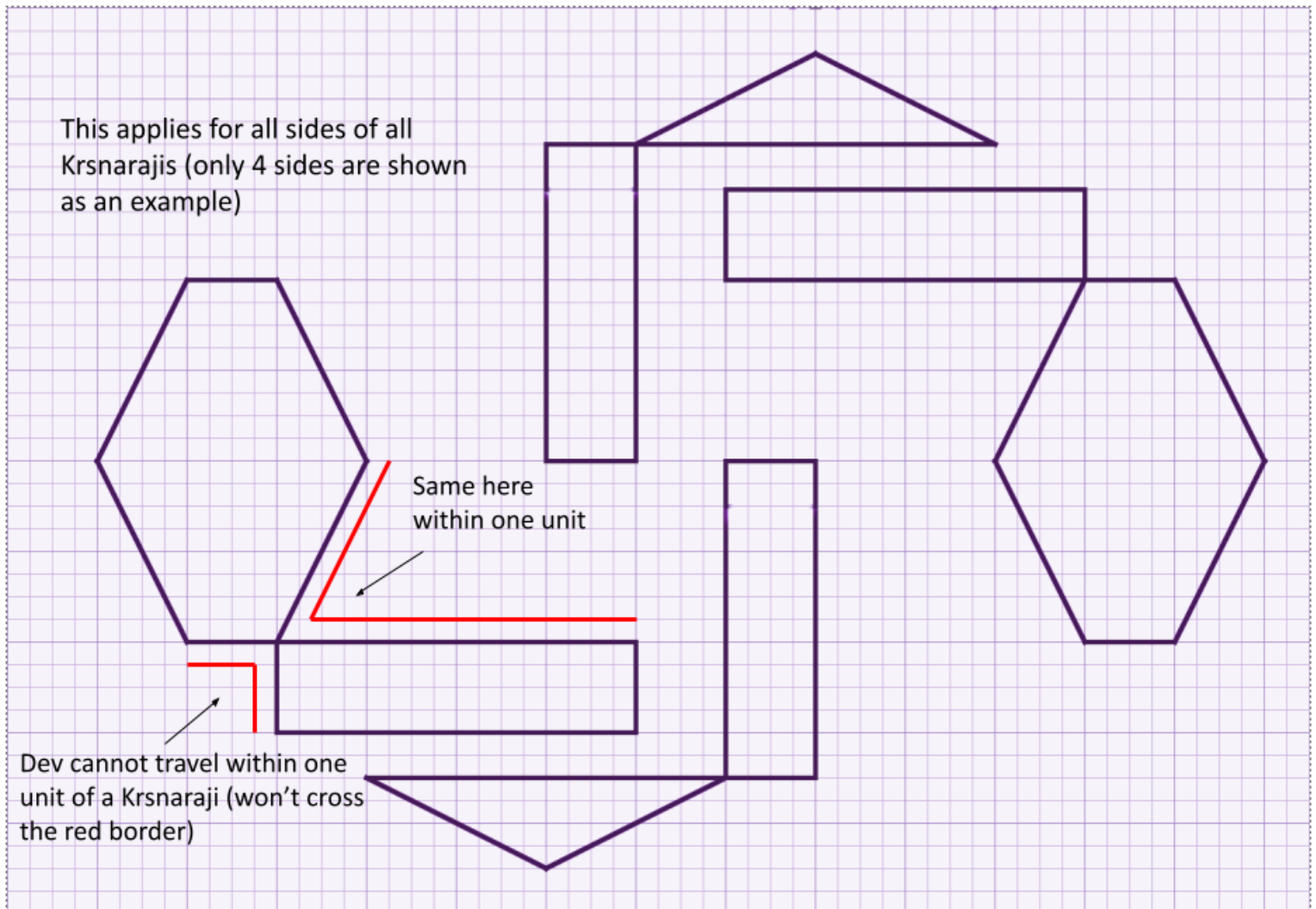
One of the strangest concepts in Jain cosmology is the idea of a *Krsnaraji* (a black gap in the Jain universe). The *Krsnarajis* are described as pitch dark areas in the *Brahmaloka* (fifth heaven) that have an enormous power of attraction (with some similarity to modern-day black holes). It is stated that the Devs (heavenly beings) don't go near the *Krsnarajis* for fear of getting pulled in.

According to the [Bhagavati Sutra](#), there are eight *Krsnarajis* in a certain geometrical formation in the *Brahmaloka*. This is a diagram of the eight *Krsnarajis* as shown parallel to the plane of the *Rista Vimana* (the residence of the *Ristabha* Devs):



Nearby the *Krsnarajis*, there is a type of Dev called the *Gardatoya* ("splashing stream") Dev that lives in the southwest border of *Brahmaloka*. Let us suppose a *Gardatoya* Dev decides to travel to all the regions near the *Krsnarajis*. **What is the total area of the restricted region where the *Gardatoya* Dev cannot travel, given no Dev can come within one unit of a *Krsnaraji*?**

In this problem, we will define one unit as one square length on the grid given below:



Problem 1 Clarifications and Tips

- The restricted area includes the areas of the *Krsnarajis* and the one unit boundary surrounding the *Krsnarajis*.
- Solution should be given in square units to one or two decimal places.
- Notice that none of the 4 sides shown above come within one unit length of a *Krsnaraji*, the same would apply to all *Krsnarajis*.

Have questions or concerns?

Please contact us at jmt@yja.org if you have any further questions.

Problem 2

The Jain time cycle (*Kalchakra*) is composed of an ascending and descending period of time. This time cycle is only present in the *Bharat* and *Airavat Kshetras* (universes) in the Jain cosmological structure. The time cycle is described in the unit of *sagaropams* (an unfathomable amount of time) which is based on a metaphor rather than a finite number. The unit of *sagaropam* is explained as a factor of 10^{15} greater than a *palyopam* (the basis of measurement for *sagaropams*). There are three types of *palyopams*, but the most basic is the [Vyavahara Palyopam](#).

Here, we present a metaphorical description of the *Vyavahara Palyopam*:

“Three pits of the extent of one yojana long, one yojana broad and one yojana deep are dug out. These pits are packed with the smallest ends of the wool of rams from one to seven days old, the bits incapable of being further cut. Then the small bits of wool are taken out one by one once every one hundred years. The time taken for emptying the three pits in this manner is called the Vyavahara palyopama.”

Based on this metaphorical description, **compute the time quantified by one *Vyavahara Palyopam*.**

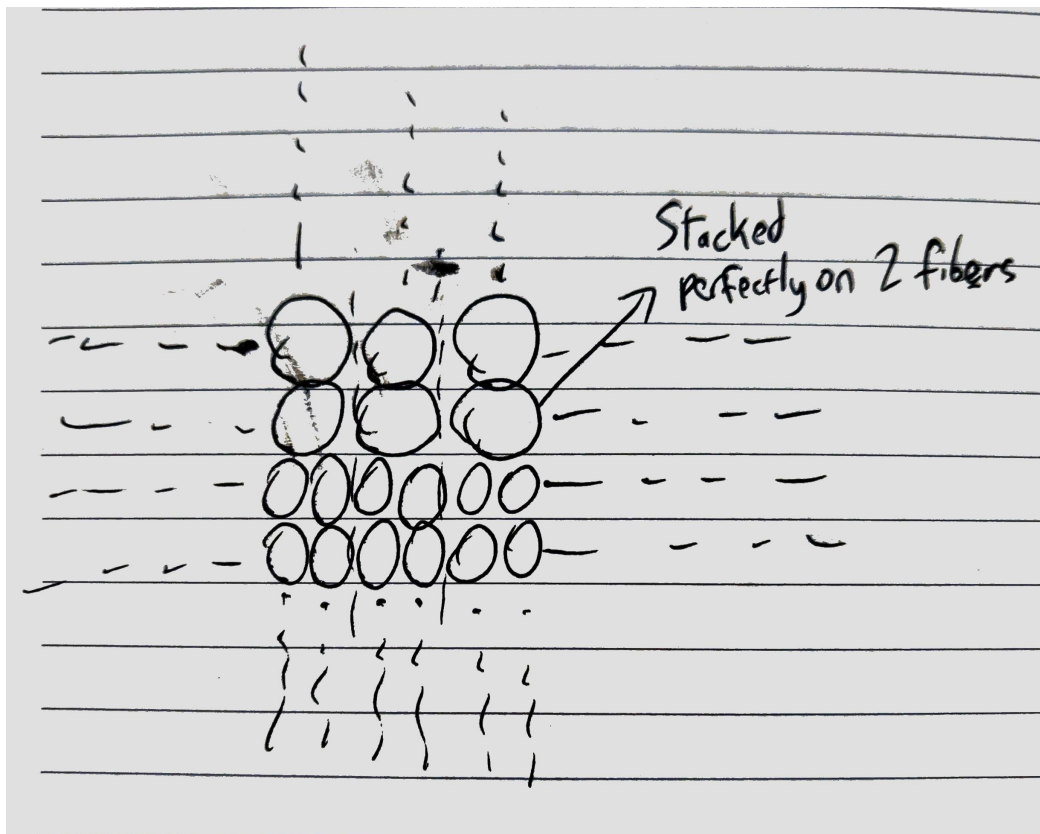
In this problem, assume the wool fibers (of the ram) are cylindrical with a diameter of 28.5 micrometers and length of 0.39 millimeters. Additionally, when wool fibers are stacked on top of each other the wool fibers on the bottom would naturally compress (reducing the diameter). In this problem, assume when 10 wool fibers are stacked above a wool fiber, the fiber on the bottom is compressed to half its diameter.

For example, if there are 21 wool fibers in a stack, the bottommost fiber would be reduced to a quarter of its diameter (2 stacks of 10 on top) and the next 10 bottommost fibers would reduce to half their diameter. The rest of the fibers are unchanged in diameter.

Problem 2 Clarifications and Tips

- In this problem, 1 yojana = 14 kilometers.
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- Assume the pits are perfectly cylindrical, with a diameter of 1 yojana and height of 1 yojana.
- *Palyopam* is loosely translated to “pit-measured period” (hence the metaphor of pits).
- Assume the fibers are stacked length-wise perfectly similar to the stack of pipes.
- When the fiber diameter doubles due to compression, assume the larger fiber stacks on two fibers perfectly.



Have questions or concerns?

Please contact us at jmt@yja.org if you have any further questions.

Submission

The submission link is <http://bit.ly/jmt3submissions>. (Please sign in to submit the form with your attached work. You may also email your solutions to jmt@yja.org before the deadline.)

You must submit your work along with your answer for your submission to be counted. Remember, only the FIRST perfect submission will be awarded, so it is advised to submit as soon as you solve the problems.

Submission Deadline: Friday, February 18th @ Midnight EST

Guidelines

- You are free to use any resources and tools, **but the thinking must be done by you.**
- Collaboration is not allowed and will result in disqualification.
- Please submit work that is legibly handwritten or typed.
- Anyone is welcome to work on the questions, but to be eligible for an award you must be between 14 and 29 years old, and not an active member of the YJA Executive Board.

Scoring & Awards

- All problems are weighted equally in the tournament, unless otherwise stated.
 - The FIRST person to submit a perfect submission (correct answers to both problems) will be eligible to receive an award.
 - The top 3 non-zero scorers (ties broken by the time of submission) will also be recognized on YJA social media channels.
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- There is no partial credit given for incorrect solutions.
 - Solutions will be posted shortly after winners are announced.

References

- <https://jainqq.org/explore/001197/153>
 - <https://jainqq.org/explore/002131/293>
 - <https://jainqq.org/explore/001618/42>
 - *That Which Is*, Umāsvāti, Nathmal Tatia (1994, HarperCollins Publishers)
 - *Tattvartha Sutra*, Umāsvāti, Manu Doshi (2007, JAINA)
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