



Supplementary Rules – Junior and Senior Categories

Tower of Hanoi

“Tower of Hanoi” is a mathematical game introduced by the French mathematician, Edouard Lucas, in 1883. There was a story about an Indian temple in Kashi Vishwanath in which there were three wooden posts. On top of one post, 64 golden disks were stacked up according to their sizes, with the smallest one on the top. Brahmin priests, acting out the command of an ancient prophet, had to move these disks, in accordance with the immutable rules of the Brahma. Each time only one disk could be moved, and a smaller disk should be placed on top of a bigger disk. If the legend were true, according to the calculation, even if the priests were able to move disks at a rate of one per second, using the smallest number of moves, it would still take them $2^{64} - 1$ seconds or roughly 584.9 billion years to finish. However, the age of our universe is just 13.8 billion years.

Operational requirements

Now you have been entrusted by the priests in the temple to create an electronic device to complete the “Tower of Hanoi” game. The device should consist of two parts: the “**controller**” and “**moving module**”. The “controller” is used to control the “moving module”. The device has to be able to complete a “Tower of Hanoi” game of minimum 10 disks.

Specifications

The “Moving module” should not exceed $150cm \times 100cm \times 100cm$ (height), with a total weight (batteries included) not more than $3kg$. There is no restriction on the “controller”.

Restriction

There is no restriction on the material used, but **ready-made device** is not allowed. The “Moving module” can only use direct current motors (2 leads). The device can only be driven by a maximum of 12 AA dry batteries.

Pitch

Each team will complete its “Tower of Hanoi” game in its own pitch, which is approximately $150cm \times 100cm$. The device will stack the disks on the top of each other (*Fig. a*). Each team will be given disks of different sizes and in different quantities in each stage of competition. The diameter of the disks will range from $3 \sim 10cm$, each with a difference in diameter of around $1cm$, Each disk is around $1.5cm$ thick (*Fig. b*). The teams will move their disks from one stack to another according to different rules of the game.

Competition System

The competition will be divided into junior and senior sections, each with 4 phases - Preliminaries, Semi-Finals, Repechage and Finals.

In Preliminaries, teams only need to finish the game of “Tower of Hanoi” within a certain time to be qualified for the next phase. After the Preliminaries, qualified teams will be divided into 6 groups by random drawing and they will participate in the Semi-Finals. In Semi-Finals, according to the competition time in each game, the two fastest teams in each group will automatically enter the Finals. In addition, among the remaining teams of all the groups, the 4 fastest teams will also enter the Finals (Note: They do not include the two fastest teams that have automatically entered the Finals.). From



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the remaining teams that fail to enter the Finals, based on their competition time, a certain number of teams * will be selected to enter the Repechage. In the Repechage, only 2 ~ 6 teams * can enter the Finals, based on their competition time. In Finals, teams will start the competition all at the same time. The 1st, 2nd and 3rd prize winners will be selected based on their finishing time. During the competition, if two or more teams hold the same position and the winner cannot be determined, an additional round of game will be held until the winner is determined.

* The number of teams will be decided based on the number of teams and it will be confirmed after the Preliminaries.

Preliminaries

A classic 3 stacks 4 disks game of "Tower of Hanoi" will be conducted. The objective is to move the entire stack of disks to another stack, complying with the following rules:

1. Only the uppermost disk on the top of a stack can be moved or carried at one time.
2. In each stack of disks, a bigger disk cannot be placed on top of a smaller disk.

A disk can be moved back and forth among different stacks, including the starting stack or a temporary stack for placing the disks during the game,

In Preliminaries, each team can take a maximum of 3 trial games during the period from 3 to 11 January 2017 (10:00~17:00) in the museum. Each trial game must be completed within 10 minutes. The teams that can complete one trial game within the set time will be qualified for the Semi-Finals. The completion time in the Preliminaries will not be counted in other stages of competition.

Semi-Finals

The qualified teams will be randomly drawn and divided into 6 groups to participate in a timed competition. In Semi-finals, a modified 3 stacks 6 disks game of "Tower of Hanoi" will be conducted. The objective is to move the entire stack of disks to another stack, complying with the following rules:

1. Only the uppermost disk on the top of a stack can be moved or carried at one time.
- ~~2. In each stack of disks the **bigger** one cannot be placed on the top of the smaller disks.~~
2. In each stack of disks, the **biggest** disk cannot be placed on top of the other smaller disks.

A disk can be moved back and forth among different stacks, including the starting stack or a temporary stack for placing the disks during the game. However, the participants have to abide by the two rules of the Semi-finals stage. In Semi-Finals, each team has a maximum of 12 minutes to complete the game. And the fastest 2 teams will be qualified for the Finals automatically. For the remaining teams in all the groups, the 4 fastest teams (not including the first two of each group that are automatically qualified for the Finals) will be selected based on their completion time during the game.

Repechage

A certain number* of teams will be selected from those who fail to proceed to the Finals. They will participate in the Repechage on the following day. The Repechage will be conducted in an inter-team format. 2 ~ 6 teams* will be finally selected to enter the Finals. Further details of the Repechage will be announced after the Semi-Finals.

* The number of teams will be determined based on the number of teams and it will be confirmed after the Preliminaries.



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Finals : The Finals will be a timed competition conducted in 2 rounds. In each round, all teams will complete a new set of “Tower of Hanoi” game which is different but similar to those in the Semi-Finals and Preliminaries. The winner will be the fastest team who has the shortest total completion time for the 2 rounds. Details of competition will be announced before the start of each round. And the competition will start after the announcement. In the Finals, all teams will participate in each round of game at the same time.

Starting position : The starting position of each team will be determined by drawing.

Flow of competition : Before each game, all teams’ devices will be inspected by the organizer to ensure that they comply with the regulations. After inspection, each team will be arranged to enter the pitch. Once all teams are ready at their positions, the judge will give the “**On your marks**” and “**Set**” commands. When the game starts, all teams have to press their own stopwatches to start counting the time, and then start to operate their devices to complete the competition *. Once the game is finished, each team has to stop their stopwatch only after they have stopped their device. After completing the game, the judge will record the time for each team and the team has to sign to confirm the result.

* Since Preliminaries is an untimed competition, teams can start their device (no need to press on the stopwatch) right after the judge has called to start.

Timeout and Maintenance

No timeout is allowed during the game. Teams can repair their devices and reset the disks of the Tower at any time with permission from the judge. During maintenance and reset, the competition will continue. When requesting for maintenance, if the device of the team is touching or carrying any disk, a member of the team has to place the disk under the device and make sure it touches the ground before maintenance can begin. Apart from maintenance and reset, no team members can touch any part of the Tower. In case of unpredictable factors which affect the results (e.g. stopwatch malfunction), the organizer, under the principles of fair play, can decide to rematch and recount the time for all or some of the participating teams.,

Violation of rules

False start : During the competition, if any team has false start during the game, all teams in that particular round need to rematch. In each round, only one false start is allowed without penalties. After the first false start, if any team in that particular round has false start again, the competition time of that violating team will be treated as invalid.

Timing violation : Except the Preliminaries, if any team starts operating its device before starting the stopwatch, or stops the stopwatch before the “Tower of Hanoi” game is completed, the organizer can give the violating team a time penalty or treat the violating team’s time as invalid, depending on the severity of the violation.

Displacement violation : If the teams stack the disks incorrectly during the competition, the teams can undo the incorrect step and continue with the competition. However, if the incorrect steps are more than one step, the teams will need to reset all the disks of “Tower of Hanoi” before continuing with the competition.

