

Eureka Event: The Physicist's Code

Rules & Regulations (Applicable to Main Event and Final Round)

- Individual Event.
- The decision of the Event Head is final.
- No mobile phones or electronic gadgets are allowed.
- No use of calculators.

Event Overview

"The Physicist's Code" is an immersive college event centered around the mysterious disappearance of Professor Arav Anand, a theoretical physicist. Before vanishing, Professor Anand left behind a coded notebook with fragments of a groundbreaking theory. Participants must decode his five-page journal, which contains five clues and five digits, hidden within scientifically challenging tasks. Each round reveals one digit of a five-digit code, which, once fully recovered, will unlock Professor Anand's final message. The rounds are designed as advanced case study-based scenarios to test conceptual depth and problem-solving skills.

Prelims

Two round game:

- **Round 1: 10 points per physics question.**
- **Round 2: 10 questions, 5 points = 50 points.**
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Winner will be decided based on number of points accumulated

Main Event

Round 1: "The Anomaly Report"

- **Theme:** Dimensional Analysis + Experimental Physics (Case-Based)
- **Case:** An intern at Professor Anand's lab mistakenly publishes a report claiming to have built a perpetual motion machine. The report includes experimental graphs, logs of energy input/output, and a list of equations.
- **Task:** Teams must:
 1. Identify all dimensional inconsistencies in the equations.
 2. Spot at least two violations of thermodynamic laws from the data.
 3. Determine which log entry shows a calibration error.

- **Code Digit 1:** Units digit of the total number of inconsistencies correctly identified (out of 7).

Round 2: "Relativity of Silence"

- **Theme:** Special Relativity + Signal Delay (Case-Based)
- **Case:** A deep-space observatory received two light signals from a fast-moving spacecraft and recorded timestamps. Professor Anand's notes suggest a paradox in the time order of the events.
- **Task:**
 1. Given the coordinates and timestamps in Earth frame, apply Lorentz transformations to analyze simultaneity.
 2. Find out in which inertial frame the events appeared simultaneous.
 3. Use the case to calculate proper time and interpret which frame is correct.
- **Code Digit 2:** Units digit of the relative velocity (in % of c) of the frame where events are simultaneous.

Round 3: "The Gravity Vault"

- **Theme:** Advanced Gravitation + Energy Conservation (Case-Based)
- **Case:** Professor Anand had built a gravity vault on an exoplanet where the gravitational field changes non-linearly with depth. The escape velocity near the surface is constant, but a probe dropped from 10 km returns data inconsistent with Earth's field equations.
- **Task:**
 1. Using given data logs, model the gravitational field variation.
 2. Determine if the potential energy curve suggests the presence of a dark matter-like core.
 3. Calculate escape energy required from 5 km depth.
- **Code Digit 3:** Units digit of the energy in MJ required to escape from 5 km.

Round 4: "The Quantum Archive"

- **Theme:** Quantum Transitions + Spectroscopy (Case-Based)
- **Case:** Professor Anand's last experiment involved a hydrogen-like ion with $Z=3$. The lab's quantum spectrometer recorded emission lines with unexpected energy ratios. His notes mention perturbation in energy levels.
- **Task:**
 1. Given wavelength data and partial configurations, identify the possible transitions and initial states.
 2. Use Rydberg's equation for multielectron ions.
 3. Estimate the quantum defect.
- **Code Digit 4:** Integer part of the estimated quantum defect (rounded).

Round 5: "The Lost Coordinates"

- **Theme:** Campus-Based Physics Treasure Hunt
- **Case:** In his final days, Professor Anand left behind physical clues hidden across locations he used to visit on campus. A part of the legacy is said to be buried in plain sight.
- **Task:**
 1. Teams are given their first physics-based riddle clue.
 2. Each correct location leads to a clue or QR code, which has the digits.
- **Code Digit 5:** (Implied from the task, found within the QR codes/clues).

Final Round: Unlock the Legacy

Sample Final Round Questions (Reference only; more nuances to be added later)

1. A researcher claims to have derived a new relation: $E = I^2 R t / k$, where E is energy, I is current, R is resistance, t is time, and k is a dimensionless constant. Identify all dimensional inconsistencies.
2. The report mentions a machine that produces more electrical energy than the heat input using thermocouples. Which two thermodynamic laws are violated and how? Justify with entropy terms.
3. Calculate the proper time interval between two events observed from two frames moving at $0.6c$ relative to each other where in lab frame.
4. Two signals are received on Earth $5 \mu\text{s}$ apart from a moving probe at $0.85c$. Using Lorentz transformations, find in which frame the events were simultaneous.
5. Energy conservation fails if gravitational potential becomes repulsive at the core (like dark energy). Using modified potential, derive escape velocity from 5 km .
6. Given transitions from $n_1 \rightarrow n_2$, $n_3 \rightarrow n_4$, and $n_5 \rightarrow n_6$ for a hydrogen-like ion, calculate Rydberg constant correction and determine the quantum defect.
7. A 5-electron system has configurations violating Pauli's principle. Given partial data, identify all illegal configurations and justify.
8. Due to spin-orbit coupling, a level splits into two lines separated by 0.0004 eV . Estimate the magnetic field responsible for this splitting.
9. The ratio of line intensities for a series is $3:5:1$. Determine the degeneracy of energy levels and possible l -values involved.
10. In a hydrogen atom, a new transition appears between levels with the same n but different l . Explain using perturbation and selection rule violation due to an external electric field (Stark effect).

HOW TO CONDUCT THE GAME:

The "Eureka Event: The Physicist's Code" will be conducted in a multi-stage format, beginning with preliminary rounds, followed by five main challenge rounds, and culminating in a final decryption stage.

- **Prelims Conduction:** The Prelims will involve two rounds. The First Round will consist of basic Physics Trivia questions, displayed likely via a projector. Participants will be provided with A4 papers and pens for their responses. Event organizers will monitor and score participants based on accumulated points.
- **Main Event (Rounds 1-4: Case Studies):** For each of these rounds ("The Anomaly Report," "Relativity of Silence," "The Gravity Vault," "The Quantum Archive"), teams will be provided with printed case study descriptions, including relevant data logs, equations, and graphs. Ample scratch paper, pens, and pencils will be provided for calculations and problem-solving. Whiteboards, markers, or flipcharts can be made available for teams to collaborate and present their workings. The teams' solutions will be evaluated based on their accuracy in identifying inconsistencies, applying transformations, modeling variations, or estimating quantum defects, leading to the extraction of the respective code digit.
- **Main Event (Round 5: "The Lost Coordinates" - Treasure Hunt):** Teams will receive their first physics-based riddle clue on paper. This round will take place across the campus. Event organizers or volunteers will be stationed at clue locations. Each correct location found by a team will lead them to the next clue or directly to a QR code containing a digit of the final code. A system for verifying found locations (e.g., check-ins with volunteers, photo proof) will be in place to ensure fair play.
- **Final Round (Unlock the Legacy):** Once teams have recovered all five digits from the preceding rounds, they will proceed to the final stage. Teams will enter the 5-digit code into a designated interface (e.g., a simple digital entry system or by verbally providing it to an event organizer). Upon successful decryption, teams will be presented with Professor Anand's final message, which will likely involve answering complex conceptual physics questions based on the sample questions provided. These questions will test their overall scientific insight gained throughout the event. A projector and screen will be used to display the final message and questions. Whiteboards or presentation tools may be used by teams to explain their answers.

Materials and Budget:

- **For Prelims:**
 - A4 papers.
 - Pens/pencils for participants.
 - Projector and screen for displaying trivia questions.
 - Whiteboard/flipchart for explanations.
- **For Main Event (Rounds 1-4 - Case Studies):**
 - Printouts of case study descriptions, data logs, equations, and graphs (sufficient copies for all teams).
 - Ample scratch paper.
 - Whiteboards/markers or flipcharts for team collaboration.

- Basic scientific calculators (if the "no calculators" rule is relaxed for these complex rounds, otherwise not needed).
- Pens/pencils.
- Measuring tapes/rulers for any experimental physics analysis (e.g., graph reading).
- Access to scientific software if required for analysis (e.g., specific physics simulation tools or data analysis software, if the event platform is digital).
- **For Main Event (Round 5 - Treasure Hunt):**
 - Printed cryptic hints/riddles.
 - QR codes (printed and hidden at various campus locations).
 - Small tokens or specific items to be found as clues.
- **General Materials:**
 - Timers/stopwatches for each round.
 - Scorekeeping materials (score sheets, digital tracking system).
 - Stationery (staplers, scissors, tape etc.).
 - Prizes for winning teams.

Classroom Requirements:

- A main classroom with a projector and screen for prelims and the final round.
- Multiple classrooms or dedicated spaces for concurrent rounds if teams are working on case studies simultaneously. These spaces should have sufficient seating and workspace for each team.
- Access to specific campus locations for the treasure hunt round.
- Reliable Wi-Fi access if any digital tools or online resources are intended to be used (e.g., for QR code scanning, or for teams to access online reference material if allowed).

Tentative Budget:

- **For Printouts & Materials (Prelims & Rounds 1-4 Case Studies):** Rs. 500-1000 (estimate based on number of participants/teams and complexity of printouts).
- **For Treasure Hunt Clue Printing & QR codes (Round 5):** Rs. 200-500.
- **For Stationery and General Supplies:** Rs. 300-600.
- **For Prizes for winning teams:** Rs. 1000-2000 (depending on prize value).
- **Contingency:** 10-15% of total estimated budget (e.g., Rs. 200-500).