National Astronomy Olympiad (Nepal)

For students aspiring to explore the cosmos through learning, curiosity, and scientific spirit.

Contents

1 Introduction

The **National Astronomy Olympiad (NAO)** is an annual nationwide competition in Nepal organized to identify and nurture young talents in the field of Astronomy and Astrophysics. It serves as the gateway for Nepali students to participate in international Olympiads such as the International Olympiad on Astronomy and Astrophysics (IOAA), the International Astronomy Olympiad (IAO), the IOAA-jr, and the Asian-Pacific Astronomy Olympiad (APAO).

The program promotes skills in communication, collaboration, critical thinking, and analytical reasoning, supporting students' future in the STEAM (Science, Technology, Engineering, Arts, Mathematics) disciplines.

2 Structure of the Program

The NAO consists of three main stages conducted between January and July each year:

2.1 Stage 1: Provincial Round (Entrance Exam)

- Held at seven provincial centers across Nepal.
- Duration: 2 hours.
- Format: 30 multiple choice questions (2 marks each) and 3 long questions (10 marks each).
- Total Marks: 90 marks.
- No negative marking.
- Students may use a non-programmable scientific calculator.

2.2 Stage 2: National Round (Pre-Closed Camp)

- Selected students from the provincial round participate in this round.
- It includes assignments, projects, and basic data analysis tasks.
- Students may be asked to prepare small reports or build simple observational tools such as paper telescopes.
- Emphasis is placed on understanding, originality, and clarity rather than competition.

2.3 Stage 3: Final Round (Closed Camp)

- The final round includes intensive learning sessions and examinations.
- Components: Theoretical tests, data analysis, and observational astronomy (often paper-based).
- Follows the IOAA syllabus structure.
- Students attend lectures on stellar physics, celestial mechanics, coordinate systems, and data processing.

3 Eligibility Criteria

- **Junior Category:** Students born after July 1, 2009, currently studying in classes 8–10 or equivalent.
- **Senior Category:** Students born after July 1, 2005, currently in classes 11–12 or equivalent.
- Only Nepali citizens are eligible.

4 Application Process

1. Download the official NAO application form.
2. Fill it carefully, including a short motivation statement (worth 5 marks).
3. Pay the registration fee of NRs. 1000 (50% waiver available for eligible students).
4. Submit the application along with:
    - Academic transcript (SEE or BLE or equivalent)
    - Character certificate
    - Birth certificate
    - Citizenship or Minor certificate
    - Payment proof
5. Submission can be made in person or via email to provincial coordinators or NASO headquarters.

5 Syllabus Overview

The NAO syllabus is divided into two categories. Below is a summarized and conceptual outline.

5.1 Senior Category

- **Mechanics:** Newton's laws, gravitation, circular motion, Kepler's laws, rotational and harmonic motion.
- **Thermodynamics:** Energy transfer, ideal gases, black-body radiation, Wien's law.
- **Optics & Waves:** Light, diffraction, Doppler effect, magnitudes, electromagnetic spectrum.
- **Electricity & Magnetism:** Basic circuits, magnetic fields, and electromagnetic theory.
- **Astrophysics:** Stellar evolution, HR diagram, luminosity, supernovae, neutron stars, and black holes.
- **Solar System:** Planets, moons, asteroids, comets, and the Earth–Moon system.
- **Mathematics:** Basic statistics, trigonometry, coordinate geometry, and conic sections.

5.2 Junior Category

Similar to the senior syllabus but limited to qualitative understanding, basic physics, solar system structure, constellations, and sky observation.

6 Sample Formulae and Constants

Below are examples of key relationships and constants commonly used in astronomy and astrophysics. Students are encouraged to explore their derivations and applications from recommended resources.

6.1 Selected Physical Constants

$$c = 2.998 \times 10^{8}\,\mathrm{m/s}, \quad G = 6.674 \times 10^{-11}\,\mathrm{N{\cdot}m^2/kg^2}$$

$$h = 6.626 \times 10^{-34}\,\mathrm{J{\cdot}s}, \quad \sigma = 5.670 \times 10^{-8}\,\mathrm{W{\cdot}m^{-2}{\cdot}K^{-4}}$$

6.2 Example Equations

- Newton's Law of Gravitation:

$$F = \frac{GMm}{r^2}$$

- Kepler's Third Law:

$$T^2 \propto r^3$$

- Pogson's Magnitude Relation:

$$m_1 - m_2 = -2.5 \log \left(\frac{B_1}{B_2} \right)$$

- Distance Modulus:

$$m - M = 5 \log d - 5$$

These serve as illustrative examples only. Students should refer to textbooks and IOAA preparation materials for detailed derivations and applications.

7 How to Prepare

7.1 Step 1: Understand the Exam Pattern

- Review the official syllabus.
- Practice both objective and descriptive question types.
- Study basic physics and astronomy topics first, then move to problem-solving.

7.2 Step 2: Strengthen Core Concepts

Focus on conceptual clarity:

- Celestial mechanics and motion of planets.
- Observation-based astronomy using Stellarium or sky maps.
- Understanding constellations, coordinate systems, and magnitude systems.

7.3 Step 3: Learn from Resources

Use resources that blend theory and practice:

- *Basic Astrophysics* by Aniket Sule (IOAA training book).
- Stellarium software for sky simulation.
- *StarMap101* and sky charts for practical understanding.
- Past papers from NAO and IOAA problem archives.

8 Assignments and Activities

During the National and Pre-Closed Camp rounds, you may encounter tasks such as:

- Calculating stellar magnitudes and distances.
- Explaining celestial coordinate systems.
- Using spherical trigonometry to determine the altitude of stars.
- Identifying stars and constellations in the night sky.
- Plotting Hubble's relation between velocity and distance.

Example: The Hubble–Lemaître Law states that the velocity of recession v of a galaxy is proportional to its distance d:

$$v = H_0 d$$

where H_0 is the Hubble constant.

9 Final Round Preparation

The closed camp focuses on:

- Theoretical astronomy and astrophysics.
- Observational astronomy using simulated data.
- Data analysis: mean, median, regression, and error estimation.

Students are trained according to the IOAA syllabus and take part in mock exams before final selection.

10 Recommended Further Resources

- **Books:**
  - Aniket Sule – *Basic Astronomy and Astrophysics: IOAA Training Book*
  - Kutner – *Astronomy: A Physical Perspective*
  - Carroll & Ostlie – *An Introduction to Modern Astrophysics*
- **Software:**
  - Stellarium – for realistic sky simulations.

  - Celestia – for 3D exploration of the universe.

- **Web Resources:**
  - IOAA official syllabus and archives: https://www.ioaastrophysics.org
  - NASA Exoplanet Archive: https://exoplanetarchive.ipac.caltech.edu
  - NAO Nepal (NASO): https://naso.edu.np

11 Conclusion

The National Astronomy Olympiad is not only a competition but a journey of curiosity and discovery. It inspires students to look at the sky with both wonder and scientific reasoning. With dedicated preparation, consistent practice, and a passion for learning, every participant can grow as a young astronomer and problem-solver.

With love,

Osish Niraula

IOAA'24 & IOAA'25