Instructions and Constants Sheet

OAC 2025 Team

October 2025

Invitational Round Instructions

1. The Invitational Round will be held over a duration of **3 days**:

   - **GMT (Greenwich Mean Time):** 12:00 noon, 10 Oct 2025 – 12:00 noon, 13 Oct 2025
   - **US Eastern Time (ET):** 08:00 a.m., 10 Oct 2025 – 08:00 a.m., 13 Oct 2025
   - **Indian Standard Time (IST):** 05:30 p.m., 10 Oct 2025 – 05:30 p.m., 13 Oct 2025

   The paper will be sent to all qualifiers by email at the start time. You must submit your solutions before the end of the above window.

2. The round will consist of a **subjective paper**. Each question requires a detailed written solution.

3. Solutions must be submitted as either:

   - Scanned handwritten work (clear and legible), or
   - A PDF written using LaTeX.

   The use of **Word documents is strongly discouraged** due to formatting inconsistencies.

4. You may use the following tools if desired:

   - Desmos, GeoGebra, Google Sheets (or any equivalent spreadsheet software)
   - Mathematica
   - Custom code (in any programming language)

   For every question where such tools are used, you must:

   - Clearly mention all software used, and
   - Attach the corresponding code file, Mathematica notebook, or spreadsheet.

5. The use of the **internet to search for answers** or the use of **AI tools** for solving problems is strictly prohibited. Any violation will result in **immediate disqualification**.

6. This is an **individual contest**. Collaboration or answer-sharing is not allowed.

7. You must keep your **rough work and derivations** safely, and upload it along with your final answers.

All the best for the Invitational Round!

Physical Constants

c	2.997925	$\times 10^{8}$	$\mathrm{m\,s^{-1}}$	Speed of light in vacuum
G	6.67430	$\times 10^{-11}$	$\mathrm{m^{3}\,kg^{-1}\,s^{-2}}$	Gravitational constant
h	6.626070	$\times 10^{-34}$	$\mathrm{J\,s}$	Planck constant
e	1.602177	$\times 10^{-19}$	C	Elementary charge
$\hbar$	1.052572	$\times 10^{-34}$	$\mathrm{J\,s}$	Reduced Planck constant
k	1.380649	$\times 10^{-23}$	$\mathrm{J\,K^{-1}}$	Boltzmann constant
μ_0	1.256637	$\times 10^{-6}$	$\mathrm{N\,A^{-2}}$	Vacuum permeability
ε_0	8.854188	$\times 10^{-12}$	$\mathrm{F\,m^{-1}}$	Vacuum permittivity
σ	5.670374	$\times 10^{-8}$	$\mathrm{W\,m^{-2}\,K^{-4}}$	Stefan-Boltzmann constant
m_e	9.109384	$\times 10^{-31}$	kg	Electron mass
	0.510999		$\mathrm{MeV\,c^{-2}}$	
m_p	1.672622	$\times 10^{-27}$	kg	Proton mass
	938.2721		$\mathrm{MeV\,c^{-2}}$	
m_n	1.674927	$\times 10^{-27}$	kg	Neutron mass
	939.5654		$\mathrm{MeV\,c^{-2}}$	
N_A	6.022141	$\times 10^{23}$	$\mathrm{mol^{-1}}$	Avogadro constant
R	8.314463		$\mathrm{J\,mol^{-1}\,K^{-1}}$	Gas constant
a_0	5.291772	$\times 10^{-11}$	m	Bohr radius
R_∞	1.097373	$\times 10^{7}$	$\mathrm{m^{-1}}$	Rydberg constant
b_λ	2.897772	$\times 10^{-3}$	$\mathrm{m\,K}$	Wien's displacement constant
b_ν	5.878926	$\times 10^{10}$	$\mathrm{Hz\,K}$	
a	7.565767	$\times 10^{-16}$	$\mathrm{J\,m^{-3}\,K^{-4}}$	Radiation constant
α	7.297353	$\times 10^{-3}$		Fine structure constant
σ_e	6.652459	$\times 10^{-29}$	$\mathrm{m^{2}}$	Thomson cross section
μ_B	9.274010	$\times 10^{-27}$	$\mathrm{J\,T^{-1}}$	Bohr magneton
r_e	2.817940	$\times 10^{-15}$	m	Classical electron radius
g	9.80665		$\mathrm{m\,s^{-2}}$	Standard gravity on Earth
atm	1.01325	$\times 10^{5}$	Pa	Standard atmosphere

Astronomical Constants

AU	1.495979	$\times 10^{11}$	m	Astronomical Unit
ly	9.460730	$\times 10^{15}$	m	Light year
pc	3.085678	$\times 10^{16}$	m	Parsec
yr	365.2563		days	Sidereal year
$M_\odot$	1.988416	$\times 10^{30}$	kg	Solar mass
$R_\odot$	6.957	$\times 10^{8}$	m	Solar radius
$L_\odot$	3.828	$\times 10^{26}$	W	Solar luminosity
$T_{\odot,\,\mathrm{eff}}$	5772		K	Solar effective temperature
$M_{\odot,\,\mathrm{V}}$	4.83			Solar magnitude
$M_{\odot,\,\mathrm{bol}}$	4.75			
$m_{\odot,\,\mathrm{V}}$	-26.832			
$\alpha_\odot$	$32'$			Size of solar disc
$\mu_\odot$	$4\pi^2$		$\mathrm{AU}^3\,\mathrm{yr}^{-2}$	Solar gravitational parameter
$M_\oplus$	5.9722	$\times 10^{24}$	kg	Earth mass
$R_\oplus$	6.3781	$\times 10^{6}$	m	Earth radius
$e_\oplus$	0.016709			Earth eccentricity
$\omega_\oplus$	283.324°			Earth's longitude of perihelion
M_{moon}	7.346	$\times 10^{22}$	kg	Moon mass
R_{moon}	1.7374	$\times 10^{6}$	m	Moon radius
$d_{\mathrm{E\text{-}M}}$	3.84399	$\times 10^{8}$	m	Earth–Moon distance
$m_{\mathrm{moon,\,V}}$	12.74			magnitude of full moon
α_{moon}	$31'$			Size of lunar disc
M_J	1.8982	$\times 10^{27}$	kg	Jupiter mass
R_J	6.9911	$\times 10^{7}$	m	Jupiter radius
a_J	5.2038		AU	Semi-major axis of Jupiter
a_V	0.723332		AU	Semi-major axis of Venus
a_M	1.523681		AU	Semi-major axis of Mars
H_0	70.1		$\mathrm{km\,s^{-1}\,Mpc^{-1}}$	Hubble constant
κ	20.49552		arcsec	Abberation constant
ε	$23^\circ\,26'\,21.4''$			Obliquity of the ecliptic
ζ	$-34'$			Refraction at horizon
Jy	1	$\times 10^{-26}$	$\mathrm{W\,m^{-2}\,Hz^{-1}}$	Jansky
$d_{\mathrm{MW\text{-}And}}$	0.7		Mpc	Milky Way-Andromeda distance
A	15		$\mathrm{km\,s^{-1}\,kpc^{-1}}$	Oort constants
B	20		$\mathrm{km\,s^{-1}\,kpc^{-1}}$	