Observational Round: Solar Physics

G0-1

English (Official)

General instructions: Observational Examiantion - Solar Physics (75 points)

The solar physics competition lasts for 2 hours and is worth a total of 75 points.

Before the exam

- You must not open the marked envelopes containing the problems before the signal indicating the beginning of the examination.
- The beginning and end of the examination will be marked by a signal from you supervisors, they will also let you know when there are fifteen minutes before the end of the exam.

During the exam

1. The Solar Physics Examination consists of one question with five parts. On your desk you should find one envelope. Inside the envelope you will find:
    - **Cover Sheet for each question with question title, your student code, question code, and your name.** Example: Solar Physics (Title) GBR- 1 DA-1 John Smith (please make sure these are correct)
    - **Question Sheets (marked Q)**
    - **Answer Sheets (marked A)**
    - **Working Sheets (marked W)**
2. This year, the format has allowed students to use installed version (not browser based version) of an application (Jhelioviewer) as part of an examination. Keep in mind that students will be closely monitored to assure all countries that participants are honest and competition is completely fair. Students are not allowed to access any other application.
3. Dedicated IOAA **Answer Sheets (marked A)** are provided for writing your answers. Enter the final answers into the appropriate boxes in the corresponding **Answer Sheet**. Please write only on the printed side of the sheet. Do not use the reverse side. **Working Sheets (marked W)** are provided for calculations.
4. Use a black or blue pen for all answers and calculations, this will allow the markers to see your answers better after scanning. If you think you made a mistake cross it out.
5. Use as many mathematical expressions as you think may help the graders to better understand your solutions. The graders may not understand your language. If it is necessary to explain something in words, please use short phrases (if possible, in English).
6. You are not allowed to leave your working desk without permission. If you need any assistance (malfunctioning calculator, need to visit a restroom, etc.), please put up your hand to signal the supervisor.
7. At the end of the competition you must stop writing immediately. Sort your Answer Sheets and Working Sheets in order and leave them to be collected in their corresponding envelopes and according to the supervisor's instructions. You are not allowed to take any sheet of paper out of the examination area.

Observational Round: Solar Physics

G0-2

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Standard Table of Constants

Fundamental Constants

Speed of light in vacuum	c	$=$	$2.998 \times 10^{8} ms^{-1}$
Planck constant	h	$=$	$6.626 \times 10^{-34} Js$
Boltzmann constant	k_B	$=$	$1.381 \times 10^{-23} JK^{-1}$
Stefan-Boltzmann constant	σ	$=$	$5.670 \times 10^{-8} Wm^{-2}K^{-4}$
Elementary charge	e	$=$	$1.602 \times 10^{-19} C$
Universal gravitational constant	G	$=$	$6.674 \times 10^{-11} Nm^{2}kg^{-2}$
Universal gas constant	R	$=$	$8.315 Jmol^{-1}K^{-1}$
Avogadro constant	N_A	$=$	$6.022 \times 10^{23} mol^{-1}$
Wien's displacement law	$\lambda_m T$	$=$	$2.898 \times 10^{-3} m \cdot K$
Mass of electron	m_e	$=$	$9.109 \times 10^{-31} kg$
Mass of proton	m_p	=	$1.673 \times 10^{-27} kg$
Mass of neutron	m_n	$=$	$1.675 \times 10^{-27} kg$
Atomic mass unit (a.m.u.)		$=$	$1.661 \times 10^{-27} kg$

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Astronomical Data

1 parsec	$1\ pc$	$=$	$3.086 \times 10^{16} m$
		$=$	$206\ 265\ au$
		$=$	$3.262\ ly$
1 astronomical unit	1 au	$=$	$1.496 \times 10^{11} m$
1 jansky	1 Jy	$=$	$10^{-26} W m^{-2} Hz^{-1}$
Hubble constant	H_0	$=$	$70\ kms^{-1} Mpc^{-1}$
Solar luminosity	L	$=$	$3.826 \times 10^{26} W$
Apparent angular diameter of Sun	θ	$=$	$32'$
Effective temperature of Sun	$T_{eff,}$	$=$	$5778K$
Obliquity of the ecliptic (Earth)	ε	$=$	$23.5°$
Inclination of the lunar orbit w.r.t. ecliptic		$=$	$05°08'43"$
Apparent visual magnitude of full moon		$=$	-12.74
North Ecliptic Pole (J2000.0)	(α_E, δ_E)		$(18^h00^m00^s, +66°33'39")$
North Galactic Pole (J2000.0)	(α_G, δ_G)		$(12^h51^m26^s, +27°07'42")$
1 sidereal day		$=$	$23^d56^m04^s$
1 tropical year		$=$	$365.2422\ solar\ days$
1 sidereal year		$=$	$365.2564\ solar\ days$

Solar Magnitudes

Apparent visual	$=$	-26.75
Absolute visual	$=$	$+4.82$
Apparent bolometric	$=$	-26.83
Absolute bolometric	$=$	$+4.74$

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Solar System

Object	Mean radius (km)	Mass (kg)	Semi-major axis (au)	Eccentricity
Sun	695 500	1.988×10^{30}	---	---
Mercury	2 440	3.301×10^{23}	0.387	0.206
Venus	6 052	4.867×10^{24}	0.723	0.007
Earth	6 378	5.972×10^{24}	1.000000	0.016 710
Moon	1 737	7.346×10^{22}	0.002572	0.054 900
Mars	3 390	6.417×10^{23}	1.524	0.093
Jupiter	69 911	1.898×10^{27}	5.203	0.048
Saturn	58 232	5.683×10^{26}	9.537	0.054
Uranus	25 362	8.681×10^{25}	19.189	0.047
Neptune	24 622	1.024×10^{26}	30.070	0.009

Gauss's Formulae

Cosine theorem : $\cos a = \cos b \cos c + \sin b \sin c \cos A$

Sine theorem : $\frac{\sin a}{\sin A} = \frac{\sin b}{\sin B} = \frac{\sin c}{\sin C}$