Team Competition

G0-1

English (Official)

General instructions: Group Radio Astronomy (115 points)

November 17, 2021.The team competition lasts for 3 hours (in a 30 hour window) and is worth a total of 115 points.

- Each country will receive the Team Competition as soon as the Theoretical exam is finished
- Any offline spreadsheet or similar tool may be used in this competition.
- The answers should be sent by 21:00 (UTC) on the 18th of November 2021.
- There would be only one Word file per team and should be labeled as XXX-Y-Team.docx. Here XXX represents a three letter country code (supervisors may refer to the standard list of International Olympic Committee codes) and Y will be replaced with either M (main) or G (guest). e.g COL-M-Team.docx
- All tables, plots etc. should be copy-pasted in the Word file.
- Some parts of this question expect you to write short answers in words. You may type these answers in your language. However, do not use complex words. For grading purposes, your answer will be translated into Spanish / English using a computer program.
- If you have drawn any diagrams by hand and want to include them in the solution, ask the team supervisors to take a photo of your diagram and give you the jpg file.
- You should export the word file to PDF so that the supervisors can upload your answers.

Team Competition

G0-2

English (Official)

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.)		$=$	$1.661 \times 10^{-27} kg$

Team Competition

G0-3

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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	$T_{eff,}$	$=$	$5778 K$
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)		$(18^h 00^m 00^s, +66°33’39”)$
North Galactic Pole (J2000.0)	(α_G, δ_G)		$(12^h 51^m 26^s, +27°07’42”)$
1 sidereal day		$=$	$23^d 56^m 04^s$
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	$=$	$+4.74$

Team Competition

G0-4

English (Official)

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

Equation for the linear least squares fit : $y = b_1 x + b_2$

where $b_1 = \frac{n\sum x_i y_i - (\sum x_i)(\sum y_i)}{n\sum x_i^2 - (\sum x_i)^2}$

and $b_2 = \overline{y} - b_1 \overline{x}$

$\overline{x}$ and $\overline{y}$ are average values of x and y.