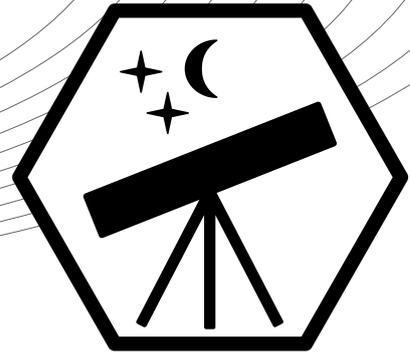


International Astronomy and Astrophysics Competition

Qualification Round 2024



Problem A : The Southern Hemisphere (5 Points)

- (A) Canopus (B) Achernar (C) LMC (D) SMC
(E) Eta Carinae Nebula (F) Crux (G) Omega Centauri (H) Alpha Centauri

Problem B : Stars in the Milky Way (5 Points)

$$N = V \cdot \rho = \pi \cdot R^2 \cdot h \cdot \rho = \pi \cdot (50,000 \text{ ly})^2 \cdot 1,000 \text{ ly} \cdot 0.05/\text{ly}^3 = 393 \cdot 10^9 \text{ (i.e., 393 billion stars)}$$

Problem C : Gravity at the ISS (5 Points)

- (a) $g(z) = \gamma \frac{M}{(R+z)^2} \implies P(z) = 1 - g(z)/g(0) = 1 - \left(\frac{R}{R+z}\right)^2 = 1 - \left(\frac{1}{1+\frac{z}{R}}\right)^2$
(b) $P(410 \text{ km}) = 11.7 \%$; ISS orbits around Earth \rightarrow centrifugal force
(c) $z(P) = R \cdot \left(\frac{1}{\sqrt{1-P}} - 1\right)^2 \rightarrow z(99 \%) = 57,339 \text{ km}$

Problem D : Field of View of the ISS (5 Points)

- (a) $\theta = 2 \cdot \arcsin\left(\frac{R}{R+z}\right) = 139.9^\circ$
(b) $S = 2\pi R \cdot \frac{180^\circ - \theta}{360^\circ} = 4459 \text{ km}$
(b) $2\pi R^2(1 - \cos(90^\circ - \theta/2))/(4\pi R^2) = 3 \%$

Problem E : Microwave Background (5 Points)

(What?) Hot, dense primordial state \rightarrow cosmic expansion \rightarrow temperature of the universe gradually decreased \rightarrow state of increased transparency \rightarrow photons can escape \rightarrow released photons are CMB (How?) 1965, Arno Penzias and Robert Wilson \rightarrow troubleshooting a persistent background noise in their radio telescope \rightarrow faint, uniform signal coming from all directions in the sky \rightarrow CMB