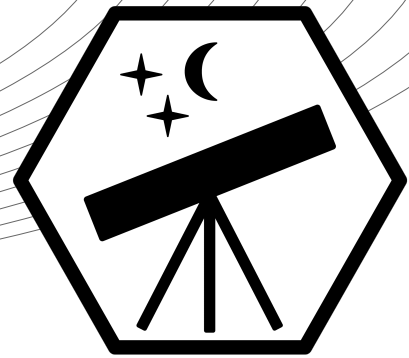


International Astronomy and Astrophysics Competition

Qualification Round 2022



Problem A : James Webb Space Telescope (5 Points)

- (A) Primary mirror (B) Science instrument module (C) Optics subsystem
(D) Secondary mirror (E) Sunshield (F) Star trackers
(G) Spacecraft bus (H) Antenna (I) Solar array
(J) Stabilization flap

Problem B : Very Dense Earth (5 Points)

$$V = \frac{M}{\rho} = \frac{4}{3}\pi R^3 \Rightarrow D = 2R = 2 \left(\frac{3M}{4\pi\rho} \right)^{1/3} = \left(\frac{6M}{\pi\rho} \right)^{1/3} = 283.6 \text{ m}$$

Problem C : Asteroid Field (5 Points)

Number of asteroid collisions: $N = \rho V = \rho \cdot \pi R^2 \cdot d$; momentum conservation:

$$Mv + Nmu \approx Mv = (M + Nm)w \Rightarrow w = \frac{Mv}{M + Nm} \Rightarrow \Delta v = v - w = v \left(1 - \frac{1}{1 + N\frac{m}{M}} \right)$$

Problem D : Position of the JWST (5 Points)

- (a) To block the radiation of the Sun
(b) $\omega = 2\pi/365d = 0.017/d$
(c) $a = \frac{F}{m} = \omega^2(d_E + d) - G\frac{M}{(d_E+d)^2} = 2.57 \cdot 10^{-4} \text{ m/s} = 22.2 \text{ m/d}$ (away from the Earth)
(d) The gravitational force of the Earth $F_{G,E} \rightarrow$ enables the stable Lagrange point L_2

Problem E : Infrared Radiation (5 Points)

- \rightarrow wavelength 1 mm to 700 nm; lower energy than red; \rightarrow infrared mostly blocked by Earth's atmosphere; \rightarrow cosmological redshift: capable of observing more distant objects
 \rightarrow observing through dust and clouds possible