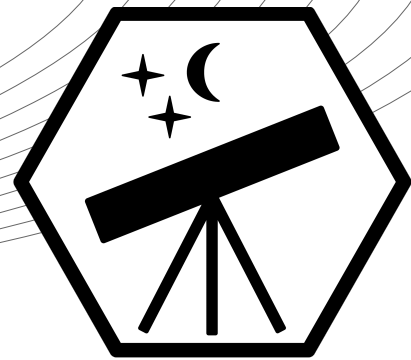


International Astronomy and Astrophysics Competition Qualification Round 2021



Problem A : Observing the Night Sky (5 Points)

- (1) 2k - 4.5k (one half) (2) Ursa Major (3) Comet, eye visibility (4) Geminids
(5) Cassiopeia (6) Cygnus (7) Andromeda

Problem B : Shock Wave Escape (5 Points)

$$vt = \frac{1}{2}at^2 + d_{AU} \implies a > \frac{v^2}{2d_{AU}} \approx 139 \text{ m/s}^2 \implies \text{The crew manages to escape!}$$

Problem C : Mysterious Planet (5 Points)

- (a) $GmM/R^2 = F = mv^2/R \implies M = v^2 \frac{R}{G} = \left(\frac{2\pi R}{T}\right)^2 \frac{R}{G} = \frac{4\pi^2 R^3}{T^2 G} \approx 1.03 \cdot 10^{26} \text{ kg}$
(b) (Planet) Neptune, (Moon) Naiad

Problem D : Gravitational Constant (5 Points)

(a)

$$E = \int_{R+h}^{\infty} F ds = -GmM \frac{1}{R+h} = -\frac{4\pi R^3}{3} \rho \cdot Gm \frac{1}{R+h} = -\frac{4\pi G}{3} m\rho \cdot \frac{R^3}{R+h}$$

(b)

$$\frac{mv^2}{2} + E(0) = E(h) \implies \frac{mv^2}{2} = -\frac{4\pi G}{3} m\rho R^3 \left(\frac{1}{R+h} - \frac{1}{R} \right) \implies G = \frac{3}{8\pi} \frac{v^2}{\rho R^2} \left(1 - \frac{R}{R+h} \right)^{-1}$$

(c) $G \approx 6.63 \cdot 10^{-11}$

Problem E : Pulsars (5 Points)

(individual written solution)