


Elementary mathematical astronomy; with examples and examination papers

DAY 1 **Problem Form**

IMO 2003 JAPAN



Country Number: _____
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First day
Tokyo, July 13, 2003

Problem 1. Let A be a subset of the set $S = \{1, 2, \dots, 1000000\}$ containing exactly 101 elements. Prove that there exist numbers t_1, t_2, \dots, t_{100} in S such that the sets

$$A_j = \{x + t_j \mid x \in A\} \quad \text{for } j = 1, 2, \dots, 100$$

are pairwise disjoint.

Problem 2. Determine all pairs of positive integers (a, b) such that

$$\frac{a^2}{2ab^2 - b^3 + 1}$$

is a positive integer.

Problem 3. A convex hexagon is given in which any two opposite sides have the following property: the distance between their midpoints is $\sqrt{3}/2$ times the sum of their lengths. Prove that all the angles of the hexagon are equal.
(A convex hexagon $ABCDEF$ has three pairs of opposite sides: AB and DE , BC and EF , CD and FA .)

Time allowed: four and a half hours.
Each problem is worth seven points.

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