IMO 1965

Berlin, German Democratic Republic

Day 1

$\boxed{1}$ Determine all values of x in the interval $0 \leq x \leq 2\pi$ which satisfy the inequality

$$2\cos x \leq \sqrt{1+\sin 2x} - \sqrt{1-\sin 2x} \leq \sqrt{2}.$$

$\boxed{2}$ Consider the sytem of equations

$$a_{11}x_1 + a_{12}x_2 + a_{13}x_3 = 0$$

$$a_{21}x_1 + a_{22}x_2 + a_{23}x_3 = 0$$

$$a_{31}x_1 + a_{32}x_2 + a_{33}x_3 = 0$$

with unknowns x_1, x_2, x_3. The coefficients satisfy the conditions:

a) a_{11}, a_{22}, a_{33} are positive numbers;

b) the remaining coefficients are negative numbers;

c) in each equation, the sum ofthe coefficients is positive.

Prove that the given system has only the solution $x_1 = x_2 = x_3 = 0$.

$\boxed{3}$ Given the tetrahedron $ABCD$ whose edges AB and CD have lengths a and b respectively. The distance between the skew lines AB and CD is d, and the angle between them is ω. Tetrahedron $ABCD$ is divided into two solids by plane ϵ, parallel to lines AB and CD. The ratio of the distances of ϵ from AB and CD is equal to k. Compute the ratio of the volumes of the two solids obtained.

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Day 2

$\boxed{4}$ Find all sets of four real numbers x_1, x_2, x_3, x_4 such that the sum of any one and the product of the other three is equal to 2.

$\boxed{5}$ Consider $\triangle OAB$ with acute angle AOB. Thorugh a point $M \neq O$ perpendiculars are drawn to OA and OB, the feet of which are P and Q respectively. The point of intersection of the altitudes of $\triangle OPQ$ is H. What is the locus of H if M is permitted to range over

a) the side AB;

b) the interior of $\triangle OAB$.

$\boxed{6}$ In a plane a set of n points ($n \geq 3$) is give. Each pair of points is connected by a segment. Let d be the length of the longest of these segments. We define a diameter of the set to be any connecting segment of length d. Prove that the number of diameters of the given set is at most n.