MATHEMATICS AND PHYSICS QUIZ

KöMaL Youth Conference, 2002 winter

1. Which discipline was referred to as „kapcsolástan" (connection theory) in nineteenth century Hungarian? (A) Combinatorics; (B) electricity; (C) neurology.

2. Aladár Mézga (a famous Hungarian cartoon character) has a special umbrella. If it is dropped from a high altitude, it will descend at a speed of 10 m/s. At approximately what distance from the point of release will its speed be 5 m/s? (A) 7 m; (B) 1.5 m; (C) 10 m.

3. In a certain club, every pair of members who do not know each other have exactly two common acquaintances, and no two members knowing each other have an acquaintance in common. How many members are there in the club? (A) 4; (B) there may be more than 4, but the number must be even; (C) there are an odd number of members.

4. Two identical rectangular plane mirrors are attached to each other along a common edge, enclosing an angle of α. A point-like source of light is placed between them in a plane that divides the angle in a ratio $1:2$. How many reflections are seen by an observer positioned at the image of the source after a reflection in the plane of symmetry of the two mirrors? (A) Infinitely many; (B) only a finite number; (C) the number of reflections may be finite or infinite, depending on $2\pi/\alpha$ being a rational or an irrational number.

5. It is known that the sum of the reciprocals of the positive integers is infinite. Let t denote an arbitrary digit, and consider the positive integers that do not contain t as a digit. The sum of the reciprocals of such numbers (A) is infinite for each t; (B) is finite for each t; (C) may be finite or infinite, depending on the value of t.

6. An ice skater is doing a pirouette. In order to spin faster, she draws her arms closer to her body (but does not propel herself with her feet any longer). In doing so, her rotational kinetic energy (A) increases; (B) decreases; (C) does not change.

7. How many solutions does the equation

$$2(a+b+c)=ab+bc+ac$$

have on the set of positive integers? (A) two; (B) seven; (C) twelve.

8. Is there a substance with $c_p < c_v$? (A) Yes, water is the only one (but only below 4 °C); (B) yes, there are several such substances; (C) no, there is no such substance.

9. If all five-digit numbers obtained by permutations of the digits 1, 2, 3, 4, 5 are concatenated in increasing order so that a long number is formed, what will be its 433rd digit? (A) 2; (B) 3; (C) 4.

10. An excited hydrogen atom at the seventh energy level is restored to ground state by emitting photons. How many different photons may occur? (A) 70; (B) 49; (C) 21.

11. The winner of a TV quiz is asked to choose one of three doors. There is a goat behind each of two doors, but the third door hides the prize: a car (or perhaps a permanent subscription to KöMaL). When the winner has pointed at one door, the moderator of the game (who knows where the car is) opens another door to show a goat. The player is allowed to change his mind and point at either of the doors yet unopened. What are his chances to win the prize then? (A) 2/3 if he stays with his original choice; (B) 2/3 if he changes his mind and points at the other door; (C) it does not make a difference whether he changes his mind or not, his chances are 1/2 in either case.

12. There is both a weak electric field and a weak magnetic field next to the surface of the Earth. Which field has the greater density of energy? (A) The electric field; (B) the magnetic field; (C) they are of the same order of magnitude.

13. The side AB of a triangle is perpendicular to the median drawn from A. What is the largest possible size of the smallest angle of the triangle? (A) A value less than 20°; (B) a value between 20° and 30°; (C) a value larger than 30°.

13+1. There are 10 000 people walking randomly about on a 70 m by 100 m soccer field. Two people chosen at random suddenly start walking towards each other on a head-on course. Those whom they approach within a distance of half a meter collide into them, and then get out of their way. Which of the events listed below has the greatest probability? The number of collisions is (A) less than 10; (B) between 10 and 100; (C) more than 100.[0]

[0] The solution is: A,B,B, B,B,A, B,C,A, C,B,B, A,B.