Advanced Level Practice Set - 2026 (September 2026)

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From 2005, the Hungarian school-leaving exam (érettségi) in mathematics can be taken at two levels: standard level and advanced level. The advanced-level exam also serves as the university entrance exam in mathematics.
The written part of the advanced-level exam takes 240 minutes. Part I consists of 4 problems worth 51 points in all. Part II consists of 5 problems worth 16 points each, of which students choose and solve 4, for 64 points. So there is a total of 115 points possible.
This problem set is similar to such an exam. We advise the reader to work through the problem set while measuring the time. There are 240 minutes to solve and present the problems.

Part I

1. a) Solve the equation $\sin^2 x - \cos^2 x = \frac{1}{2}$ on the interval $\left]-\frac{\pi}{2}, \frac{3\pi}{2}\right[$. *(7 points)*

   b) Solve the equation $\left(x^2 - x - 2\right) \cdot \lg x = \cos \frac{\pi}{2}$. ($\lg$ denotes the base 10 logarithm.) *(6 points)*

2. a) Tamás's library of one hundred books consists of Hungarian, English, and German books. $p\%$ of the books are in Hungarian, and $p\%$ of the books in foreign languages are in English; there is only one German book. Find the number of Hungarian and of English books. *(6 points)*

   b) Find the common ratios of the geometric sequences whose first term is 1 and every term of which is equal to the arithmetic mean of the next two terms. *(7 points)*

3. Consider the function $f : [-2, 2] \to \mathbb{R}$, $f(x) = x^2 + 2x + c$, where c is a real parameter.

   a) How should we choose the value of the parameter c so that the minimum value of the function is -3? Give the range of the function in this case. *(6 points)*

   b) Give the truth value of the following statement. Justify your answer. *(3 points)*

   "If the corresponding vertices of two simple graphs have pairwise equal degrees, then the two graphs are isomorphic."

   c) State the converse of the statement above. *(2 points)*

4. We throw two dice at the same time; each of them has 0 on one face, 3 on two faces, and 6 on three faces. Let A be the set of possible sums of the numbers thrown with the two dice, and B the set of possible products of the numbers thrown.

   a) Give the sets A and B. *(2 points)*

   b) Given that the sum of the numbers thrown is 6, what is the probability that their product is even? *(5 points)*

   c) Find the expected value of the sum of the numbers thrown. *(7 points)*

Part II

5. The famous Rotary circular walk near Pécs runs approximately along a circle whose equation, in a coordinate system placed on the map, is

$$x^2 + y^2 - 6x - 4y - 12 = 0$$

   a) How long is the circular walk, rounded to hundreds of meters, if the unit of the coordinate system is 200 meters? *(4 points)*

   The most popular entrance of the walk is at the point $(6, -2)$ of the map; most people join the walk here, and there is also a lookout here. The town would like to build more lookouts, so that hikers can enjoy the panorama from more directions. The planners decided to place three more lookouts along the walk, so that the four lookouts are at the vertices of a square.

b) Find the coordinates of the other three lookouts. *(9 points)*

Keeping his New Year's resolution, Miklós completed the Rotary walk every month from January 2026 on. Each time he recorded how long it took him to walk around. In the first three months his average time was 2 hours 8 minutes, and in the next five months 2 hours 4 minutes.

c) What average does he need in the last four months, so that his average for the whole year (12 months) is 2 hours? *(3 points)*

6. A box contains eight red, three white, and four green 2×2 building bricks.

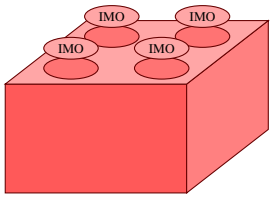
Anna reaches into the box, takes out three bricks one after the other, and stacks them on top of each other in the order she took them out.

a) What is the probability that she gets a red-white-green tower representing the Hungarian flag? *(2 points)*

Anna ended up drawing three bricks of different colors. Bori reached into the box with the remaining bricks and took out some of them: exactly the smallest number needed so that, drawing at random, she certainly has at least two bricks of some color.

b) What is the probability that Bori holds exactly two red bricks? *(4 points)*

Csilla plays with two identical red 2×2 bricks with the inscription IMO on each stud, as in the figure.



She wants to put them together by placing the bottom of one onto the top of the other, fixing them with at least one stud.

c) In how many ways can she put the two bricks together so that their side faces are parallel? (Two buildings are different if they cannot be brought into coincidence by rotation.) *(8 points)*

d) Among the buildings considered different in part c), how many are there that cannot be told apart by looking at them? *(2 points)*

7. a) Solve the following equation over the set of natural numbers ($n \geq 4$).

$$\binom{n}{4} + \binom{n+1}{4} = 2 \cdot \binom{n}{2}$$

(8 points)

b) Prove that in every square number ending in 6, the tens digit is odd. (A square number is the square of a natural number.) *(8 points)*

8. The area of a plot of land in the shape of a trapezoid is 3600 m^2. A path along one of its diagonals divides the plot into a part in the shape of an equilateral triangle and a part in the shape of a non-equilateral triangle. The ratio of the areas of the two parts, in this order, is $5 : 4$.

a) Find the sides and the angles of the trapezoid. *(10 points)*

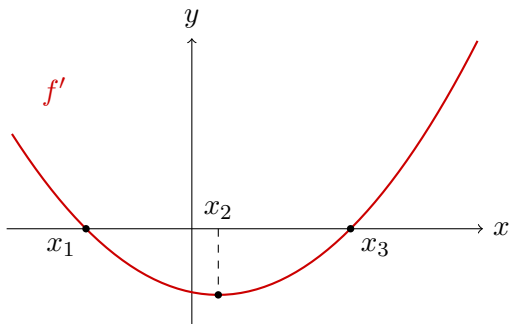
The flat trapezoid-shaped plot is on a slope. Its bases are horizontal, but the longer base is 10 meters higher than the shorter one. From a point of the shorter base, a self-driving battery-powered lawn mower starts uphill, perpendicular to the bases. It collects the cut grass in its bag, so it has to exert a larger and larger force to move on. This force is given by $F(x) = 80 + x$ (in newtons), where x is the distance traveled by the mower from the starting point (in meters). So for traveling t meters the machine uses

$$W(t) = \int_0^t (80 + x)\, dx$$

joules of energy.

b) How far can the mower travel, if the energy it can get from its battery is 3300 J? *(6 points)*

9. a) Let f be a cubic function defined on the set of real numbers. The figure shows a part of the graph of its derivative f'; the two zeros are x_1 and x_3, and the minimum point of the derivative is x_2.



On each of the four intervals marked, examine the signs of the first and second derivatives of f. Write P in the corresponding cell of the table if the sign is positive, and N if it is negative. Also examine the monotonicity and convexity of f on each interval, and write your answers in words in the corresponding cells.

x	$x < x_1$	$x_1 < x < x_2$	$x_2 < x < x_3$	$x > x_3$
sign of f'				
sign of f''				
f is				
convexity of f				

(8 points)

b) Give one of the functions f of part a) whose derivative satisfies $x_1 = -3$ and $x_3 = 5$. *(3 points)*

In a laboratory, the growth of a rare species of bacteria is studied. The number of bacteria as a function of time can be estimated by the exponential model

$$N(t) = 150 \cdot 1.25^t \qquad (t > 0)$$

where t is the time in hours since the start of the experiment and $N(t)$ is the number of bacteria.

c) Does the number of bacteria reach 4100 by the end of the 15th hour? *(2 points)*

d) After how much time does the number grow to eleven times its initial value? Round your answer to whole hours. *(3 points)*

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