Advanced Level Practice Set - 2026 (February 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. Find the largest subset of the set of natural numbers that can be the domain of the following expressions.

   a) $\log_x\left(-2x^2-7x+15\right)$ *(6 points)*

   b) $\sqrt{\frac{x^2-2x}{-2x^2-7x+15}}$ *(6 points)*

2. In an online game, we have to move a ladybug figure from the origin of the coordinate system to the point $F\,(8,4)$. In each step, the ladybug can only move one unit to the right or up.

   a) In how many ways can the ladybug get from the origin to F? (Two routes are different if one of them steps on a lattice point that the other does not.) *(6 points)*

   b) The point $F\,(8,4)$ is the focus of a parabola. What can the equation of the parabola be, if its axis is parallel to the y-axis and it meets the y-axis at the point with second coordinate 10? *(6 points)*

3. Every member of an after-school group folds paper airplanes all afternoon. From experience, 3 percent of the folded airplanes are defective: they cannot be made to fly.

   a) What is the probability that if we choose 5 of the paper airplanes, with replacement, there will be a defective one among them? *(5 points)*

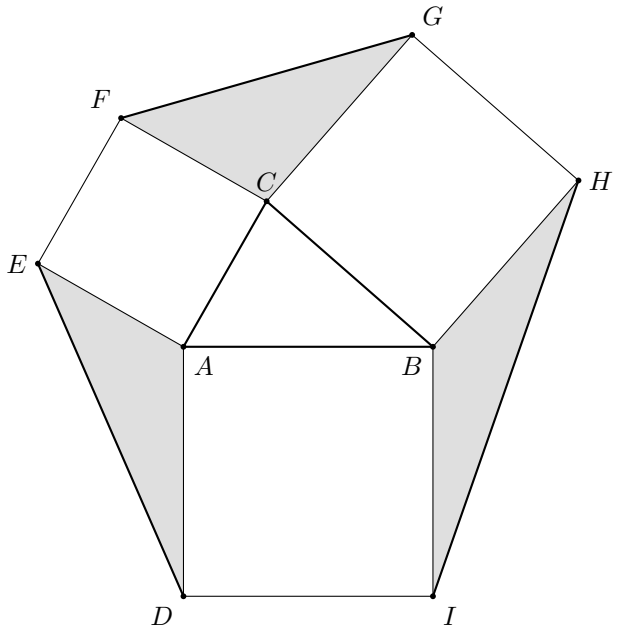
   A student made statistics of the number of paper airplanes finished per 10 minutes. The sum of the median and the lower quartile of the data is 28, the difference of the upper and lower quartiles is 6, and the difference of the upper quartile and the median is 4.

   b) Find these values for the data. *(4 points)*

   c) Draw a box plot of the data, if the minimum is 8, the maximum is 22, and there are no outliers. *(3 points)*

   d) The members of the group decided to revive an old custom: they surprise each other with postcards during the summer break. So they exchanged their home addresses with each other (mutually). They imagined the exchanges as a graph, with the edges representing the address exchanges. If there had been two more of them (who also exchange addresses with everybody), the graph would have had 45 more edges. How many students were in the group? *(3 points)*

4. On each side of a triangle we draw a square outward, with side equal to that side of the triangle. Connecting the free vertices of neighboring squares, we get the triangles ADE, CFG, and BHI, as in the figure.



a) Prove that the area of each of these triangles is equal to the area of the original triangle ABC. *(4 points)*

b) Find the area of the hexagon $DEFGHI$, if the sides of the original triangle are 6 cm, 7 cm, and 8 cm long. *(6 points)*

c) Give the truth values of the following statements, where α is an arbitrary real number.

A: $\cos(270^\circ + \alpha) = \sin\alpha$

B: $1 + \cos 2\alpha = 2\sin^2\alpha$

C: $\sin(60^\circ - \alpha) = \cos(30^\circ + \alpha)$ *(3 points)*

Part II

5. The height of a triangle to its side b, its side a, its side b, and its side c, measured in centimeters, are four consecutive terms of an arithmetic sequence with common difference 2, in this order.

   a) How many times the numerical value of the perimeter is the numerical value of the area of the triangle? *(8 points)*

   b) Into what parts does the height to the side b divide the side b? *(3 points)*

   c) Prove that $2^{4n} + 4$ is divisible by 20 for every positive integer n. *(5 points)*

6. We draw two circles in the coordinate plane, with equations $x^2 + y^2 - 14x - 12y + 60 = 0$ and $x^2 + y^2 - 2x - 6y = 0$. Let O_1 be the center of the circle with the larger radius and O_2 the center of the circle with the smaller radius. Let A and B be the intersection points of the two circles.

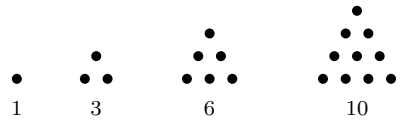
   a) Prove that the area of the triangle O_1AB is twice the area of the triangle O_2AB. *(8 points)*

   Consider the disks $x^2 + y^2 - 14x - 12y + 60 \leq 0$ and $x^2 + y^2 - 2x - 6y \leq 0$ as sets of points.

   b) Find the area of the intersection of the two sets. *(5 points)*

   c) Find the area of the union of the two sets. *(3 points)*

7. A number is called a triangular number if we can get it by adding all the natural numbers from 1 up to some number. The sum of the first n positive integers is the nth triangular number. The arrangement in the figure shows why they are called triangular numbers.



a) We choose one of the first hundred positive integers. Consider the following events:

A: the chosen number is a triangular number,

B: the chosen number is a square number,

C: the chosen number is a prime.

Find the following probabilities: $P(A)$, $P(A \cdot C)$, $P\left(\overline{A+B}\right)$. (Here $A \cdot C$ means "A and C", and $A+B$ means "A or B".) *(8 points)*

b) Adding the nth positive square number to the nth triangular number, we get $14\,751$. Find n and these numbers. *(8 points)*

8. Consider the two functions defined on the set of positive real numbers $f : \mathbb{R}^+ \to \mathbb{R}$, $f(x) = \cos x$ and $g : \mathbb{R}^+ \to \mathbb{R}$, $g(x) = 2x - \frac{\pi}{2}$.

   a) Find the following values: $f\left(g\left(\frac{3\pi}{4}\right)\right)$, $g^{-1}\left(\frac{\pi}{2}\right)$, $g\left(f\left(\frac{\pi}{4}\right)\right)$. *(3 points)*

   b) Find the area of the region enclosed by the y-axis, the graphs of f and g, and the line $x = \frac{\pi}{4}$. *(5 points)*

   c) Solve the following equation on the interval $[0, 2\pi]$.

$$\cos 2x + \sin\left(x + \frac{\pi}{3}\right) = \frac{1}{2}\sin x$$

   (8 points)

9. We place two balls one above the other in a right circular cone whose apex angle is $60°$, so that the larger ball rests on the base of the cone, the two balls touch each other, and both touch the lateral surface of the cone.

   a) Find the ratio of the radii of the two balls. *(7 points)*

   b) How many times the total volume of the two balls is the volume of the cone? *(6 points)*

   c) Find the volume of the cone, if its height is 18 cm. *(3 points)*

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