Mathematics

(Requirements and sample questions)

ALGEBRA

- Modification of algebraic expressions. Multiplying, adding and subtracting algebraic expressions. Expanding brackets.
- Simplifying, adding and subtracting fractions.
- The basic formulas for counting with powers and roots. Logarithms.
- The factorizations of algebraic expressions.
- Goniometrical functions and formulas.
- Inverse functions.
- The rules for calculating with complex numbers.

Q: Find a simple form of $\sqrt{\frac{\sqrt[2]{a^3}}{\sqrt[3]{b^6 a^{-3}}}}$.

A) $a^{-\frac{3}{4}} b^2$ B) $a^{\frac{5}{4}} b^{-1}$ C) $\frac{1}{b}$ D) $a^{\frac{5}{4}} b^2$

Q: If $0 < \alpha < \pi$ and $\sin\alpha = 0.72$, what is $\sin(\pi - \alpha)$?

A) $\cos\alpha$ B) -0.72 C) 0.18 D) 0.72

FUNCTIONS

- Basic properties of elementary functions.
- Graphs of elementary functions. Domain and range. Even, odd, inverse, periodic, increasing, decreasing and bounded function. Maximum and minimum of the function.

Q: The function $y = x^2 + 2x + 1$ is:

A) even B) odd C) increasing for large x D) decreasing for large x

Q: What is the domain of a function $y = \log_{10}\left(\frac{1+2x}{2-x}\right)$?

A) (−2, 2) B) All reals C) (0, 2)U (2,4) D) (−1/2, 2)

SEQUENCES AND SERIES

- Arithmetical and geometrical sequence.
- Sum of a geometric series.

Q: What is the sum of first 10 terms of an arithmetical sequence if the twelfth term a_{12} is 14 and the sixteenth term a_{16} = 22?

A) 10 B) 36 C) 110 D) 180

EQUATIONS AND INEQUALITIES

- Basic types of equations and inequalities. In particular: linear, quadratic, irrational, logarithmic, exponential and goniometrical equations, resp. inequalities.
- Solving equations (and inequalities) in one variable.
- Solving equations (and inequalities) involving absolute value.
- Solving of a system of equations in many variables.

Q: What is the solution of equation: $\log_2(x-2)=3$
A)5 B) 2 C) 10 D) no solution

Q: What is the solution of inequality: $\frac{16}{|x+3|}>2$
A) $(-11,-3)\cup(-3,5)$ B) $(-\infty,-11)\cup(5,\infty)$ C) $(-11,5)$ D) no solution

COMBINATORICS AND PROBABILITY

- Combinations, variations, permutations.
- Randomness and probability.
- Mutually exclusive, collectively exhaustive, complementary and independent events.
- Probability of more events (all happen, either of them happens).

Q: There are 3 black and 3 white balls in the bowl. What is the probability that two randomly picked balls are not of the same color?
A) 3/6 B) 2/5 C) 3/5 D) 11/30

Q: The 8 digit binary code may include only digits 0 and 1, which can be repeated in the code. How many combinations are there?
A) 16 B) 65 C) 8! D) 256

GEOMETRY I

- Plane and solid geometry. Geometrical shapes in plane and space.
- Perimeters, areas and volumes of basic formations in the plane and in the space.

Q: The surface area of the square *M* is $8a^2$. What is the area of the square *N*, which side is equal to the diagonal of the square M?
A) $16a^2$ B) $8\sqrt{3}\,a^2$ C) $8\sqrt{2}\,a^2$ D) $8a^2$

Q: What is the volume of a cube if its surface area is 72?
A) 72 B) $24\sqrt{3}$ C) $432\sqrt{2}$ D) 5184

GEOMETRY II

- Analytic geometry in the plane and in the space. Vector.
- Analytical equations of conic sections, lines and planes. Intersection.
- Line joining two points. Length, midpoint and gradient.
- Scalar and vector product.

Q: What is the slope k of the line segment with end points (3, 20), (28, −22)?
A) 6.7 B) -2.8 C) -0.26 D) 0.06

Q: A curve has equation $x^2 - 4x + 6y - 6 = 0$. What is this?
A) circle B) ellipse C) parabola D) hyperbola

Q: Find the parameter p so that the vectors $\boldsymbol{u} = (2, p)$ and $\boldsymbol{v} = (3 - p, 4)$ are perpendicular to each other.
A) -3 B) 0 C) 2 D) 4