

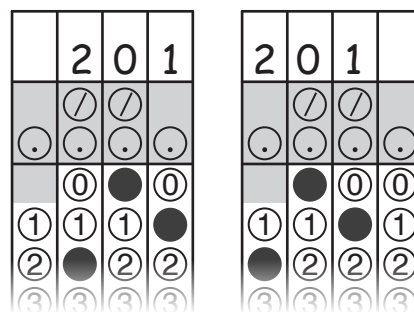
DO NOT TURN TO THE NEXT PAGE until your proctor tells you.

Please read the directions carefully.

- ▶ You have 100 minutes for 32 Problems.
- ▶ Mark your answers on your Answer Form with a pencil.
- ▶ Extra scratch paper is neither given nor allowed. You may use blank pages/spaces in the booklet as scratch paper.
- ▶ There are no penalties for incorrect answers. Answer as many problems as you can; go back and check your work and also go to questions you skip, before the time is over.
- ▶ Calculators are not permitted. Cell phones must be turned off completely and placed out of sight. MathCON problems are ALL done without a calculator.
- ▶ The problems are divided into three categories by difficulty levels:
 - 3 Points (Questions 1-8)
 - 5 Points (Questions 9-24)
 - 7 Points (Questions 25-32)
- ▶ Problems 29-32, the last four problems are constructed-response problems. Enter your numerical answer in the grid on your answer sheet as shown on the right.
 1. Although not required, it is suggested that you write your answer from left to right in the boxes at the top of the columns to help you fill in the circles accurately. You will receive credit only if the circles are filled in correctly.

2. Mark no more than one circle in any column.
3. You may start your answers in any column, space permitting. Columns you don't use should be left blanks, and there should be no blank columns between columns that are not blank. For example, if your answer is 201, then either arrangement of filled-in circles shown below is acceptable.

For example: Answer: 201 – either position is correct.



4. No problem has a negative answer.

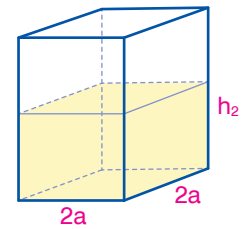
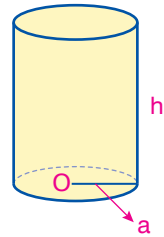
▶ **Notations in Geometry Problems:**

- A : Point A
- \overleftrightarrow{AB} : Line through points A and B
- \overline{AB} : Line segment joining A and B
- AB : Length of the line segment AB
- $\angle ABC$: Angle with the vertex point at B
- $m\angle ABC$: Measure of angle ABC
- \perp : Perpendicular
- // : Parallel

2. [Geometry, 3 Points]

A cylinder with a radius of a cm and a height of h_1 is filled with water. All the water was poured into a square prism with a base side length of $2a$ cm.

What is $\frac{h_1}{h_2}$ if the height of the water in the square prism is h_2 ?



- A) $\frac{3\pi}{2}$ B) $\frac{\pi}{4}$ C) $\frac{2\pi}{3}$ D) $\frac{4}{\pi}$ E) $\frac{6}{\pi}$

3. [Number Theory, 3 Points]

Dylan writes down the integers from 333 to 392 in ascending order without a gap. Then he divides up this sequence of numbers into groups of four:

$$333334335336337 \dots 391392 \rightarrow (3333)(3433)(5336)(3373) \dots (9039)(1392)$$

Which of the following groups of four is impossible for him to obtain?

- A) 1372 B) 3553 C) 6236 D) 7437 E) 7388

5. [Algebra, 3 Points]

In a 150 m race, Aziel, Banks, and Cillian ran at a steady speed throughout the race at (different) speeds. Banks and Cillian were 30 m and 60 m behind Aziel, respectively, when Aziel finished. How far behind Cillian was Banks, when Banks finished?

- A) 35 m B) 37.5 m C) 40 m D) 42.5 m E) 45 m



7. [Number Theory, 3 Points]

What is the units digit of

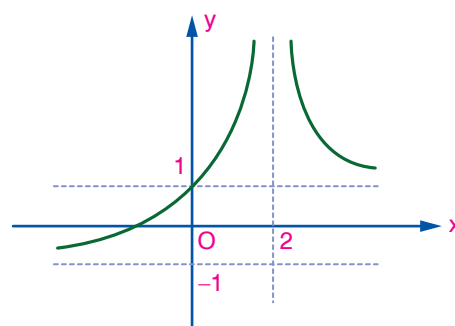
$$2018^{2018} + 2019^{2019} + 2020^{2020} + 2021^{2021}?$$

- A) 0 B) 2 C) 4 D) 6 E) 8

9. [Algebra, 5 Points]

The graph of a function is given on the right.

Which of the following could be the equation of the function?

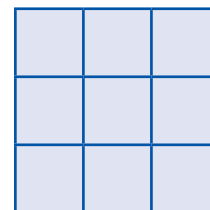


- A) $y = \frac{|x+2|}{x-2}$ B) $y = \frac{|x-2|}{x+2}$ C) $y = \frac{|x+1|}{x-2}$ D) $y = \frac{x-2}{|x+2|}$ E) $y = \frac{x+2}{|x-2|}$

12. [Combinatorics, 5 Points]

The square in the figure is divided into 9 smaller squares.

When any four-sided shape is chosen at random in the figure, what is the probability that the four sides form a square?



- A) $\frac{7}{18}$ B) $\frac{13}{36}$ C) $\frac{1}{3}$ D) $\frac{11}{36}$ E) $\frac{5}{18}$