The Faculty of Mathematics at the University of Waterloo
in association with
The Centre for Education in Mathematics and Computing
presents

The Twenty-Third Annual Small c Competition

for First and Second Year Students

Friday, September 26, 2025

Time: 1 hour
Calculators are permitted.
Instructions:

1. Do not open this booklet until you are told to do so.

10. You may use slide rules, abaci, rulers, compasses and paper for rough work. You may also use log tables; log cabins are not permitted. Protractors are also permitted, though contractors are not.

11. If you wish to cry, please do so quietly. Do not get any tears on the answer page.

100. Any contestant carrying a (toy) stuffed goose must proudly display it.

101. You must **print your name and ID number on the response form**. No other information is needed but answers to the contest questions are highly recommended.

110. This is a multiple choice test. Each question is followed by five possible answers marked **A**, **B**, **C**, **D**, and **E**. Only one of these is correct. When you have decided on your choice, fill in the appropriate bubble on the response form.

111. Scoring: Each correct answer is worth 5 in Part A, 6 in Part B, and 8 in Part C.
There is *no penalty for an incorrect answer*.
Each unanswered question is worth 2, to a maximum of 20.

1000. Diagrams are *not necessarily drawn to scale*. They are intended as aids only.

1001. Nord VPN is an official sponsor of the Small c. Nord VPN: helping you cheat on exams while in the bathroom since 2016.

1011. When a proctor instructs you to begin, you will have 111100 minutes of working time.

1011. Anyone overheard making a joke about the Toronto Maple Leafs will be immediately removed from the premises.

1100. The second official sponsor of the Small c is Dove. **Soap** is a magical substance that, when combined with water and a vague sense of personal responsibility, removes odors, oils, and shame. Side effects may include: making friends, keeping roommates, and finally being allowed back into group projects.

1101. Data was scrambled during construction in the MC building. Try to find the flipped bit above.

1110. Turn off and put away your cell phones, tablets, laptops, desktops, satellites and quantum computers.

1111. Hint: The answer to at least one question is **B**.

10000. One bonus mark will be awarded to any contestant that gets Question 1 wrong and Question 25 right.

10001. Praising the Small c Competition on the subreddit `reddit.com/r/uwaterloo` is permitted (and encouraged) as of 7 p.m. tonight.

10010. The only website you may use during the contest is `theonion.com`.

10011. Als u dit kunt lezen, spreekt u het Nederlands.

10100. As a student at University of Waterloo, you are much more than just a number. That being said, don't forget to put your Student ID Number on the response form.

Part A

1. At some universities, applicants are asked to compute $29 + 12 + 23$ as a skill-testing question. What is the correct answer?

   (A) 6^2 **(B)** 4^4 **(C)** 8^8 **(D)** 64^0 **(E)** 2^6

2. If the following sequence of given arrows repeats, what arrow will be in the 48^{th} position? The leftmost arrow is in the first position of the sequence.

   (A) **(B)**  **(C)**  **(D)** **(E)** 

3. Tonald Drump has 7 tariffs on European nations, 8 tariffs on South American nations, and 6 tariffs on African nations. How many more tariffs should be put on European nations so that half of all tariffs on these 3 continents will be on European nations?

   (A) 4 **(B)** 5 **(C)** 6 **(D)** 7 **(E)** 8

4. A UofT student uses a calculator to find an answer, but instead of pressing the  key, they press the  key by mistake. The student's answer was 9. What should the answer have been?

   (A) 243 **(B)** 81 **(C)** 729 **(D)** 3 **(E)** 6561

5. For what value of p is $x = 1$ a solution to $px^2 - 7x - 5 = 0$?

   (A) 0 **(B)** 12 **(C)** -12 **(D)** $-\frac{5}{12}$ **(E)** $\frac{5}{12}$

6. The product of 2, 3, 5, and y is equal to the sum of 2, 3, 5, and y. What is the value of y?

   (A) $\frac{1}{3}$ **(B)** $\frac{10}{31}$ **(C)** $\frac{10}{29}$ **(D)** $\frac{3}{10}$ **(E)** $\frac{10}{3}$

7. What is the value of the sum $(-300) + (-297) + (-294) + \cdots + 306 + 309$? The sum contains all integers of the form $3n$, where n is an integer and $-100 \leq n \leq 103$.

   (A) 309 **(B)** 927 **(C)** 615 **(D)** 918 **(E)** 18

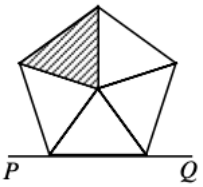
8. In a WUSA referendum concerning whether or not to raise tuition costs in order to erect a large statue of Mr. Goose on the Laurier Campus, $\frac{3}{5}$ of a student body voted 'yes' and 28% voted 'no'. There were only 2 options on the ballot. What percentage of students did not vote?

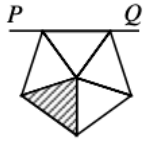
   (A) 72% **(B)** 40% **(C)** 32% **(D)** 12% **(E)** 88%

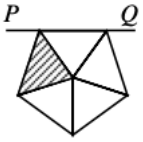
9. Mr. Goose knows that $x(x(x+1)+2)+3 = x^3 + x^2 + x - 6$ for some real number x. Which of the following can Mr. Goose (correctly) conclude?

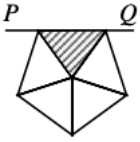
   (A) $x = 11$ **(B)** $x = -9$ **(C)** $x \in \{-4, 3\}$ **(D)** $x \in \{-1, 0\}$ **(E)** $x = -2$

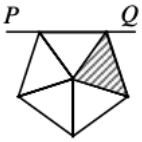
10. When the regular pentagon shown is reflected about the line PQ, and then rotated clockwise 144° about its center, its position is

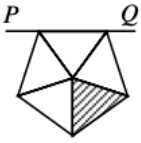


(A) 

(B) 

(C) 

(D) 

(E) 

Part B

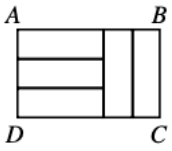
11. A student who was too cool to write the Small c instead drew $\triangle ABC$ in their dorm room. $\triangle ABC$ has $\sin(B) = \dfrac{12}{13}$ and $\sin(C) = \dfrac{4}{5}$. What is the value of $\dfrac{|AB|}{|AC|}$ for this triangle?

(A) $\frac{48}{65}$ **(B)** $\frac{65}{48}$ **(C)** $\frac{26}{35}$ **(D)** $\frac{13}{15}$ **(E)** $\frac{15}{13}$

12. While eating at [redacted] on Tuesday evening, you evaluate the expression $15^6 \times 28^5 \times 55^7$. How many zeroes does this number end with?

(A) 10 **(B)** 18 **(C)** 26 **(D)** 13 **(E)** 5

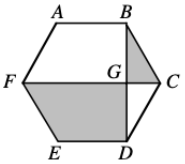
13. On Wednesday morning, while sitting on a toilet for a long time wondering why you ate at [redacted] last night, you see the following graffiti on the wall:



It shows rectangle $ABCD$ divided into five congruent rectangles. What is the ratio $AB : BC$?

(A) 3 : 2 **(B)** 2 : 1 **(C)** 5 : 2 **(D)** 5 : 3 **(E)** 4 : 3

14. In regular hexagon $ABCDEF$, shown below, chords FC and BD intersect at G. The ratio of the area of quadrilateral $FEDG$ to the area of $\triangle BCG$ is

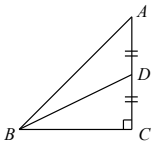


(A) $3\sqrt{3} : 1$ **(B)** 4 : 1 **(C)** 6 : 1 **(D)** $2\sqrt{3} : 1$ **(E)** 5 : 1

15. At an Anime convention you overhear the following from two extremely popular people. 'The digits $3, 4, 5$, and 6 are randomly arranged to form a four digit integer. What is the probability that the sum of the first and last digits is even?' They are unable to answer the question. What is the correct answer?

(A) $\frac{1}{4}$ **(B)** $\frac{1}{3}$ **(C)** $\frac{1}{6}$ **(D)** $\frac{1}{2}$ **(E)** $\frac{2}{3}$

16. A third year CS Major is doing a co-op placement at Tim Hortons. Towards the end of a long shift, to deal with crippling boredom, they draw the diagram below, which satisfies $AD = DC$, $\sin(\angle DBC) = 0.6$, and $\angle ACB = 90°$. What is the value of $\tan(\angle ABC)$?



(A) $\frac{16}{25}$ **(B)** $\frac{3}{10}$ **(C)** $\frac{10}{3}$ **(D)** $\frac{2}{3}$ **(E)** $\frac{3}{2}$

17. In a sequence, every term after the second term is twice the sum of the two preceding terms. The seventh term of the sequence is 8, and the ninth term is 24. What is the eleventh term of the sequence?

(A) 160 **(B)** 304 **(C)** 128 **(D)** 56 **(E)** 64

18. Consider the curves $y = \log_{10}(x-2)$ and $y = 1 - \log_{10}(x+1)$. The sum of the x-values of all points of intersection is

(A) -3 **(B)** 0 **(C)** 1 **(D)** 4 **(E)** 7

19. For a fixed real number k, let $f(x) = 2^{kx} + 9$. Given that $f(3) : f(6) = 1 : 3$, what is the value of k?

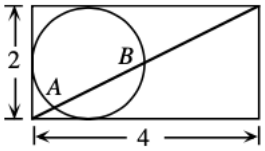
(A) $\frac{5}{6}$ **(B)** $\frac{23}{64}\log_2(11)$ **(C)** $\frac{25}{121}\log_2(18)$ **(D)** $\frac{1}{3}\log_2(6)$ **(E)** $\frac{20}{51}\log_2(9)$

20. Friends A, B, C, D, and E said 'bruh' a lot during a conversation. Let a, b, c, d, and e be the number of times each friend, respectively, said 'bruh'. Given that $5a = 4b = 3c = 2d = e$, find the smallest possible positive value of $a + 2b + 3c + 4d + 5e$.

(A) 87 **(B)** 522 **(C)** 180 **(D)** 120 **(E)** 60

Part C

21. A circle is tangent to three sides of a rectangle having side lengths 2 and 4 as shown. A diagonal of the rectangle intersects the circle at points A and B. The length of AB is



(A) $\sqrt{5}$ **(B)** $\frac{4\sqrt{5}}{5}$ **(C)** $\sqrt{5} - \frac{1}{5}$ **(D)** $\sqrt{5} - \frac{1}{6}$ **(E)** $\frac{5\sqrt{5}}{6}$

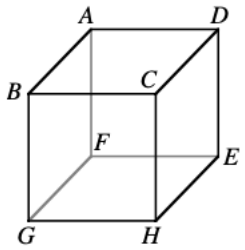
22. Vivek has a positive integer with 2025 digits, of which the leftmost digit is 3. In this integer, the 2-digit number formed by any two consecutive digits is divisible by 17 or 23. The 2025^{th} digit may be either 'a' or 'b'. What is the value of $a + b$?

(A) 3 **(B)** 7 **(C)** 4 **(D)** 10 **(E)** 17

23. For the system of equations $x^2 + x^2y^2 + x^2y^4 = 525$ and $x + xy + xy^2 = 35$, the sum of the real y values that satisfy the system of equations is

(A) 20 **(B)** 2 **(C)** 5 **(D)** $\frac{55}{2}$ **(E)** $\frac{5}{2}$

24. The given cube is cut into four pieces by two planes. The first plane is parallel to face $ABCD$ and passes through the midpoint of edge BG. The second plane passes through the midpoints of edges AB, AD, HE, and GH. Two of the pieces have volume V_1 and two of the pieces have volume V_2, with $V_1 < V_2$. Determine the ratio $V_1 : V_2$.



(A) $3 : 8$ **(B)** $7 : 24$ **(C)** $7 : 25$ **(D)** $7 : 17$ **(E)** $5 : 11$

25. Batman is locked in a room, and the door has a keypad. The Joker has left the following devious note to torment Batman:

> Let $X = \{1, 2, 3, 4, 5, 6, 7, 8, 9\}$. The password to escape the room is
>
> the number of bijections $p : X \to X$ such that $\sum_{i=1}^{9} |p(i) - i| = 40$.

What is the password to escape the room? (Assume the note left by The Joker is truthful.)

(A) 5184 **(B)** 4576 **(C)** 2880 **(D)** 8064 **(E)** 6144