The CENTRE for EDUCATION
in MATHEMATICS and COMPUTING
cemc.uwaterloo.ca

Hypatia Contest

(Grade 11)

Wednesday, April 1, 2026
(in North America and South America)

Thursday, April 2, 2026
(outside of North America and South America)

UNIVERSITY OF WATERLOO

Time: 75 minutes

Do not open this booklet until instructed to do so.

Number of questions: 4 **Each question is worth 10 marks**

Calculating devices are allowed, provided that they do not have any of the following features: (i) internet access, (ii) the ability to communicate with other devices, (iii) information previously stored by students (such as formulas, programs, notes, etc.), (iv) a computer algebra system, (v) dynamic geometry software.

Parts of each question can be of two types:

1. **SHORT ANSWER** parts indicated by 
   - worth 2 or 3 marks each
   - full marks given for a correct answer which is placed in the box
   - **part marks awarded only if relevant work** is shown in the space provided
2. **FULL SOLUTION** parts indicated by 
   - worth the remainder of the 10 marks for the question
   - **must be written in the appropriate location** in the answer booklet
   - marks awarded for completeness, clarity, and style of presentation
   - a correct solution poorly presented will not earn full marks

WRITE ALL ANSWERS IN THE ANSWER BOOKLET PROVIDED.

- Extra paper for your finished solutions must be supplied by your supervising teacher and inserted into your answer booklet. Write your name, school name, and question number on any inserted pages.
- Express answers as simplified exact numbers except where otherwise indicated. For example, $\pi + 1$ and $1 - \sqrt{2}$ are simplified exact numbers.

Do not discuss the problems or solutions from this contest online for the next 48 hours.

The name, grade, school and location of some top-scoring students will be published on our website, cemc.uwaterloo.ca. In addition, the name, grade, school and location, and score of some top-scoring students may be shared with other mathematical organizations for other recognition opportunities.

NOTE:

1. Please read the instructions on the front cover of this booklet.
2. Write all answers in the answer booklet provided.
3. For questions marked  , place your answer in the appropriate box in the answer booklet and **show your work**.
4. For questions marked  , provide a well-organized solution in the answer booklet. Use mathematical statements and words to explain all of the steps of your solution. Work out some details in rough on a separate piece of paper before writing your finished solution.
5. Diagrams are *not* drawn to scale. They are intended as aids only.
6. While calculators may be used for numerical calculations, other mathematical steps must be shown and justified in your written solutions, and specific marks may be allocated for these steps. For example, while your calculator might be able to find the x-intercepts of the graph of an equation like $y = x^3 - x$, you should show the algebraic steps that you used to find these numbers, rather than simply writing these numbers down.
7. No student may write more than one of the Fryer, Galois and Hypatia Contests in the same year.

1. If points are *collinear*, then they lie on the same straight line.


(a) If the points $A(1, 2)$, $B(2, 5)$ and $C(3, c)$ are collinear, what is the value of c?


(b) Three distinct points $D(0, 7)$, E and $F(14, 0)$ are collinear. If the coordinates of point E are positive integers, how many such points are possible?


(c) Determine the value of n so that the points $P(15, 12)$, $Q(6, n - 4)$ and $R(18, n)$ are collinear.

2. A *peak number* is a 5-digit positive integer, $ABCBA$, with digits $0 < A < B < C < 10$. For example, 27 872 is a peak number with $A = 2$, $B = 7$ and $C = 8$, but 52 625 and 46 954 are not peak numbers.

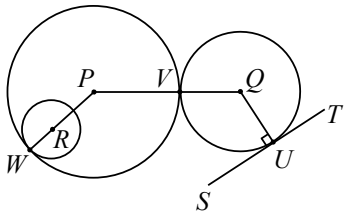

(a) What is the positive difference between the largest and smallest peak numbers?


(b) How many peak numbers are greater than 36 245 and less than 45 932?


(c) Determine all peak numbers that are a multiple of 15.

3. In the diagram, the circles with centres P and Q are externally tangent to one another at V, the circles with centres P and R are internally tangent to one another at W, and ST is tangent to the circle with centre Q at U.

Fact 1: The line through the centres of two circles that are tangent to one another passes through their point of tangency. For example, in the diagram, the line through P and Q passes through V, and the line through P and R passes through W.



Fact 2: A line tangent to a circle is perpendicular to the radius drawn to the point of tangency. For example, in the diagram, ST is perpendicular to QU.

(a) In Figure 1 below, a small circle with centre A and radius 10 is drawn inside a large circle with centre B and radius 36. The two circles are internally tangent to one another at C. Diameter CD of the large circle passes through A and intersects the small circle at E. What is the length of DE?

(b) In Figure 2 below, a small circle with centre G and radius 12 is drawn inside a large circle with centre F and radius 49. The two circles are internally tangent to one another at K. Diameter HI of the large circle is tangent to the small circle at J. Determine the length of FJ.

(c) In Figure 3 below, a small circle with centre X and radius 5 is drawn inside a large circle with centre Z and radius 18. These two circles are internally tangent to one another at L. Diameter UV of the large circle is tangent to the small circle at M. A medium circle with radius r is externally tangent to the small circle at N, internally tangent to the large circle at V, and has centre Y on UV. Determine the value of r.

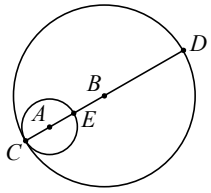


Figure 1

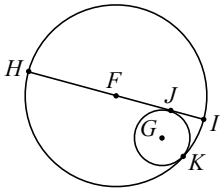


Figure 2

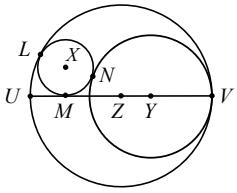


Figure 3

4. A positive integer n is a *sum of two positive squares* if there exist integers $a > 0$ and $b > 0$ for which $n = a^2 + b^2$. For example, 29 is a sum of two positive squares since $29 = 2^2 + 5^2$. However, each of 11 and 16 is not a sum of two positive squares.

A *Sorensen number*, S, is a positive integer that can be written as a sum of two positive squares in the following three distinct ways:

$$S = m^2 + x^2 = (m+1)^2 + y^2 = (m+2)^2 + z^2 \qquad (*)$$

for some positive integers m, x, y, and z. In the questions that follow, x, y and z are positive integers satisfying $(*)$.

(a) If $y^2 - z^2 = x^2 - y^2 + k$, what is the value of the constant k?

(b) The expression $y^2 - z^2$ can be written as a sum of p consecutive odd integers, the largest of which is $2y - 1$. Similarly, $x^2 - y^2$ can be written as a sum of q consecutive odd integers, the largest of which is $2x - 1$. Determine an expression for y written in terms of p and q.

(c) Determine two different Sorensen numbers.

The CENTRE for EDUCATION
in MATHEMATICS and COMPUTING
cemc.uwaterloo.ca

For students...

Thank you for writing the 2026 Hypatia Contest! Each year, more than 260 000 students from more than 80 countries register to write the CEMC's Contests.

Encourage your teacher to register you for the Canadian Intermediate Mathematics Contest or the Canadian Senior Mathematics Contest, which will be written in November 2026.

Visit our website `cemc.uwaterloo.ca` to find

- Free copies of past contests
- Information about careers in and applications of mathematics and computer science

For teachers...

Visit our website `cemc.uwaterloo.ca` to

- Obtain information about our 2026/2027 contests
- Register your students for the Canadian Senior and Intermediate Mathematics Contests which will be written in November
- Look at our free online courseware
- Use our free Problem Set Generator to create problem sets for curriculum support and enrichment
- Learn about our face-to-face workshops and our web resources
- Subscribe to our free Problem of the Week
- Investigate our online Master of Mathematics for Teachers
- Find your school's contest results