Grade 6 Math Circles  
Fall 2018 - December 4/5  

Jeopardy  

Vectors  

$100$ What is a scalar? What is a vector? What is the difference between them?  

$200$ If $\vec{A} = 3$ km [West], what is $-2\vec{A}$?  

$300$ Alice goes to the supermarket 5 km North of her house and back. Assuming she took a straight path, what is the distance she travelled? What is her displacement?  

$400$ Sam wants to row across a river. She can row at 3 km/h. The river has a current of 5 km/h [N]. She wants to end up directly East across the river from where she started. What information are we given (in terms of speed, velocity, and direction) for this vector addition?  

$500$ Carl is out cycling. He first goes 3 km [NE] and then cycles 10 km [NW]. Finally, he goes 4 km [SW]. Determine his final displacement.  

Matrices  

$100$ What is $A^T$?  

$$A = \begin{bmatrix} 13 & 2 & 1 \\ 5 & 3 & 4 \end{bmatrix}$$  

$200$ What is the matrix that results from this addition?  

$$\begin{bmatrix} 4 & -2 \\ 24 & 0 \\ 7 & 30 \end{bmatrix} + \begin{bmatrix} 9 & 11 \\ 5 & 16 \\ 8 & -4 \end{bmatrix}$$
$300$ Evaluate the following.

\[
3 \begin{bmatrix} 2 & 4 & 1 \\ 12 & 0 & 5 \\ 20 & 3 & 4 \end{bmatrix} - \begin{bmatrix} 3 & 6 & 1 \\ 17 & 4 & 8 \\ 53 & 5 & 10 \end{bmatrix}
\]

$400$ Given the following vectors, find the area of the parallelogram formed by them.

\[
\vec{p} = \begin{bmatrix} 12 \\ 7 \end{bmatrix}, \quad \vec{q} = \begin{bmatrix} 5 \\ 4 \end{bmatrix}
\]

$500$ How does Google PageRank determine the importance of a webpage?

**Area of Triangles**

$100$ Name 3 methods that can be used to find the area of a triangle.

$200$ What is the area of a triangle with side lengths of 12 cm, 16 cm, and 20 cm?

$300$ What is the area of this triangle?

$400$ What type of triangle only requires one triangle be subtracted from the rectangle in the complete the rectangle method?
$500$ Given that the perimeter of $\triangle DEF$ is 42, $AB=AC$, and the area of $\triangle ABC$ is 300 units$^2$, what is the area of hexagon $ABCDEF$?

![Diagram of triangle ABCDEF with sides labeled and one angle marked]

**Structure of Math**

$100$ What is an axiom? What is a definition? How are they similar?

$200$ How are inductive and deductive logic different? Which one does math normally use?

$300$ What does it mean for a definition to be “well-defined”?

$400$ “For all puppies, for any puppy you choose there exists a collar such that if the puppy is wearing the collar, then the puppy won’t get lost.” What kind of statement is this?

$500$ Consider this group (set) of numbers $\{1,3,6,19\}$. Prove that there exists a number in the set such that this number is not triple another number in the set.

**Misc.**

$100$ What is the earliest year of past Grade 6 Math Circles material on the Math Circles website?

$200$ What does University of Waterloo’s DC building stand for?

$300$ What is the name of a Grade 11 Math Contest that the CEMC creates?

$400$ How old are the Math Circles instructors?

$500$ What is the capital of Denmark?
Gauss Contest

$100$ In the square shown, what is the value of $x$? (*Gauss 2017 Question 6*)

![Image of a square with a diagonal split into a right triangle.]

A. 0  B. 45  C. 60  D. 180  E. 360

$200$ In the diagram, $\triangle PQR$ is equilateral and is made up of 4 smaller equilateral triangles. If each of the smaller triangles has a perimeter of 9 cm, what is the perimeter of $\triangle PQR$? (*Gauss 2017 Question 10*)

![Image of an equilateral triangle split into 4 smaller equilateral triangles.]

A. 15 cm  B. 9 cm  C. 36 cm  D. 27 cm  E. 18 cm

$300$ Five students ran a race. Ryan was faster than Henry and Faiz. Henry was slower than Faiz. Toma was faster than Ryan but slower than Omar. Which student finished fourth? (*Gauss 2017 Question 15*)

A. Faiz  B. Henry  C. Omar  D. Ryan  E. Toma

$400$ If $\frac{1}{2}$ of the number represented by $x$ is 32, what is $2x$? (*Gauss Grade 7 2000 Question 8*)

A. 128  B. 64  C. 32  D. 256  E. 16

$500$ In the diagram all rows, columns, and diagonals sum to 12. What is the sum of the four corner numbers? (*Gauss Grade 7 2000 Question 15*)

![Image of a 2x2 grid with numbers 4, 4, 3 in the first row and 3, 4, 4 in the second row.]

A. 14  B. 15  C. 16  D. 17  E. 12
Final Jeopardy

In the diagram, $ABCD$ is a square with area 25 cm$^2$. If $PQCD$ is a rhombus with area 20 cm$^2$, what is the area of the shaded region in cm$^2$? (Gauss Grade 8 2003 Question 24)