# Symmetry

*Short-answer questions about symmetry.*

**Question 1** *What is your name?*

***Free Response:***

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**Question 2** *Categorize the capital letters of the alphabet by their symmetries. Use the following font:*

ABCDEFGHIJKLMNOPQRSTUVWXYZ

***Free Response:*** ***Hint:***

- *Vertical line symmetry: A, H, I, M, O, T, U, V, W, X, Y*
- *Horizontal line symmetry: B, C, D, E H, I, K, O, X*
- $180^\circ$ *rotational symmetry: H, I, N, O, S, X, Z*
- *None: F, G, J, L, P, Q, R.*

*Notes: (1) In many fonts that look much the same, the K has no symmetry. (2) In this font, the O is slightly taller than it is wide. If it were a circle, there would be more symmetry. (See later problem.)*

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**Question 3** *Write the words COKE and PEPSI in capital letters so that they read vertically. Use a mirror to look at a reflection of the words. What is different about the reflections of the two words? Explain.*

***Free Response:*** ***Hint:*** *If the K has horizontal line symmetry in the font, then all the letters in COKE have horizontal line symmetry, which becomes vertical line symmetry when the word is written vertically. PEPSI, on the other hand, has several letters without that symmetry.*

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**Question 4** *Describe all of the symmetries of the following figures:*

Author(s): Bart Snapp and Brad Findell

(a) *An equilateral triangle*

(b) *An isosceles triangle that is not equilateral*

(c) *A square*

(d) *A rectangle that is not a square*

(e) *A rhombus that is not a square*

(f) *A (non-special) parallelogram*

(g) *A regular $n-gon$*

***Free Response:*** ***Hint:***

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**Question 5** *What are the symmetries of a circle?*

***Free Response:*** ***Hint:*** *A circle has rotational symmetry by any angle about its center. A circle has reflection symmetry about any line through its center. A circle does not have translation symmetry.*

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**Question 6** *How can you use the symmetries of a circle to determine whether a figure is indeed a circle?*

***Free Response:*** ***Hint:*** *Perform any of the symmetry transformations to be sure that the circle is actually mapped onto itself.*

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**Question 7** *What are the symmetries of a line?*

(a) *Describe all translation symmetries.*

(b) *Describe all rotation symmetries.*

(c) *Describe two types of reflection symmetries.*

(d) *Given a line, describe a rotation symmetry and a reflection symmetry that have the same effect on a line. How do the corresponding transformations differ in what they do to the surrounding space?*

***Free Response:*** ***Hint:*** *A line has translation symmetry by a vector of any length parallel to the line. A line has $180^\circ$ rotational symmetry about any point on the line. A line has reflection symmetry about any perpendicular to the line.*

**Question 8** *How can you use the symmetries of a line to determine whether a figure is indeed a line?*

***Free Response:*** ***Hint:*** *Perform any of the symmetry transformations to be sure that the line is actually mapped onto itself.*

**Question 9** *Find some tessellations. For each tessellation, describe all of its symmetries.*

***Free Response:*** ***Hint:***