12. It is possible for a figure to have reflectional but not rotational symmetry. An example of this is a smiley face.

13. Answer may vary. Sample: Rotational symmetry occurs through angles of rotation that put a long petal that is behind the other long petals at the top position. Since there are 3 such petals $360^\circ \div 3 = 120^\circ$, the angles occur at multiples of 120°.

14. **Conditional:** If a figure has 180° rotational symmetry, then it has point symmetry.

Converse: If a figure has point symmetry, then it has 180° rotational symmetry.

Inverse: If a figure does not have 180°rotational symmetry, then it does not have point symmetry.

Contrapositive: If a figure does not have point symmetry, then it does not have 180°rotational symmetry.

15. 180° and 270° rotational symmetry

16. The figure has 180° rotational symmetry and point symmetry.

17. Answers may vary. Sample: Decorative patterns like those found on floors, carpets, and moldings are examples of translational symmetry.

18. reflection over a vertical line through the center

19. A reflection over a vertical line that that passes through the center of both circles

A reflection over a horizontal line that passes through the point where both circles intersect

A 180°rotation

20. 5

21. 45°, 90°, 135°, 180°, 225°, 270°, and 315°

22. 90°, 180°, 270°

23. 3; lines of reflection and rotations at 120° and 240°.

24. Answer may vary. Sample: DID can have horizontal reflectional symmetry; MOM has vertical reflectional symmetry, 8118 can have both horizontal and vertical reflectional symmetry as well as 180˚ rotational and point symmetry.

25. You could visualize folding each flag along a line of reflection and rotating it about its center.

26. The structure of each snowflake is based on a regular hexagon. A hexagon has 6 lines of reflection.

A hexagon has 6 equal sides, so rotating it one-sixth of a full rotation will create an identical image. This means that there is rotational symmetry at 60˚or any multiple of 60˚.

27. **a.** 6 lines of reflection; rotational symmetry at any multiple of 60˚. These angles are 60˚, 120˚, 180˚, 240˚, and 300˚; point symmetry

b. vertical line of reflection

c. rotational symmetry at 180˚, point symmetry

28. (A), (B), (D)

29. (D)

30. **Part A** Any polygon that has rotational symmetry for 90˚ and 180˚ can be used, for example, a square or a plus sign.

Part B A figure with that rotational symmetry most likely also has horizontal and vertical reflectional symmetry.

Part C Designs will vary but should have the required symmetry.