18. $x^2 + y^2 + z^2 = 2z$

19. $y^2 + z^2 \le 4$

20. $x^2 + z^2 = 4$

21. $z = y^2$

22. $z \ge \sqrt{x^2 + y^2}$

23. $x + 2y + 3z = 6$

In Exercises 24–32, describe (and sketch if possible) the set of points in $\mathbb{R}^3$ that satisfy the given pair of equations or inequalities.

24. $\begin{cases} x = 1 \\ y = 2 \end{cases}$

25. $\begin{cases} x = 1 \\ y = z \end{cases}$

26. $\begin{cases} x^2 + y^2 + z^2 = 4 \\ z = 1 \end{cases}$

27. $\begin{cases} x^2 + y^2 + z^2 = 4 \\ x^2 + y^2 + z^2 = 4x \end{cases}$

28. $\begin{cases} x^2 + y^2 + z^2 = 4 \\ x^2 + z^2 = 1 \end{cases}$

29. $\begin{cases} x^2 + y^2 = 1 \\ z = x \end{cases}$

30. $\begin{cases} y \ge x \\ z \le y \end{cases}$

31. $\begin{cases} x^2 + y^2 \le 1 \\ z \ge y \end{cases}$

32. $\begin{cases} x^2 + y^2 + z^2 \le 1 \\ \sqrt{x^2 + y^2} \le z \end{cases}$

In Exercises 33–36, specify the boundary and the interior of the plane sets S whose points (x, y) satisfy the given conditions. Is S open, closed, or neither?

33. $0 < x^2 + y^2 < 1$

34. $x \ge 0, \quad y < 0$

35. $x + y = 1$

36. $|x| + |y| \le 1$

In Exercises 37–40, specify the boundary and the interior of the sets S in 3-space whose points (x, y, z) satisfy the given conditions. Is S open, closed, or neither?

37. $1 \le x^2 + y^2 + z^2 \le 4$

38. $x \ge 0, \quad y > 1, \quad z < 2$

39. $(x - z)^2 + (y - z)^2 = 0$

40. $x^2 + y^2 < 1, \; y + z > 2$

10.2 Vectors

A **vector** is a quantity that involves both **magnitude** (size or length) and **direction**. For instance, the *velocity* of a moving object involves its speed and direction of motion, so is a vector. Such quantities are represented geometrically by arrows (directed line segments) and are often actually identified with these arrows. For instance, the vector