1. $n(S \cup T) = n(S) + n(T) - n(S \cap T)$
   $= 4 + 4 - 2 = 6$

2. $n(S \cup T) = n(S) + n(T) - n(S \cap T)$
   $= 17 + 13 - 0$
   $= 30$

3. $n(S \cup T) = n(S) + n(T) - n(S \cap T)$
   $15 = 6 + 9 - n(S \cap T)$
   $n(S \cap T) = 6 + 9 - 15 = 0$

4. $n(S \cup T) = n(S) + n(T) - n(S \cap T)$
   $15 = 4 + 12 - n(S \cap T)$
   $n(S \cap T) = 4 + 12 - 15 = 1$

5. $n(S \cup T) = n(S) + n(T) - n(S \cap T)$
   $10 = n(S) + 7 - 5$
   $n(S) = 10 - 7 + 5 = 8$

6. $n(S \cup T) = n(S) + n(T) - n(S \cap T)$
   $14 = 14 + n(T) - 6$
   $n(T) = 14 - 14 + 6 = 6$

7. S is a subset of T.

8. S is a subset of T.

9. Let P = {adults in South America fluent in Portuguese} and
   S = {adults in South America fluent in Spanish}.
   Then $P \cup S$ = {adults in South America fluent in Portuguese or Spanish} and
   $P \cap S$ = {adults in South America fluent in Portuguese and Spanish}.
   $n(P) = 170, n(S) = 155,$
   $n(P \cup S) = 314$ (numbers in millions)
   $n(P \cup S) = n(P) + n(S) - n(P \cap S)$

   $314 = 170 + 155 - n(P \cap S)$
   $n(P \cap S) = 170 + 155 - 314 = 11$
   11 million are fluent in both languages.

10. Let M = {fist-year students enrolled in a math course} and E = {first-year students enrolled in an English course}.
    Then $M \cup E$ = {all first-year students} and $M \cap E$ = {first-year students enrolled in both math and English}.
    $n(E) = 600, n(M \cap E) = 400, n(M \cup E) = 1000$
    $n(M \cup E) = n(M) + n(E) - n(M \cap E)$
    $1000 = n(M) + 600 - 400$
    $n(M) = 1000 - 600 + 400 = 800$
    800 are taking a math course.

11. Let U = {all letters of the alphabet},
    let V = {letters with vertical symmetry}, and
    H = {letters with horizontal symmetry}.
    Then $V \cup H$ = {letters with vertical or horizontal symmetry} and
    $V \cap H$ = {letters with both vertical and horizontal symmetry}.
    $n(V) = 11, n(H) = 9, n(V \cap H) = 4$
    $n(V \cup H) = n(V) + n(H) - n(V \cap H)$
    $n(V \cup H) = 11 + 9 - 4 = 16$
    $n((V \cup H)') = n(U) - n(V \cup H) = 26 - 16 = 10$
    There are 10 letters with no symmetry.

12. Let V = {subscribers to streaming video service} and M = {subscribers to streaming music service}.
    Then $V \cup M$ = {subscribers to streaming video or music} and
    $V \cap M$ = {subscribers to both streaming video and music}.
    $n(V) = 250, n(M) = 75, n(V \cap M) = 25$
    $n(V \cup M) = n(V) + n(M) - n(V \cap M)$
    $= 250 + 75 - 25$
    $= 300$
    300 subscribe to at least one of these streaming services.

13. Let A = {cars with a navigation system} and P = {cars with push-button start}.
    Then $A \cup P$ = {cars with a navigation system or push-button start} and
    $A \cap P$ = {cars with both a navigation system and push-button start},
    $n(A) = 325, n(P) = 216, n(A \cap P) = 89$

$$n(A \cup P) = n(A) + n(P) - n(A \cap P)$$
$$= 325 + 216 - 89$$
$$= 452$$

452 cars were manufactured with at least one of the two options.

14. Let $S = \{\text{investors in stocks}\}$ and $B = \{\text{investors in bonds}\}$.

Then $S \cup B = \{\text{investors in either stocks or bonds}\}$ and $S \cap B = \{\text{investors in both stocks and bonds}\}$.

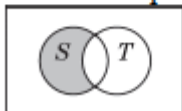$$n(S) = 90, n(B) = 70, n(S \cup B) = 120$$
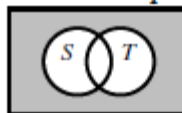$$n(S \cup B) = n(S) + n(B) - n(S \cap B)$$
$$120 = 90 + 70 - n(S \cap B)$$
$$n(S \cap B) = 90 + 70 - 120 = 40$$

40 investors owned both.

15. Consists of points not in T but in S.

16. Consists of points not in S and not in T.

17. Consists of points in T or not in S.
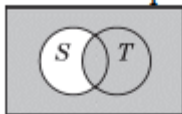
18. Consists of points not in S or not in T.
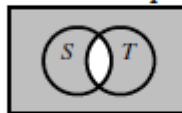
19. $(S \cap T')' = S' \cup T$

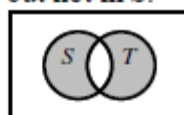Consists of points in T or not in S.
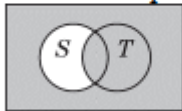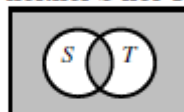
20. $(S \cap T)' = S' \cup T'$

Consists of points not in S or not in T.
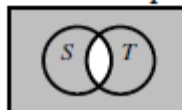
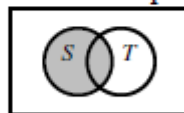**21.** Consists of points in S but not in T or points in T but not in S.

22. Consists of points in both S and T or points in neither S nor T.

23. $S \cup (S \cap T) = S$

Consists of points in S.

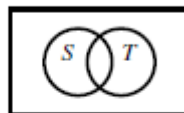**24.** $S \cup (T' \cup S) = S \cup T'$

Consists of points in S or not in T.
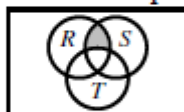
25. $S \cup S' = U$
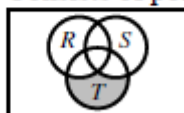
Consists of all points.

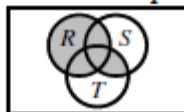**26.** $S \cap S' = \varnothing$

Consists of no points.

27. Consists of points in R and S but not in T.
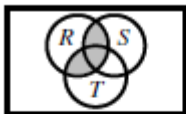
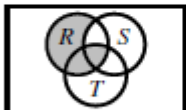**28.** Consists of points in T but not in R and not in S.

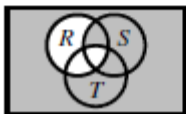**29.** Consists of points in R or points in both S and T.

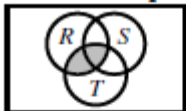**30.** Consists of points in both R and S or points in both R and T.

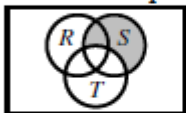**31.** Consists of points in R but not in S or points in both R and T.

32. Consists of points not in R or points in S but not in T.

33. Consists of points in both R and T.

34. Consists of points in S but not in T.

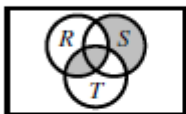**35.** Consists of points not in R, S, and T.

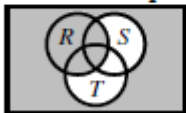**36.** $(R \cap S \cap T)' = R' \cup S' \cup T'$

Consists of points not in R, S, and T.

37. Consists of points in R and T or points in S but not T.

38. Consists of points in R or points not in S or T.

39. $S' \cup (S \cap T)' = S' \cup S' \cup T' = S' \cup T'$

40. $S \cap (S \cup T)' = S \cap S' \cap T' = (S \cap S') \cap T' = \varnothing$

41. $(S' \cup T)' = S \cap T'$

42. $(S' \cap T')' = S \cup T$

43. $T \cup (S \cap T)' = T \cup S' \cup T'$
$= (T \cup T') \cup S'$
$= U$

44. $(S' \cap T)' \cup S = S \cup T' \cup S = S \cup T'$

45. S'

46. $(S \cap T') \cup (S' \cap T)$

47. $R \cap T$

48. $R' \cap S \cap T'$

49. $R' \cap S \cap T$
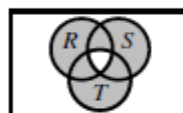
50. $R \cap (T \cup S')$
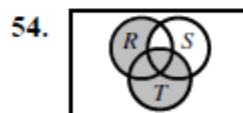
51.

$T \cup (R \cap S')$

52.
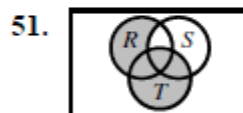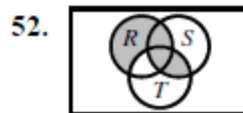
$(R \cap T') \cup (S \cap T)$

53. First draw a Venn diagram for
$(R \cap S') \cup (S \cap T') \cup (T \cap R')$.

The set consists of the complement.
$(R \cap S \cap T) \cup (R' \cap S' \cap T')$

54.

$R \cup (S \cap T')$

55. Everyone who is not a citizen or is both over the age of 18 and employed

56. People between the ages of 5 and 18 who are citizens and employed

57. Everyone over the age of 18 who is unemployed

58. All citizens who are over the age of 18 or employed

59. Noncitizens who are 5 years of age or older

60. No one (everyone who is under the age of 5 and employed).