

Section 1.6 Answers

1.

| p | \bar{p} | $p \wedge \bar{p}$ |
|-----|-----------|--------------------|
| 0 | 1 | 0 |
| 1 | 0 | 0 |

2.

| p | 1 | $p \vee 1$ |
|-----|---|------------|
| 0 | 1 | 1 |
| 1 | 1 | 1 |

3.

| p | q | \bar{q} | $p \wedge \bar{q}$ |
|-----|-----|-----------|--------------------|
| 0 | 0 | 1 | 0 |
| 0 | 1 | 0 | 0 |
| 1 | 0 | 1 | 1 |
| 1 | 1 | 0 | 0 |

4.

| p | q | $p \vee q$ | $\overline{p \vee q}$ |
|-----|-----|------------|-----------------------|
| 0 | 0 | 0 | 1 |
| 0 | 1 | 1 | 0 |
| 1 | 0 | 1 | 0 |
| 1 | 1 | 1 | 0 |

5.

| p | q | \bar{q} | $p \oplus \bar{q}$ |
|-----|-----|-----------|--------------------|
| 0 | 0 | 1 | 1 |
| 0 | 1 | 0 | 0 |
| 1 | 0 | 1 | 0 |
| 1 | 1 | 0 | 1 |

6.

| p | q | \bar{p} | $\bar{p} \wedge q$ | $p \vee (\bar{p} \wedge q)$ |
|---|---|-----------|--------------------|-----------------------------|
| 0 | 0 | 1 | 0 | 0 |
| 0 | 1 | 1 | 1 | 1 |
| 1 | 0 | 0 | 0 | 1 |
| 1 | 1 | 0 | 0 | 1 |

7.

| p | q | r | $p \vee q$ | $(p \vee q) \wedge r$ |
|---|---|---|------------|-----------------------|
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | 0 | 0 |
| 0 | 1 | 0 | 1 | 0 |
| 0 | 1 | 1 | 1 | 1 |
| 1 | 0 | 0 | 1 | 0 |
| 1 | 0 | 1 | 1 | 1 |
| 1 | 1 | 0 | 1 | 0 |
| 1 | 1 | 1 | 1 | 1 |

8.

| p | q | r | \bar{r} | $p \vee q \vee \bar{r}$ |
|---|---|---|-----------|-------------------------|
| 0 | 0 | 0 | 1 | 1 |
| 0 | 0 | 1 | 0 | 0 |
| 0 | 1 | 0 | 1 | 1 |
| 0 | 1 | 1 | 0 | 1 |
| 1 | 0 | 0 | 1 | 1 |
| 1 | 0 | 1 | 0 | 1 |
| 1 | 1 | 0 | 1 | 1 |
| 1 | 1 | 1 | 0 | 1 |

9.

| p | q | \bar{q} | $p \wedge q$ | $p \vee \bar{q}$ | $\overline{p \vee \bar{q}}$ | $(p \wedge q) \vee \overline{p \vee \bar{q}}$ |
|---|---|-----------|--------------|------------------|-----------------------------|---|
| 0 | 0 | 1 | 0 | 1 | 0 | 0 |
| 0 | 1 | 0 | 0 | 0 | 1 | 1 |
| 1 | 0 | 1 | 0 | 1 | 0 | 0 |
| 1 | 1 | 0 | 1 | 1 | 0 | 1 |

10.

| p | q | \bar{p} | \bar{q} | $\bar{p} \vee \bar{q}$ | $\bar{p} \vee q$ | $(\bar{p} \vee \bar{q}) \wedge (\bar{p} \vee q)$ |
|---|---|-----------|-----------|------------------------|------------------|--|
| 0 | 0 | 1 | 1 | 1 | 1 | 1 |
| 0 | 1 | 1 | 0 | 1 | 1 | 1 |
| 1 | 0 | 0 | 1 | 1 | 0 | 0 |
| 1 | 1 | 0 | 0 | 0 | 1 | 0 |

11. No, because the 4th and 7th columns are not the same.

| p | q | $p \wedge q$ | $\overline{p \wedge q}$ | \bar{p} | \bar{q} | $\bar{p} \wedge \bar{q}$ |
|---|---|--------------|-------------------------|-----------|-----------|--------------------------|
| 0 | 0 | 0 | 1 | 1 | 1 | 1 |
| 0 | 1 | 0 | 1 | 1 | 0 | 0 |
| 1 | 0 | 0 | 1 | 0 | 1 | 0 |
| 1 | 1 | 1 | 0 | 0 | 0 | 0 |

12. Yes, because the 4th and 7th columns are identical.

| p | q | $p \vee q$ | $\overline{p \vee q}$ | \bar{p} | \bar{q} | $\bar{p} \wedge \bar{q}$ |
|---|---|------------|-----------------------|-----------|-----------|--------------------------|
| 0 | 0 | 0 | 1 | 1 | 1 | 1 |
| 0 | 1 | 1 | 0 | 1 | 0 | 0 |
| 1 | 0 | 1 | 0 | 0 | 1 | 0 |
| 1 | 1 | 1 | 0 | 0 | 0 | 0 |

13. Yes, because the 3rd and 6th columns are identical.

| p | q | $p \oplus q$ | \bar{p} | \bar{q} | $\bar{p} \oplus \bar{q}$ |
|---|---|--------------|-----------|-----------|--------------------------|
| 0 | 0 | 0 | 1 | 1 | 0 |
| 0 | 1 | 1 | 1 | 0 | 1 |
| 1 | 0 | 1 | 0 | 1 | 1 |
| 1 | 1 | 0 | 0 | 0 | 0 |

14. No, because the 5th and last columns are not identical.

| p | q | r | q^r | $p \vee (q^r)$ | $p \vee q$ | $(p \vee q)^r$ |
|---|---|---|-------|----------------|------------|----------------|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 0 | 1 | 0 | 0 | 0 | 1 | 0 |
| 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| 1 | 0 | 0 | 0 | 1 | 1 | 0 |
| 1 | 0 | 1 | 0 | 1 | 1 | 1 |
| 1 | 1 | 0 | 0 | 1 | 1 | 0 |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 |

15. Yes, because the first and last columns are identical.

| p | q | p^q | $p \vee (p^q)$ |
|---|---|-------|----------------|
| 0 | 0 | 0 | 0 |
| 0 | 1 | 0 | 0 |
| 1 | 0 | 0 | 1 |
| 1 | 1 | 1 | 1 |

16. Yes, because the 5th and last columns are identical.

| p | q | r | $p \vee q$ | $(p \vee q) \vee r$ | $q \vee r$ | $p \vee (q \vee r)$ |
|---|---|---|------------|---------------------|------------|---------------------|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | 0 | 1 | 1 | 1 |
| 0 | 1 | 0 | 1 | 1 | 1 | 1 |
| 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| 1 | 0 | 0 | 1 | 1 | 0 | 1 |
| 1 | 0 | 1 | 1 | 1 | 1 | 1 |
| 1 | 1 | 0 | 1 | 1 | 1 | 1 |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 |

17. No, because the 3rd and last columns are not identical. (But I think you can see that the last expression is the **negation** of column 3.)

| p | q | $p \oplus q$ | \bar{p} | \bar{q} | $p \wedge q$ | $\bar{p} \wedge \bar{q}$ | $(p \wedge q) \vee (\bar{p} \wedge \bar{q})$ |
|---|---|--------------|-----------|-----------|--------------|--------------------------|--|
| 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 |
| 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 |
| 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 |
| 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 |

18. This expression is logically equivalent to p, as shown below.

| p | p | $p \wedge p$ |
|---|---|--------------|
| 0 | 0 | 0 |
| 1 | 1 | 1 |

19. This expression is logically equivalent to 1, as shown below.

| p | \bar{p} | $p \vee \bar{p}$ |
|---|-----------|------------------|
| 0 | 1 | 1 |
| 1 | 0 | 1 |

20. This expression is logically equivalent to 0, as shown below.

| p | 0 | $p \wedge 0$ |
|---|---|--------------|
| 0 | 0 | 0 |
| 1 | 0 | 0 |

21. This expression simplifies to 1.

| p | \bar{p} | $\bar{p} \oplus p$ |
|---|-----------|--------------------|
| 0 | 1 | 1 |
| 1 | 0 | 1 |

22. This expression simplifies to 0.

| p | q | $p \oplus q$ | \bar{q} | $p \oplus \bar{q}$ | $(p \oplus q) \wedge (p \oplus \bar{q})$ |
|---|---|--------------|-----------|--------------------|--|
| 0 | 0 | 0 | 1 | 1 | 0 |
| 0 | 1 | 1 | 0 | 0 | 0 |
| 1 | 0 | 1 | 1 | 0 | 0 |
| 1 | 1 | 0 | 0 | 1 | 0 |

23. This expression is logically equivalent to p, as shown below.

| p | q | $p \wedge q$ | $p \vee (p \wedge q)$ |
|---|---|--------------|-----------------------|
| 0 | 0 | 0 | 0 |
| 0 | 1 | 0 | 0 |
| 1 | 0 | 0 | 1 |
| 1 | 1 | 1 | 1 |

24. This expression simplifies to q.

| p | q | $p \vee q$ | $q \wedge (p \vee q)$ |
|---|---|------------|-----------------------|
| 0 | 0 | 0 | 0 |
| 0 | 1 | 1 | 1 |
| 1 | 0 | 1 | 0 |
| 1 | 1 | 1 | 1 |

25. This expression is logically equivalent to $p \wedge q$.

| p | q | \bar{p} | $\bar{p} \vee q$ | $p \wedge (\bar{p} \vee q)$ |
|---|---|-----------|------------------|-----------------------------|
| 0 | 0 | 1 | 1 | 0 |
| 0 | 1 | 1 | 1 | 0 |
| 1 | 0 | 0 | 0 | 0 |
| 1 | 1 | 0 | 1 | 1 |

26. This expression simplifies to $p \vee q$.

| p | q | \bar{p} | $\bar{p} \wedge q$ | $p \vee (\bar{p} \wedge q)$ |
|---|---|-----------|--------------------|-----------------------------|
| 0 | 0 | 1 | 0 | 0 |
| 0 | 1 | 1 | 1 | 1 |
| 1 | 0 | 0 | 0 | 1 |
| 1 | 1 | 0 | 0 | 1 |