4(d) \( r \land s \iff T \), so the disjunction is \( T \).

6. Not equivalent. If \( P \iff T \), \( Q \) and \( R \) are \( F \), then \((P \land Q) \lor R \iff F\), while \( P \lor (Q \land R) \iff T \).

9(a) Neither. If both \( P \) and \( Q \) are \( T \), then the value is \( T \), while if \( P \iff T \) and \( Q \iff F \), the value is \( F \).

10(b) Tautology.

1.2

3(c) \( Q \) is False.

5(d) True, as \( F \iff 2 \iff False \).

6(b) True, as both sides are True.

7(a) This is equivalent to \( P \iff Q \), so \( \neg P \iff \neg Q \).

12(f) If both \( P \) and \( Q \) are \( T \), or both are \( F \), both statements are \( T \). If \( P \iff F \) and \( Q \iff T \) (or vice versa), both statements are \( F \).

16(b) Tautology. If \( P \iff T \), \( P \land (P \lor Q) \iff T \) regardless of \( Q \), and if \( P \iff F \), \( P \land (P \lor Q) \iff F \) regardless of \( Q \).

1.3

6(c) In \( T \) (as \( (x > 8) \) is always True), \( \neg u \) (as \( (x \text{ odd}) \) is always False), \( u \lor v \) (as \( (x > 8) \) is always True), but not \( u \lor w \) (take \( x = 3 \)).

8(c) False (the only solution \( x = -1 \) is not \( x \in \mathbb{N} \)).

10(c) False. The negation \((\exists x)(\exists y)(x^2 + y^2 \neq -1)\) is True as \( x^2 + y^2 \geq 0 \).

10(e) True. Take \( x = 0 \), \( (\exists x)(\exists y)(\forall z)(xy = xz) \) is True!
4. (b) By (iv), the weapon was candleshod. By (iii), Scarlett is guilty.

5. (f) Proof There exist integers $k, l$, so that

\[ x = 2k + 1, \quad y = 2l + 1. \]

Then

\[ 3x - 5y = 3(2k + 1) - 5(2l + 1) = 6k - 10l - 2 \]

\[ = 2(3k - 5l - 1), \]

an even number. \(\Box\)

6.(f) Proof Case 1: \(a \geq 0\), then \(|a| \leq b \iff a \leq b\), which holds by assumption.

Case 2: \(a < 0\), then \(|a| \leq b \iff -a \leq b\), which also holds by assumption. \(\Box\)

8a. Proof Case 1: \(n\) even. Then \(n = 2k\) for some \(k \in \mathbb{Z}\), and \(n^2 + n + 3 = 4k^2 + 2k + 3 = 2(2k^2 + k + 1)\), an odd number.

Case 2: \(n\) odd. Then \(n = 2k + 1\) for some \(k \in \mathbb{Z}\), and \(n^2 + n + 3 = 4k^2 + 4k + 1 + 2k + 1 + 3\)

\[ = 4k^2 + 6k + 5 = 2(2k^2 + 3k + 2) + 1, \]

an odd number. \(\Box\)

9d. Proof. Note \(2x + 5 \leq 11 \iff x \leq \frac{(11 - 5)}{2} = 3\).

Further \(x^3 + 2x^2 = x^2(x + 2) < 0 \iff x < -2\). But \(x < -2\) implies \(x < 3\). \(\Box\)

11(b). C. The proof needs the correction: \(...\), and for some integer \(r\), \(c = ar\), then \(b + c = a(q + r)\), so \(a \mid (b + c)\). \(\Box\)