12. a. $\neg p$: The election isn't decided
b. $p \lor q$: The election is decided or the votes have been counted
c. $\neg p \land q$: The election isn't decided and the votes have been counted.
d. $q \to p$: If the votes have been counted, then the election has been decided.
e. $\neg q \to \neg p$: If the votes have not been counted, then the election is not decided.
f. $\neg p \to \neg q$: If the election isn't decided, then the votes have not been counted.
g. $p \leftrightarrow q$: The election is decided if and only if the votes have been counted.
h. $\neg q \lor (\neg p \land q)$: The votes have not been counted or the election isn't decided and the votes have been counted.

30. b. If it's a sunny summer day, then I go to the beach

Contrapositive: If I do not go to beach, then it is not a sunny day.

Converse: If I go to the beach, then it is a sunny summer day

Inverse: If it isn't a sunny summer day, then I do not go to the beach

34. d.

p	q	p∧q	p∨q	(p∧q) → (p∨q)
T	T	T	T	T
T	F	F	T	T
F	T	F	T	T
F	F	F	F	T

f.

p	q	p↔q	p ↔ ¬q	(p↔q) ⊕ (p↔¬q)
T	T	T	F	T
T	F	F	T	T
F	T	F	T	T
F	F	T	F	T

48 a. $11000 \wedge (01011 \vee 11011) = \boxed{11000}$

$$\begin{array}{c}11000 \\ \underline{11011} \wedge \\ 11000\end{array} \qquad \begin{array}{c}01011 \\ \underline{11011} \vee \\ 11011\end{array}$$

b. $(01111 \wedge 10101) \vee 01000 = \boxed{01101}$

$$\begin{array}{c}01111 \\ \underline{10101} \wedge \\ 00101\end{array} \qquad \begin{array}{c}00101 \\ \underline{01000} \vee \\ 01101\end{array}$$

c. $(01010 \oplus 11011) \oplus 01000 = \boxed{11001}$

$$\begin{array}{c}01010 \\ \underline{11011} \oplus \\ 10001\end{array} \qquad \begin{array}{c}10001 \\ \underline{01000} \oplus \\ 11001\end{array}$$

D. $(11011 \vee 01010) \wedge (10001 \vee 11011) = \boxed{11011}$

$$\begin{array}{c}11011 \\ \underline{01010} \\ 11111\end{array} \qquad \begin{array}{c}10001 \\ \underline{11011} \\ 11011\end{array}$$

$$\begin{array}{c}11111 \\ \underline{11011} \\ 11011\end{array}$$

Section 1.2

4 $\boxed{w \leftrightarrow (d \vee s)}$

10. p: Software is being upgraded
q: Users can access file system
r: Users can save new files.

$p \to \neg q \qquad \neg q \to r$

$\qquad\qquad$ negation

$\neg r \to \neg p \equiv p \to r$

$p \to \neg q \qquad \not\equiv p \to r$

$\qquad\qquad\uparrow$

$\qquad$ Contradiction

18.

empty	+in 1	+in 2
T1	T2	T3

T1	T2	T3	
T	T	T	X-can't all be true
T	T	F	
T	F	T	
T	F	F	
F	T	T	
F	T	F	✓
F	F	T	
F	F	F	X- cand all be false

a. False
b. True, Trunk 1 and trunk 3
c. False
d. False

28.)   A: C is knave   B: A is Knight   C: I am the spy

A	B	C	
T	T	T	⓪ Cody can't be 2 things at once
T	T	F	✓
T	F	T	①
T	F	F	Alex can't be knight if B is false
F	T	T	② Alex can't be knight and lie
F	T	F	③
F	F	T	A + B cannot both be false if c is true
F	F	F	Knights cant lie

A is the knight,   B is the SPY,   C is the knave.

44.a) $\neg p \vee \neg q$

44.b) $p \vee (\neg p \wedge q)$

$\neg ((\neg p \wedge q) \vee p)$