1.1

2.) a.) $n \wedge m$

b.) $f \wedge m$

c.) $n \vee m$

d.) $\neg d$

e.) $f \wedge n$

f.) $\neg t$

3.) a.) true

b.) false

c.) true

d.) true

4.) a.) Inclusive: true   Exclusive: true

b.) Inclusive: true   Exclusive: true

c.) Inclusive: true   Exclusive: false

d.) Inclusive: true   Exclusive: true

1.2

$2^2=4$

4.) a.)

P	q	¬p ⊕ q
T	T	T
T	F	F
F	T	F
F	F	T

b.)

P	q	¬(p∨q)
T	T	F
T	F	F
F	T	F
F	F	T

c.) $2^3=8$

p	q	r	r∨(p∧¬q)
T	T	T	T
T	T	F	F
T	F	T	T
T	F	F	T
F	T	T	T
F	T	F	F
F	F	T	T
F	F	F	F

d.)

p	q	r	(r∨p)∧(¬r∨¬q)
T	T	T	F
T	T	F	T
T	F	T	T
T	F	F	T
F	T	T	F
F	T	F	F
F	F	T	T
F	F	F	F

7.) a) (B∨D∨M)

b.) (B∧D)∨(B∧M)∨(D∧M)

c.) B∨(D∧M)

8.) a.) r=F p=q=T

b.) p=F q=F

c.) p=T q=F

1.3

2.) a.) Inverse: If she doesn't finish her homework, she will not go to the party

Contrapositive: If she does not go to the party, she will not finish her homework

Converse: If she goes to the party, she will finish her homework

b.) Inverse: If he didn't train for race, then he doesn't finish the race

Contrapositive: If he doesn't finish the race, then he didn't train for the race

Converse: If he finishes the race, he trains for the race.

c.) Inverse: If the patient did not take the medicine, then she did not have side effects.

Contrapositive: If she did not have side effects, then she didn't take the medicine.

Converse: If she has side effects, she took the medicine

d.) Inverse: If its not sunny, the game was not held.

Contrapositive: If the game was not held, it was not sunny

Converse: If the game was held, it was sunny

1.3

$2^2 = 4$

4.) a.)

p	q	$(\neg p \wedge q) \to \neg p$
T	T	T
T	F	T
F	T	F
F	F	T

b.)

p	q	$(p \to q) \to (q \to p)$
T	T	T
T	F	T
F	T	F
F	F	T

c.)

p	q	$(p \vee q) \leftrightarrow (q \to \neg p)$
T	T	F
T	F	F
F	T	T
F	F	F

d.)

p	q	$(p \leftrightarrow q) \oplus (p \leftrightarrow \neg q)$
T	T	T
T	F	T
F	T	T
F	F	F

5.)
a.) $\neg j \to c$

b.) $c \to \neg j$

c.) $\neg j \to \neg c$

d.) $c \leftrightarrow \neg j$

8.)
a.) The roads were wet, so traffic was heavy

b.) The roads were wet, and there was an accident

c.) There was not an accident and traffic was not heavy

d.) traffic was heavy, so there is an accident or the roads were wet.

1.4

1.)
a.) tautology because no matter what truth values are, it is always true

b.) tautology because truth values are always true

c.) contradiction because truth values are false

d.) tautology because truth values are true.

$2^2=4$

2.) a.)

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

b.)

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

c.)

p	q	¬p→q	p∨q
T	T	T	T
T	F	T	T
F	T	T	T
F	F	F	F

3.) a.)

p	q	p→q	q→p
T	T	T	T
T	F	F	T
F	T	T	F
F	F	T	T

b.)

p	q	¬p→q	¬p∨q
T	T	T	T
T	F	T	F
F	T	T	T
F	F	F	T

c.)

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

d.)

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

6.) a.) p∧s

  ¬(p∧s)

De Morgan: (¬p ∨ ¬s)

  The applicant does not have written permission or is not at least 16 years old

b.) p∨e

  ¬(p∨e)

De Morgan: (¬p ∧ ¬e)

  The applicant does not have written permission and is not at least 18 years old.

1.5

1.) a.) $p \rightarrow q \land (q \lor p)$

$(\neg p \lor q) \land (q \lor p)$ = Conditional Identity

$(q \lor \neg p) \land (q \lor p)$ = Communitive law

$q \lor (\neg p \land p)$ = Distributive law

$q \lor (p \land \neg p)$ = Communitative law

$q \lor F$ = Complement laws

q = Identity laws

b.) $(\neg p \lor q) \rightarrow (p \land q)$

$\neg(\neg p \lor q) \lor (p \land q)$ = Conditional Identities

$(\neg \neg p \land \neg q) \lor (p \land q)$ = De Morgan

$(p \land \neg q) \lor (p \land q)$ = Double Negation

$p \land (\neg q \lor q)$ = Distributive law

$p \land T$ = Complement

p = Identity

c.) $r \lor (\neg r \rightarrow \neg p)$

$r \lor (\neg \neg r \lor p)$ = Conditional

$r \lor (r \lor p)$ = double negation

$(r \lor r) \lor p$ = Associative

$r \lor p$ = Idempotent

2.) a.) $\neg p \rightarrow \neg q$

$p \lor \neg q$ = Conditional

$\neg q \lor p$ = Communitative

$q \rightarrow p$ = Conditional

b.) $p \land (\neg p \rightarrow q)$

$p \land \neg(\neg p \lor q)$ = Conditional

$p \land (\neg \neg p \lor \neg q)$ = De Morgan

$p \land (p \lor \neg q)$ = Double Negation

$p \land T$ = Complement

p = Identity

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2.) c.) $(p \to \neg q) \wedge (p \to r)$

$\quad (\neg p \vee \neg q) \wedge (\neg p \vee r) = $ Conditional

$\quad\quad \neg p \vee (\neg q \wedge r) = $ Distributive

d.) $\quad p \to (q \wedge r) = $ Conditional

$\quad \neg p \to (q \to r)$

$\quad \neg p \to (\neg q \vee r) = $ Conditional

$\quad \neg\neg p \vee (\neg q \vee r) = $ Conditional

$\quad p \vee (\neg q \vee r) = $ double negation

$\quad (p \vee \neg q) \vee r \quad = $ distributive

$\quad (\neg q \vee p) \vee r \quad = $ Commutative

$\quad q \to (p \vee r) = $ Conditional

5.) a.)

$\quad p = $ If x is a rational number

$\quad q = $ If y is a rational number

$\quad r = $ If $x - y$ is a rational number

$\quad p \wedge \neg q \to r$

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

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

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

$\quad \neg p \wedge (q \wedge r)$

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

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

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

$\quad (p \wedge \neg r) \to q$

Goal: $p \wedge \neg r \to q$