1.   a. p: You play, w: You win,
   $\neg p \to \neg w$

   b. d: Your friends dance, f: Your friends are my friends,
   $\neg d \to \neg f$

   c. e: Timmy's age is over 8, t: Timmy's age is less than 13,
   m: Timmy gets Tween-priced movie tickets.
   $(e \wedge t) \to m$

   d. s: I get enough sleep, c: I drink coffee, w: I go to work.
   $(s \vee c) \to w$

2. a. b.

p	q	r	a. $(p \wedge q) \to r$	b. $p \to (q \vee r)$
T	T	T	T	T
T	T	F	F	T
T	F	T	T	T
T	F	F	T	F
F	T	T	T	F
F	T	F	T	F
F	F	T	T	F
F	F	F	T	F

c.

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

3.   a. $P(x) \to Q(X)$

   b. $P(x) \to \neg Q(x)$

   c. $\neg P(x) \to Q(x)$

   d. $\neg P(x) \to Q(x)$

4.   a. $i \wedge \neg j$: You go to New Delhi and you do NOT see the Jantar Mantar.

   b. $(j \vee c) \wedge \neg b$: Jessica gets chocolate OR Jessica gets cake AND Jessica DOES NOT have a happy birthday.

   c. $p \wedge \neg(w \wedge s) \equiv p \wedge \neg w \vee \neg s$: You have a group project AND neither you do all the work, nor someone else does all the work.

5.   a. $\forall x \in D, \neg B(x) \to H(x)$

 – Converse: $\forall x \in D, H(x) \to \neg B(x)$
   For all people x, if x is hungry, then x didn't eat breakfast
 – Inverse: $\forall x \in D, B(x) \to \neg H(x)$
   For all people x, if x ate breakfast then x is NOT hungry
 – Contrapositive: $\forall x \in D, \neg H(x) \to B(x)$
   For all people x, if x is NOT hungry, then x ate breakfast

b. $\forall x \in D, (P(x) \vee G(x)) \to M(x)$

 – Converse: $\forall x \in D, M(x) \to (P(x) \vee G(x))$
   For all people x, if x is a musician, then x plays piano
   or x plays guitar
 – Inverse: $\forall x \in D, \neg(P(x) \vee G(x)) \to \neg M(x)$
   For all people x, if x does NOT play piano
   and does NOT play guitar, then x is NOT a musician
 – Contrapositive: $\forall x \in D, \neg M(x) \to \neg(P(x) \vee G(x))$
   For all people x, if x is NOT a musician, then x doesn't play
   piano and x doesn't play guitar.

c. $\forall x \in \mathbb{R} : P(x) \to Q(x)$

 – Converse: $\forall x \in D, Q(x) \to P(x)$
   For all real numbers x, if $x^2 > 4$ then $x > 2$.
 – Inverse: $\forall x \in D, \neg P(x) \to \neg Q(x)$
   For all real numbers x, if $x \leq 2$ then $x^2 \leq 4$
 – Contrapositive: $\forall x \in D, \neg Q(x) \to \neg P(x)$
   For all real numbers x, if $x^2 \leq 4$ then $x \leq 2$

d. $\forall x \in \mathbb{Z} : R(x) \to S(x)$

 – Converse: $\forall x \in D, S(x) \to R(x)$
   For all integers x, if $x^3 = 1$ then $x^2 = 1$
 – Inverse: $\forall x \in D, \neg R(x) \to \neg S(x)$
   For all integers x, if $x^2 \neq 1$ then $x^3 \neq 1$
 – Contrapositive: $\forall x \in D, \neg S(x) \to \neg R(x)$
   For all integers x, if $x^3 \neq 1$ then $x^2 \neq 1$