3. What is the truth value of each of the following wffs in the interpretation where the domain consists of the integers?
   a. \((\forall x)(\exists y)(x + y = x)\)
   b. \((\exists y)(\forall x)(x + y = x)\)
   c. \((\forall x)(\exists y)(x + y = 0)\)
   d. \((\exists y)(\forall x)(x + y = 0)\)
   e. \((\forall x)(\forall y)(x < y \lor y < x)\)
   f. \((\forall x)(x < 0 \rightarrow (\exists y)(y > 0 \land x + y = 0))\)
   g. \((\exists x)(\exists y)(x^2 = y)\)
   h. \((\forall x)(x^2 > 0)\)

4. What is the truth value of each of the following wffs in the interpretation where the domain consists of the real numbers?
   a. \((\forall x)(\exists y)(x = y^2)\)
   b. \((\exists x)(\forall y)(x = y^2)\)
   c. \((\exists x)(\forall y)(x = y^2)\)
   d. \((\forall x)(\exists y)(x = y^2)\)

5. Give the truth value of each of the following wffs in the interpretation where the domain consists of the states of the United States, \(Q(x, y)\) is ”x is north of y,” \(P(x)\) is ”x starts with the letter M,” and \(a\) is ”Massachusetts.”
   a. \((\forall x)P(x)\)
   b. \((\forall x)(\forall y)(\forall z)[Q(x, y) \land Q(y, z) \rightarrow Q(x, z)]\)
   c. \((\exists y)(\exists z)Q(y, x)\)
   d. \((\forall x)(\exists y)[P(y) \land Q(x, y)]\)
   e. \((\exists y)Q(a, y)\)
   f. \((\exists x)[P(x) \land Q(x, a)]\)

6. Give the truth value of each of the following wffs in the interpretation where the domain consists of people, \(M(x, y)\) is ”x is the mother of y,” \(F(x)\) is ”x is female,” \(M(x)\) is ”x is male.”
   a. \((\forall x)(\exists y)(M(y, x))\)
   b. \((\exists x)(\forall y)(M(x, y))\)
   c. \((\exists x)(\forall y)(M(x, y) \rightarrow F(y))\)
   d. \((\exists x)(\forall y)(M(x, y) \land M(y))\)
   e. \((\exists x)(\forall y)(M(x, y) \rightarrow M(y))\)

14. Using the predicate symbols shown and appropriate quantifiers, write each English language statement as a predicate wff. (The domain is the whole world.)
   a. \(B(x)\): x is a ball
   b. \(R(x)\): x is round
   c. \(S(x)\): x is a soccer ball
   
   a. All balls are round.
   b. Not all balls are soccer balls.
   c. All soccer balls are round.
   d. Some balls are not round.
   e. Some balls are round but soccer balls are not.
   f. Every round ball is a soccer ball.
   g. Only soccer balls are round balls.
   h. If soccer balls are round, then all balls are round.

15. Using the predicate symbols shown and appropriate quantifiers, write each English language statement as a predicate wff. (The domain is the whole world.)
   a. \(M(x)\): x is a man
   b. \(W(x)\): x is a woman
   c. \(T(x)\): x is tall
   
   a. All men are tall.
   b. Some women are tall.
   c. All men are tall but no woman is tall.
   d. Only women are tall
   e. No man is tall.
   f. If every man is tall, then every woman is tall.
   g. Some woman is not tall.
   h. If no man is tall, then some woman is not tall.