1] Consider the following FOL sentences. In each, identify: arguments, predicates, function symbols. Determine the arity of the predicate and say whether it is an infix or prefix. Translate the last sentence in the space provided.

(a) Cube(a)

(b) \( c = d \)

(c) Between(lm(a),a,b)

2] In Fitch, which rule would you use to be able to state that RightOf(a, b) is a consequence of LeftOf(b, a)?

3] Supply a Fitch proof for the following argument. Don’t forget to support your statements by citing the appropriate lines. You may use Ana Con for reasons of symmetry or transitivity.

1. RightOf(b, c)
2. LeftOf(d, e)
3. \( b = d \)
4. 
5. 
6. 
7. LeftOf(c, e)

4] What is an atomic sentence?

5] State the definition of a literal.

6] Given an example in TW of a literal that is not an atomic sentence.

7] In Set, give an example of a sentence that is not a literal.
8] Complete the following truth table.

<table>
<thead>
<tr>
<th>( P )</th>
<th>( Q )</th>
<th>( P \land Q )</th>
<th>( P \lor Q )</th>
<th>( P \rightarrow Q )</th>
<th>( P \leftrightarrow Q )</th>
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<tbody>
<tr>
<td>( T )</td>
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9] Use the space below to create a world where all of the following statements are true.

(a) \( \neg \text{Tet}(f) \)
(b) \( \neg \text{SameCol}(c, a) \)
(c) \( \neg \neg \text{SameCol}(c, b) \)
(d) \( \neg \text{Dodec}(f) \)
(e) \( c \neq b \)
(f) \( \neg (d \neq e) \)
(g) \( \neg \text{SameShape}(f, c) \)
(h) \( \text{SameShape}(d, c) \)
(i) \( \neg \text{Cube}(e) \)
(j) \( \neg \text{Tet}(c) \)
10] State the Law of Excluded Middle.

11] State DeMorgan’s Laws. (Full credit for both statements.)
   i) ii)

12] State the Distributive Laws. (Full credit for both statements.)
   i) ii)

13] Your task is to assign the names a, b, and c in such a way that all the sentences in the list come out true.
   (a) Tet(b) ↔ Tet(c)
   (b) Dodec(b) ↔ Dodec(c)
   (c) Cube(b) ↔ Cube(c)
   (d) Tet(a) ∧ ¬Tet(b)
   (e) FrontOf(a, b) → (FrontOf(b, c) ∨ FrontOf(c, b))
   (f) LeftOf(a, c) → ¬LeftOf(a, b)
   (g) BackOf(b, a) ↔ BackOf(c, b)
14] Consider the following values for sentences in the language of Tarski’s World:
   I: $P$ is a tautology.
   II: $P$ is a logical necessity.
   III: $P$ is a logical possibility.
   IV: $P$ is TT-possibility.
   V: $P$ is not a truth table possibility.

(a) Give an example of a sentence satisfying I.

(b) Give an example of a sentence satisfying II. and not I.

(c) Give an example of a sentence satisfying III. and not II.

(d) Give an example of a sentence satisfying IV. and not III.

(e) Give an example of a sentence satisfying V. and not VI.

(f) Is it possible to give an example of a TW sentence that does not satisfy any of the values?

15] Given a fixed FOL, state the definition for what it means for two sentences, say $P$ and $Q$, to be logically equivalent.

16] Given a fixed FOL, state the definition for what it means for the sentence $S$ to be a tautological consequence of the sentence $T$ (a.k.a. TT-consequence).

17] Consider the statement: “If $P$ is a TT-consequence of $Q$, then $P$ is a logical consequence of $Q.”
   Is this a true statement (yes or no)? If no, then give an example of two TW sentences, say $P$ and $Q$, such that $P$ is a TT-consequence of $Q$ but not a logical consequence of $Q$.

18] Consider the statement: “If $P$ is a logical consequence of $Q$, then $P$ is a TT-consequence of $Q.”
   Is this a true statement (yes or no)? If no, then give an example of two TW sentences, say $P$ and $Q$, such that $P$ is a logical consequence of $Q$ but not a TT-consequence of $Q.
For each of the following arguments decide whether the argument is valid. If it is, give an informal proof as to why. If it is not valid, supply a counterexample.

a)
1. Small(a) ∨ Small(b)
2. Small(b) ∨ Small(c)
3. Small(c) ∨ Small(d)
4. Small(d) ∨ Small(e)
5. ¬Small(c)
6. Small(a) ∨ ¬Small(e)

b)
1. Tet(a) ∨ ¬(Tet(b) ∧ Tet(c))
2. ¬(¬Tet(b) ∨ ¬Tet(d))
3. (Tet(e) ∧ Tet(c)) ∨ (Tet(c) ∧ Tet(d))
4. Tet(a)

c)
1. FrontOf(a,b) ∧ Tet(a)
2. Tet(a) → Cube(b)
3. ¬Cube(b) ∨ ¬BackOf(b,a)
4. Cube(a)