Name:_____ Quiz #4

Re-write each of the following expressions as a well-formed sentence of FOL by **only adding or subtracting parentheses**. Do not make any other changes to the expressions. If the expression is already a well-formed sentence, simply write the word 'sentence' in the blank. Do not add more parentheses than are necessary. (10)

1. $\exists y$ SameSize(a, y) $\wedge$ Small(a) _____Sentence_____

Re-write each of the following expressions as a well-formed sentence of FOL by **only adding or subtracting quantifiers (with variables)**. Do not make any other changes to the expressions. If the expression is already a well-formed sentence, simply write the word 'sentence' in the blank. Do not add more quantifiers or variables than are necessary. (10)

2. $\exists x$ Cube(x) $\wedge$ Large(x) _____$\exists x$ Cube(x) $\wedge$ $\exists x$ Large(x)_____

List the bound and free variables for each of the following. If more than one is bound/free clarify which is which. If no variables are bound/free, write 'none'. (5)

3. For number 2 above, which variables are bound?___the x in 'Cube(x)'_____
and which are free?___the x in 'Large(x)'_____

Translate each of the English sentences below into well-formed FOL sentences. (10)

4. Some dodecahedron is large. _____$\exists x$ (Dodec(x) $\wedge$ Large(x))_____

Translate each of the following sentences of FOL into colloquial English. (10)

5. $\exists x$ (Dodec(x) $\wedge \neg$Large(x))
Some dodecahedron is not large.

For the following, refer to Exam World 4 and indicate whether each is a well-formed sentence of FOL by writing 'Yes' or 'No' in the blank provided. For each sentence, indicate whether it is true or false by writing 'True' or 'False' in the blank provided. Note: Your answers for some of the blanks may necessitate that you write nothing in other blanks. (14)

	Sentence?	True/False?
6. $\forall x(Tet(x) \rightarrow Cube(x))$	__YES__	_TRUE__
7. $\exists x\ LeftOf(x, b) \leftrightarrow \exists y\ RightOf(b, y)$	__YES__	_TRUE_

Note: I can't create a world and insert it into this document, so imagine a world that has a cube somewhere in the middle named b, and a unnamed dodecahedron to b's left and another unnamed dodecahedron to b's right. Otherwise the world is empty.

For each of the following invalid arguments, use the space provided to draw a counter-example "world" that makes all the premises true and the conclusion false. Your "worlds" do not have to depict the entire grid in Tarski's World, nor do they have to be three-dimensional. A simple picture that is labeled clearly will suffice. If you have to draw sizes, you may label your blocks "small", "medium", or "large" so I can tell how big you intend it to be. Label your "world" so that I know which argument it is intended for. (11)

8. $\exists x\ Cube(x)$
   $\underline{\exists x\ Large(x)}$
   $\exists x\ (Cube(x) \wedge Large(x))$

Draw a world where there is a small cube and a large tet. Then the premises are true, but the conclusion is false.

Translate each of the English sentences below into well-formed FOL sentences. (15)

9. Every cube is to the right of *b*.
   $\forall x\ (Cube\ (x) \rightarrow RightOf\ (x, b))$

Decide whether the sentences below are logical truths or not. If a sentence is a logical truth, write 'logical truth'. If a sentence is not a logical truth, then draw a "world" in which the sentence is false. Label your "world". (15)

10. $\neg\exists y\ Tet(y) \leftrightarrow \exists y\ \neg Tet(y)$ Logical Truth (since we don't allow empty worlds.)