



## FOA1Q

Started on	Monday, 6 November 2023, 7:17 PM
State	Finished
Completed on	Monday, 6 November 2023, 7:32 PM
Time taken	15 mins 2 secs
Grade	4.8 out of 5.0 (96%)

## Question 1

Correct

Mark 1.0 out of 1.0

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Consider the following formula with variables  $x, y, z$  (and the usual precedence rules for the logical operators):

$$\exists x \in \mathbb{Z}: x > y \wedge \forall z \in \mathbb{Z}: z > y \rightarrow x < z+1$$

1. Which variables are free in the  $\forall$ -formula?

☒ x ☒ y ☐ z ☐ none

Mark 1.0 out of 1.0

The correct answer is:

◦ y



## Question 2

Correct

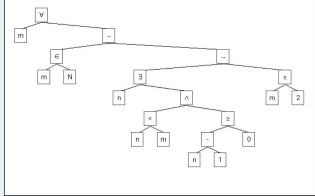
Mark 2.0 out of 2.0

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Take the following formula in first-order logic:

$$\forall m \in \mathbb{N}: (\exists n < m: n-1 \geq 0) \rightarrow m \geq 2$$

Construct the abstract syntax tree of this formula in standard syntax (to get only a single variable without condition under each quantifier, you have to add some implicit logical connective). To do so, fill the following picture by moving each node to the correct position in the tree.



Die Antwort ist richtig.

Comment:

## Question 3

Complete

Mark 1.8 out of 2.0

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Take the following statement in natural language:

*Every uncle is male and is a sibling of some parent of someone.*

*(Jeder Onkel ist männlich und ist ein Geschwister eines Elternteils von jemandem.)*

Write this statement as a closed formula (no free variables) in first-order logic in standard syntax (with all parentheses) using the predicates  $isUncle(x)$  ("x is uncle"),  $isMale(x)$  ("x is male"),  $isParent(y, x)$  ("y is parent of x"), and  $isSibling(y, x)$  ("y is sibling of x").

Please use for logical quantifiers and connectives the syntax "forall", "exists", "~", "\/", "\\", "\>", "<=>", e.g.

(forall x: ((p(x) \\/ (~q(x))) -> (exists

forall x: (isUncle(x) -> (isMale(x) /\ exists y:

(isParent(y, z) /\ isSibling(y, x)))

Comment: