Exercise 1: Javascript

Given the following Javascript code snippet:

```javascript
1 s = "some\_random\_string";
2 s.x = 42;
3 s.x;
```

1. Use the JavaScript shell from [http://www.squarefree.com/shell/shell.html](http://www.squarefree.com/shell/shell.html) to execute the above Javascript code. Which results do you get?

2. Change the first or second line of the example, such that executing the third line (s.x;) prints 42.

3. Explain the behavior you observe. What would you suggest to prevent such mysterious bugs from happening?

Exercise 2: Types for JAUS

Which of the following JAUS expressions are type correct? Give a type derivation for all type correct expressions. Assume that variable $x$ is of type `int` and variable $y$ is of type `boolean`.

1. $1 + true$
2. $23 + (47 - 11)$
3. $!(false)$
4. $y + x$
5. $!y$

Exercise 3: Evaluation of JAUS

Evaluate the following JAUS expressions as far as possible.

1. $23 + (47 - 11)$
2. $(1 + 1) + true$

Which of the resulting expressions are values?
Exercise 4: Type soundness

Prove the following theorem:
If $\vdash e_0 : t$ then there exists $e_n$ such that $\vdash e_n : t$ and $e_0 \rightarrow e_1 \rightarrow \ldots \rightarrow e_{n-1} \rightarrow e_n$.

*Hint:* The following lemma might be helpful. You don’t need to prove it.
For every expression $e_0$, there exists an expression $e_n$ such that $e_0 \rightarrow e_1 \rightarrow \ldots \rightarrow e_{n-1} \rightarrow e_n$ and no expression $e_{n+1}$ exists with $e_n \rightarrow e_{n+1}$. 