Task 1.1

	$\{n \geq 0\}$
1 $i := 0$	$\{n \geq 0 \wedge i = 0\}$
2 $s := 0$	$\{n \geq 0 \wedge i = 0 \wedge s = 0\} \Rightarrow \{p\}$
3 $\{$**inv p** $= \quad i \leq n \wedge s = i^2\}$	
4 while$(i < n)\{$	$\{p \wedge i < n\} \Rightarrow \{i + 1 \leq n \wedge s + (2 * i + 1) = (i + 1)^2\}$
5 $\quad s := s + (2 * i + 1)$	$\{i + 1 \leq n \wedge s = (i + 1)^2\}$
6 $\quad i := i + 1$	$\{p\}$
7 $\}$	$\{p \wedge i \geq n\} \Rightarrow \{s = n^2\}$

Line 4 proof obligation is proven by the hint
$i^2 = (i + 1)^2 - 2i - 1 \equiv (i + 1)^2 = i^2 + 2i + 1$
With $s = i^2$ then $s + (2 * i + 1) = (i + 1)^2$

Task 1.2

	$\{n \geq 0\}$
1 $i := 0$	$\{n \geq 0 \wedge i = 0\}$
2 $s := 0$	$\{n \geq 0 \wedge i = 0 \wedge s = 0\} \Rightarrow \{p\}$
3 $\{$**inv p** $= \quad i \leq n \wedge s = i^2\}$	
4 while$(i < n)\{$	$\{p \wedge i < n\} \not\Rightarrow \{i + 1 \leq n \wedge s + (2 * i) = (i + 1)^2\}$
5 $\quad s := s + (2 * i)$	$\{i + 1 \leq n \wedge s = (i + 1)^2\}$
6 $\quad i := i + 1$	$\{p\}$
7 $\}$	$\{p \wedge i \geq n\} \Rightarrow \{s = n^2\}$

Line 4 is the bug as it is invalid
$s + (2 * i) \equiv i^2 + 2i$ and $i^2 + 2i \neq (i + 1)^2$

Task 2.1

In the dafny file, **sumarray.dfy**.

Task 2.2

In the dafny file, **find.dfy**.

Task 2.3

In the dafny file, **posneg.dfy**.

Task 3.1

(a) $wlp(a[x = 0?i : j] := 1, a[i] = 1)$
$$
\begin{aligned}
&= [1/a[x = 0?i : j]](a[i] = 1) \\
&= x = 0?[1/a[i]](a[i] = 1) : [1/a[j]](a[i] = 1) \\
&= x = 0?1 = 1 : a[i] = 1 \\
&= x = 0?\mathrm{T} : a[i] = 1 \\
&= x = 0 \vee a[i] = 1
\end{aligned}
$$

(b) let $e_2 = [5/a[i]](a[1]) \equiv\ i = 1?5 : a[1]$
$wlp(a[i] := 5, a[a[1]] = 5)$
$$
\begin{aligned}
&= e_2 = i?5 = 5 : a[e_2] = 5 \\
&= e_2 = i \vee a[e_2] = 5
\end{aligned}
$$

(c) $wlp(a[j] := a[i] + 1, a[j] > a[i])$
$$
\begin{aligned}
&= [a[i] + 1/a[j]](a[j] > a[i]) \\
&= [a[i] + 1/a[j]]a[j] > [a[i] + 1/a[j]][a[i]] \\
&= a[i] + 1 > (i = j?a[i] + 1 : a[i]) \\
&= i = j?a[i] + 1 > a[i] + 1 : a[i] + 1 > a[i] \\
&= i = j?F : T \\
&= i \neq j
\end{aligned}
$$

Task 4.1

I spent about 4 hours on this.