This homework concerns the video-module on the correctness of programs.

**Question 1.** Write the formula for the number of values in the range $b..c$:  

**Question 2.** In the video on ranges, we gave a mnemonic for remembering the number of values in a range. Write that formula here:

**Question 3.** Below are four array segments. To the right, using what you wrote in answering question 2, write the number of values in each segment in terms of the relevant variables.

<table>
<thead>
<tr>
<th>$b$</th>
<th>$h$</th>
<th>$k$</th>
<th>$m$</th>
<th>$n$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- $b[h..k]$  
- $b[k+1..m]$  
- $b[m+1..n−1]$  
- $b[n..p−1]$  

**Question 4.** State the formula that says segment $b[p..q]$ is empty:  

**Question 5.** Below, draw an array diagram that represents this assertion:

$b[h..j−1] ≤ x$  
$b[j] = x$  
$b[j+1..k ≥ x]$  

**Question 6.** Write down the meaning of the Hoare triple  ${B}$ $\{C\}$ $\{D\}$:  

**Question 7.** Using the definition of the assignment statement  ${R[x:= e]}$  $x = e$;  ${R}$, calculate the preconditions of the following assignment statements. You do not have to simplify them.

- $x = y + 1$;  
- $y = 2*x$;  
- $y = y+2$;  
- $x*y = z$  
- $x + y + z = 2*x$  
- $x + y = 8$
**Question 8.** Calculate the precondition of the following two sequences of assignments. It’s recommended to simplify a precondition after calculating it before moving on the next step. Here’s one reason to do that. Since x and y are being replaced in each one, it helps to keep the number of occurrences of them to a minimum. For example, you can rewrite

\[ x = B \land y = x + A \quad \text{as} \quad x = B \land y = B + A. \]

\[
\begin{array}{ll}
\{ & \\
\} & \\
t= x; & x = x + y;
\end{array}
\]

\[
\begin{array}{ll}
\{ & \\
\} & \\
x = y; & y = x - y;
\end{array}
\]

\[
\begin{array}{ll}
\{ & \\
\} & \\
y = t; & x = x - y;
\end{array}
\]

\[
\{ x = B \land y = C \}
\]

**Question 9.** We gave the following rule for determining when an if-else statement is correct:

**Hoare triple for if-else:**

If \( \{ Q \land (B) \} S1 \{ R \} \) and \( \{ Q \land \neg B \} S2 \{ R \} \)

then \( \{ Q \} \text{ if } (B) S1 \text{ else } S2 \{ R \} \)

Write below a similar rule for determining when an if-statement is correct:

**Hoare triple for the if-statement:**

If \( \{ \} \)

then \( \{ Q \} \text{ if } (B) S1 \{ R \} \)