Homework on program correctness

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.

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

<table>
<thead>
<tr>
<th>Segment 1</th>
<th>Segment 2</th>
<th>Segment 3</th>
<th>Segment 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>b[h..k]</td>
<td>b[k+1..m]</td>
<td>b[m+1..n−1]</td>
<td>b[n..p−1]</td>
</tr>
</tbody>
</table>

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

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

```
[expression]
```

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

<table>
<thead>
<tr>
<th>{             }</th>
<th>{             }</th>
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</thead>
<tbody>
<tr>
<td>x= y+1;</td>
<td>y= 2*x;</td>
<td>y= y+2;</td>
</tr>
<tr>
<td>{x * y = z}</td>
<td>{x + y + z = 2*x}</td>
<td>{x + y = 8}</td>
</tr>
</tbody>
</table>

**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.

```
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

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

\[
\{ \} \quad \{ \}
\]

\[
t = x;
\]

\[
\{ \} \quad \{ \}
\]

\[
x = y;
\]

\[
\{ \} \quad \{ \}
\]

\[
y = t;
\]

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

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

**Hoare triple for if-else:**

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