**Question 1.** Consider the following two relations:

<table>
<thead>
<tr>
<th>R: A</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>S: B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

For each query below, compute its result on the above database.

a) Query 1.

```sql
SELECT T.A, COUNT (T.D)
FROM (SELECT R.A, SUM(S.C) AS D
      FROM R, S
      WHERE R.B=S.B
      GROUP BY R.A) AS T
HAVING COUNT(T.D) <= 2
GROUP BY T.A
```

Solution: a tuple (1,1)

b) Query 2.

```sql
SELECT DISTINCT R.A
FROM R
WHERE NOT EXISTS (SELECT *
                  FROM R R1, S
                  WHERE R1.B=S.B AND R.A > S.C)
```

Solution: values 1 and 3

c) Query 3.

\[
\{x \mid \exists y \ R(x, y) \land (\forall y \ (R(x, y) \rightarrow \exists u \exists v \ (S(u, y) \land S(v, y) \land u \neq v)))\}
\]

Solution: a single value 3

**Question 2.** In this question, we use the following relational schema:

- **Country(name, capital, area)**, name is the key
- **People(country, population, children, adult)** where country refers to the name in Country, population is the total population, and children and adult is the percentage of the children and adult population.
- **Language(country, language, percentage)** – for each language spoken in the country, it lists the percentage of the population that speaks the language.

a) Write the following query in SQL: Find names and capitals of countries where children outnumber adults, and at least three different languages are spoken.

Solution:
SELECT C.name, C.capital
FROM Country C, People P, Language L
WHERE C.name=P.country AND C.name=L.country
    AND P.children > P.adult
GROUP BY C.name
HAVING COUNT(L.language) > 2

b) Write the following query in SQL: Find languages that are only spoken in countries whose total population exceeds $10^7$.

Solution:

SELECT L.language
FROM Language L
WHERE NOT EXISTS (SELECT *
    FROM Country C, People P, Language L1
    WHERE C.name=P.country AND
        C.name=L1.country AND
        P.population < 10000000 AND
        L.language = L1.language)

Question 4 Write the SQL query \( \text{SELECT MAX}(A) \text{ FROM } R \) in relational algebra. You may assume that \( R \) has a single attribute \( A \).

Solution: \( R \rightarrow \pi_A(\sigma_{A<B}(R \times \rho_{B\leftarrow A}(R))) \)