In a secret service database application, a relation has the scheme Number-Code-Task. Each secret agent is given a three digit number, a four alphabet code, and a special task. A tuple in this relation may look like (007, ZEST, busting). The database is mostly queried using the three digit number but sometimes it may be queried using the four alphabet code. Presently n agents are employed.

1. (a) Show how would this data is stored using the characteristic vector approach.
   (b) What percentage of the space is utilized?
   (c) What is the order of running time required to find an agent by name in this approach?

<table>
<thead>
<tr>
<th>Number</th>
<th>Code</th>
<th>Task</th>
</tr>
</thead>
<tbody>
<tr>
<td>007</td>
<td>ZEST</td>
<td>busting</td>
</tr>
</tbody>
</table>

(b) Space Utilized = \( \frac{n}{1000} \times 100\% = \frac{n}{10}\% \)

(c) \( T(n) = O(N) \)
   where \( N = 10^3 = 1000 \)

2. For the above application, the hashing approach is used. Number is used as the primary index and hashed into 3 buckets. Name is used as the secondary index, and hashed into 4 buckets.
   (a) Roughly how many tuples are indexed by one bucket in the Secondary Hash table?
   (b) If \( h(x) = x \mod 3 \) is used, where \( x \) is the agent’s number, what do 007 and 700 hash to?
   (c) What is the order of running time required to find an agent by name in this approach?

(a) Tuples per bucket = \( \frac{n}{4} \)

(b) 007 and 700 hash to Bucket 1

(c) Running time = \( O(n/4) \)