13.4

The size is at most 1,000. $r_1 \bowtie r_2$ yields at most 1,000 tuples, and $(r_1 \bowtie r_2) \bowtie r_3$ yields at most 1,000 tuples then.

Strategy:

Assume that the index based on the primary key is built respectively for the 3 relations already. Since maximum possible size of $r_1 \bowtie r_2$ (1,000) is less than the maximum possible size of $r_2 \bowtie r_3$ (1,500), $r_1 \bowtie r_2$ is executed at first.

1. Use the index for r_2 to find at most 1 tuple that matches a tuple of r_1
2. Use the index for r_3 to find at most 1 tuple that matches a tuple of $r_1 \bowtie r_2$

13.15

1. Use the index to locate the first tuple that $building = \text{"Watson"},\ dept\_name = \text{"Music"}$
2. Make use of the tuple and retrieve all the tuples that $building < \text{"Watson"}$
3. Select tuples that $budget < 55,000$ from the tuples retrieved in step 2