

13.3.

(b) BNL: Using r_2 as the outer relation, the cost is $\lceil 1500 / (M - 1) \rceil \cdot 800 + 1500$ I/Os.

(c) SMJ: The sorting cost is $3000 (\lceil \log_{M-1}(1500 / M) \rceil + 1) + 1600 (\lceil \log_{M-1}(800 / M) \rceil + 1)$. The merge cost is $1500 + 800$.

(d) HJ: If $M > 800 / (M - 1)$, there is only one hashing round, and hence, the cost is $3(1500 + 800)$. Otherwise, there are $r = \lceil \log_{M-1} 800 - 1 \rceil$ hashing rounds, and the total cost is $r(3000 + 800) + 1500 + 800$.