1. 11-digit, 250 keys to hash, m=1000, linear probing
the fewer collisions, the better hash function.
we will compare $\lfloor\sqrt{k}\rfloor$, abcd and (# of 1's + # of 2's + ··· + # of 9's).

a). $h_1(k) = \lfloor\sqrt{k}\rfloor \% 1000$.

let $\lfloor\sqrt{k}\rfloor = n$.

$n \le \sqrt{k} < n+1$ best case.

$n^2 \le k \le n^2 + 2n + 1$.

therefore there are $2n+1$ keys can cause collision
where $n = \lfloor\sqrt{k}\rfloor = floor(10^{5.5}) \approx 10^{5.5}$

b). $h_2(k) = abcd \% 1000$.

only abcd matters
therefore approx. 10^7 keys can cause collision.

c) $h_3(k) = (\#\text{ of } 0 \text{ in } k) + (\#\text{ of } 1 \text{ in } k) + \cdots + (\#\text{ of } 9 \text{ in } k)$
$= 11$ no matter what k is.
therefore there would have a collision in every
insertion. $10^{11} - 1$.

$\frac{10^4}{10^{11}}$

since $10^{5.5} < 10^7 < 10^{11}$
a. is the best.