Q1. The keys, and their priorities, are given in a way that rotations are not needed to guarantee the heap property.

Then it is required to insert in this heap the pair \((13,2)\). So the first step is to find the correct position to insert \((13,2)\), then it starts a sequence of rotations that re-establish the underlying heap property.
Since $n=2$, and the values of $c$, $e$ are greater than they are not linked. Conversely, $d$ is inserted in position 1 and $f$ is inserted in position 2, so the final configuration is $1011f$.

Q3.

\[\begin{array}{|c|c|c|c|}
\hline
\text{Symbol} & f_c \text{ or } f_{\text{sym}} & \text{pos} & 1 \ 2 \ 3 \ 4 \\
\hline
1 & b, g & 2 & 1 \\
2 & a, c, d & 2 & 1 \\
3 & e, f & 1 & 1 \\
4 & 0 & 0 & 2 \\
\hline
\end{array}\]

- $v=1 < f_c [1] = 2 \rightarrow v = (11)_2 = 3 > f_c [2] = 2$
- $v=0 < f_c [1] = 2 \rightarrow v = (00)_2 < f_c [2] = 2 \rightarrow v = (000)_2 > f_{\text{sym}} [3, 2] = 1$
- $v=0 < f_c [1] = 2 \rightarrow v = (000)_2 < f_c [2] = 2 \rightarrow v = (000)_2 > f_{\text{sym}} [3, 2] = 1$

\[\sum \text{ level} \]

\[\begin{array}{|c|c|}
\hline
\text{symbol} & 3 \\
\hline
1 & a \\
2 & b \\
3 & c \\
4 & d \\
\hline
\end{array}\]

\[\begin{array}{|c|c|c|}
\hline
\text{num} & 1 \ 2 \ 3 \ 4 \\
\hline
0 & 2 \ 3 \ 2 \\
\hline
\end{array}\]
Q4. We know that the length in bit of compressed trie is given by the formula $d = \lceil \log_2 \frac{2^s}{5} \rceil$, where $s$ is $\prod P \left( \log \frac{1}{p(i)} \right)$

$= [\log (0.5)]^4 \cdot [\log (0.5)]^2 \cdot [\log 4]^4 \cdot [\log 4]^2 = \left( \frac{4}{2^3} \right)^4 \cdot \left( \frac{2}{2^2} \right)^2 = \frac{1}{2^6}$

$d = \lceil \log_2 2 - 2^{\frac{15}{6}} \rceil = \lceil \log_2 2^{13} \rceil = 11$ bit.

Q5. Partial trie is obtained from the completed trie to the left by keeping only the first character of every edge.

1. $p = \frac{a}{c} \frac{b}{a} \frac{c}{b} \frac{a}{5} \rightarrow s_2$ is selected
2. compute lcp $(p, s_2) = 3$ \[\begin{array}{c}
5 \\
1 \\
\end{array}\]
3. we proceed upward the partial trie until we reach the edge $c$ and since

$[\bar{a}] > [\bar{a}]$ we have $\text{lad} P$ go to $p$, $s_2$

the right of the subtree descending from that edge, and thus $p$ is lexicographically between $s_3$ and $s_4$. 