2. (a) For Jelinek-Mercer,

$$p(w|d) = (1-\lambda)\frac{c(w,d)}{|d|} + \lambda p(w|REF)$$

$$\log p(q|d) = \sum_{i=1}^{m} \log p(q_i|d) = \sum_{i=1}^{|V|} c(w_i,q)\log p(w_i|d)$$

$$= \sum_{w \in q} c(w,q)\log p(w|d).$$

plug in $p(w|d)$ we have

$$\log p(q|d) = \sum_{\substack{w \in q \\ w \in d}} c(w,q)\log\left[(1-\lambda)\frac{c(w,d)}{|d|} + \lambda P(w|REF)\right]$$

$$+ \sum_{\substack{w \in q \\ w \notin d}} c(w,q)\log\left[\lambda P(w|REF)\right]$$

$$= \sum_{\substack{w \in q \\ w \in d}} c(w,q)\log\left[(1-\lambda)\frac{c(w,d)}{|d|} + \lambda P(w|REF)\right]$$

$$- \sum_{\substack{w \in q \\ w \in d}} c(w,q)\log\left[\lambda P(w|REF)\right]$$

$$+ \sum_{w \in q} c(w,q)\log\left[\lambda P(w|REF)\right]$$