Practice FRQ

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3. (a) $CO_3{}^{2-}(aq) + Ca^{2+} \longrightarrow CaCO_3(s)$

   (b) A single Ca^{2+} ion should be included (difficult to draw quickly here)

   (c)

$$\frac{.93}{101.1} = .0092[\text{mol}_{\text{CaCO}_3}] \qquad (1)$$
$$\text{Coefficients are the same, so: } .0092[\text{mol}_{\text{Na}_2\text{CO}_3}]$$

   (d) The student is wrong. If the precipitate still had some moisture, it would be heavier, which means that more grams would be weighed. This means that there would be greater moles calculated, and, therefore, a greater molarity, as there would be more moles per liter calculated.

   (e) The liquid would be able to conduct electricity, as the spectator $NO_3{}^-$ and Na^+ ions, as well as the excess Ca^{2+} ions will be able to induce electron flow, and, therefore, a current.

   (f) i. The student could employ the use of pH testing paper. Using that result, the student could calculate the OH^- by using the formula 10^{a-14}, where a is the pH found.

   ii. After determining the OH^- concentration, the student could simply use the k_b formula, or $k_b = \frac{[HCO_3{}^-][OH^-]}{[CO_3{}^{2-}]}$, and rearrange it into: $[CO_3{}^{2-}] = \frac{[HCO_3{}^-][OH^-]}{2.1 \cdot 10^{-4}}$. Because $CO_3{}^{2-}$ is the limiting factor, the same concentration of $HCO_3{}^-$ and OH^- will be generated. Most importantly, an ICE table should be formed:

I	a	0	0
C	-x	x	x
E	a-x	x	x

   . The initial concentration is given by the expression: $a = \frac{x^2}{k_b} + x$

   (g) The concentration is less than, as suggested by the low k_b value. This value indicates that the reactants are favored over the products.

   (h) Na_2CO_3 is unsuitable for being such a buffer. Using the k_b value, a k_a value may be found: $\frac{10^{-14}}{k_b} = k_a = 4.76 \cdot 10^{-11}$, this means that the pk_a value is: $-\log_{10}(4.76 \cdot 10^{-11}) = 10.32$. Because this value is nowhere near 6, this will be a poor buffer.