

Name: \_\_\_\_\_



**3.091 Introduction to Solid State Chemistry**  
**Fall Term 2018**  
**Quiz 8.5**

Do yourself a solid.

1) A pteropod shell (made of  $\text{CaCO}_3$ ) weighs 0.01 mg. By the year 2100 the ocean will be 126% more acidic than pre-industrial levels if we continue on our current path. This will lead to the dissolution of the shell:  $\text{CaCO}_3(s) \rightarrow \text{Ca}^{2+}(aq) + \text{CO}_3^{2-}(aq)$

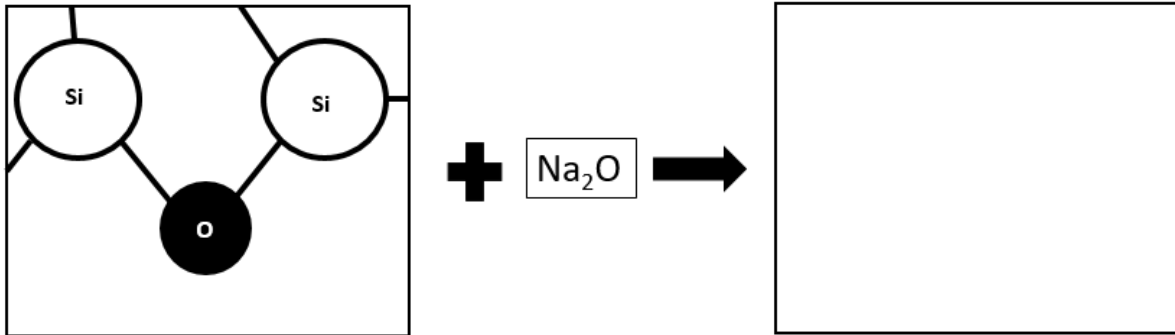
You measure this reaction by weighing the shell vs. time every 1 hour and you record your results:

Experiment	[ $\text{CaCO}_3$ ] (mg)
1 (t=0 hr)	0.01
2 (t=1 hr)	0.008
3 (t=2 hrs)	0.006
4 (t=3 hrs)	0.004

- a) If the shell fully dissolves in 0.1 liters of water, what is the molar concentration of the resulting  $\text{CO}_3^{2-}$ ? (1.5 points)
- b) What is the order of the reaction? (1.5 points)
- c) What is the rate of the reaction (expressed in M/s)? (1.5 points)
- d) What is the rate constant for the reaction and what units does it have? (1.5 points)

2) You find a sheet of glass in the Glass Lab and want to increase its resistance to fracture, so you can throw baseballs at it. This glass is soda glass, meaning  $\text{Na}_2\text{O}$  was added in the melt.

a) A schematic of a 2D cross-section of amorphous  $\text{SiO}_2$  is shown below in one box. Draw how adding  $\text{Na}_2\text{O}$  changes this structure.



b) After adding  $\text{Na}_2\text{O}$ , does the glass transition temperature increase, decrease, or stay the same?

c) In order to strengthen the glass, you decide to use an ion exchange method. What is one ion that you could exchange in, and which ion leaves the glass during this process?

d) Describe how ion exchange increases the toughness of the glass, with reference to molar volume and the stress field.

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