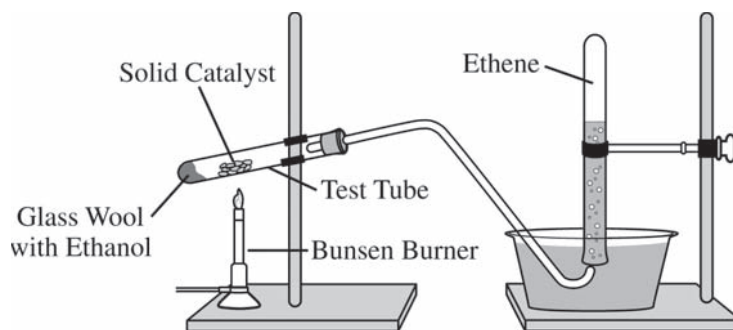
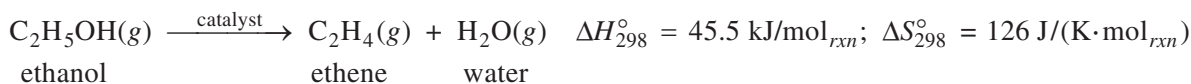


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2. Ethene,  $\text{C}_2\text{H}_4(g)$  (molar mass 28.1 g/mol), may be prepared by the dehydration of ethanol,  $\text{C}_2\text{H}_5\text{OH}(g)$  (molar mass 46.1 g/mol), using a solid catalyst. A setup for the lab synthesis is shown in the diagram above. The equation for the dehydration reaction is given below.



A student added a 0.200 g sample of  $\text{C}_2\text{H}_5\text{OH}(l)$  to a test tube using the setup shown above. The student heated the test tube gently with a Bunsen burner until all of the  $\text{C}_2\text{H}_5\text{OH}(l)$  evaporated and gas generation stopped. When the reaction stopped, the volume of collected gas was 0.0854 L at 0.822 atm and 305 K. (The vapor pressure of water at 305 K is 35.7 torr.)

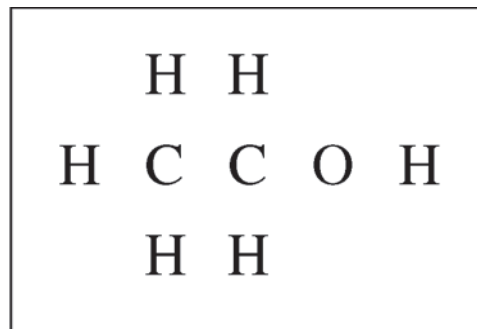
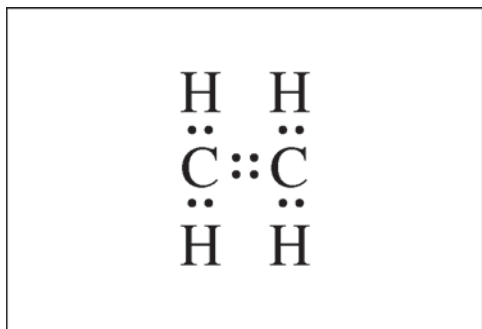
- (a) Calculate the number of moles of  $\text{C}_2\text{H}_4(g)$
- that are actually produced in the experiment and measured in the gas collection tube and
  - that would be produced if the dehydration reaction went to completion.
- (b) Calculate the percent yield of  $\text{C}_2\text{H}_4(g)$  in the experiment.

Because the dehydration reaction is not observed to occur at 298 K, the student claims that the reaction has an equilibrium constant less than 1.00 at 298 K.

- (c) Do the thermodynamic data for the reaction support the student's claim? Justify your answer, including a calculation of  $\Delta G_{298}^\circ$  for the reaction.

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- (d) The Lewis electron-dot diagram for  $C_2H_4$  is shown below in the box on the left. In the box on the right, complete the Lewis electron-dot diagram for  $C_2H_5OH$  by drawing in all of the electron pairs.



- (e) What is the approximate value of the  $C-O-H$  bond angle in the ethanol molecule?
- (f) During the dehydration experiment,  $C_2H_4(g)$  and unreacted  $C_2H_5OH(g)$  passed through the tube into the water. The  $C_2H_4$  was quantitatively collected as a gas, but the unreacted  $C_2H_5OH$  was not. Explain this observation in terms of the intermolecular forces between water and each of the two gases.