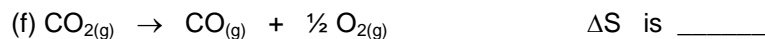
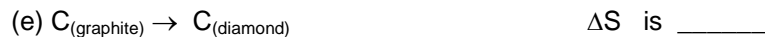
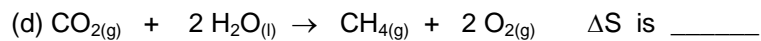
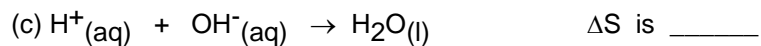
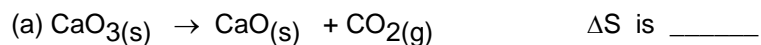


## Free Energy Questions

1. Predict the sign of  $\Delta S^\circ$  for the following reactions:



2. There are two primary driving forces behind a chemical reaction,  $\Delta H$  (enthalpy) and  $\Delta S$  (entropy).

What type of reaction tends to be spontaneous, endothermic or exothermic?

What is the sign on  $\Delta H$  when this is the case?

Does an increase or decrease in entropy tend to be the spontaneous change?

What is the sign on  $\Delta S$  when this is the case?

3. What is "free energy"? For a given reaction what does  $\Delta G$  represent?

4. How do you go about predicting the spontaneity of a reaction? To insure that a reaction will be nonspontaneous, what must the signs of  $\Delta H$  and  $\Delta S$  be?

5. Consider the reaction  $\text{N}_2 + \text{O}_2 \rightarrow 2 \text{NO}$

Given:  $\Delta H^\circ = 180.7 \text{ kJ}$  and  $\Delta S^\circ = 24.7 \text{ J/K}$

Is this reaction spontaneous? If not, at what temperature would it become spontaneous? Justify your answer.

6. The process:  $\text{H}_2\text{O}_{(s)} \rightarrow \text{H}_2\text{O}_{(l)}$  proceeds spontaneously at room temperature in spite of having a positive  $\Delta H$  value. Explain.....

7. Predict the **signs** of  $\Delta H$ ,  $\Delta S$  and  $\Delta G$  of the system for the following processes at 1 atm:  
(The normal melting point of mercury is  $-39^\circ\text{C}$ .)

(a) mercury melts at  $-19^\circ\text{C}$      $\Delta H$  \_\_\_\_\_     $\Delta S$  \_\_\_\_\_     $\Delta G$  \_\_\_\_\_

(b) mercury melts at  $-39^\circ\text{C}$      $\Delta H$  \_\_\_\_\_     $\Delta S$  \_\_\_\_\_     $\Delta G$  \_\_\_\_\_

(c) mercury melts at  $-80^\circ\text{C}$      $\Delta H$  \_\_\_\_\_     $\Delta S$  \_\_\_\_\_     $\Delta G$  \_\_\_\_\_

8. Dry ice,  $\text{CO}_{2(s)}$  sublimates (changes from a solid to a gas) at room temperature.

(a) Write a reaction for the above process

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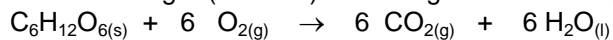
(b) What is the sign of  $\Delta H$  for this process? \_\_\_\_\_

(c) What is the sign of  $\Delta S$  for this process? \_\_\_\_\_

(d) What is the sign of  $\Delta G$  for this process? \_\_\_\_\_ (*hint – does it happen?*)

(e) Which driving force,  $\Delta H$  or  $\Delta S$ , has final “say” in the outcome of the react? Explain.....

9. Your body metabolizes sugar (sucrose) according to the following reaction:



Where  $\Delta H = -2803\text{kJ/mol}$ ,  $\Delta S = 257.6 \text{ J/Kmol}$  at  $310\text{K}$ . Calculate  $\Delta G$  and determine if this reaction spontaneous.