

Name:

Date:

Period:

Seat #:

Show all work

$$\Delta G^\circ = \Sigma \Delta G_f^\circ \text{ products} - \Sigma \Delta G_f^\circ \text{ reactants}$$

[1] Which of the following processes are spontaneous?

a. Spreading the fragrance of perfume through a room	YES	NO
b. Separating a mixture of N ₂ and O ₂ into pure containers of each	YES	NO
c. Bursting of a normally inflated balloon	YES	NO
d. The reaction of sodium metal with chlorine gas to form NaCl	YES	NO
e. The dissolution of NaCl(s) in water form NaCl(aq)	YES	NO

[2] Consider what happens when the explosive TNT is detonated.

a. Is the detonation a spontaneous process?	YES	NO
b. What is the sign of q for the process?		

[3] The normal boiling point of methanol is 64.7 °C and its molar enthalpy of vaporization is $\Delta H_{\text{vap}} = 71.8 \text{ kJ/mol}$.

a. When methanol boils at its normal boiling point, will its entropy increase or decrease?
b. Calculate the value of ΔS when 1.00 mol of methanol is vaporized at 64.7°C.

[4] What do you expect the sign of ΔS to be for the following situations?

a. In a reaction, 2 moles of gaseous reactants → 3 moles gaseous products.
b. In a chemical reaction, two gases combine to form a solid.

[5] In which of the following situations does entropy of the system increases?

a. Melting of ice cubes	YES	NO
b. Dissolving sugar in a cup of hot coffee	YES	NO
c. Formation of methane and oxygen gas from CO ₂ and H ₂ O	YES	NO
d. A solid sublimates	YES	NO
e. Volume of a gas increases	YES	NO

[6] For each of the following pairs, circle the one with the higher entropy per mole at room temp. Explain why.

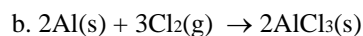
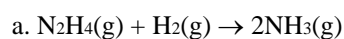
a. Ar(l) or Ar(g)	b. He(g) at 3atm or He(g) at 1.5atm
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[7] Predict the sign of the entropy change of the system for each reaction. Explain why.

a. $2\text{SO}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{SO}_3(\text{g})$	NEGATIVE	POSITIVE
b. $\text{Ba}(\text{OH})_2(\text{s}) \rightarrow \text{BaO}(\text{s}) + \text{H}_2\text{O}(\text{g})$	NEGATIVE	POSITIVE
c. $\text{CO}(\text{g}) + 2\text{H}_2(\text{g}) \rightarrow \text{CH}_3\text{OH}(\text{l})$	NEGATIVE	POSITIVE

$$\Delta S^\circ = \Sigma \Delta S^\circ_{\text{products}} - \Sigma \Delta S^\circ_{\text{reactants}}$$

[8] Using S° values from Appendix Four, calculate ΔS° values for each reaction.



$$\Delta S^\circ \left(\frac{\text{J}}{\text{mol}\cdot\text{K}} \right)$$

$\text{N}_2\text{H}_4(\text{g})$	238.5
$\text{H}_2(\text{g})$	130.7
$\text{NH}_3(\text{g})$	192.8
$\text{AlCl}_3(\text{s})$	109.3
$\text{Cl}_2(\text{g})$	223.1
$\text{Al}(\text{s})$	28.3

[9] For a certain chemical reaction, $\Delta H^\circ = -35.4 \text{ kJ}$ and $\Delta S^\circ = -85.5 \text{ J/K}$.

a. Is the reaction endothermic or exothermic?	
b. Does the reaction lead to an increase or decrease in the disorder of the system?	
c. Calculate ΔG° for the reaction at 298 K.	
d. Is the reaction spontaneous at 298K under standard conditions?	

[10] a. Using data in Appendix Four, calculate ΔH° , ΔS° , and ΔG° at 298K for the reaction below.

$\text{H}_2(\text{g}) + \text{F}_2(\text{g}) \rightarrow 2\text{HF}(\text{g})$	$\Delta H^\circ =$		
	$\Delta S^\circ =$		
	$\Delta G^\circ =$		
	$\Delta S^\circ \text{ (J/mol}\cdot\text{K)}$	$\Delta H^\circ \text{ (kJ/mol)}$	$\Delta G^\circ \text{ (kJ/mol)}$
$\text{H}_2(\text{g})$	130.7	0	----
$\text{F}_2(\text{g})$	202.8	0	----
$\text{HF}(\text{g})$	173.8	-273.3	-275.4
b. Show that $\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$			

[11] a. Using data from Appendix four, calculate the change in Gibbs free energy for the following reaction.

2NOCl(g) → 2NO(g) + Cl ₂ (g)			ΔG° =
	ΔS° (J/mol·K)	ΔH° (kJ/mol)	ΔG° (kJ/mol)
NOCl(g)	261.7	51.7	66.4
NO(g)	210.8	91.3	87.6
Cl ₂ (g)	2231	0	0
b. Is the reaction spontaneous under standard conditions? Explain.			YES NO

[12] A particular reaction is spontaneous at 450 K. The enthalpy change for the reaction is +34.5 kJ. What can you conclude about the sign and magnitude of ΔS for the reaction?