

Name: _____

Period: _____

Seat#: _____

Directions: Show all work in a way that would earn you credit on the AP Test! This is always the rule! Some answers are provided at the end in italics and underlined. If you need more space, use binder paper and staple to your worksheet.

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

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 \rightarrow 3 moles gaseous products.

b) b. In a chemical reaction, two gases combine to form a solid.

**Dougherty Valley HS Chemistry - AP
Thermodynamics – Entropy and Gibbs 2**

5) In which of the following situations does entropy of the system increase?

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
-------------------	-------------------------------------

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

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

8) Using S° values from an appendix or your reference sheet, calculate ΔS° values for each reaction.

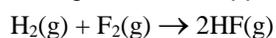
a) $\text{N}_2\text{H}_4(\text{g}) + \text{H}_2(\text{g}) \rightarrow 2\text{NH}_3(\text{g})$	16.4
b) $2\text{Al}(\text{s}) + 3\text{Cl}_2(\text{g}) \rightarrow 2\text{AlCl}_3(\text{s})$	-507.3

**Dougherty Valley HS Chemistry - AP
Thermodynamics – Entropy and Gibbs 2**

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.
<u>-60.9</u>
d) Is the reaction spontaneous at 298K under standard conditions?

10) Using data in an appendix or your reference sheet, calculate ΔH° , ΔS° , and ΔG° at 298K for the reaction below.



a) Calculate ΔH° , ΔS° , and ΔG° using $\Sigma \text{prod.} - \Sigma \text{reactants}$	$\Delta H^\circ =$
	$\Delta S^\circ =$
	$\Delta G^\circ =$
b) Using the ΔH° , ΔS° values you calculated above, show that $\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$	
<u>-550.8</u>	

11) Using data from an appendix or your reference sheet, calculate the change in Gibbs free energy for the reaction.

a) $2\text{NOCl}(\text{g}) \rightarrow 2\text{NO}(\text{g}) + \text{Cl}_2(\text{g})$		
<u>42.4</u>		
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?

