

# ANSWERS

TTC

1 (A)  $\Delta G = -513 \text{ kJ}$

(B) Find  $\Delta H_{\text{rxn}}$  ( $-552.8 \text{ kJ}$ )

Solve for  $\Delta S = -0.132 \text{ kJ/K}$  or  $-132 \text{ J/K}$

2 (A) Find  $\Delta H_{\text{rxn}}$  ( $-2855 \text{ kJ}$ ) and  $\Delta S_{\text{rxn}} = 961.9 \text{ J/K}$

Solve for  $\Delta G = -3,142 \text{ kJ}$

(B) NO-  $\Delta G$  is negative at all temperatures.

3. (1) Ag has greater entropy

non-rigid metallic "sea of electrons" vs. network covalent

(2) Ne at 0.5 atm. The gas would be expanded into a larger volume, so there is more random motion of particles

(3)  $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$  Larger molecules exhibit more vibrations and therefore have greater entropy.

(4) Ca at  $150^\circ\text{C}$ . At higher temperatures, particles of any substance are moving more quickly.

4 (a) ~~The entropy change~~ The system changes from two gases with high entropy to a low-entropy solid. This would be a large DECREASE in entropy, so  $\Delta S$  is negative.

(b) If reaction is spontaneous, then  $\Delta G$  must be neg.  
If  $\Delta S$  is negative, then  $\Delta H$  must be negative to mathematically give a negative  $\Delta G$ .

(c)  $\Delta G = \Delta H - T\Delta S$  positive  
 at higher values of  $T$ , the term  $-T\Delta S$  will dominate and  $\Delta G$  will change from negative to positive. ~~the~~  
 A positive  $\Delta G$  indicates that the forward reaction is nonspontaneous. However, at high  $T$  the reverse reaction would be spontaneous.

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3(a)  $\Delta S = \sum S^\circ(\text{prod}) - \sum S^\circ(\text{react})$

~~$-232.7 = [x] - [200.9 + 2(130.7)]$~~

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$x = S^\circ \text{ for } C_2H_6 = 229.6 \text{ J/mol K}$

(b)  $\Delta H_{rxn} = \sum \Delta H_f^\circ(\text{prod}) - \sum \Delta H_f^\circ(\text{react})$

$\Delta H_{rxn} = (-84.7) - (226.7 + 2(0.0)) = -311.4 \text{ kJ}$

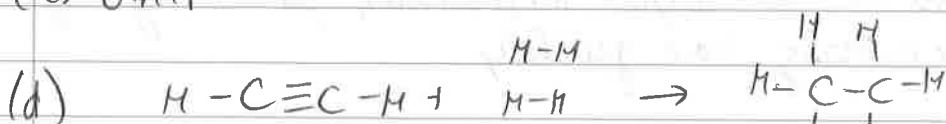
$\Delta G = \Delta H - T\Delta S$

$\Delta G = (-311.4) - (298)(-0.2327)$

$\Delta G = -242 \text{ kJ}$

The reaction is SPONTANEOUS.

(c) OMIT

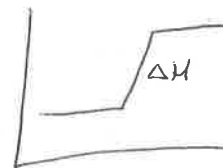


$2(C-H) \quad 2(414)$	Break bonds	$Form$	$C-C \quad -347$
$C \equiv C \quad x$		Bonds	$6 C-H \quad -6(414)$
$2(H-H) \quad 2(436)$			
$1700 + x$			$-2831$

$(1700 + x) + (-2831) = \Delta H_{rxn} = -311.4 \text{ kJ}$

$x = 819.6 \text{ kJ/mol}$

- D 1. Enthalpy change is the  $\Delta H$
- (A) Change in free energy of a system at constant temperature.
  - (B) Change in disorder of a system at constant pressure.
  - (C) Change in temperature of a system at constant pressure.
  - (D) amount of energy absorbed or lost by a system
- B 2. For an exothermic reaction,  $\Delta H$  is always
- (A) positive.
  - (B) negative.
  - (C) zero.
  - (D) small.
- B 3. In an endothermic reaction, the total energy at the beginning of the reaction is
- (A) greater than the total energy at the end of the reaction.
  - (B) less than the total energy at the end of the reaction.
  - (C) equal to the total energy at the end of the reaction.
  - (D) None of the above
- D 4.  $\Delta H$  is always positive for a
- (A) spontaneous reaction.
  - (B) nonspontaneous reaction.
  - (C) exothermic reaction.
  - (D) endothermic reaction.
- D 5. Compounds whose enthalpies of formation are highly negative
- (A) do not exist.
  - (B) are very unstable.
  - (C) are somewhat stable.
  - (D) are very stable.
- D 6. A compound that is very unstable and likely to decompose violently would have a
- (A) small negative enthalpy of formation.
  - (B) small positive enthalpy of formation.
  - (C) large negative enthalpy of formation.
  - (D) large positive enthalpy of formation.
- D 7. The majority of spontaneous chemical reactions in nature are
- (A) free-energy reactions.
  - (B) positive enthalpic reactions.
  - (C) endothermic
  - (D) exothermic
- B 8. Spontaneous reactions are driven by
- (A) decreasing enthalpy and decreasing entropy.
  - (B) decreasing enthalpy and increasing entropy.
  - (C) increasing enthalpy and decreasing entropy.
  - (D) increasing enthalpy and increasing entropy.



D

9. Entropy in a system increases when
- (A) gases are diluted
  - (B) ions disperse in a solution.
  - (C) the total moles of gaseous product exceed the total moles of gaseous reactant.
  - (D) All of the above

C

10. If a process increases entropy, the process
- (A) is always spontaneous.
  - (B) is never spontaneous.
  - (C) is likely to be spontaneous.
  - (D) is not likely to be spontaneous.

A

11. Which of the following substances has the highest entropy?
- (A) steam
  - (B) ice water
  - (C) liquid water
  - (D) crushed ice

C

12. What is the symbol for free-energy change?
- (A)  $\Delta S$
  - (B)  $\Delta H$
  - (C)  $\Delta G$
  - (D)  $\Delta T$

B

13. A reaction is spontaneous if  $\Delta G$  is
- (A) zero.
  - (B) negative.
  - (C) positive.
  - (D) greater than  $\Delta H$ .

D

14. For a process in which  $\Delta H$  is  $-298$  kJ and  $\Delta S$  is  $100$  J/k, calculate the change in the free energy at  $0^\circ\text{C}$
- (A)  $-298$  kJ
  - (B)  $-325$  kJ
  - (C)  $-198$  kJ
  - (D)  $-271$  kJ

$$\Delta G = \Delta H - T\Delta S$$

B

15. Which choice would definitely be non-spontaneous for the following changes in enthalpy and entropy?
- (A)  $+\Delta H$  and  $+\Delta S$
  - (B)  $+\Delta H$  and  $-\Delta S$
  - (C)  $-\Delta H$  and  $+\Delta S$
  - (D)  $-\Delta H$  and  $-\Delta S$
  - (E)  $\Delta H = 0$  and  $+\Delta S$

order