

Entropy/Electrochemistry
Mini Quiz

KEY Name _____

1. _____

Which of the laws of thermodynamics concern(s) entropy?

- A. only the first
B. only the second
C. only the third
D. both the first and second
E. both the second and third

2. _____

In which of the following processes does the entropy of the system increase?

- A. $\text{HCO}_3^-(\text{aq}) + \text{H}_3\text{O}^+(\text{aq}) \longrightarrow \text{CO}_2(\text{g}) + 2\text{H}_2\text{O}(\text{liq})$
 B. $\text{Cl}_2(\text{g}) + 2\text{Br}^-(\text{aq}) \longrightarrow 2\text{Cl}^-(\text{aq}) + \text{Br}_2(\text{liq})$
 C. $4\text{NO}(\text{g}) + 2\text{O}_3(\text{g}) \longrightarrow 2\text{N}_2\text{O}_5(\text{g})$
 D. all of them
 E. none of them

3. _____

Which one of the following statements is false?

- A. the entropy of the universe increases in a spontaneous process
 B. S° for the stable form of an element is zero at 25 °C
 C. $\Delta G = 0$ for a system at equilibrium
 D. the Gibbs free energy is a minimum for a system at equilibrium
 E. the Gibbs free energy of the system decreases in a spontaneous process

4. _____

Given the thermodynamic values shown, calculate ΔG° for the reaction shown at 100 °C:

	$\text{Al}_2\text{O}_3(\text{s})$	$+ 3\text{H}_2(\text{g})$	$\xrightarrow{100^\circ\text{C}}$	$2\text{Al}(\text{s})$	$+ 3\text{H}_2\text{O}(\text{g})$
ΔH_f°	-1666 kJ/mol	0		0	-242 kJ/mol
S°	51 J mol ⁻¹ .K ⁻¹	131 J mol ⁻¹ .K ⁻¹		28 J mol ⁻¹ .K ⁻¹	189 J mol ⁻¹ .K ⁻¹
	A. -14,200 kJ	B. -38 kJ		C. 246 kJ	D. 873 kJ
					E. 1068 kJ

5. _____

None of the following processes are spontaneous at 25 °C. All but one are spontaneous at very high temperatures (500-1000 °C). Which one is not spontaneous under any of the conditions just described?

- A. $2\text{O}_3(\text{g}) \longrightarrow 3\text{O}_2(\text{g})$
 B. $\text{CH}_3\text{CH}_3(\text{g}) \longrightarrow \text{CH}_2=\text{CH}_2(\text{g}) + \text{H}_2(\text{g})$
 C. $\text{CH}_3\text{CH}_2\text{CO}_2\text{H}(\text{g}) \longrightarrow \text{CH}_3\text{CH}_3(\text{g}) + \text{CO}_2(\text{g})$
 D. $2\text{CH}_2=\text{CH}_2(\text{g}) \longrightarrow \text{CH}_2=\text{CHCH}_2\text{CH}_3(\text{g})$
 E. $\text{CH}_3\text{CH}_2\text{OH}(\text{g}) \longrightarrow \text{CH}_2=\text{CH}_2(\text{g}) + \text{H}_2\text{O}(\text{g})$

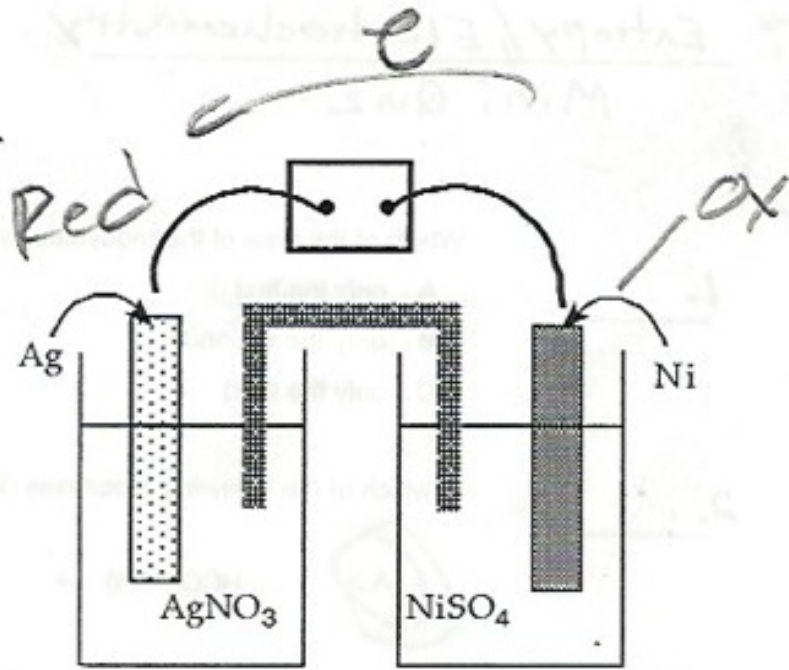
$\Delta G = \Delta H - T\Delta S$

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(+)

Questions

6-8 concern the galvanic cell shown at the right.



6. What is the standard cell potential E° for this galvanic cell?

- A. -0.57 V
- B. 0.57 V
- C. 1.03 V
- D. 1.26 V
- E. 1.74 V

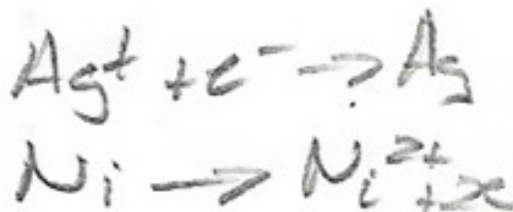
$.80V$
 $.23V$

 $1.03V$

7. What is the cell potential E for this cell when $[Ni^{2+}] = 2.0 M$ and $[Ag^+] = 0.1M$?

- A. -0.73 V
- B. 0.16
- C. 0.95 V
- D. 0.99 V
- E. 1.11 V

$E = E^\circ - \frac{.0592}{n} \log Q$



8. Which one of the following statements concerning the galvanic cell shown is true?

- A. Silver (Ag) is the anode.
- B. Ni^{2+} is reduced.
- C. Ni is reduced.
- D. $[AgNO_3]$ increases in the left compartment
- E. Electrons flow from the Ni electrode to the Ag electrode (i.e., from right to left).

9. The material from which the electrode is normally constructed in the standard hydrogen electrode is:

- A. platinum
- B. copper
- C. zinc
- D. lead
- E. graphite

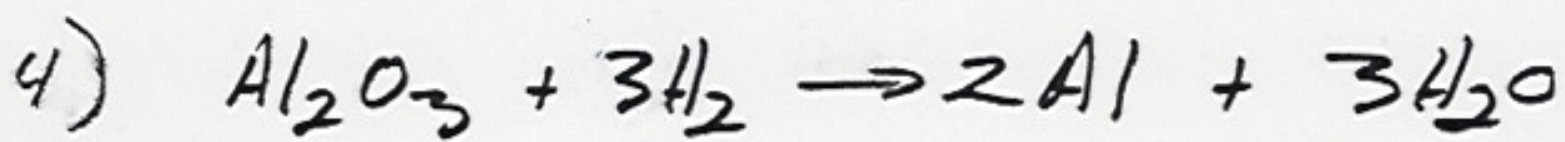
10. Which one of the following will liberate $H_2(g)$ from 1 M hydrochloric acid?

- A. Cl_2
- B. K^+
- C. Mn
- D. PbO_2
- E. Pt

11. Based on the information contained in the table of standard reduction potentials which one of the following statements is true? (All substances are in their standard state.)

- A. Bromine is a better oxidizing agent than chlorine.
- B. Lithium is the strongest reducing agent of the group 1A metals in aqueous solution.
- C. Hydrogen gas (H_2) is evolved when metallic silver (Ag) is added to a 1M solution of a strong acid.
- D. A coating of magnesium forms on a strip of aluminum when the strip is placed in aqueous $MgCl_2$.
- E. Potassium permanganate ($KMnO_4$) is unstable in acid solution because it oxidizes water to hydrogen peroxide (H_2O_2).

skip



$$\Delta H^\circ = 3(-242) - (-1666) = 940 \text{ kJ}$$

$$\Delta S^\circ = \left[2(28) + 3(189) \right] - \left[51 + 3(131) \right]$$

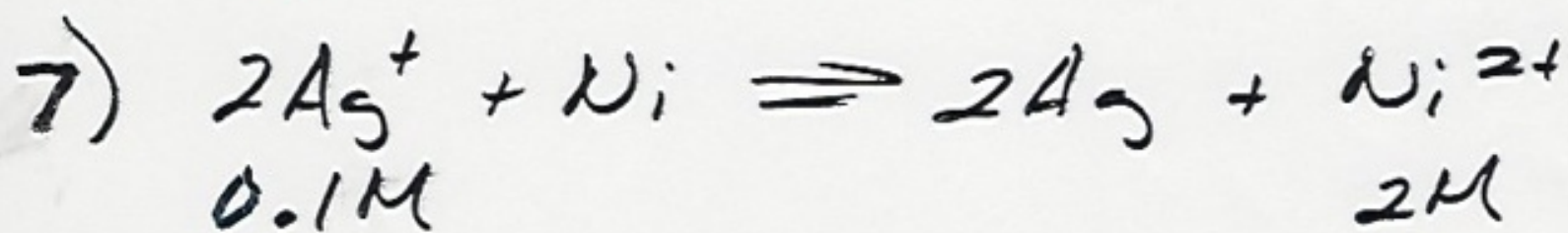
$$= 179 \text{ J/K}$$

$$= 0.179 \text{ kJ/K}$$

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

$$= 940 \text{ kJ} - (373 \text{ K})(0.179 \text{ kJ/K})$$

$$\Delta G = 873 \text{ kJ}$$



$$\frac{0.80}{0.23} = E^\circ$$

$$E = E^\circ - \frac{0.0591}{n} \log Q$$

$$= 1.03 - \frac{0.0591}{2} \log \frac{2}{(0.1)^2}$$

$$E = 0.96 \text{ V}$$

