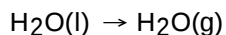


1022_3rd Exam_1030521

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

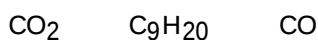
1) For the following example, identify the following.



- A) a negative ΔH and a negative ΔS
- B) a positive ΔH and a positive ΔS
- C) a negative ΔH and a positive ΔS
- D) a positive ΔH and a negative ΔS
- E) It is not possible to determine without more information.

Answer: B

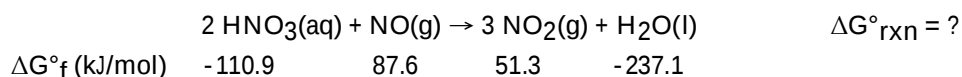
2) Place the following in order of increasing molar entropy at 298 K.



- A) $\text{CO}_2 < \text{C}_9\text{H}_{20} < \text{CO}$
- B) $\text{CO}_2 < \text{CO} < \text{C}_9\text{H}_{20}$
- C) $\text{C}_9\text{H}_{20} < \text{CO} < \text{CO}_2$
- D) $\text{C}_9\text{H}_{20} < \text{CO}_2 < \text{CO}$
- E) $\text{CO} < \text{CO}_2 < \text{C}_9\text{H}_{20}$

Answer: E

3) Calculate the $\Delta G^\circ_{\text{rxn}}$ using the following information.



- A) +51.0 kJ
- B) +171.1 kJ
- C) -162.5 kJ
- D) -54.5 kJ
- E) -87.6 kJ

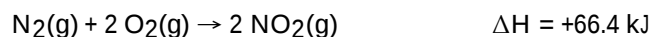
Answer: A

4) Which of the following reactions will have the largest equilibrium constant (K) at 298 K?

- A) $\text{CaCO}_3(\text{s}) \rightarrow \text{CaO}(\text{s}) + \text{CO}_2(\text{g})$ $\Delta G^\circ = +131.1 \text{ kJ}$
- B) $\text{Fe}_2\text{O}_3(\text{s}) + 3 \text{CO}(\text{g}) \rightarrow 2 \text{Fe}(\text{s}) + 3 \text{CO}_2(\text{g})$ $\Delta G^\circ = -28.0 \text{ kJ}$
- C) $2 \text{Hg}(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2 \text{HgO}(\text{s})$ $\Delta G^\circ = -180.8 \text{ kJ}$
- D) $3 \text{O}_2(\text{g}) \rightarrow 2 \text{O}_3(\text{g})$ $\Delta G^\circ = +326 \text{ kJ}$
- E) It is not possible to determine without more information.

Answer: C

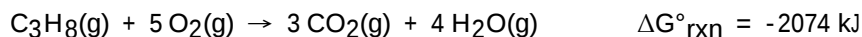
- 5) Consider the following reaction at constant P. Use the information here to determine the value of ΔS_{surr} at 298 K. Predict whether or not this reaction will be spontaneous at this temperature.



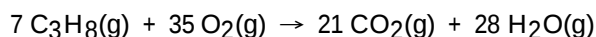
- A) $\Delta S_{\text{surr}} = +223 \text{ J/K}$, reaction is spontaneous
 B) $\Delta S_{\text{surr}} = +2656 \text{ kJ/K}$, reaction is not spontaneous
 C) $\Delta S_{\text{surr}} = -223 \text{ J/K}$, reaction is not spontaneous
 D) $\Delta S_{\text{surr}} = -66.4 \text{ J/K}$, reaction is not spontaneous
 E) $\Delta S_{\text{surr}} = -66.4 \text{ J/K}$, it is not possible to predict the spontaneity of this reaction without more information.

Answer: C

- 6) Given the following equation,



Calculate $\Delta G^\circ_{\text{rxn}}$ for the following reaction.



- A) -2074 kJ B) -296 kJ C) +14518 kJ D) +2074 kJ E) -14518 kJ

Answer: E

- 7) For a given compound, list the decreasing order of entropy for a liquid, solid, and gas

- A) solid > liquid > gas
 B) solid > gas > liquid
 C) gas > solid > liquid
 D) gas > liquid > solid
 E) liquid > solid > gas

Answer: D

- 8) Under which of the following conditions would one mole of He have the highest entropy, S?

- A) 127°C and 15 L B) 17°C and 25 L C) 17°C and 15 L D) 127°C and 25 L

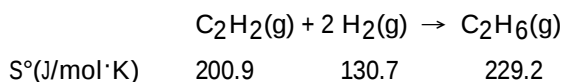
Answer: D

- 9) For a given reaction, $\Delta H = -19.9 \text{ kJ/mol}$ and $\Delta S = -55.5 \text{ J/Kmol}$. The reaction will have $\Delta G = 0$ at _____ K. Assume that ΔH and ΔS do not vary with temperature.

- A) 0.359 B) 2.79 C) 359 D) 298 E) 2789

Answer: C

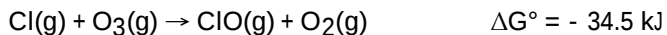
- 10) Calculate $\Delta S^\circ_{\text{rxn}}$ for the following reaction. The S° for each species is shown below the reaction.



- A) -233.1 J/K B) -102.4 J/K C) 229.2 J/K D) +560.8 J/K E) +303.3 J/K

Answer: A

11) Determine the equilibrium constant for the following reaction at 298 K.



A) 8.96×10^{-7}

B) 0.986

C) 4.98×10^{-4}

D) 1.12×10^6

E) 5.66×10^5

Answer: D

12) The _____ Law of Thermodynamics states the entropy of a perfect crystal at absolute zero is zero.

A) Zero

B) First

C) Second

D) Third

E) Fourth

Answer: D

13) Estimate $\Delta G^\circ_{\text{rxn}}$ for the following reaction at 825 K.



A) -2.63 kJ

B) +37 kJ

C) +645 kJ

D) -645 kJ

E) -37 kJ

Answer: B

14) Which one of the following has the highest standard molar entropy, S° , at 25°C?

A) $\text{Cl}_2\text{(g)}$

B) $\text{I}_2\text{(g)}$

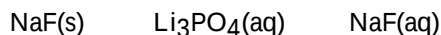
C) $\text{O}_2\text{(g)}$

D) $\text{F}_2\text{(g)}$

E) $\text{Br}_2\text{(l)}$

Answer: B

15) Place the following in order of decreasing standard molar entropy.



A) $\text{NaF(s)} > \text{Li}_3\text{PO}_4\text{(aq)} > \text{NaF(aq)}$

B) $\text{Li}_3\text{PO}_4\text{(aq)} > \text{NaF(aq)} > \text{NaF(s)}$

C) $\text{NaF(aq)} > \text{Li}_3\text{PO}_4\text{(aq)} > \text{NaF(s)}$

D) $\text{NaF(aq)} > \text{NaF(s)} > \text{Li}_3\text{PO}_4\text{(aq)}$

E) $\text{NaF(s)} > \text{NaF(aq)} > \text{Li}_3\text{PO}_4\text{(aq)}$

Answer: B

16) Determine the equilibrium constant for the following reaction at 498 K.



A) 8.10×10^{31}

B) 1.87×10^{10}

C) 5.34×10^{-11}

D) 2.31×10^{-22}

E) 4.33×10^{21}

Answer: B

17) Place the following in order of increasing molar entropy at 298 K.

NO CO SO

- A) NO < CO < SO
- B) SO < CO < NO
- C) CO < NO < SO
- D) CO < SO < NO
- E) SO < NO < CO

Answer: C

18) Calculate the $\Delta G^\circ_{\text{rxn}}$ using the following information.

	$2 \text{HNO}_3(\text{aq}) + \text{NO}(\text{g}) \rightarrow 3 \text{NO}_2(\text{g}) + \text{H}_2\text{O}(\text{l})$				$\Delta G^\circ_{\text{rxn}} = ?$
ΔH°_f (kJ/mol)	-207.0	91.3	33.2	-285.8	
S° (J/mol·K)	146.0	210.8	240.1	70.0	

- A) +50.8 kJ B) -151 kJ C) +222 kJ D) -85.5 kJ E) -186 kJ

Answer: A

19) Identify the compound with the lowest standard free energy of formation.

- A) NaCl(s)
- B) NO(g)
- C) O₃(g)
- D) O₂(g)
- E) It is hard to determine.

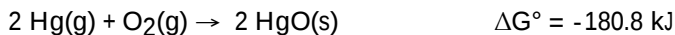
Answer: A

20) Identify the compound with the highest standard free energy of formation.

- A) NO(g)
- B) H₂(g)
- C) NaCl(s)
- D) O₃(g)
- E) It is hard to determine.

Answer: D

21) Calculate ΔG_{rxn} at 298 K under the conditions shown below for the following reaction.

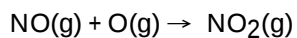


$$P(\text{Hg}) = 0.025 \text{ atm}, P(\text{O}_2) = 0.037 \text{ atm}$$

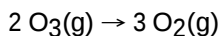
- A) +60.7 kJ B) +207 kJ C) -154.4 kJ D) -26.5 kJ E) -164 kJ

Answer: C

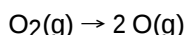
22) Use Hess's law to calculate $\Delta G^\circ_{\text{rxn}}$ using the following information.



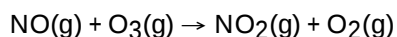
$$\Delta G^\circ_{\text{rxn}} = ?$$



$$\Delta G^\circ_{\text{rxn}} = +489.6 \text{ kJ}$$



$$\Delta G^\circ_{\text{rxn}} = +463.4 \text{ kJ}$$



$$\Delta G^\circ_{\text{rxn}} = -199.5 \text{ kJ}$$

A) +277.0 kJ

B) -225.7 kJ

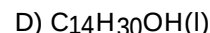
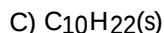
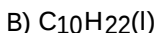
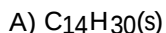
C) -676.0 kJ

D) +753.5 kJ

E) -1152.5 kJ

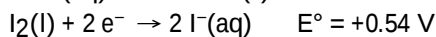
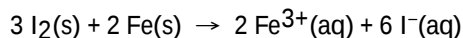
Answer: C

23) Which one of the following would be expected to have the lowest standard molar entropy, S° , at 25°C?



Answer: C

24) Use the tabulated half-cell potentials to calculate the equilibrium constant (K) for the following balanced redox reaction at 25°C.



A) 8.9×10^{-18}

B) 1.7×10^{29}

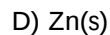
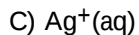
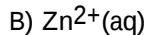
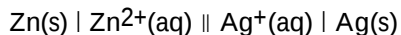
C) 2.4×10^{58}

D) 1.1×10^{17}

E) 3.5×10^{-59}

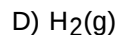
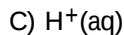
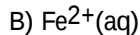
Answer: C

25) What is the reducing agent in the redox reaction represented by the following cell notation?



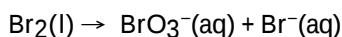
Answer: D

26) What is undergoing oxidation in the redox reaction represented by the following cell notation?



Answer: A

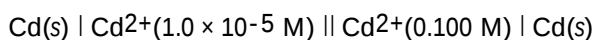
- 27) Balance the following redox reaction if it occurs in basic solution. What are the coefficients in front of Br_2 and OH^- in the balanced reaction?



- A) $\text{Br}_2 = 1, \text{OH}^- = 2$
 B) $\text{Br}_2 = 3, \text{OH}^- = 3$
 C) $\text{Br}_2 = 2, \text{OH}^- = 5$
 D) $\text{Br}_2 = 3, \text{OH}^- = 6$
 E) $\text{Br}_2 = 1, \text{OH}^- = 6$

Answer: D

- 28) Given that $E^\circ_{\text{red}} = -0.40 \text{ V}$ for Cd^{2+}/Cd at 25°C , find E° and E for the concentration cell expressed using shorthand notation below.



- A) $E^\circ = 0.00 \text{ V}$ and $E = +0.12 \text{ V}$
 B) $E^\circ = -0.40 \text{ V}$ and $E = -0.28 \text{ V}$
 C) $E^\circ = -0.40 \text{ V}$ and $E = -0.16 \text{ V}$
 D) $E^\circ = 0.00 \text{ V}$ and $E = +0.24 \text{ V}$

Answer: A

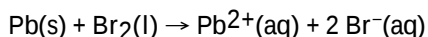
- 29) Calculate the cell potential for the following reaction that takes place in an electrochemical cell at 25°C .



- | | | | | |
|-----------------------------|---|------------------------------|----------------------|----------------------|
| $\text{Ag}^+(\text{aq})$ | $+ \text{e}^- \rightarrow \text{Ag}(\text{s})$ | $E^\circ = +0.800 \text{ V}$ | | |
| $\text{Sn}^{2+}(\text{aq})$ | $+ 2\text{e}^- \rightarrow \text{Sn}(\text{s})$ | $E^\circ = -0.14 \text{ V}$ | | |
| A) $+0.98 \text{ V}$ | B) -0.94 V | C) $+1.02 \text{ V}$ | D) -0.85 V | E) $+0.86 \text{ V}$ |

Answer: E

- 30) Use the standard half-cell potentials listed below to calculate the standard cell potential for the following reaction occurring in an electrochemical cell at 25°C . (The equation is balanced.)

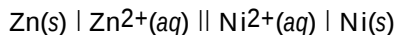


- | | |
|---|-----------------------------|
| $\text{Pb}^{2+}(\text{aq}) + 2 \text{e}^- \rightarrow \text{Pb}(\text{s})$ | $E^\circ = -0.13 \text{ V}$ |
| $\text{Br}_2(\text{l}) + 2 \text{e}^- \rightarrow 2 \text{Br}^-(\text{aq})$ | $E^\circ = +1.07 \text{ V}$ |

- A) -0.60 V B) -1.20 V C) -0.94 V D) $+1.20 \text{ V}$ E) $+0.94 \text{ V}$

Answer: D

- 31) For the galvanic cell reaction, expressed below using shorthand notation, what half-reaction occurs at the cathode?



- A) $\text{Zn}(\text{s}) \rightarrow \text{Zn}^{2+}(\text{aq}) + 2 \text{e}^-$
 B) $\text{Ni}^{2+}(\text{aq}) + 2 \text{e}^- \rightarrow \text{Ni}(\text{s})$
 C) $\text{Ni}(\text{s}) \rightarrow \text{Ni}^{2+}(\text{aq}) + 2 \text{e}^-$
 D) $\text{Zn}^{2+}(\text{aq}) + 2 \text{e}^- \rightarrow \text{Zn}(\text{s})$

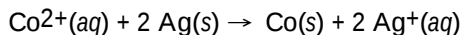
Answer: B

32) Describe how water can be a good conductor of current.

- A) add salt
- B) vaporize the water
- C) heat the water
- D) use pure water
- E) chill the water

Answer: A

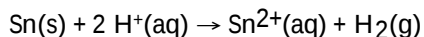
33) What is the reduction half-reaction for the following overall galvanic cell reaction?



- A) $\text{Co}^{2+}(\text{aq}) + 2 \text{e}^{-} \rightarrow \text{Co}(\text{s})$
- B) $\text{Ag}(\text{s}) + \text{e}^{-} \rightarrow \text{Ag}^{+}(\text{aq})$
- C) $\text{Ag}^{+}(\text{aq}) + \text{e}^{-} \rightarrow \text{Ag}(\text{s})$
- D) $\text{Co}^{2+}(\text{aq}) + \text{e}^{-} \rightarrow \text{Co}(\text{s})$

Answer: A

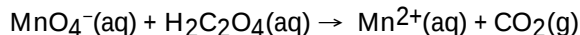
34) Determine the cell notation for the redox reaction given below.



- A) $\text{Sn}(\text{s}) \mid \text{Sn}^{2+}(\text{aq}) \parallel \text{H}^{+}(\text{aq}) \mid \text{H}_2(\text{g}) \mid \text{Pt}$
- B) $\text{Sn}(\text{s}) \mid \text{H}_2(\text{g}) \parallel \text{Sn}^{2+}(\text{aq}) \mid \text{H}^{+}(\text{aq}) \mid \text{Pt}$
- C) $\text{H}^{+}(\text{aq}) \mid \text{H}_2(\text{g}) \mid \text{Pt} \parallel \text{Sn}(\text{s}) \mid \text{Sn}^{2+}(\text{aq})$
- D) $\text{H}_2(\text{g}) \mid \text{H}^{+}(\text{aq}) \mid \text{Pt} \parallel \text{Sn}^{2+}(\text{aq}) \mid \text{Sn}(\text{s})$
- E) $\text{Sn}^{2+}(\text{aq}) \mid \text{Sn}(\text{s}) \parallel \text{H}_2(\text{g}) \mid \text{H}^{+}(\text{aq}) \mid \text{Pt}$

Answer: A

35) What element is being reduced in the following redox reaction?



- A) Mn
- B) C
- C) H
- D) O

Answer: A

36) Which of the following processes have a $\Delta S > 0$?

- A) $\text{N}_2(\text{g}) + 3 \text{H}_2(\text{g}) \rightarrow 2 \text{NH}_3(\text{g})$
- B) $\text{Na}_2\text{CO}_3(\text{s}) + \text{H}_2\text{O}(\text{g}) + \text{CO}_2(\text{g}) \rightarrow 2 \text{NaHCO}_3(\text{s})$
- C) $\text{CH}_3\text{OH}(\text{l}) \rightarrow \text{CH}_3\text{OH}(\text{s})$
- D) $\text{CH}_4(\text{g}) + \text{H}_2\text{O}(\text{g}) \rightarrow \text{CO}(\text{g}) + 3 \text{H}_2(\text{g})$
- E) All of the above processes have a $\Delta S > 0$.

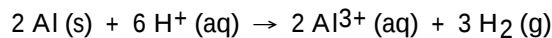
Answer: D

37) The _____ Law of Thermodynamics states the energy is conserved in chemical processes.

- A) Zero
- B) First
- C) Second
- D) Third
- E) Fourth

Answer: B

38) How many electrons are transferred in the following reaction?



A) 1

B) 2

C) 3

D) 5

E) 6

Answer: E

Table 18.1 Selected Standard Electrode Potentials at 25°C

Reaction	E° , V
$\text{Mg}^{2+} \text{(aq)} + 2 \text{e}^- \rightarrow \text{Mg (s)}$	-2.356
$\text{Fe}^{2+} \text{(aq)} + 2 \text{e}^- \rightarrow \text{Fe (s)}$	-0.440
$\text{Pb}^{2+} \text{(aq)} + 2 \text{e}^- \rightarrow \text{Pb (s)}$	-0.125
$2 \text{H}^+ \text{(aq)} + 2 \text{e}^- \rightarrow \text{H}_2 \text{(g)}$	0.0
$\text{Cu}^{2+} \text{(aq)} + 2 \text{e}^- \rightarrow \text{Cu (s)}$	+0.337
$\text{I}_2 \text{(s)} + 2 \text{e}^- \rightarrow 2 \text{I}^- \text{(s)}$	+0.535
$\text{Fe}^{3+} \text{(aq)} + 2 \text{e}^- \rightarrow \text{Fe}^{2+} \text{(aq)}$	+0.771
$\text{Ag}^+ \text{(aq)} + \text{e}^- \rightarrow \text{Ag (s)}$	+0.800
$\text{O}_2 \text{(g)} + 4 \text{H}^+ \text{(aq)} + 2 \text{e}^- \rightarrow 2 \text{H}_2\text{O}$	+1.229
$\text{Cl}_2 \text{(g)} + 2 \text{e}^- \rightarrow 2 \text{Cl}^- \text{(aq)}$	+1.358
$\text{F}_2 \text{(g)} + 2 \text{e}^- \rightarrow 2 \text{F}^- \text{(aq)}$	+2.866

39) (Refer to Table 18.1) Which is the best oxidizing agent?

A) Cu^{2+}

B) Cl_2

C) Mg^{2+}

D) F^-

E) Fe^{3+}

Answer: B

40) (Refer to Table 18.1) Which is the best reducing agent?

A) F^-

B) Mg

C) Fe^{2+}

D) Ag

E) Pb

Answer: B

41) (Refer to Table 18.1) Which is the most easily oxidized?

A) Mg

B) Cl^-

C) Cu

D) H^+

E) Fe

Answer: A

42) (Refer to Table 18.1) Which is the most easily reduced?

A) Cl^-

B) Mg^{2+}

C) Cl_2

D) H^+

E) Cu

Answer: C

43) (Refer to Table 18.1) Which of the following will reduce Fe^{3+} to Fe^{2+} but not H^+ to H_2 (g)?

A) Fe

B) Ag

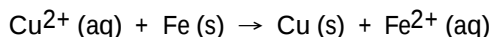
C) Mg

D) Cl^-

E) Cu

Answer: E

44) (Refer to Table 18.1) Will the following reaction occur spontaneously as written?



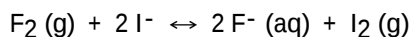
A) yes

B) no

C) impossible to tell

Answer: A

45) (Refer to Table 18.1) Calculate the value of K_{eq} at 25° C for the reaction:



A) 5.3×10^{39}

B) 2.33

C) 2.6×10^{39}

D) 6.0×10^{78}

E) 1.4×10^{-79}

Answer: D

46) Use the Nernst equation to determine E_{cell} at 25° C for the following voltaic cell. ($E^\circ_{\text{cell}} = +1.100 \text{ V}$)



A) 1.16

B) 1.10

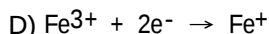
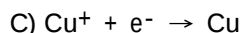
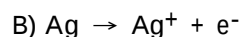
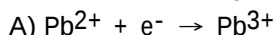
C) 1.07

D) 1.13

E) 1.04

Answer: D

47) Which of the following half-reactions is not correct?



Answer: A

48) What mass, in g, of copper will be deposited from a solution of Cu^{2+} by a current of 2.50 A in 2.00 h?

A) 1.65

B) 11.9

C) 5.93

D) 23.7

E) 0.187

Answer: C

49) In the process of electroplating a metal spoon with silver metal, the spoon is the

A) anode.

B) cathode.

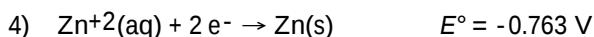
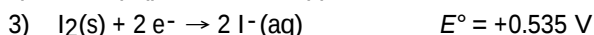
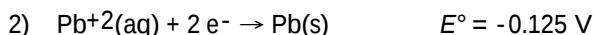
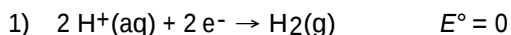
C) salt bridge.

D) Both A and B are correct.

E) none of the above

Answer: B

50) Which two of the following half-reactions will combine to give the galvanic cell with the highest cell potential?



A) 3 and 4

B) 1 and 3

C) 2 and 3

D) 2 and 4

E) 1 and 4

Answer: A