EQUATIONS

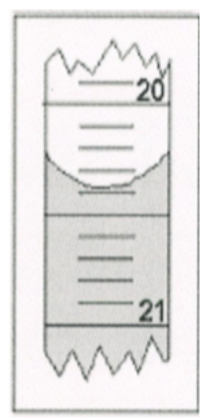
		Integrated Rate Laws
$\ln\left(\frac{k_2}{k_1}\right) = \frac{E_a}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$	$E = E^\circ - \frac{RT}{nF}\ln Q$	zero: $[A] = [A]_0 - kt$
$pH = pK_a + \log\left(\frac{[A^-]}{[HA]}\right)$	$\Delta U = q + w$ $\quad \Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$	first: $\ln[A] = \ln[A]_0 - kt$
$\Delta E_{H\text{-}atom} = R_H\left(\frac{1}{n_i^2} - \frac{1}{n_f^2}\right)$	$\Delta G^\circ = -RT\ln K$ $\quad \Delta G^\circ = -nFE^\circ$	second: $\frac{1}{[A]} = \frac{1}{[A]_0} + kt$

$E = E^\circ - (0.0592V/n)\log Q$, $R = 8.3145$ J/(mol K), $F = 96{,}485$ C/(mol e^-), 1A = 1C/s
first order half life = $t_{1/2} = 0.693/k$, second order half-life $t_{1/2} = 1/(k[A]_0)$

Reduction half reaction	**E°(V)**
$Ag^+(aq) + e^- \rightarrow Ag(s)$	0.80
$Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$	0.34
$Pb^{2+}(aq) + 2e^- \rightarrow Pb(s)$	-0.13
$Zn^{2+}(aq) + 2e^- \rightarrow Zn(s)$	-0.76
$Mn^{2+}(aq) + 2e^- \rightarrow Mn(s)$	-1.180
$Al^{3+}(aq) + 3e^- \rightarrow Al(s)$	-1.665

1. Which of the following statements is TRUE?
A) Intermolecular forces are generally stronger than bonding forces.
B) Molecules are generally attracted to each other.
C) Energy is given off when the attraction between two molecules is broken.
D) Increasing the pressure on a solid usually causes it to become a liquid.
E) None of the above are true.

2. Unlike graduated cylinders, burets read from small to large numbers as more liquid is delivered. What is the reading on the buret pictured here to the appropriate number of significant figures?

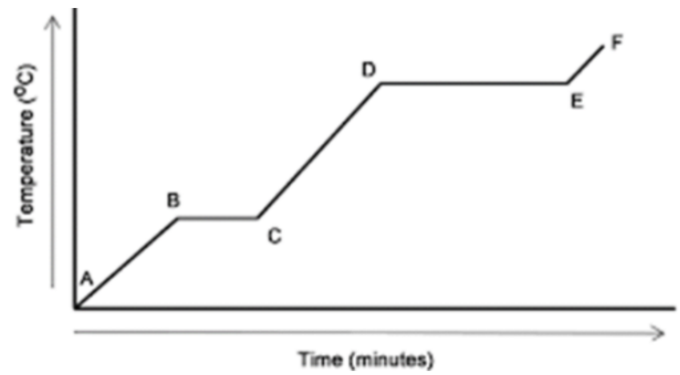


A) 20.4 mL
B) 20.38 mL
C) 21.6 mL
D) 21.62 mL
E) 20.5 mL

3. In liquid propanol,
$CH_3CH_2CH_2OH$
which intermolecular forces are present?
A) Dispersion, hydrogen bonding and dipole-dipole forces are present.
B) Only dipole-dipole and ion-dipole forces are present.
C) Only dispersion and dipole-dipole forces are present.
D) Only hydrogen bonding forces are present.

4. Which of the following statements is TRUE?
A) Vapor pressure increases with temperature.
B) Hydrogen bonds are stronger than covalent bonds.
C) Intermolecular forces hold the atoms in molecules together.
D) Dispersion forces are generally stronger than dipole-dipole forces.
E) None of the above are true.

5. For the diagram here, what does the line segment B→C represent?
A) melting
B) boiling
C) warming solid
D) warming liquid
E) warming gas

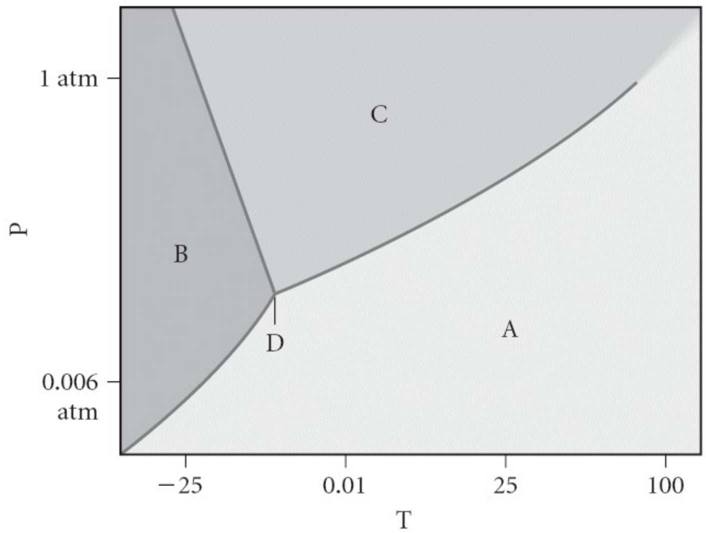


6. Find the vapor pressure of an equimolar mixture of water ($P_{vap}°$ = 23.8 torr) and ethanol ($P_{vap}°$ = 45.0 torr).
A) 68.8 torr
B) 21.2 torr
C) 45.0 torr
D) 34.4 torr
E) Not enough information given.

7. Which of the following aqueous solutions would have the lowest freezing point?
A) 0.10 *m* $Na_2CO_3(aq)$
B) 0.10 *m* $NaCl(aq)$
C) 0.10 *m* $K_2CO_3(aq)$
D) 0.10 *m* $Na_3PO_4(aq)$
E) 0.10 *m* $CH_3CH_2OH(aq)$

8. The enthalpy change for converting 10.0 g of ice at -25.0°C to water at 80.0°C is __________ kJ. The specific heats of ice, water, and steam are 2.09 J/gK, 4.18 J/gK, and 1.84 J/gK, respectively. For H_2O, ΔH_{fus} = 6.01 kJ/mol, and ΔH_{vap} = 40.67 kJ/mol.
A) 12.28
B) 6.16
C) 3870
D) 7.21
E) 9.88

9. Assign the appropriate labels to the phase diagram shown below.



A) A = liquid, B = solid, C = gas, D = critical point
B) A = gas, B = solid, C = liquid, D = triple point
C) A = gas, B = liquid, C = solid, D = critical point
D) A = solid, B = gas, C = liquid, D = supercritical fluid
E) A = liquid, B = gas, C = solid, D = triple point

10. Which of the following is considered a molecular solid?
A) Cu
B) NH_4NO_3
C) I_2
D) Xe
E) None of these is a molecular solid.

11. Identify the type of solid for AgCl.
A) metallic atomic solid
B) ionic solid
C) nonbonding atomic solid
D) molecular solid
E) networking atomic solid

12. Choose the statement below that is TRUE.
A) A solution will form between two substances if the solute-solvent interactions are of comparable strength to the solute-solute and solvent-solvent interactions.

B) A solution will form between two substances if the solute-solvent interactions are small enough to be overcome by the solute-solute and solvent-solvent interactions.
C) A solution will form between two substances if the solute-solute interactions are strong enough to overcome the solvent-solvent interactions.
D) A solution will form between two substances only if the solvent-solvent interactions are weak enough to overcome the solute-solvent interactions.
E) None of the above are true.

13. Suppose a reaction $2A \rightarrow A_2$ follows second order kinetics. Find the concentration of [A] after 36 seconds. Given: $[A]_o = 2.4$ M and $k = 0.50$ 1/(M s).
A) 18 M
B) 0.055 M
C) 3.6×10^{-8} M
D) 0.42 M
E) 0.11 M

14. What mass (in g) of NH_3 must be dissolved in 475 g of methanol to make a 0.250 *m* solution?
A) 2.02 g
B) 4.94 g
C) 1.19 g
D) 8.42 g
E) 1.90 g

15. Calculate the molality $MgCl_2$ in an aqueous solution prepared by dissolving 0.400 moles of $MgCl_2$ in 47.2 moles of water.
A) 0.470 *m*
B) 4.70×10^{-4} *m*
C) 8.47 *m*
D) 44.8 *m*
E) 0.00841 *m*

16. Determine the freezing point depression of a solution that contains 30.7 g glycerin ($C_3H_8O_3$, molar mass = 92.09 g/mol) in 376 mL of water. Assume water has a density of 1.00 g/mL. Some possibly useful constants for water are $K_f = 1.86$°C/*m* and $K_b = 0.512$°C/*m*.
A) 0.887°C
B) 1.65°C
C) 3.33°C
D) 3.33°C

E) 0.654°C

17. Place the following aqueous solutions of nonvolatile, nonionic compounds in order of **decreasing** osmotic pressure.

I. 0.011 M sucrose   II. 0.00095 M glucose   III. 0.0060 M glycerin

A) I > III > II
B) I > II > III
C) II > III > I
D) III > I > II
E) II > I > III

18. Identify the solute with the highest van't Hoff factor.
A) nonelectrolyte
B) NaCl
C) $MgSO_4$
D) $MgCl_2$
E) $FeCl_3$

19. Which of the following will lead to a small *A* (also known as *pre-exponential factor* or *frequency factor*) in the equation $k = Ae^{-Ea/(RT)}$?
A) small reactant concentration
B) spherical reactant symmetry
C) very specific reactant spatial orientation requirements
D) high activation energy

20. Given the following balanced equation, determine the rate of reaction with respect to $[O_2]$.

$$2\ O_3(g) \rightarrow 3\ O_2(g)$$

A) Rate $= -\dfrac{2\ \Delta[O_2]}{\Delta t}$

B) Rate $= -\dfrac{2}{3}\dfrac{\Delta[O_2]}{\Delta t}$

C) Rate $= +\dfrac{1}{3}\dfrac{\Delta[O_2]}{Dt}$

D) Rate = $+\frac{3\ \Delta[O_2]}{\Delta t}$

E) It is not possible to determine without more information.

21. Given the following balanced equation, if the rate of Cl_2 loss is 4.84×10^{-2} M/s, what is the rate of loss of NO?

$$2\ NO(g) + Cl_2(g) \rightarrow 2\ NOCl(g)$$

A) 4.84×10^{-2} M/s
B) 2.42×10^{-2} M/s
C) 1.45×10^{-1} M/s
D) 9.68×10^{-2} M/s
E) 1.61×10^{-2} M/s

22. What is the overall order of the following reaction, given the rate law?

$$X + 2\ Y \rightarrow 4\ Z \qquad \text{Rate} = k[X][Y]$$

A) 3rd order
B) 5th order
C) 2nd order
D) 1st order
E) 0th order

23. Given the following rate law, how does the rate of reaction change if the concentration of X is doubled?

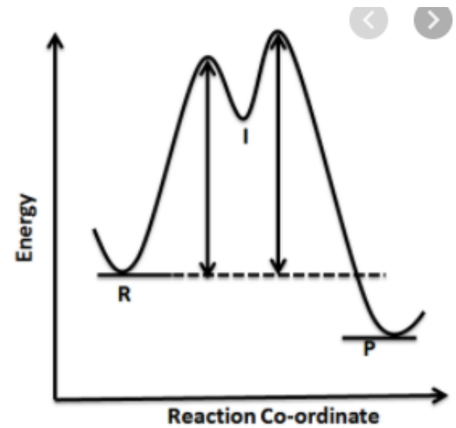
$$\text{Rate} = k\ [X][Y]^2$$

A) The rate of reaction will increase by a factor of 2.
B) The rate of reaction will increase by a factor of 4.
C) The rate of reaction will increase by a factor of 5.
D) The rate of reaction will decrease by a factor of 2.
E) The rate of reaction will remain unchanged.

24. If the concentration of a reactant is 6.25% of its original value, how many half-lives has it gone through?
A) 7

B) 6
C) 3
D) 4
E) 5

25. Suppose a reaction follows a mechanism represented by the figure here. Which step would be the slow step in the mechanism?
A) R→I
B) R→P
C) I→P
D) Ea_2
E) P→R



26. To initiate the below reaction, an otherwise empty 1.00L container was loaded with 0.54 atm of HI. What would be the partial pressure of H_2 at equilibrium? Given: $K_p = 49$ atm.

$$H_2(g) + I_2(g) \leftrightarrow 2HI(g)$$

A) 0.060 atm
B) 0.0098 atm
C) 0.11 atm
D) 0.030 atm
E) 0.18 atm

27. Identify a heterogeneous catalyst.
A) CFCs with ozone
B) Pd in H_2 gas
C) KI dissolved in H_2O_2
D) H_2SO_4 with concentrated HCl
E) H_3PO_4 with an alcohol

28. Nitrogen dioxide decomposes at 300°C via a second-order process to produce nitrogen monoxide and oxygen according to the following chemical equation.

$$2\ NO_2(g) \rightarrow 2\ NO(g) + O_2(g).$$

A sample of $NO_2(g)$ is initially placed in a 2.50-L reaction vessel at 300°C. If the half-life and the rate constant at 300°C are 11 seconds and 0.54 $M^{-1}\ s^{-1}$, respectively, how many moles of NO_2 were in the original sample? Given, for second order, $t_{1/2} = 1/(k[A]_o)$
A) 0. 17 mol
B) 0. 42 mol

C) 5.9 mol
D) 15 mol

29. Express the equilibrium constant for the following reaction.

$$N_2(g) + 3\ H_2(g) \Leftrightarrow 2\ NH_3(g)$$

A) $K = \dfrac{[N_2][H_2]^{1/3}}{[NH_3]^{1/2}}$

B) $K = \dfrac{[NH_3]^6}{[N_2]^3[H_2]^9}$

C) $K = \dfrac{[NH_3]^2}{[N_2][H_2]^3}$

D) $K = \dfrac{[N_2][H_2]^3}{[NH_3]^2}$

E) $K = \dfrac{[NH_3]^{1/2}}{[N_2][H_2]^{1/3}}$

30. Express the equilibrium constant for the following reaction.

$$2\ Na(s) + 2\ H_2O(l) \rightleftharpoons 2\ NaOH(aq) + H_2(g)$$

A) $K = \dfrac{[NaOH]^2[H_2]}{[Na]^2[H_2O]^2}$

B) $K = [H_2][NaOH]^{-2}$

C) $K = \dfrac{[Na]^2[H_2O]^2}{[NaOH]^2[H_2]}$

D) $K = [H_2][NaOH]^2$

E) $K = \dfrac{[NaOH]^{1/2}[H_2]}{[Na]^{1/2}[H_2O]^{1/2}}$

31. In a reaction mixture containing only reactants, what is the value of Q?
A) -1
B) 1
C) ∞
D) 0
E) It cannot be determined without concentrations.

32. Which of the following statements is TRUE?
A) If $Q < K$, it means the reverse reaction will proceed to form more reactants.
B) If $Q > K$, it means the forward reaction will proceed to form more products.
C) If $Q = K$, it means the reaction is at equilibrium.
D) All of the above are true.
E) None of the above are true.

33. The following reaction is exothermic. Which change will shift the equilibrium to the left?

$$2\ SO_2(g) + O_2(g) \rightleftharpoons 2\ SO_3(g)$$

A) raising the temperature
B) adding SO_3
C) removing O_2
D) all of the above
E) none of the above

34. Consider the following reaction at equilibrium. What effect will adding more H_2S have on the system?

$$2\ H_2S(g) + 3\ O_2(g) \rightleftharpoons 2\ H_2O(g) + 2\ SO_2(g)$$

A) The reaction will shift to the left.
B) No change will be observed.
C) The equilibrium constant will decrease.
D) The equilibrium constant will increase.
E) The reaction will shift in the direction of products.

35. At a certain temperature, nitrogen and hydrogen react to form ammonia:

$$N_2(g) + 3\ H_2(g) \rightleftharpoons 2\ NH_3(g).$$

When initial amounts of N_2, H_2, and NH_3 are mixed, the concentration of NH_3 increases. Which statement below is TRUE?
A) $K_c < Q$
B) $K_c > Q$

C) $K_c = Q$
D) More information is needed to make a statement about K_c.

36. Which of the following is a BrØnsted-Lowry acid?
A) NH_4^+
B) CH_4
C) NH_2^-
D) NH_3
E) Br_2

37. What is the conjugate base of $H_2PO_4^-$?
A) HPO_4^{2-}
B) PO_4^{3-}
C) H_3PO_4
D) H_3O^+
E) OH^-

38. Identify the weak diprotic acid.
A) HNO_3
B) H_3PO_4
C) H_2SO_3
D) $HClO_4$
E) H_2SO_4

39. Which of the following is a STRONG acid?
A) $C_6H_5CO_2H$
B) HCN
C) $HClO_4$
D) NH_4^+
E) H_2O

40. Which of the following solutions would have the highest pH? Assume that they are all 0.10 M in acid at 25°C. The acid is followed by its K_a value.

A) HF, 3.5×10^{-4}
B) HCN, 4.9×10^{-10}
C) HNO_2, 4.6×10^{-4}
D) $HCHO_2$, 1.8×10^{-4}
E) $HClO_2$, 1.1×10^{-2}

41. Calculate the concentration of H_3O^+ in a solution that contains 5.5×10^{-5} M OH^- at 25°C. Identify the solution as acidic, basic or neutral.
A) 1.8×10^{-10} M, basic
B) 1.8×10^{-10} M, acidic
C) 5.5×10^{-10} M, neutral
D) 9.2×10^{-1} M, acidic
E) 9.2×10^{-1} M, basic

42. Calculate the hydronium ion concentration in an aqueous solution with a pH of 9.85 at 25°C.
A) 7.1×10^{-5} M
B) 4.2×10^{-10} M
C) 8.7×10^{-10} M
D) 6.5×10^{-5} M
E) 1.4×10^{-10} M

43. Which of the following acids is the STRONGEST? The acid is followed by its K_a value.
A) HF, 3.5×10^{-4}
B) HCN, 4.9×10^{-10}
C) HNO_2, 4.6×10^{-4}
D) $HCHO_2$, 1.8×10^{-4}
E) $HClO_2$, 1.1×10^{-2}

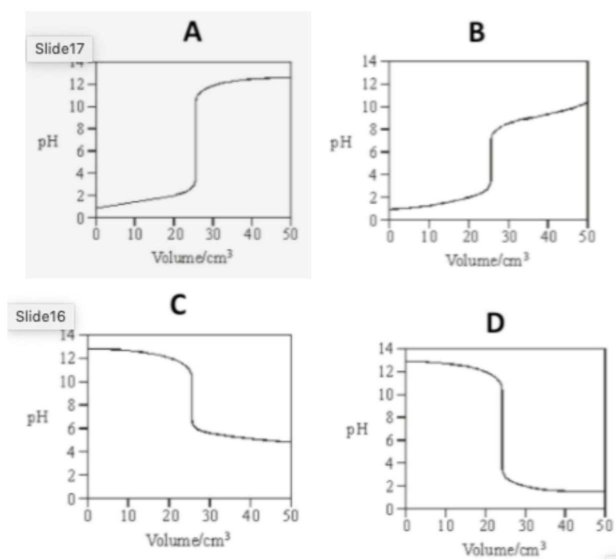
44. Determine the pH of a 0.741 M KOH solution at 25°C.
A) 0.13
B) 13.87
C) 0.17
D) 12.65
E) 11.88

45. Which one of the following will form a basic solution in water?
A) $NaC_2H_3O_2$
B) LiCN
C) $KClO_2$
D) LiBrO
E) All of the above will form basic solutions.

46. In a triprotic acid, which K_a has the highest value?
A) K_{a1}
B) K_{a2}
C) K_{a3}
D) K_{b1}
E) K_{b2}

47. Which of the following is a Lewis base?
A) BF_3
B) H_2O
C) SiF_4
D) C_5H_{12}
E) None of the above are Lewis bases.

48. Which titration curve pictured here corresponds to titrating a strong base (in the beaker) with a strong acid (in the buret)?
A) A
B) B
C) C
D) D



49. Which of the following solutions is a good buffer system?
A) A solution that is 0.10 M $HC_2H_3O_2$ and 0.10 M $LiC_2H_3O_2$
B) A solution that is 0.10 M HF and 0.10 M $NaC_2H_3O_2$
C) A solution that is 0.10 M HCl and 0.10 M NH_4^+
D) A solution that is 0.10 M NaOH and 0.10 M KOH

E) None of the above are buffer systems.

50. You wish to prepare an $HC_2H_3O_2$ buffer with a pH of 4.24. If the pK_a of is 4.74, what ratio of $C_2H_3O_2^-/HC_2H_3O_2$ must you use?
A) 0.10
B) 0.50
C) 0.32
D) 2.0
E) 2.8

51. Calculate the pH of a solution formed by mixing 100.0 mL of 0.20 M HClO with 200.0 mL of 0.30 M KClO. The K_a for HClO is 2.9×10^{-8}.
A) 5.99
B) 8.01
C) 7.54
D) 7.06
E) 6.46

52. Which of the following is TRUE?
A) An effective buffer has a [base]/[acid] ratio in the range of 10 - 100.
B) A buffer is most resistant to pH change when [acid] = [conjugate base]
C) An effective buffer has very small absolute concentrations of acid and conjugate base.
D) A buffer can not be destroyed by adding too much strong base. It can only be destroyed by adding too much strong acid.
E) None of the above are true.

53. When titrating a monoprotic strong acid with a weak base at 25°C, the
A) pH will be 7 at the equivalence point.
B) pH will be greater than 7 at the equivalence point.
C) titration will require more moles of the base than acid to reach the equivalence point.
D) titration will require more moles of acid than base to reach the equivalence point.
E) pH will be less than 7 at the equivalence point.

54. How is the number of microstates (i.e. the number of ways to arrange the system) related to the entropy?
A) entropy is high when the number of microstates is high
B) entropy increases when the number of microstates increases
C) entropy is proportional to the natural logarithm of the number of microstates

D) all of the above are true

55. Determine the molar solubility of $CaSO_4$ in a solution containing 0.100 M Na_2SO_4.
K_{sp} ($CaSO_4$) = 2.4×10^{-5}.
A) 4.9×10^{-3} M
B) 2.4×10^{-4} M
C) 5.8×10^{-10} M
D) 1.2×10^{-5} M
E) 0.10 M

56. Determine the molar solubility of $Fe(OH)_2$ in pure water. K_{sp} for $Fe(OH)_2$)= 4.87×10^{-17}.
A) 2.44×10^{-17} M
B) 1.62×10^{-17} M
C) 4.03×10^{-9} M
D) 3.65×10^{-6} M
E) 2.30×10^{-6} M

57. A solution containing $CaCl_2$ is mixed with a solution of $Li_2C_2O_4$ to form a solution that is 2.1×10^{-5} M in calcium ion and 4.75×10^{-5} M in oxalate ion. What will happen once these solutions are mixed? K_{sp} (CaC_2O_4) = 2.3×10^{-9}.
A) A precipitate will form since Q > K_{sp} for calcium oxalate.
B) Nothing will happen since both calcium chloride and lithium oxalate are soluble compounds.
C) Nothing will happen since calcium oxalate is extremely soluble.
D) Nothing will happen since K_{sp} > Q for all possible precipitants.
E) There is not enough information to determine.

58. What is the ΔG for the reaction below if ΔG° is -9.64 kJ/mol, $[H_2] = [I_2] = 1.00M$, [HI] = 3.16M, and T = 298K? Given: ΔG = ΔG° + RTlnQ

$$H_2(g) + I_2(g) \leftrightarrow 2HI(g)$$

A) -9.64 kJ/mol
B) -15.3 kJ/mol
C) -3.94 kJ/mol
D) 5.70 kJ/mol

59. Identify the change in state that does not have an increase in entropy.
A) water freezing
B) water boiling
C) ice melting
D) dry ice subliming
E) water evaporating

60. Find E_{cell} for the reaction below if $[Au^{3+}] = 0.766M$ and $[Pb^{2+}] = 0.00180M$. Given, $E_{cell}^o = 1.628V$.

$$3Pb(s) + 2Au^{3+}(aq) \leftrightarrow 3Pb^{2+}(aq) + 2Au(s)$$

A) 1.55V
B) 1.71V
C) 1.628V
D) 2.10V
E) Not enough information

61. For the following example, identify the following.

$$\text{heat} + 3O_2\ (g) \rightarrow 2O_3(g)$$

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

62. Calculate $\Delta S°_{rxn}$ for the following reaction. The S° for each species is shown below the reaction.

	$C_2H_2(g)$	$+ 2\ H_2(g)$	$\rightarrow C_2H_6(g)$
S°(J/mol·K)	200.9	130.7	229.2

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

63. For small atoms, isotopes are most stable when the number of neutrons (N) is equal to the number of protons (Z). Which of the following would you expect to have the shortest half-life?
A) ^{16}O
B) ^{12}C
C) ^{16}N
D) ^{19}F

64. Determine the equilibrium constant for the following reaction at 498 K.

$$2\ Hg(g) + O_2(g) \rightarrow 2\ HgO(s) \qquad \Delta H° = -304.2\ kJ;\ \Delta S° = -414.2\ J/K$$

A) 1.87×10^{10}
B) 8.10×10^{31}
C) 2.31×10^{-22}
D) 5.34×10^{-11}
E) 4.33×10^{21}

65. Balance the following redox reaction if it occurs in acidic solution. What are the coefficients in front of H^+ and Fe^{3+} in the balanced reaction?

$$Fe^{2+}(aq) + MnO_4^-(aq) \rightarrow Fe^{3+}(aq) + Mn^{2+}(aq)$$

A) $H^+ = 2$, $Fe^{3+} = 3$
B) $H^+ = 8$, $Fe^{3+} = 5$
C) $H^+ = 3$, $Fe^{3+} = 2$
D) $H^+ = 5$, $Fe^{3+} = 1$
E) $H^+ = 8$, $Fe^{3+} = 1$

66. Identify the location of oxidation in an electrochemical cell.
A) the anode
B) the cathode
C) the electrode
D) the salt bridge
E) the socket

67. Determine the cell notation for the redox reaction given below.

$$Sn(s) + 2\ Ag^{+}(aq) \rightarrow Sn^{2+}(aq) + 2\ Ag(s)$$

A) $Ag^{+}(aq) \mid Ag(s) \parallel Sn(s) \mid Sn^{2+}(aq)$
B) $Ag(s) \mid Ag^{+}(aq) \parallel Sn^{2+}(aq) \mid Sn(s)$
C) $Sn(s) \mid Sn^{2+}(aq) \parallel Ag^{+}(aq) \mid Ag(s)$
D) $Sn^{2+}(aq) \mid Sn(s) \parallel Ag(s) \mid Ag^{+}(aq)$
E) $Sn(s) \mid Ag(s) \parallel Sn^{2+}(aq) \mid Ag^{+}(aq)$

68. 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.)

$$3\ Cl_2(g) + 2\ Fe(s) \rightarrow 6\ Cl^{-}(aq) + 2\ Fe^{3+}(aq)$$

$Cl_2(g) + 2\ e^{-} \rightarrow 2\ Cl^{-}(aq)$ $\quad E° = +1.36$ V
$Fe^{3+}(aq) + 3\ e^{-} \rightarrow Fe(s)$ $\quad E° = -0.04$ V

A) +4.16 V
B) -1.40 V
C) -1.32 V
D) +1.32 V
E) +1.40 V

69. Which of the following reactions would have the smallest value of K at 298 K?
A) $A + B \rightarrow C$; $E°_{cell} = +1.22$ V
B) $A + 2\ B \rightarrow C$; $E°_{cell} = +0.98$ V
C) $A + B \rightarrow 2\ C$; $E°_{cell} = -0.030$ V
D) $A + B \rightarrow 3\ C$; $E°_{cell} = +0.15$ V
E) More information is needed to determine.

70. Nickel can be plated from aqueous solution according to the following half reaction. How long would it take (in min) to plate 29.6 g of nickel at 4.7 A?

$$Ni^{2+}(aq) + 2\ e^{-} \rightarrow Ni(s)$$

A) 1.7×10^{2} min
B) 5.9×10^{2} min

C) 3.5×10^2 min
D) 4.8×10^2 min
E) 6.2×10^2 min