Review for 112 final (ACS exam)

1. According to the Brønsted–Lowry definition, bases, when reacting with acids

(A) give up protons
(B) accept protons .
(C) lose electrons
(D) form hydronium ions
(E) accept electrons

2. In the reaction: $CN^- + H_2O \rightleftarrows HCN + OH^-$
which is an acid–base conjugate pair?

(A) H_2O and HCN
(B) H_2O and OH^-
(C) CN^- and H_2O
(D) HCN and OH^-

3. Which species can act either as an acid or as a base in aqueous solution?

(A) HCO_3^-
(B) HNO_2
(C) HIO_4
(D) H_3PO_4

4. Which equilibrium can be described as an acid–base reaction using the Lewis acid–base definitions, but ***not*** using the Brønsted–Lowry definitions?

(A) $NH_3 + CH_3COOH \rightleftarrows CH_3COO^- + NH_4^+$
(B) $H_2O + CH_3COOH \rightleftarrows H_3O^+ + CH_3COO^-$
(C) $4NH_3 + Cu(H_2O)_4^{2+} \rightleftarrows Cu(NH_3)_4^{2+} + 4H_2O$
(D) $2NH_3 + H_2SO_4 \rightleftarrows 2NH_4^+ + SO_4^{2-}$
(E) $Fe(H_2O)_6^{3+} + H_2O \rightleftarrows H_3O^+ + Fe(H_2O)_5(OH)^{2+}$

5. HCl is a strong acid. What is the pH of 200 mL of 0.002 M HCl?

(A) 2.0
(B) 2.7
(C) 3.4
(D) 4.0

6. The pH of a solution is 5. If the pH of this solution is decreased to 2, by what factor is the concentration of hydrogen ion increased?

(A) 2 1/2
(B) 3
(C) 10
(D) 100
(E) 1000

7. A 25.0-mL sample of 0.130 M HCl is mixed with 15.0 mL of 0.240 M of NaOH. The pH of the resulting solution will be nearest

(A) 2.1
(B) 7
(C) 11.9
(D) 13.0

8. Which series is the correct order of decreasing acid strength for each group of acids?

(A) $H_2S > H_2Te > H_2Se > H_2O$
(B) $HClO_3 > HClO_4 > H_2SO_4 > HNO_3$
(C) $HClO_4 > HClO_3 > HClO_2 > HClO$
(D) $HF > HCl > HBr > HI$

9. The ***weakest*** of the bases listed is

Acid	Conjugate Base	K_a (Ionization Constant of Acid)
HCl	Cl^-	100% ionized
HSO_4^-	SO_4^{2-}	1.2×10^{-2}
H_2S	HS^-	5.7×10^{-8}
HS^-	S^{2-}	1.2×10^{-13}

(A) Cl^-
(B) CN^-
(C) HS^-
(D) S^{2-}
(E) SO_4^{2-}

10. Which substance dissolves in water to form an acidic solution?

(A) KCl
(B) Na_3PO_4
(C) NH_4Cl
(D) Na_2CO_3

11. In the titration of 50.0 mL of 0.100 M benzoic acid (a monoprotic acid) with 50.0 mL of 0.100 M Na0H, the properties of the solution at the equivalence point will correspond exactly to the properties of

(A) a 0.100 M sodium solution.
(B) a 0.0500 M sodium hydroxide solution.
(C) a 0.0500 M benzoic acid solution.
(D) a 0.0500 M sodium benzoate solution.

12. The addition of a small amount of acid or base will have very little effect on the pH value of a solution containing equal molar concentrations of

(A) NH_4Cl and NaCl
(B) NaOH and HCl
(C) NH_3 and NH_4Cl
(D) NaOH and NaCl
(E) NH_3 and NaCl

13. Which one of the acids shown in the table is the strongest?

Acid	K_a
$HCHO_2$	1.8×10^{-4}
CH_3CO_2H	1.8×10^{-5}
HClO	3.0×10^{-8}
HF	6.8×10^{-4}

(A) $HCHO_2$
(B) CH_3CO_2H
(C) HClO
(D) HF

14. For a substance to be considered a strong electrolyte, it must

(A) be an ionic compound
(B) dissociate virtually completely to its ions in solution
(C) be highly soluble in water
(D) contain both metal and nonmetal atoms

15. A precipitate will form when an aqueous solution of lead(II) nitrate is added to an aqueous solution of

(A) NH_4NO_3
(B) $Mg(NO_3)_2$
(C) $NaNO_3$
(D) KNO_3
(E) NaCl

16. To what volume must 150 mL of a 3.60 M solution be diluted to prepare a solution which is 2.40 M?

(A) 1296 mL
(B) 1000 mL
(C) 444 mL
(D) 285 mL
(E) 225 mL

17. If you need 50.0 mL of a 0.250 M $KMnO_4$ solution which method do you use to prepare it?

(A) Dissolve 39.5 g $KMnO_4$ in enough water to make 50.0 mL solution.
(B) Dissolve 12.5 g $KMnO_4$ in enough water to make 50.0 mL solution.
(C) Dissolve 1.98 g $KMnO_4$ in enough water to make 50.0 mL solution.
(D) Dilute 20.0 mL of 0.500 M $KMnO_4$ to 50.0 mL.
(E) Dilute 2.50 mL of 1.00 M $KMnO_4$ to 50.0 mL.

18. When water molecules in the liquid state enter the gaseous state we can say that

(A) the *inter*molecular forces have weakened.
(B) the *intra*molecular forces have weakened.
(C) the intermolecular forces have strengthened
(D) the intramolecular forces have strengthened.
(E) both the inter and intramolecular forces have weakened.

19. The intermolecular forces(s) responsible for CH_4's having the lowest boiling point in the set CH_4, SiH_4, GeH_4, SnS_4 is/are

(A) hydrogen bonding
(B) dipole-dipole interactions
(C) London-dispersion forces
(D) mainly hydrogen bonding but also dipole-dipole interactions
(E) mainly London-dispersion forces but also dipole-dipole interactions

20. A 1.26 M $Cu(NO_3)_2$ solution has a density of 1.19 g/cm^3. What is the molality of the solution?

(A) 1.06 *m*
(B) 1.32 *m*
(C) 6.34 *m*
(D) 6.72 *m*
(E) 8.44 *m*

21. Which of the following would have the lowest freezing point?

(A) pure H_2O
(B) 1 *m* urea (CON_2H_4)
(C) 1 *m* KCl
(D) 1 *m* $NaNO_3$
(E) 1 *m* Na_2SO_4

22. Which substance is most soluble in water?

(A) C_6H_6
(B) C_2H_5OH
(C) $CaCO_3$
(D) CO_2

23. Which statement correctly expresses a relation between solubility and temperature?

(A) An increase in temperature increases the solubility of a gas in a liquid.
(B) The change of solubility with temperature is the same for all substances.
(C) The solubility of a liquid in a liquid is independent of temperature.
(D) The solubility of most solids in water increases with increasing temperature.
(E) The solubility of most solids in water decreases with increasing temperature.

24. What is the mole fraction of water in 200. g of 95% (by mass) ethanol, C_2H_5OH?

Molar Mass	
C_2H_5OH	46 g·mol^{-1}

(A) 0.050
(B) 0.12
(C) 0.56
(D) 0.88

25. A 0.10 *m* aqueous solution of HF shows a freezing point of –0.198 °C. What is the percent dissociation of HF?

Molal Freezing Point Constant
K_f for water = 1.86 °C·m^{-1}

(A) 6.4%
(B) 10%
(C) 20%
(D) 98%

26. What is the molar mass of a non-volatile molecular solute if 120 g of it dissolved in 500 g of water causes the solution to boil at 101.04 °C at atmospheric pressure?

Molal Boiling Point Constant
K_b for water = 0.52 °C·m^{-1}

(A) 60
(B) 120
(C) 240
(D) 300

27. At equilibrium

(A) All chemical processes have ceased.
(B) The rate of the forward reaction equals that of the reverse.
(C) The rate constant for the forward reaction equals that of the reverse.
(D) Both the rate of the forward reaction equals that of the reverse and the rate constant for the forward reaction equals that of the reverse.
(E) None of the above.

28. A 1.00 liter flask contained 0.24 mol NO_2 at 700 K. which decomposed according to the following equation. When equilibrium was achieved, 0.14 mol NO was present. Calculate K_c.

$$2\ NO_2(g) \rightleftarrows 2\ NO(g) + O_2(g)$$

(A) 0.098
(B) 0.14
(C) 1.1×10^{-2}
(D) 5.7×10^{3}
(E) 9.6×10^{-3}

29. Under which of the following conditions does the equilibrium constant K change for the reaction

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

(A) changing the size of the container
(B) introducing more I_2 into the container
(C) measuring the molar concentrations instead of pressures
(D) changing the temperature
(E) none of these, it is always constant

30. Consider an equilibrium mixture of oxygen and ozone according to the equation

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

The partial pressure of O_2 was measured in a flask at equilibrium as 1.25 atm and the total pressure in the flask was 1.75 atm. Calculate K_p. Constant temperature was maintained.

(A) 8.0×10^{-3}
(B) 0.90
(C) 0.13
(D) 1.6
(E) 2.7

31. Calcium carbonate decomposes when heated according to the following reaction:

$$CaCO_3(s) \rightleftarrows CaO(s) + CO_2(g)$$

The mass of the $CaCO_3$ could be increased by

(A) adding more CO_2
(B) decreasing the volume of the container
(C) removing some CaO
(D) ncreasing the temperature
(E) both A and B

32. At a specific temperature, the equilibrium constant for the following reaction is given.

$$2\ NO_2\ (g) + O_2(g) \rightleftarrows 2\ NO_3(g) \qquad K_c = 0.25$$

If 1.5 mol NO_2, 3.0 mol $O_2$and 2.0 mol NO_3 are introduced into a 1.00 liter flask, what changes in concentration (if any) will be observed as the system reaches equilibrium?

(A) $[NO_2]$ increases; $[O_2]$ increases; $[NO_3]$ decreases
(B) $[NO_2]$ increases; $[O_2]$ decreases; $[NO_3]$ decreases
(C) $[NO_2]$ decreases; $[O_2]$ decreases; $[NO_3]$ increases
(D) $[NO_2]$ decreases; $[O_2]$ increases; $[NO_3]$ increases
(E) all concentrations remain the same

33. The pH of a 4.52 M solution of a weak acid is 3.90 at 25 ºC. What is K_a for the weak acid?

(A) 1.3×10^{-4}
(B) 1.8×10^{-5}
(C) 2.9×10^{-6}
(D) 3.5×10^{-9}
(E) 1.5×10^{-11}

34. If you mix equal molar quantities of the following substances, how many will produce an acidic solution?

Set 1: $NaOH + HCl$
Set 2: $NaOH + HNO_3$
Set 3: $NH_3 + HCl$
Set 4: $NaOH + CH_3CO_2H$

(A) four
(B) three
(C) two
(D) one
(E) zero (none are acidic)

35. At the neutralization point of the titration of an acid with base, what condition is met?

(A) volume of base added from buret equals volume of acid in reaction flask
(B) molarity of base from the buret equals molarity of acid in reaction flask
(C) moles of base added from the buret equals moles of acid in reaction flask
(D) % ionization of base added from the buret equals % ionization of the acid in flask.
(E) all of the above conditions are met.

36. What is the concentration of F^- in a saturated solution of BaF_2 if $K_{sp} = 1.7 \times 10^{-6}$?

(A) 7.5×10^{-3} M
(B) 8.2×10^{-4} M
(C) 1.5×10^{-2} M
(D) 4.3×10^{-7} M
(E) 1.5×10^{-6} M

37. In which reaction will an increase in total pressure at constant temperature favor formation of the products?

(A) $CaCO_3(s) \rightleftarrows CaO(s) + CO_2(g)$
(B) $H_2(g) + Cl_2(g) \rightleftarrows 2HCl(g)$
(C) $2NO(g) + O_2(g) \rightleftarrows 2NO_2(g)$
(D) $COCl_2(g) \rightleftarrows CO(g) + Cl_2(g)$

38. For the reaction: $2SO_2(g) + O_2(g) \rightleftarrows 2SO_3(g)$ $\Delta H = -198$ kJ

carried out at constant volume, the concentration of O_2 at equilibrium will increase if

(A) SO_2 is added to the system.
(B) SO_3 is added to the system.
(C) the temperature of the system is lowered.
(D) an inert gas is added to the system.

39. A solution of sodium acetate in water is observed to become more alkaline as the temperature is raised. Which conclusion can be drawn?

$$Na^+ + C_2H_3O_2^- + H_2O \rightleftarrows HC_2H_3O_2 + Na^+ + OH^-$$

(A) The forward reaction proceeds with an evolution of heat.
(B) The forward reaction proceeds with a absorption of heat.
(C) Acetic acid is less volatile than water.
(D) Sodium acetate is less soluble in hot water than in cold water.
(E) At higher temperatures the reaction $Na^+ + OH^- \rightarrow NaOH$ will occur.

40. Into an empty vessel $COCl_2(g)$ is introduced at 1.0 atm pressure whereupon it dissociates until equilibrium is established: $2COCl_2(g) \rightleftarrows C(graphite) + CO_2(g) + 2Cl_2(g)$

If x represents the partial pressure of $CO_2(g)$ at equilibrium, what is the value of the equilibrium constant, K_p?

(A) $\dfrac{x \cdot 2x^2}{(1.0 - 2x)^2}$ (C) $\dfrac{x \cdot (2x)^2}{(1.0 - 2x)^2}$

(B) $\dfrac{x \cdot x \cdot 2x^2}{(1.0 - 2x^2)}$ (D) $\dfrac{x \cdot (2x)^2}{(1.0 - x)^2}$

41. A buffer of pH 4.1 is to be prepared from a weak acid and its salt. The best acid from which to prepare the buffer is

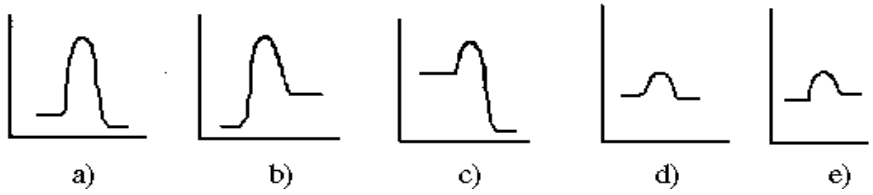
(A) phthalic acid, $K_1 = 1.3\ \ 10^{-3}$ (first ionization)
(B) hydrogen phthalate, $K_2 = 3.9\ \ 10^{-5}$ (second ionization of phthalic acid)
(C) benzoic acid, $K = 6.3 \times 10^{-5}$
(D) hydrocyanic acid, $K = 4 \times 10^{-10}$

42. The solubility of $BaCO_3$ is 7.9×10^{-3} g·L^{-1}. Calculate the solubility product, K_{sp} ignoring hydrolysis.

Molar Mass	
$BaCO_3$	197 g·mol^{-1}

(A) 1.6×10^{-2}
(B) 1.6×10^{-9}
(C) 4.0×10^{-5}
(D) 6.2×10^{-5}

43. A reaction has an activation energy of 40 kJ and an overall energy change of -100 kJ. What is the potential energy diagram which best describes this reaction?



44. The decomposition of phosphine, PH_3, follows first-order kinetics:

$$4\ PH_3\ (g) \rightarrow P_4\ (g) + 6\ H_2\ (g)$$

The half-life for the reaction at 550 ºC is 81.3 seconds. How long does it take for the reaction to be 75.8 % complete?

(A) 8.52 seconds
(B) 28.4 seconds
(C) 63.8 seconds
(D) 117 seconds
(E) 180 seconds

45. A reaction was found to be second order in carbon monoxide concentration. What happens to the rate of the reaction if the concentration of carbon monoxide is doubled with everything else held constant?

(A) it doubles
(B) it remains unchanged
(C) it triples
(D) it increases by a factor of 4

46. Kinetic data for the following reaction was determined experimentally:

$$4\ NO_2\ (g) + O_2\ (g) \rightarrow 2\ N_2O_5\ (g)$$

Experiment Number	Initial Concentration $[NO_2]_0$ (mol/L)	Initial Concentration $[O_2]_0$ (mol/L)	Initial rate of reaction (mol/L)
1	0.40	0.10	3.3
2	0.20	0.10	1.7
3	0.20	0.50	41.

What is the rate law for the reaction?

(A) rate = $k\ [NO_2]^4[O_2]^1$
(B) rate = $k\ [NO_2]^{1/2}[O_2]^2$
(C) rate = $k\ [NO_2]^2[O_2]^2$
(D) rate = $k\ [NO_2]^1[O_2]^1$
(E) rate = $k\ [NO_2]^1[O_2]^2$

47. In general, as the temperature increases, the rate of a chemical reaction

(A) increases due to an increased activation energy.
(B) increases only for an endothermic reaction.
(C) increases due to a greater number of effective collisions.
(D) increases because bonds are weakened.
(E) is not changed.

48. In basic solution, $(CH_3)_3CCl$ reacts according to the equation

$$(CH_3)_3CCl + OH^- \rightarrow (CH_3)_3COH + Cl^-$$

The accepted mechanism for the reaction is
$(CH_3)_3CCl \rightarrow (CH_3)_3C^+ + Cl^-$ (slow)
$(CH_3)_3C^+ + OH^- \rightarrow (CH_3)_3COH$ (fast)
What is the rate law expression for the reaction?

(A) rate = $k\ [(CH_3)_3C^+]^2,[OH^-]$
(B) rate = $k\ [(CH_3)_3C^+][OH^-]^2$
(C) rate = $k\ [Cl^-]$
(D) rate = $k\ [(CH_3)_3CCl]$
(E) rate = $k\ [(CH_3)_3CCl][OH^-]$

49. The Arrhenius equation, $k = Ae^{-E/RT}$ expresses the relationship between the reaction rate constant, k, and the energy of activation, E. The probability that colliding molecules will react

(A) increases with increasing energy of activation.
(B) depends only on the empirical constant, A.
(C) increases with decreasing temperature.
(D) decreases with increasing energy of activation.

50. The value of the rate constant of a reaction can generally be expected to

(A) be independent of temperature.
(B) increase with increasing temperature.
(C) decrease with increasing temperature.
(D) decrease with increasing temperature only if the reaction is exothermic.

51. If a reaction proceeding by the mechanism $\mathbf{A} + \mathbf{B} \rightarrow \mathbf{C} + \mathbf{D}$
occurs at a rate x, and if the concentrations of **A** and **B** are both doubled, what will be the new rate of reaction?

(A) x
(B) $2x$
(C) $4x$
(D) $8x$
(E) $16x$

52. Which statement most accurately describes the behavior of a catalyst?

(A) A catalyst increases the ΔG of a reaction and hence the forward rate.
(B) A catalyst reduces the ΔH of a reaction and hence the temperature needed to produce products.
(C) A catalyst reduces the activation energy for a reaction and increases the rate of a reaction.
(D) A catalyst increases the equilibrium constant and final product concentrations.

53. The rate expression for a second order reaction is

(A) rate = k [A]
(B) rate = k [A] [B]
(C) rate = k $[A]^2$ [B]
(D) rate = k $[A]^2$ $[B]^2$

54. Use the data in the following table to calculate the free energy change for the reaction at 25 ºC:

$$\tfrac{1}{2}\ N_2\ (g) + 3/2\ H_2\ (g) \rightarrow NH_3\ (g)$$

Compound	ΔS^o (J/K-mol)	ΔH^o_f (kJ/mol)
N_2 (g)	192	0
NH_3 (g)	193	–46
H_2 (g)	131	0

(A) –53.3 kJ
(B) 29.6 kJ
(C) 53.3 kJ
(D) –29.6 kJ
(E) –16.5 kJ

55. If a process is exothermic and not spontaneous then what must be true?

(A) $\Delta S > 0$
(B) $\Delta H > 0$
(C) $\Delta G = 0$
(D) $\Delta S < 0$
(E) $\Delta H = 0$

56. Use the data in the following table to calculate the equilibrium constant for the reaction of lime with water at 298 K:

$$CaO\ (s) + H_2O\ (l) \rightarrow Ca(OH)_2\ (s)$$

Compound	ΔG°_f (kJ/mol)
CaO(s)	-604
H_2O (l)	-237
$Ca(OH)_2$ (s)	-899

(A) 1.50×10^{10}
(B) 1.07
(C) 3.03×10^{-31}
(D) 1.51×10^{6}
(E) 2.01×10^{10}

57. Which of the following shows the greatest increase in disorder?

(A) $NH_4Br(s) \rightarrow NH_3(g) + HBr(g)$
(B) $C_2H_4(g) + HBr(g) \rightarrow C_2H_5Br(g)$
(C) $CO_2(s) \rightarrow CO_2(g)$
(D) $C(s) + \frac{1}{2} O_2(g) \rightarrow CO(g)$
(E) $C(graphite) + 2H_2(g) \rightarrow CH_4(g)$

58. Which change is likely to be accompanied by the greatest increase in entropy?

(A) $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$ (at 25 °C)
(B) $Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$ (at 25 °C)
(C) $CO_2(s) \rightarrow CO_2(g)$ (at –70 °C)
(D) $H_2O(g) \rightarrow H_2O(l)$ (at 100 °C)

59. When $Al_2O_3(s)$ is formed from the elements at standard conditions, the values of ΔH° and ΔG° at 298 K are $-1617\ kJ \cdot mol^{-1}$ and $-1577\ kJ \cdot mol^{-1}$, respectively. The standard entropy of formation per mole, in joules per degree, will be

(A) –315
(B) –157
(C) –93.3
(D) –0.0933
(E) +15.7

60. A particular chemical reaction has a negative ΔH and negative ΔS. Which statement is correct?

(A) The reaction is spontaneous at all temperatures.
(B) The reaction is nonspontaneous at all temperatures.
(C) The reaction becomes spontaneous as temperature increases.
(D) The reaction becomes spontaneous as temperature decreases.

61. At 298 K, the reaction represented by: $CaCO_3(s) \rightleftarrows CaO(s) + CO_2(g)$ is

Compound and State	ΔH_f^0 ($kJ \cdot mol^{-1}$)	ΔG_f^0 ($kJ \cdot mol^{-1}$)
$CO_2(g)$	–393	–393
$CaO(s)$	–636	–603
$CaCO_3(s)$	–1210	–1130

(A) exothermic with $\Delta H = +181$ kJ
(B) endothermic with $\Delta H = -181$ kJ
(C) endothermic with $\Delta H = +134$ kJ
(D) endothermic with $\Delta H = +181$ kJ

62. At 298 K the equilibrium constant for: $H_2(g) + {}^1/_2O_2(g) \rightleftarrows H_2O(l)$

Compound and State	$\Delta G°_f$, kJ/mol
$H_2O(l)$	–237
$H_2O(g)$	–229

(A) is larger than the K_{eq} for $H_2(g) + {}^1/_2O_2(g) \rightleftarrows H_2O(g)$
(B) will have a value of 1.0 at equilibrium.
(C) cannot be computed since data on O_2 and H_2 are not provided.
(D) will have the same value as the K_{eq} for $H_2(g) + {}^1/_2O_2(g) \rightleftarrows H_2O(l)$

63. What is the consequence of heating this equilibrium system at constant pressure?

$$2SO_2(g) + O_2(g) \rightleftarrows 2\ SO_3(g) \qquad \Delta H = -198\ kJ$$

(A) The concentration of SO_3 will decrease.
(B) The partial pressure of SO_2 will decrease.
(C) The equilibrium constant will increase.
(E) The total volume of the system will decrease.

64. Consider the following reaction: $2Fe_2O_3(s) + 3C(s) \rightleftarrows 4Fe(s) + 3CO_2(g)$ $\Delta Hr° = 462$ kJ, $\Delta Sr° = 558$ J·K–1
Calculate the equilibrium constant for this reaction at 525°C.

(A) 8.07×10^{-2}
(B) 2.18×10^{-2}
(C) 5.20×10^{-7}
(D) 3.04×10^{-3}
(E) 1.9×10^{6}

65. Calculate ΔG for the following reaction at 298 K.: $Ag(NH_3)^{2+}(aq, 0.400\ M) \rightleftarrows Ag^+(aq, 0.100\ M) + 2NH_3(aq, 0.300\ M)$
$\Delta G° = -41.0$ kJ for this reaction at 298 K.

(A) 50.4 kJ
(B) 31.6 kJ
(C) –45.1 kJ
(D) –9.4 kJ
(F) –50.4 kJ

66. Consider the equation: $2\ NaI(aq) + Cl_2(g) \rightarrow I_2(aq) + 2\ NaCl(aq)$
The element undergoing reduction is

(A) sodium
(B) iodide
(C) chlorine
(D) iodine
(E) water

67. The driving force for the reaction of zinc metal with a solution of lead(II) nitrate is

(A) the formation of a precipitate
(B) the formation of a gas
(C) the evolution of a gas
(D) the dissolving of a solid
(E) the transfer of electrons

68. Given the two half reactions and their potentials, which net reaction is *not* spontaneous?

$Zn^{2+}(aq) + 2e^- \rightarrow Zn(s)$ $\quad E^o = -0.763$ V

$Ni^{2+}(aq) + 2e^- \rightarrow Ni(s)$ $\quad E^o = -0.250$ V

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

69. Balance the following redox equation which occurs in acidic solution:

$$Cu(s) + NO_3^-(aq) \rightarrow Cu^{2+}(aq) + NO(g)$$

(A) $4\ H^+ + NO_3^- + Cu(s) \rightarrow Cu^{2+} + NO + 2\ H_2O$
(B) $2\ H_2O + NO_3^- + Cu(s) \rightarrow NO + Cu^{2+} + 4\ H^+$
(C) $2\ NO_3^- + 8\ H^+ + 3\ Cu(s) \rightarrow 3\ Cu^{2+} + 2\ NO + 4\ H_2O$
(D) $3\ NO_3^- + 6\ H^+ + 2\ Cu(s) \rightarrow 2\ Cu^{2+} + NO + 3\ H_2O$
(E) $6\ H^+ + 3\ NO_3^- + 2\ Cu^{2+} \rightarrow Cu(s) + NO + 3\ H_2O$

70. The value of E^o for the following reaction is 0.63 V. What is the value of E for this reaction when the concentration of Zn^{2+} is 0.00020 *M* and the concentration of Pb^{2+} is 1.0 *M*?

$Pb^{2+}(aq) + Zn(s) \rightarrow Zn^{2+}(aq) + Pb(s)$

(A) 0.52 V
(B) 0.85 V
(C) 0.41 V
(D) 0.74 V

71. If a current of 6 amps is passed through a solution of Ag^+ for 1.5 hours, how many grams of silver are produced?

(A) 0.604 g
(B) 36.2 g
(C) 0.335 g
(D) 3.04 g
(E) 1.00 g

Use the data in the following table to answer the following three questions:

Standard Reduction Potentials at 25 ºC	E^o (V)
$F_2(g) + 2\ e^- \rightarrow F^-(aq)$	2.87
$Cl_2(g) + 2e^- \rightarrow Cl^-(aq)$	1.36
$I_2(g) + 2e^- \rightarrow I^-(aq)$	0.535
$Ag^+(aq) + e^- \rightarrow Ag(s)$	0.80
$Zn^{2+} + 2e^- \rightarrow Zn(s)$	–0.14
$2\ H_2O(l) + 2e^- \rightarrow H_2(g) + 2\ OH^-(aq)$	–0.828
$Al^{3+}(aq) + 3e^- \rightarrow Al(s)$	–1.66
$K^+(aq) + e^- \rightarrow K(s)$	–2.93

72. Predict the products at the cathode when electric current is passed through a solution of KI.

(A) K (s)
(B) H_2 (g)
(C) I_2 (l)
(D) O_2 (g)
(E) H_2O (l)

73. Calculate E° for the following reaction:
F^- (aq) + Cl_2 (g) → F_2 (g) + 2 Cl^- (aq)

(A) –1.51 V
(B) 8.46 V
(C) –4.23 V
(D) –8.46 V
(E) 4.23 V

74. Which of the following is the best reducing agent?

(A) Ag^+
(B) Al
(C) F^-
(D) Zn^{2+}
(E) F_2

75. In every electrolytic and galvanic (voltaic) cell the anode is that electrode

(A) at which oxidation occurs.
(B) which attracts cations.
(C) at which electrons are supplied to the solution.
(D) at which reduction occurs.

76. During the electrolysis of an aqueous solution of $CuSO_4$ with inert electrodes

(A) the anode loses mass and the cathode gains mass.
(B) the mass of the anode remains the same but the cathode gains mass.
(C) the mass of the anode decreases but the mass of the cathode remains constant.
(D) the anode and the cathode neither gain nor lose mass.
(E) both electrodes gain in mass.

77. The same quantity of electricity is passed through 1 M solutions of HCl and of H_2SO_4 at different temperatures. The number of grams of hydrogen evolved from the H_2SO_4 solution, compared to that evolved from the HCl solution, is

(A) twice as much.
(B) one half as much.
(C) the same.
(D) a function of the molarity of the solutions.
(F) a function of the temperature of the solutions.

78. How many coulombs of electricity are required to completely convert 0.340 g of $AgNO_3$ into metallic Ag?

(A) 19.3
(B) 96.5
(C) 193
(D) 386

Answers

1	**B**	**14**	**B**	**27**	**B**	**40**	**C**	**53**	**B**	**66**	**C**
2	**B**	**15**	**E**	**28**	**B**	**41**	**C**	**54**	**E**	**67**	**E**
3	**A**	**16**	**E**	**29**	**D**	**42**	**B**	**55**	**D**	**68**	**B**
4	**C**	**17**	**C**	**30**	**C**	**43**	**C**	**56**	**A**	**69**	**C**
5	**B**	**18**	**A**	**31**	**E**	**44**	**E**	**57**	**A**	**70**	**D**
6	**E**	**19**	**C**	**32**	**A**	**45**	**D**	**58**	**C**	**71**	**B**
7	**C**	**20**	**B**	**33**	**C**	**46**	**E**	**59**	**A**	**72**	**B**
8	**C**	**21**	**E**	**34**	**D**	**47**	**C**	**60**	**D**	**73**	**A**
9	**A**	**22**	**B**	**35**	**C**	**48**	**D**	**61**	**D**	**74**	**B**
10	**C**	**23**	**D**	**36**	**C**	**49**	**D**	**62**	**A**	**75**	**A**
11	**D**	**24**	**B**	**37**	**C**	**50**	**B**	**63**	**A**	**76**	**B**
12	**C**	**25**	**A**	**38**	**B**	**51**	**C**	**64**	**A**	**77**	**C**
13	**D**	**26**	**B**	**39**	**B**	**52**	**C**	**65**	**E**	**78**	**C**