

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

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

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

1. What is the strongest type of intermolecular force present in NH_2CH_3 ?

- A) dispersion
- B) dipole-dipole
- C) hydrogen bonding
- D) ion-dipole
- E) none of the above

Answer: C

Diff: 1 Page Ref: 11.3

2. Place the following compounds in order of **increasing** strength of intermolecular forces.

CH_4 $\text{CH}_3\text{CH}_2\text{CH}_3$ CH_3CH_3

- A) $\text{CH}_3\text{CH}_2\text{CH}_3 < \text{CH}_4 < \text{CH}_3\text{CH}_3$
- B) $\text{CH}_3\text{CH}_2\text{CH}_3 < \text{CH}_3\text{CH}_3 < \text{CH}_4$
- C) $\text{CH}_3\text{CH}_3 < \text{CH}_4 < \text{CH}_3\text{CH}_2\text{CH}_3$
- D) $\text{CH}_4 < \text{CH}_3\text{CH}_2\text{CH}_3 < \text{CH}_3\text{CH}_3$
- E) $\text{CH}_4 < \text{CH}_3\text{CH}_3 < \text{CH}_3\text{CH}_2\text{CH}_3$

Answer: E

Diff: 2 Page Ref: 11.3

3. The normal boiling point for H_2Se is higher than the normal boiling point for H_2S . This can be explained by

- A) larger dipole-dipole forces for H_2Se .
- B) larger dispersion forces for H_2Se .
- C) larger hydrogen-bond forces for H_2Se .

D) larger dipole-dipole forces, larger dispersion forces, and larger hydrogen-bond forces for H_2Se .

Answer: B

Diff: 3 Page Ref: 11.3

4. Which substance below has the strongest intermolecular forces?

A) A_2X , $\Delta H_{\text{vap}} = 39.6 \text{ kJ/mol}$

B) BY_2 , $\Delta H_{\text{vap}} = 26.7 \text{ kJ/mol}$

C) C_3X_2 , $\Delta H_{\text{vap}} = 36.4 \text{ kJ/mol}$

D) DX_2 , $\Delta H_{\text{vap}} = 23.3 \text{ kJ/mol}$

E) EY_3 , $\Delta H_{\text{vap}} = 21.5 \text{ kJ/mol}$

Answer: A

Diff: 1 Page Ref: 11.5

5. Which of the following substances would you predict to have the highest ΔH_{vap} ?

A) Xe

B) CH_4

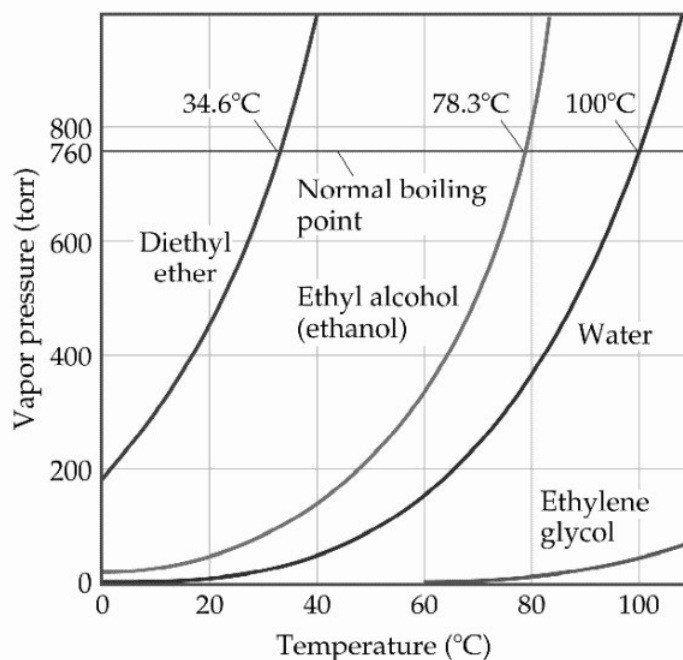
C) He

D) Br_2

E) N_2

Answer: D

Diff: 2 Page Ref: 11.5



6. Based on the figure above, the boiling point of ethyl alcohol under an external pressure of 0.0724 atm is _____ °C.

A) 80

B) 60

C) 70

D) 40

E) 20

Answer: E

Diff: 3 Page Ref: 11.5

7. The heat of vaporization of water at 100°C is 40.66 kJ/mol . Calculate the quantity of heat that is absorbed/released when 9.00 g of steam condenses to liquid water at 100°C .

A) 20.3 kJ of heat are absorbed.

B) 20.3 kJ of heat are released.

C) 81.3 kJ of heat are absorbed.

D) 81.3 kJ of heat are released.

Answer: B

Diff: 4 Page Ref: 11.7

8. Ethyl chloride, $\text{C}_2\text{H}_5\text{Cl}$, is used as a local anesthetic. It works by cooling tissue as it vaporizes; its heat of vaporization is 26.4 kJ/mol . How much heat could be removed by 20.0 g of ethyl chloride?

A) 8.18 kJ

B) 341 kJ

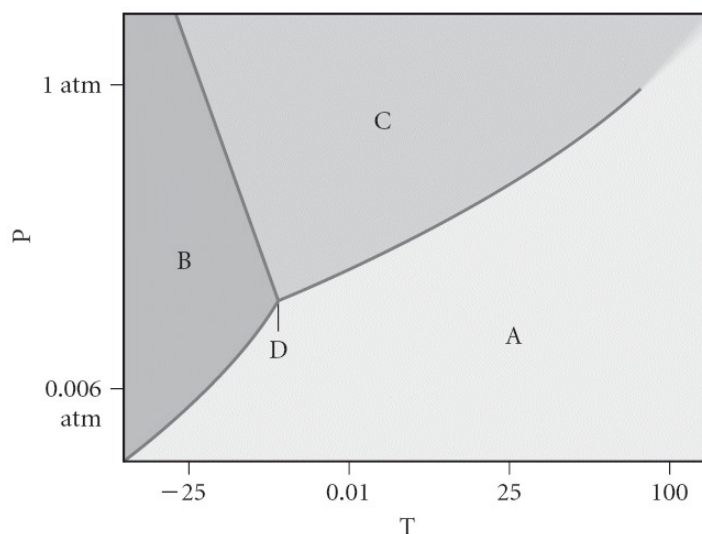
C) 528 kJ

D) 3410 kJ

Answer: A

Diff: 4 Page Ref: 11.7

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

Answer: B

Diff: 1 Page Ref: 11.8

10. Which of the following is considered an ionic solid?

- A) $(\text{NH}_4)_2\text{CO}_3$
- B) CCl_4
- C) SeBr_2
- D) XeF_4
- E) None of these is an ionic solid.

Answer: A

Diff: 1 Page Ref: 11.12

11. Identify the type of solid for ice.

- A) metallic atomic solid
- B) ionic solid
- C) nonbonding atomic solid
- D) molecular solid
- E) networking atomic solid

Answer: D

Diff: 1 Page Ref: 11.12

12. Which of the following compounds will be most soluble in pentane (C_5H_{12})?

- A) pentanol ($\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}$)
- B) benzene (C_6H_6)
- C) acetic acid ($\text{CH}_3\text{CO}_2\text{H}$)
- D) ethyl methyl ketone ($\text{CH}_3\text{CH}_2\text{COCH}_3$)
- E) None of these compounds should be soluble in pentane.

Answer: B

Diff: 1 Page Ref: 12.2

13. Give the term for the amount of solute in moles per liter of solution.

- A) molality
- B) molarity
- C) mole fraction
- D) mole percent
- E) mass percent

Answer: B

Diff: 1 Page Ref: 12.5

14. A solution is prepared by dissolving 49.3 g of KBr in enough water to form 473 mL of solution. Calculate the mass % of KBr in the solution if the density is 1.12 g/mL.

- A) 10.4%
- B) 8.57%
- C) 10.1%
- D) 11.7%
- E) 9.31%

Answer: E

Diff: 3 Page Ref: 12.5

15. A 1.00 L sample of water contains 0.0036 g of Cl^- ions. Determine the concentration of chloride ions in ppm if the density of the solution is 1.00 g/mL.

- A) 2.8 ppm
- B) 7.2 ppm
- C) 3.6 ppm
- D) 1.8 ppm
- E) 5.4 ppm

Answer: C

Diff: 3 Page Ref: 12.5

16. Choose the solvent below that would show the greatest boiling point elevation when used to make a 0.10 *m* nonelectrolyte solution.

- A) CCl_4 , $K_b = 29.9^\circ\text{C}/m$
- B) C_6H_6 , $K_b = 5.12^\circ\text{C}/m$
- C) $\text{CH}_3\text{CH}_2\text{OCH}_2\text{CH}_3$, $K_b = 1.79^\circ\text{C}/m$
- D) $\text{CH}_3\text{CH}_2\text{OH}$, $K_b = 1.99^\circ\text{C}/m$
- E) CHCl_3 , $K_b = 4.70^\circ\text{C}/m$

Answer: A

Diff: 1 Page Ref: 12.6

17. Place the following solutions in order of **increasing** osmotic pressure.

I. 0.15 M $\text{C}_2\text{H}_6\text{O}_2$ II. 0.15 M MgCl_2 III. 0.15 M NaCl

- A) $\text{III} < \text{I} < \text{II}$
- B) $\text{II} < \text{III} < \text{I}$
- C) $\text{I} < \text{II} < \text{III}$
- D) $\text{II} < \text{I} < \text{III}$
- E) $\text{I} < \text{III} < \text{II}$

Answer: E

Diff: 1 Page Ref: 12.6

18. Choose the aqueous solution that has the highest boiling point. These are all solutions of nonvolatile solutes and you should assume ideal van't Hoff factors where applicable.

- A) 0.100 *m* AlCl_3
- B) 0.100 *m* NaCl
- C) 0.100 *m* MgCl_2
- D) 0.100 *m* $\text{C}_6\text{H}_{12}\text{O}_6$
- E) They all have the same boiling point.

Answer: A

Diff: 1 Page Ref: 12.7

19. At a given temperature the vapor pressures of benzene and toluene are 183 mm Hg and 59.2 mm Hg, respectively. Calculate the total vapor pressure over a solution of benzene and toluene with $X_{\text{benzene}} = 0.580$.

- A) 106 mm Hg
- B) 121 mm Hg
- C) 131 mm Hg
- D) 242 mm Hg

Answer: C

Diff: 3 Page Ref: 12.6

20. Write a balanced reaction for which the following rate relationships are true.

$$\text{Rate} = -\frac{1}{2} \frac{\Delta[\text{N}_2\text{O}_5]}{\Delta t} = \frac{1}{4} \frac{\Delta[\text{NO}_2]}{\Delta t} = \frac{\Delta[\text{O}_2]}{\Delta t}$$

- A) $2 \text{N}_2\text{O}_5 \rightarrow 4 \text{NO}_2 + \text{O}_2$
- B) $4 \text{NO}_2 + \text{O}_2 \rightarrow 2 \text{N}_2\text{O}_5$
- C) $2 \text{N}_2\text{O}_5 \rightarrow \text{NO}_2 + 4 \text{O}_2$
- D) $\frac{1}{4} \text{NO}_2 + \text{O}_2 \rightarrow \frac{1}{2} \text{N}_2\text{O}_5$
- E) $\frac{1}{2} \text{N}_2\text{O}_5 \rightarrow \frac{1}{4} \text{NO}_2 + \text{O}_2$

Answer: A

Diff: 2 Page Ref: 13.2

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



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

Answer: A

Diff: 2 Page Ref: 13.3

22. What are the units of k in the following rate law?

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

- A) $\frac{\text{M}}{\text{s}}$
- B) Ms
- C) $\text{M}^{-1}\text{s}^{-1}$
- D) $\frac{\text{M}^2}{\text{s}}$
- E) $\frac{\text{s}}{\text{M}^2}$

Answer: C

Diff: 2 Page Ref: 13.3

23. Determine the rate law and the value of k for the following reaction using the data provided.

$\text{CO(g)} + \text{Cl}_2\text{(g)} \rightarrow \text{COCl}_2\text{(g)}$	$[\text{CO}]_i \text{ (M)}$	$[\text{Cl}_2]_i \text{ (M)}$	Initial Rate ($\text{M}^{-1}\text{s}^{-1}$)
	0.25	0.40	0.696
	0.25	0.80	1.97
	0.50	0.80	3.94

- A) Rate = $11 \text{ M}^{-3/2}\text{s}^{-1} [\text{CO}][\text{Cl}_2]^{3/2}$
- B) Rate = $36 \text{ M}^{-1.8}\text{s}^{-1} [\text{CO}][\text{Cl}_2]^{2.8}$
- C) Rate = $17 \text{ M}^{-2}\text{s}^{-1} [\text{CO}][\text{Cl}_2]^2$
- D) Rate = $4.4 \text{ M}^{-1/2}\text{s}^{-1} [\text{CO}][\text{Cl}_2]^{1/2}$
- E) Rate = $18 \text{ M}^{-3/2}\text{s}^{-1} [\text{CO}]^2[\text{Cl}_2]^{1/2}$

Answer: A

Diff: 3 Page Ref: 13.3

24. The rate constant for the first-order decomposition of N_2O is 3.40 s^{-1} . What is the half-life of the decomposition?

- A) 0.491 s
- B) 0.204 s
- C) 0.236 s
- D) 0.424 s
- E) 0.294 s

Answer: B

Diff: 2 Page Ref: 13.4

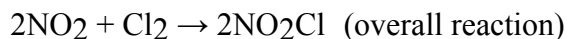
25. For a reaction, what generally happens if the temperature is increased?

- A) a decrease in k occurs, which results in a faster rate
- B) a decrease in k occurs, which results in a slower rate
- C) an increase in k occurs, which results in a faster rate
- D) an increase in k occurs, which results in a slower rate
- E) there is no change with k or the rate

Answer: C

Diff: 1 Page Ref: 13.5

26. Given the following proposed mechanism, predict the rate law for the overall reaction.



Mechanism



- A) Rate = $k[\text{NO}_2][\text{Cl}_2]$

- B) Rate = $k[\text{NO}_2]^2[\text{Cl}_2]$
 C) Rate = $k[\text{NO}_2][\text{Cl}]$
 D) Rate = $k[\text{NO}_2\text{Cl}][\text{Cl}]$
 E) Rate = $k[\text{NO}_2\text{Cl}]^2$

Answer: A

Diff: 1 Page Ref: 13.6

27. The decomposition of dinitrogen pentoxide is described by the chemical equation



If the rate of disappearance of N_2O_5 is equal to 1.60 mol/min at a particular moment, what is the rate of appearance of NO_2 at that moment?

- A) 0.800 mol/min
 B) 1.60 mol/min
 C) 3.20 mol/min
 D) 6.40 mol/min

Answer: C

Diff: 3 Page Ref: 13.3

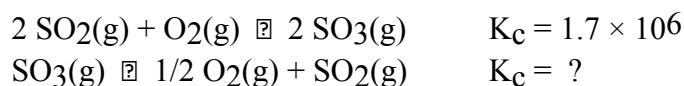
28. A particular first-order reaction has a rate constant of $1.35 \times 10^2 \text{ s}^{-1}$ at 25.0°C . What is the magnitude of k at 75.0°C if $E_a = 85.6 \text{ kJ/mol}$?

- A) $3.47 \times 10^4 \text{ s}^{-1}$
 B) $1.92 \times 10^4 \text{ s}^{-1}$
 C) 670 s^{-1}
 D) $3.85 \times 10^6 \text{ s}^{-1}$
 E) $1.36 \times 10^2 \text{ s}^{-1}$

Answer: B

Diff: 4 Page Ref: 13.5

29. The equilibrium constant is given for one of the reactions below. Determine the value of the missing equilibrium constant.

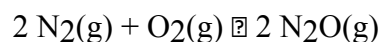


- A) 3.4×10^2
 B) 8.5
 C) 1.3×10^3
 D) 1.2×10^{-6}
 E) 7.7×10^{-4}

Answer: E

Diff: 2 Page Ref: 14.3

30. Determine the value of K_c for the following reaction if the equilibrium concentrations are as follows: $[\text{N}_2]_{\text{eq}} = 3.6 \text{ M}$, $[\text{O}_2]_{\text{eq}} = 4.1 \text{ M}$, $[\text{N}_2\text{O}]_{\text{eq}} = 3.3 \times 10^{-18} \text{ M}$.



- A) 2.2×10^{-19}
- B) 4.5×10^{18}
- C) 2.0×10^{-37}
- D) 5.0×10^{36}
- E) 4.9×10^{-17}

Answer: C

Diff: 3 Page Ref: 14.6

31. In a reaction mixture containing only products, what is the value of Q?

- A) -1
- B) 1
- C) ∞
- D) 0
- E) It cannot be determined without concentrations.

Answer: C

Diff: 1 Page Ref: 14.7

32. Consider the following reaction and its equilibrium constant:



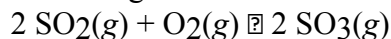
A reaction mixture contains 0.22 M CH₄, 0.67 M CO₂ and 1.3 M H₂O. Which of the following statements is TRUE concerning this system?

- A) The reaction will shift in the direction of products.
- B) The equilibrium constant will increase.
- C) The reaction quotient will increase.
- D) The reaction will shift in the direction of reactants.
- E) The system is at equilibrium.

Answer: D

Diff: 3 Page Ref: 14.7

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

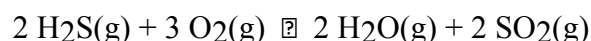


- A) raising the temperature
- B) adding SO₃
- C) removing O₂
- D) all of the above
- E) none of the above

Answer: D

Diff: 1 Page Ref: 14.9

34. Consider the following reaction at equilibrium. What effect will increasing the volume of the reaction mixture have on the system?

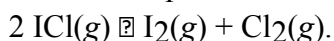


- A) The reaction will shift to the right in the direction of products.
- B) No effect will be observed.
- C) The reaction will shift to the left in the direction of reactants.
- D) The equilibrium constant will decrease.
- E) The equilibrium constant will increase.

Answer: C

Diff: 2 Page Ref: 14.9

35. At a certain temperature the equilibrium constant, K_C , equals 0.11 for the reaction:



What is the equilibrium concentration of ICl if 0.45 mol of I_2 and 0.45 mol of Cl_2 are initially mixed in a 2.0-L flask?

- A) 0.14 M
- B) 0.17 M
- C) 0.27 M
- D) 0.34 M

Answer: A

Diff: 5 Page Ref: 14.8

36. Which of the following is a Brønsted-Lowry base?

- A) CH_4
- B) HCN
- C) NH_3
- D) Cl_2
- E) None of the above are Brønsted-Lowry bases.

Answer: C

Diff: 1 Page Ref: 15.3

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^-

Answer: A

Diff: 1 Page Ref: 15.3

38. Give the characteristics of a strong acid.

- A) ionizes completely in aqueous solutions
- B) has a very electronegative atom attached to the oxygen
- C) has a polar bond
- D) has a weaker bond to hydrogen
- E) all of the above

Answer: E

Diff: 1 Page Ref: 15.4

39. Which of the following is a WEAK acid?

- A) HClO_4
- B) H_2SO_4
- C) HCl
- D) HCO_2H
- E) HNO_3

Answer: D

Diff: 1 Page Ref: 15.4

40. Which of the following is TRUE?

- A) A neutral solution contains $[\text{H}_2\text{O}] = [\text{H}_3\text{O}^+]$
- B) An neutral solution does not contain any H_3O^+ or OH^-
- C) An acidic solution has $[\text{H}_3\text{O}^+] > [\text{OH}^-]$
- D) A basic solution does not contain H_3O^+
- E) None of the above are true.

Answer: C

Diff: 1 Page Ref: 15.5

41. Calculate the concentration of OH^- in a solution that contains $3.9 \times 10^{-4} \text{ M}$ H_3O^+ at 25°C . Identify the solution as acidic, basic or neutral.

- A) $2.6 \times 10^{-11} \text{ M}$, acidic
- B) $2.6 \times 10^{-11} \text{ M}$, basic
- C) $3.9 \times 10^{-4} \text{ M}$, neutral
- D) $2.7 \times 10^{-2} \text{ M}$, basic
- E) $2.7 \times 10^{-2} \text{ M}$, acidic

Answer: A

Diff: 2 Page Ref: 15.5

42. Calculate the hydroxide ion concentration in an aqueous solution with a pH of 9.85 at 25°C .

- A) $7.1 \times 10^{-5} \text{ M}$
- B) $4.2 \times 10^{-10} \text{ M}$
- C) $8.7 \times 10^{-10} \text{ M}$
- D) $6.5 \times 10^{-5} \text{ M}$
- E) $1.4 \times 10^{-10} \text{ M}$

Answer: A

Diff: 2 Page Ref: 15.5

43. Which of the following acids is the WEAKEST? The acid is followed by its K_a value.

- A) $\text{HC}_2\text{H}_3\text{O}_2$, 1.8×10^{-5}
- B) HIO , 2.3×10^{-11}
- C) HBrO , 2.3×10^{-9}
- D) HClO , 2.9×10^{-8}
- E) $\text{C}_6\text{H}_5\text{CO}_2\text{H}$, 6.3×10^{-5}

Answer: B

Diff: 1 Page Ref: 15.6

44. Determine the pH of a 0.116 M Ba(OH)₂ solution at 25°C.

- A) 8.62
- B) 13.06
- C) 13.37
- D) 0.63
- E) 12.56

Answer: C

Diff: 2 Page Ref: 15.7

45. Determine the K_b for CN⁻ at 25°C. The K_a for HCN is 4.9×10^{-10} .

- A) 4.9×10^{-14}
- B) 2.3×10^{-9}
- C) 1.4×10^{-5}
- D) 2.0×10^{-5}
- E) 3.7×10^{-7}

Answer: D

Diff: 2 Page Ref: 15.8

46. Determine the pH of a 0.18 M H₂CO₃ solution. Carbonic acid is a diprotic acid whose K_{a1} = 4.3×10^{-7} and K_{a2} = 5.6×10^{-11} .

- A) 11.00
- B) 10.44
- C) 5.50
- D) 4.31
- E) 3.56

Answer: E

Diff: 5 Page Ref: 15.9

47. A solution with a hydrogen ion concentration of 3.25×10^{-6} M is _____ and has a hydroxide ion concentration of _____.

- A) acidic, 3.08×10^{-8} M
- B) acidic, 3.08×10^{-9} M
- C) basic, 3.08×10^{-8} M
- D) basic, 3.08×10^{-9} M

Answer: B

Diff: 3 Page Ref: 15.5

48. Which one of the following salts, when dissolved in water, produces the solution with a pH *closest* to 7.00?

- A) NH₄Br
- B) Ca O
- C) K HSO₄
- D) Cs I

Answer: D

Diff: 1 Page Ref: 15.8

49. Which one of the following statements is TRUE?

- A) A buffer is an aqueous solution composed of two weak acids.
- B) A buffer can absorb an unlimited amount of acid or base.
- C) A buffer resists pH change by neutralizing added acids and bases.
- D) A buffer does not change pH when strong acid or base is added.
- E) None of the above are true.

Answer: C

Diff: 1 Page Ref: 16.2

50. You wish to prepare an $\text{HC}_2\text{H}_3\text{O}_2$ buffer with a pH of 5.44. If the pK_a of is 4.74, what ratio of $\text{C}_2\text{H}_3\text{O}_2^-/\text{HC}_2\text{H}_3\text{O}_2$ must you use?

- A) 0.70
- B) 0.20
- C) 1.4
- D) 5.0
- E) 1.1

Answer: D

Diff: 2 Page Ref: 16.2

51. Calculate the pH of a solution formed by mixing 200.0 mL of 0.30 M HClO with 100.0 mL of 0.20 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

Answer: D

Diff: 4 Page Ref: 16.2

52. Which of the following acids (listed with pK_a values) and their conjugate base would form a buffer with a pH of 8.10?

- A) $\text{HC}_7\text{H}_5\text{O}_2$, $\text{pK}_a = 4.19$
- B) HF , $\text{pK}_a = 3.46$
- C) HClO , $\text{pK}_a = 7.54$
- D) HCN , $\text{pK}_a = 9.31$
- E) HClO_2 , $\text{pK}_a = 1.96$

Answer: C

Diff: 1 Page Ref: 16.3

53. A 100.0 mL sample of 0.18 M HClO_4 is titrated with 0.27 M LiOH . Determine the pH of the solution before the addition of any LiOH .

- A) 1.74
- B) 1.05
- C) 0.74
- D) 0.57

E) 1.57

Answer: C

Diff: 2 Page Ref: 16.4

54. A 100.0 mL sample of 0.10 M $\text{Ca}(\text{OH})_2$ is titrated with 0.10 M HBr. Determine the pH of the solution after the addition of 300.0 mL HBr.

A) 1.60

B) 1.30

C) 1.00

D) 12.40

E) 1.12

Answer: A

Diff: 3 Page Ref: 16.4

55. Determine the molar solubility of CuCl in a solution containing 0.050 M KCl.

$K_{\text{sp}}(\text{CuCl}) = 1.0 \times 10^{-6}$.

A) 1.0×10^{-12} M

B) 5.0×10^{-7} M

C) 2.0×10^{-5} M

D) 1.0×10^{-3} M

E) 0.050 M

Answer: C

Diff: 2 Page Ref: 16.5

56. Determine the molar solubility of BaF_2 in pure water. K_{sp} for $\text{BaF}_2 = 2.45 \times 10^{-5}$.

A) 1.83×10^{-2} M

B) 1.23×10^{-5} M

C) 2.90×10^{-2} M

D) 4.95×10^{-3} M

E) 6.13×10^{-6} M

Answer: A

Diff: 3 Page Ref: 16.5

57. Which of the following solutions is a good buffer system?

A) A solution that is 0.10 M $\text{HC}_2\text{H}_3\text{O}_2$ and 0.10 M $\text{LiC}_2\text{H}_3\text{O}_2$

B) A solution that is 0.10 M HF and 0.10 M $\text{NaC}_2\text{H}_3\text{O}_2$

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.

Answer: A

Diff: 1 Page Ref: 16.2

58. Which of the following compounds solubility will not be affected by a low pH in solution?

A) AgCl

B) $\text{Mg}(\text{OH})_2$

- C) CaF_2
- D) CuS
- E) BaCO_3

Answer: A

Diff: 1 Page Ref: 16.5

59. Which of the following processes have a $\Delta S > 0$?

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

Answer: C

Diff: 2 Page Ref: 17.3

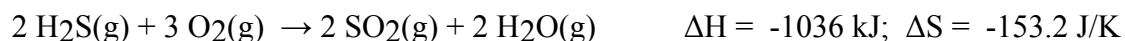
60. Consider a reaction that has a positive ΔH and a positive ΔS . Which of the following statements is TRUE?

- A) This reaction will be spontaneous only at high temperatures.
- B) This reaction will be spontaneous at all temperatures.
- C) This reaction will be nonspontaneous at all temperatures.
- D) This reaction will be nonspontaneous only at high temperatures.
- E) It is not possible to determine without more information.

Answer: A

Diff: 2 Page Ref: 17.5

61. Above what temperature does the following reaction become nonspontaneous?



- A) $6.762 \times 10^3 \text{ K}$
- B) 158.7 K
- C) 298 K
- D) This reaction is nonspontaneous at all temperatures.
- E) This reaction is spontaneous at all temperatures.

Answer: A

Diff: 3 Page Ref: 17.5

62. Given the following equation,



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



- A) -23.0 kJ

- B) 69.0 kJ
- C) -69.0 kJ
- D) -7.67 kJ
- E) 23.0 kJ

Answer: C

Diff: 2 Page Ref: 17.7

63. Which of the following is NOT true for ΔG_{rxn} ?

- A) If $\Delta G^{\circ}_{\text{rxn}} > 0$, the reaction is spontaneous in the forward direction.
- B) If $Q = 1$, then $\Delta G_{\text{rxn}} = \Delta G^{\circ}_{\text{rxn}}$.
- C) If $\Delta G^{\circ}_{\text{rxn}} = 0$, the reaction is spontaneous in the reverse direction.
- D) If $\Delta G^{\circ}_{\text{rxn}} > 0$, the reaction is spontaneous in the reverse direction.
- E) Under equilibrium conditions, $\Delta G_{\text{rxn}} = 0$.

Answer: A

Diff: 4 Page Ref: 17.8

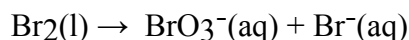
64. Identify the statement that is FALSE.

- A) The entropy of a gas is greater than the entropy of a liquid.
- B) Entropy generally increases with increasing molecular complexity.
- C) Free atoms have greater entropy than molecules.
- D) Entropy increases with dissolution.
- E) For noble gasses, entropy increases with size.

Answer: C

Diff: 1 Page Ref: 17.6

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

Answer: D

Diff: 4 Page Ref: 18.2

66. Identify the location of reduction in an electrochemical cell.

- A) the anode
- B) the cathode
- C) the electrode
- D) the salt bridge
- E) the socket

Answer: B

Diff: 1 Page Ref: 18.3

67. What is the reducing agent in the redox reaction represented by the following cell notation?

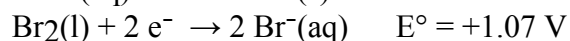
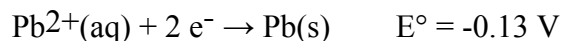
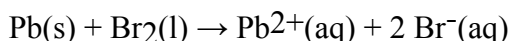


- A) Ni(s)
- B) Ni²⁺(aq)
- C) Ag⁺(aq)
- D) Ag(s)
- E) Pt

Answer: A

Diff: 1 Page Ref: 18.4

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.)

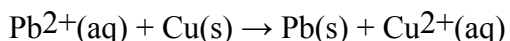


- A) +1.20 V
- B) +0.94 V
- C) -0.94 V
- D) -1.20 V
- E) -0.60 V

Answer: A

Diff: 2 Page Ref: 18.4

69. Use the tabulated half-cell potentials to calculate ΔG° for the following balanced redox reaction.

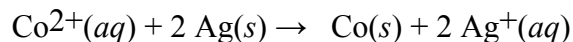


- A) -41 kJ
- B) -0.47 kJ
- C) +46 kJ
- D) +91 kJ
- E) -21 kJ

Answer: D

Diff: 3 Page Ref: 18.5

70. What is the reduction half-reaction for the following overall galvanic cell reaction?



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

Answer: C

Diff: 3 Page Ref: 18.3