

1. Sulfuric acid is a very strong inorganic used in commercial and non-commercial laboratories. What is the molarity of a 70.00 wt % solution of sulfuric acid in water? The density of the solution is 1.6503 g/mL.

- 0.7137 M
- 7.141 M
- 11.78 M
- 4.328 M
- 0.01178 M

2. Determine the freezing point of a solution containing 5.55 g of Na_3PO_4 (molar mass = 163.94 g/mol) dissolved in 100.0 g of water.

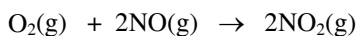
(K_f for water is $1.86^\circ\text{C}\cdot\text{kg/mol}$.)

- -0.63°C
- -1.26°C
- -1.88°C
- -2.52°C
- -5.04°C

3. The solubility of oxygen gas in water at 25°C and 1.0 atm pressure is 0.041 g/L. What is the solubility of oxygen in water at 3.0 atm and 25°C ?

- 0.041 g/L
- 0.14 g/L
- 0.31 g/L
- 3.0 g/L
- 0.12 g/L

4. Determine the rate law for the reaction below, given the following data.



| Experiment Number | $[\text{O}_2]_0$ (M) | $[\text{NO}]_0$ (M) | Initial rate ($\text{M}\cdot\text{s}^{-1}$) |
|-------------------|----------------------|---------------------|---|
| 1 | 0.0350 | 0.0240 | 0.143 |
| 2 | 0.0350 | 0.0150 | 0.0559 |
| 3 | 0.0450 | 0.0240 | 0.184 |

- rate = $k [\text{O}_2] [\text{NO}]^2$
- rate = $k [\text{O}_2] [\text{NO}]$
- rate = $k [\text{O}_2]^2 [\text{NO}]$
- rate = $k [\text{O}_2]^2 [\text{NO}]^2$
- rate = $k [\text{O}_2]^{1/2} [\text{NO}]$

5. The half-life of a particular first-order reaction is 12.2 min. How long would it take for 65.0% of the reactant to react?

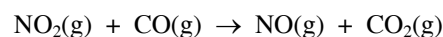
- 7.58 min
- 14.8 min
- 15.9 min
- 18.5 min
- The initial concentration of the reactant must be known in order to answer this question.

6. A certain first order reaction has a rate constant of $6.5 \times 10^{-2} \text{ s}^{-1}$ at 25°C . If the reaction rate doubles when the temperature is increased to 35°C , what is the activation energy for this reaction?

- 8.3 kJ/mol

- 41 kJ/mol
- 53 kJ/mol
- 83 kJ/mol
- 89 kJ/mol

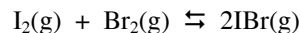
7. Consider the reaction below:



The experimentally determined rate law for this reaction is: rate = $k[\text{NO}_2]^2$. Which of the following mechanisms is consistent with the observed rate law?

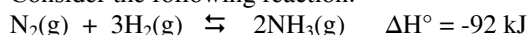
- $\text{NO}_2(\text{g}) + \text{CO}(\text{g}) \rightarrow \text{NO}(\text{g}) + \text{CO}_2(\text{g})$
- $\text{NO}_2(\text{g}) + \text{NO}_2(\text{g}) \rightarrow \text{NO}(\text{g}) + \text{O}(\text{g})$ (slow)
 $\text{CO}(\text{g}) + \text{O}(\text{g}) \rightarrow \text{CO}_2(\text{g})$ (fast)
- $\text{CO}(\text{g}) + \text{CO}(\text{g}) \rightarrow \text{CO}_2(\text{g}) + \text{C}(\text{g})$ (slow)
 $\text{NO}_2(\text{g}) + \text{C}(\text{g}) \rightarrow \text{NO}(\text{g}) + \text{CO}(\text{g})$ (fast)
- $\text{NO}_2(\text{g}) + \text{NO}_2(\text{g}) \rightarrow \text{NO}(\text{g}) + \text{NO}_3(\text{g})$ (slow)
 $\text{NO}_3(\text{g}) + \text{CO}(\text{g}) \rightarrow \text{NO}_2(\text{g}) + \text{CO}_2(\text{g})$ (fast)
- All of these mechanisms are consistent with the rate law.

8. 1.0 mol of I_2 and 1.0 mol of Br_2 are placed in a 2.00 L flask and allowed to reach equilibrium. At equilibrium, the flask contains 1.68 mol of IBr . What is the value of K_c for this reaction?



- 11
- 4.0
- 110
- 6.1

9. Consider the following reaction:

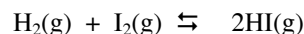


In order to increase the equilibrium yield of ammonia, we could:

- increase the temperature
- decrease the temperature
- increase the pressure by compression
- decrease the pressure by expansion

- 1 only
- 2 only
- 1 and 3 only
- 2 and 3 only
- 1 and 4 only

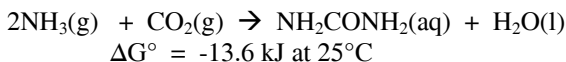
10. In an experiment, 0.100 mol H_2 and 0.100 mol I_2 are mixed in a 1.00 L container and the reaction forms HI . If $K_c = 50.0$ for this reaction, what is the equilibrium concentration of HI ?



- 0.156 M
- 0.0780 M
- 7.07 M
- 0.200 M
- 0.0384 M

11. A 0.10 M solution of a weak monoprotic acid is 5.0% dissociated. What is the equilibrium constant, K_a , for this acid?
- 5.0×10^{-2}
 - 5.0×10^{-3}
 - 2.5×10^{-4}
 - 2.5×10^{-5}
 - 2.5×10^{-6}
12. The K_a for formic acid (HCHO_2) is 1.8×10^{-4} . What is the pH of a 0.35 M solution of sodium formate (NaCHO_2)?
- 10.71
 - 5.36
 - 3.29
 - 8.64
 - 7.00
13. A 200.0 mL solution of 0.40 M $\text{CH}_3\text{COOH}(\text{aq})$ and 0.40 M $\text{NaCH}_3\text{COO}(\text{aq})$ has 20.0 mL of 1.0 M $\text{HCl}(\text{aq})$ added to it. What is the pH after the HCl has been added? ($K_a = 1.8 \times 10^{-5}$ for CH_3COOH)
- 4.7
 - 4.5
 - 4.9
 - 7.0
 - 9.5
14. Consider the titration of 40.0 mL of 0.100 M acetic acid (CH_3COOH , $K_a = 1.8 \times 10^{-5}$) with 0.150 M NaOH. What is the pH after the addition of 15.0 mL of NaOH?
- 4.74
 - 4.92
 - 4.49
 - 4.64
 - 4.85
15. Consider the titration of 50.00 mL of 0.100 M hydrofluoric acid (HF , $K_a = 6.76 \times 10^{-4}$) with 0.125 M NaOH. What is the pH at the equivalence point?
- 7.96
 - 7.00
 - 3.17
 - 10.83
 - 12.74
16. A particular saturated solution of $\text{Ca}_3(\text{PO}_4)_2$ has $[\text{Ca}^{2+}] = [\text{PO}_4^{3-}] = 2.9 \times 10^{-7}$ M. What is the value of K_{sp} for $\text{Ca}_3(\text{PO}_4)_2$?
- 2.2×10^{-31}
 - 5.0×10^{-13}
 - 2.1×10^{-33}
 - 8.4×10^{-14}
 - 7.2×10^{-21}
17. What is the molar solubility of CaF_2 in pure water at 25°C ? (K_{sp} for CaF_2 is 1.5×10^{-10} .)
- 5.0×10^{-11} M
 - 5.3×10^{-4} M
 - 8.7×10^{-6} M
 - 4.2×10^{-4} M
 - 3.3×10^{-4} M
18. What is the molar solubility of MgF_2 in a solution containing 0.100 M NaF? (K_{sp} for MgF_2 is 7.4×10^{-11} .)
- 3.7×10^{-10}
 - 1.8×10^{-9}
 - 7.4×10^{-10}
 - 7.4×10^{-9}
 - 2.6×10^{-4}
19. K_{sp} for BaF_2 is 1.8×10^{-7} . If 50.0 mL of 0.010 M $\text{Ba}(\text{NO}_3)_2$ is added to 50.0 mL of 0.010 M NaF, will a precipitate form?
- Yes, a precipitate will form.
 - No, a precipitate will not form.
20. Consider the following reaction, which is spontaneous at room temperature:
- $$\text{NH}_3(\text{g}) + \text{BF}_3(\text{g}) \rightarrow \text{H}_3\text{NBF}_3(\text{s})$$
- Which of the following statements must be true of this reaction?
- $\Delta H < 0$
 - $\Delta H > 0$
 - $\Delta G > 0$ at all temperatures
 - $\Delta G < 0$ at all temperatures
21. Determine the normal boiling point of ethanol ($\text{CH}_3\text{CH}_2\text{OH}$), given that its enthalpy of vaporization is 38.6 kJ/mol and its entropy of vaporization is 110 J/mol·K.
- 128°C
 - 92°C
 - 78°C
 - 61°C
 - 86°C
22. Use the thermodynamic data below to determine the standard free energy change, ΔG° , for the following reaction at 25°C .
- $$\text{CaO}(\text{s}) + \text{CO}_2(\text{g}) \rightarrow \text{CaCO}_3(\text{s}) \quad \Delta H^\circ = -178.7 \text{ kJ}$$
- The standard molar entropies of these substances at 25°C are as follows:
- | | |
|---------------------------|-------------------------------|
| $\text{CaO}(\text{s})$ | $S^\circ = 39.7 \text{ J/K}$ |
| $\text{CO}_2(\text{g})$ | $S^\circ = 213.6 \text{ J/K}$ |
| $\text{CaCO}_3(\text{s})$ | $S^\circ = 92.9 \text{ J/K}$ |
- 160 kJ
 - +47.6 kJ
 - +3830 kJ
 - 226 kJ
 - 131 kJ

23. Urea (NH_2CONH_2), an important nitrogen fertilizer, is produced industrially by the reaction



What is the value of ΔG at 25°C for this reaction under the following set of conditions?

25.0 atm $\text{NH}_3(\text{g})$
 0.500 atm $\text{CO}_2(\text{g})$
 1.00 M NH_2CONH_2

- a) 0.63 kJ d) -27.8 kJ
 b) 14.2 kJ e) -20.0 kJ
 c) -18.1 kJ

24. Consider the following reaction:



What is the equilibrium constant for this reaction at 25°C ?

- a) 0.15 d) 9.8×10^{-10}
 b) 1.0 e) 2.5×10^5
 c) 2.7×10^{-3}

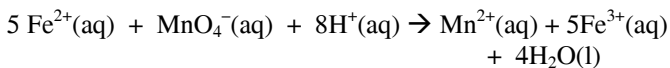
25. Solid carbon dioxide is commonly known as dry ice. What are the signs of ΔG , ΔH , and ΔS for the sublimation of dry ice at 25°C ?

| | ΔG | ΔH | ΔS |
|----|------------|------------|------------|
| a) | - | + | - |
| b) | + | - | - |
| c) | + | + | + |
| d) | - | - | + |
| e) | - | + | + |

26. The oxidation state of nitrogen given for all of the following species is correct except

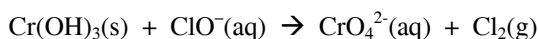
- a) N_2H_4 -2
 b) NH_2OH -3
 c) N_2O +1
 d) N_2 0
 e) HNO_2 +3

27. Which substance in the reaction below is the oxidizing agent?



- a) Fe^{2+} d) Mn^{2+}
 b) MnO_4^- e) Fe^{3+}
 c) H^+

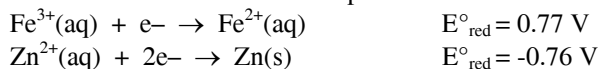
28. Balance the following oxidation-reduction reaction which occurs in basic solution:



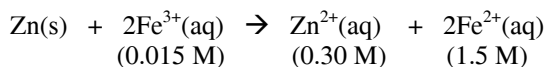
When this equation is balanced using the smallest whole-number coefficients, what is the coefficient on H_2O , and on which side of the reaction is H_2O found, product side or reactant side?

- a) 2, reactant side
 b) 8, product side
 c) 12, reactant side
 d) 2, product side
 e) 14, product side

29. Given these standard reduction potentials:



What is the cell potential of the galvanic cell at 25°C which uses the following reaction?



- a) 1.53 V d) 0.09V
 b) 1.63 V e) 1.43 V
 c) 1.49 V

30. What is the product of the alpha decay of uranium-238?

- a) ^{234}Th d) ^{235}U
 b) ^{238}Np e) ^{242}Pu
 c) ^{238}Pa

31. 100.0 mL of an aqueous solution containing 0.120 g of an unknown molecular compound generates an osmotic pressure of 18.0 mm Hg at 20.0°C . What is the molar mass of the unknown compound?

- a) 86 g/mol d) 860 g/mol
 b) 122 g/mol e) 1220 g/mol
 c) 164 g/mol

32. Place the following aqueous solutions in order of decreasing freezing point (from highest freezing point to lowest freezing point).

- I. 0.075 m $\text{Zn}(\text{NO}_3)_2$
 II. 0.15 m glucose ($\text{C}_6\text{H}_{12}\text{O}_6$, a nonelectrolyte)
 III. 0.050 m $\text{Al}_2(\text{SO}_4)_3$
 IV. 0.20 m NH_4NO_3

- a) II > IV > I > III
 b) I > IV > III > II
 c) II > I > III > IV
 d) III > I > II > IV
 e) III > II > IV > I

Answers

1. C 6. C 11. C 16. C 21. C 26. B 31. E
 2. D 7. D 12. D 17. E 22. E 27. B 32. C
 3. E 8. C 13. B 18. D 23. D 28. D
 4. A 9. D 14. E 19. B 24. A 29. E
 5. D 10. A 15. A 20. A 25. E 30. A