
Questions 1–13 cover material from Exam 3

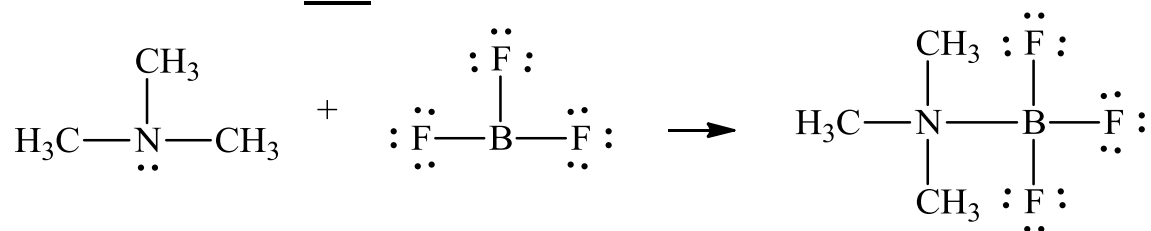
1. Which of the following salts dissolves in water to give a solution in the indicated pH range?

- A. NaH_2AsO_4 , pH = 7 C. $\text{KC}_2\text{H}_3\text{O}_2$, pH < 7
B. NH_4Cl , pH > 7 D. LiF , pH > 7
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2. Which pair has the **stronger** acid listed first?

- A. HIO , HCl C. H_2Se , H_2O
B. HClO , HClO_4 D. HF , HI
-

3. Which statement is **true** for the reaction below?



- A. $(\text{CH}_3)_3\text{N}$ is a Lewis acid; it is an electron pair donor.
B. $(\text{CH}_3)_3\text{N}$ is a Lewis base; it is an electron pair acceptor.
C. BF_3 is a Lewis base; it is an electron pair donor.
D. BF_3 is a Lewis acid; it is an electron pair acceptor.
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4. A few milliliters of 0.050 M HCl are added to 200 mL of a buffer containing 0.125 mol HNO_2 (nitrous acid) and 0.125 mol NaNO_2 (sodium nitrite). Which of the following reactions represents the neutralization of the strong acid?

- A. $\text{H}_3\text{O}^+(\text{aq}) + \text{NO}_2^-(\text{aq}) \rightarrow \text{HNO}_2(\text{aq}) + \text{H}_2\text{O}(\text{l})$
B. $\text{OH}^-(\text{aq}) + \text{HNO}_2(\text{aq}) \rightarrow \text{NO}_2^-(\text{aq}) + \text{H}_2\text{O}(\text{l})$
C. $\text{H}_2\text{O}(\text{l}) + \text{NO}_2^-(\text{aq}) \rightarrow \text{HNO}_2(\text{aq}) + \text{OH}^-(\text{aq})$
D. $\text{H}_3\text{O}^+(\text{aq}) + \text{OH}^-(\text{aq}) \rightarrow 2 \text{H}_2\text{O}(\text{l})$
-

5. Which buffer would be **most effective** against the addition of a **strong base**?

- A. 0.00100 M HCN, 0.00100 M NaCN
- B. 0.500 M HCN, 0.200 M NaCN
- C. 0.200 M HCN, 0.500 M NaCN
- D. 0.100 M HCN, 0.100 M NaCN

6. A 1.00 L buffer solution contains 0.200 mol $\text{HC}_4\text{H}_7\text{O}_2$ and 0.200 mol $\text{KC}_4\text{H}_7\text{O}_2$ ($\text{p}K_a$ for $\text{HC}_4\text{H}_7\text{O}_2$ is 4.82). What is the pH of the solution after 0.050 mol of solid NaOH is added? Assume no change in volume.

- A. 6.74
- B. 5.04
- C. 4.34
- D. 2.84

7. A 20.0 mL sample of 0.500 M ethylamine ($\text{C}_2\text{H}_5\text{NH}_2$, $K_b = 5.6 \times 10^{-4}$) is titrated with 1.00 M HCl. What is the pH at the equivalence point?

- A. $\text{pH} > 7.00$
 - B. $\text{pH} = 7.00$
 - C. $\text{pH} < 7.00$
 - D. Not enough information is given.
-

8. Calculate the molar solubility of $\text{Co}(\text{OH})_2$ in pure water. K_{sp} for $\text{Co}(\text{OH})_2$ is 5.9×10^{-15} .

A. $9.3 \times 10^{-10} \text{ M}$

C. $7.6 \times 10^{-20} \text{ M}$

B. $1.1 \times 10^{-5} \text{ M}$

D. $5.9 \times 10^{-2} \text{ M}$

9. Which of the following solutions will see an **increase** in solubility with a **decrease** in pH?

A. KF

C. CdBr_2

B. CuCl

D. PbI_2

10. Two solutions are mixed together such that the final concentrations are

$$[\text{Mg}^{2+}] = 1.0 \times 10^{-3} \text{ M}; [\text{C}_2\text{O}_4^{2-}] = 2.0 \times 10^{-2} \text{ M}.$$

The K_{sp} for MgC_2O_4 is 4.8×10^{-6} . Will a precipitate form?

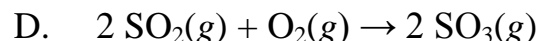
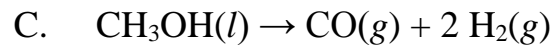
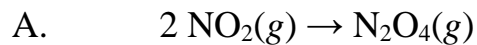
A. A precipitate will not form because $Q < K_{\text{sp}}$.

B. A precipitate will not form because $Q > K_{\text{sp}}$.

C. A precipitate will form because $Q < K_{\text{sp}}$.

D. A precipitate will form because $Q > K_{\text{sp}}$.

11. Which of the following processes is accompanied by an **increase** in entropy of the system?



12. What is the change in the entropy of the surroundings at 125 K for a reaction whose enthalpy change is 375 kJ/mol?

A. $-0.345 \text{ kJ/mol}\cdot\text{K}$

C. $1.25 \text{ kJ/mol}\cdot\text{K}$

B. $-3.00 \text{ kJ/mol}\cdot\text{K}$

D. $4.50 \text{ kJ/mol}\cdot\text{K}$

13. If an exothermic reaction has a positive change in entropy, what can be said about ΔG and the spontaneity of the reaction?

A. ΔG will be negative for all temperatures and the reaction will be spontaneous in the forward direction.

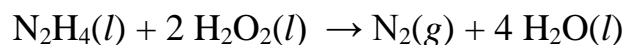
B. ΔG will be positive for all temperatures and the reaction will be nonspontaneous in the forward direction.

C. At low temperatures, ΔG will be positive and the reaction will be spontaneous in the forward direction.

D. At high temperatures, ΔG will be negative and the reaction will be nonspontaneous in the forward direction.

Questions 14–26 cover material after Exam 3.

14. Using the data below, calculate the standard entropy change for the following reaction.



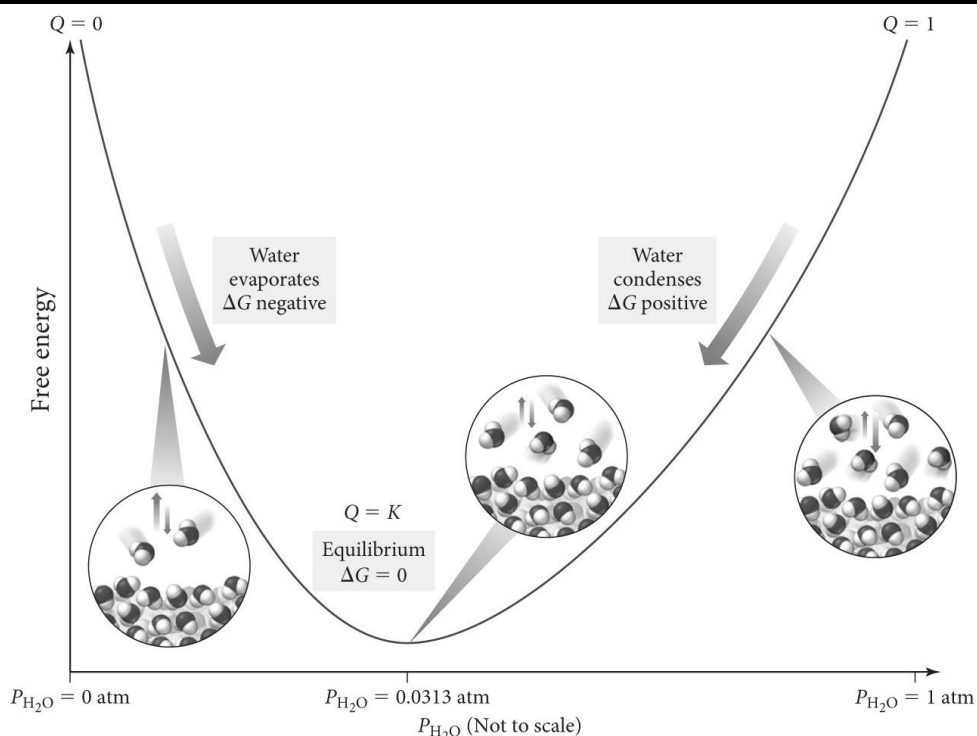
Substance	S° (J/K·mol)
$\text{N}_2\text{H}_4(l)$	121.2
$\text{H}_2\text{O}_2(l)$	109.6
$\text{N}_2(g)$	191.6
$\text{H}_2\text{O}(l)$	188.8

- A. -149.6 J/K C. 606.4 J/K
B. 511.2 J/K D. 750.4 J/K

15. For a reaction with $\Delta H^\circ = 129$ kJ/mol and $\Delta S^\circ = 83.1$ J/mol·K, what is ΔG° at 258 K?

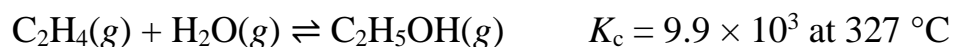
- A. -493 kJ/mol C. 46.3 kJ/mol
B. -237 kJ/mol D. 108 kJ/mol
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16. ΔG vs. $P_{\text{H}_2\text{O}}$ is graphed for the phase change, $\text{H}_2\text{O}(l) \rightleftharpoons \text{H}_2\text{O}(g)$. If a water sample at 25°C is observed to spontaneously evaporate, what can be said about the conditions, including $P_{\text{H}_2\text{O}}$?



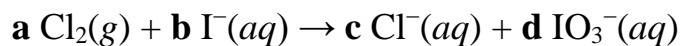
- A. The system is under nonstandard conditions because $P_{\text{H}_2\text{O}} < 0.0313 \text{ atm}$ and $Q < K$.
 B. The system is under nonstandard conditions because $P_{\text{H}_2\text{O}} > 0.0313 \text{ atm}$ and $Q = K$.
 C. The system is under standard conditions because $P_{\text{H}_2\text{O}} < 1 \text{ atm}$ and $Q < 1$.
 D. The system is under standard conditions because $P_{\text{H}_2\text{O}} = 1 \text{ atm}$ and $Q = 1$.

17. Calculate $\Delta G_{\text{rxn}}^\circ$ at 327°C for this reaction.



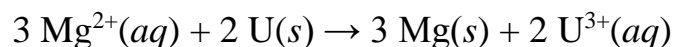
- A. -17 kJ/mol C. -46 kJ/mol
 B. -26 kJ/mol D. -87 kJ/mol

18. What is the coefficient **c** when the reaction below is balanced in acid?

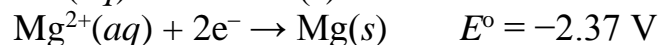
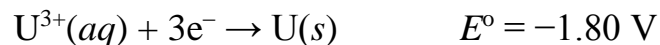


- | | | | |
|----|---|----|---|
| A. | 1 | C. | 3 |
| B. | 2 | D. | 6 |

19. Calculate E_{cell}° at 25 °C and determine the spontaneity of this reaction

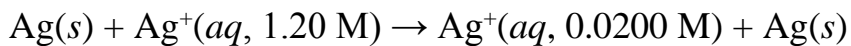


from these half-cell potentials.



- | | | | |
|----|-------------------------|----|------------------------|
| A. | -0.57 V, nonspontaneous | C. | 0.57 V, nonspontaneous |
| B. | -4.47 V, spontaneous | D. | 4.47 V, spontaneous |

20. What is E_{cell} for the silver concentration cell below?

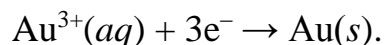


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|----|---------|----|----------|
| A. | 1.20 V | C. | 0.105 V |
| B. | 0.406 V | D. | 0.0108 V |
-

21. Which reaction occurs at the **cathode** during the electrolysis of molten Al_2O_3 ?

- A. Al^{3+} is reduced to Al. C. O^{2-} is reduced to O_2 .
B. Al^{3+} is oxidized to Al. D. O^{2-} is oxidized to O_2 .

22. Gold can be plated out of a solution containing Au^{3+} ions according to the half-reaction:



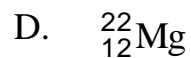
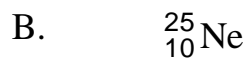
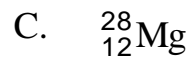
How long would it take to plate 2.0 g of gold using a current of 1.5 A?

- A. 17 min C. 56 min
B. 33 min D. 3.9×10^4 min

23. Which type of radioactive decay emits high-energy electromagnetic waves, often in conjunction with other types of radiation?

- A. α decay C. γ emission
B. β decay D. ${}_{+1}^0e$ emission
-

24. The elements below lie in the region of the *Valley of Stability* where $N/Z \approx 1$. Select the nuclide that undergoes positron emission to achieve stability.



25. Strontium-90 is radioactive and decays by a first-order process with a half-life of 28.0 years. How much of a 0.800 mol sample of strontium is left after 112 years?

A. 0.0200 mol

C. 0.400 mol

B. 0.0500 mol

D. 0.600 mol

26. A radioactive sample contains 1.50 g of an isotope that decays with a rate constant of 0.190 day^{-1} . What mass of the isotope **remains** after 5.5 days?

A. 1.10 g

C. 0.27 g

B. 0.53 g

D. 0.042 g

Answer Key:

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