

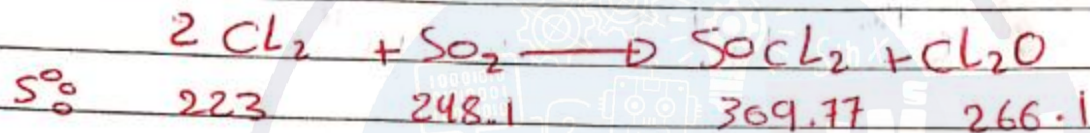
If ΔH° for the following reaction is 160.2 kJ/mol, Use the given data at 298 K to calculate ΔG° for the reaction:



Substance	S° (J/K.mol)
$\text{SO}_2(\text{g})$	248.1
$\text{SOCl}_2(\text{g})$	309.77
$\text{Cl}_2\text{O}(\text{g})$	266.1
$\text{Cl}_2(\text{g})$	223.0

- a. 195.4 kJ
- b. 186.0 kJ
- c. 135.8kJ
- d. 133.6 kJ
- e. 129.3 kJ

$$1) \quad \Delta H^\circ = 160.2 \frac{\text{kJ}}{\text{mol}} \quad , \quad T = 298 \text{ K}$$



$$\Delta G^\circ = \Delta H^\circ - T \Delta S^\circ \quad \left\{ \quad \Delta S^\circ = \sum S^\circ_{\text{prod}} - \sum S^\circ_{\text{reactant}} \right.$$

$$= 160.2 - (298 \times 0.105) = 104.77 \frac{\text{J}}{\text{K} \cdot \text{mol}}$$

$$= 129 \frac{\text{kJ}}{\text{mol}} \quad = 0.10477 \frac{\text{kJ}}{\text{K} \cdot \text{mol}}$$

What is the pH of a 0.35 M solution of methylamine (CH_3NH_2 , $K_b = 4.4 \times 10^{-4}$) at 25°C ?

- a. 1.91
- b. 8.16
- c. 5.55
- d. 12.09
- e. 13.54

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$$2) [\text{CH}_3\text{NH}_2] = 0.35 \text{ M}, K_b = 4.4 \times 10^{-4}$$

$$1. [\text{OH}^-] = \sqrt{K_b [\text{base}]}$$
$$= \sqrt{4.4 \times 10^{-4} \times 0.35} = 0.0124 \text{ M}$$

$$2. \text{pOH} = -\log [\text{OH}^-] = -\log [0.0124] = 1.9$$

$$3. \text{pH} = 14 - \text{pOH} = 14 - 1.9 = 12.1$$

What is the pH of a 0.03 M solution of NH_3 ? pK_a for NH_4^+ is 9.26.

a. 10.9

b. 10.3

c. 11.3

d. 7.0

e. 12.2

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$$3) [NH_3] = 0.03 \quad \rightarrow P_{Ka} \text{ for } NH_4^+ = 9.26$$

$$1. K_a = 10^{-P_{Ka}} = 10^{-9.26} = 5.5 \times 10^{-10}$$

$$2. K_b = \frac{K_w}{K_a} = \frac{1 \times 10^{-14}}{5.5 \times 10^{-10}} = 1.82 \times 10^{-5}$$

$$3. [OH^-] = \sqrt{K_b [base]} = \sqrt{1.82 \times 10^{-5} \times 0.03} \\ = 0.00074$$

$$4. P_{OH} = -\log [OH^-] = 3.13$$

$$5. P_H = 14 - P_{OH} = 14 - 3.13 = 10.87 \\ \approx 10.9$$

You have prepared 250 mL of an acetate buffer solution having the following concentrations:

$[\text{HC}_2\text{H}_3\text{O}_2] = 0.060 \text{ M}$, $[\text{C}_2\text{H}_3\text{O}_2^-] = 0.040 \text{ M}$, What is the pH of the buffer? $\text{pK}_b = 9.26$ for acetic acid at 25°C .

- a. 4.56
- b. 4.92
- c. 5.69
- d. 9.44
- e. 9.08

$$4) [\text{acid}] = 0.06, [\text{conj}] = 0.04, pK_b = 9.26$$

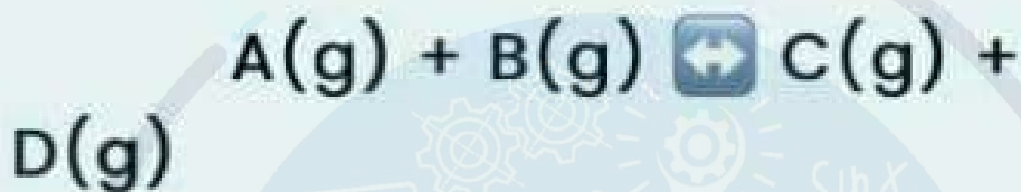
$$1. K_b = 10^{-pK_b} = 10^{-9.26} = 5.5 \times 10^{-10}$$

$$2. K_a = \frac{K_w}{K_b} = 1.82 \times 10^{-5}$$

$$3. [\text{H}_3\text{O}^+] = K_a \frac{[\text{acid}]}{[\text{conj}]} \\ = 0.0000273$$

$$4. p_{\text{H}} = -\log [\text{H}_3\text{O}^+] = 4.56$$

At equilibrium, a 1.0 litre container was found to contain 0.20 mol of A, 0.20 mol of B, 0.40 mol of C, and 0.40 mol of D. If 0.10 mol of C and 0.10 mol of D are added to this system, which of the following statements is TRUE?



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- a. More products are formed to increase Q
 - b. More reactants are formed to increase Q
 - c. The system remains in equilibrium.
 - d. $Q = K_c$
 - e. $Q < K_c$

The answer is A

The pH of a solution of sodium cyanide (NaCN) in water will be:

- a. Neutral
- b. Less than 7
- c. More than 7
- d. We cannot know

The answer is C

At a certain temperature, the silver-ion concentration in a saturated solution of silver(I) sulfate (Ag_2SO_4) is $2.9 \times 10^{-2} \text{ M}$. What is K_{sp} for silver(I) sulfate at this temperature?

- a. 9.6×10^{-5}
- b. 6.9×10^{-7}
- c. 1.2×10^{-5}
- d. 2.1×10^{-4}
- e. 8.3×10^{-4}

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$$Ag = 2.9 \cdot 10^{-2} M$$



$$\therefore [SO_4] \times 2 = [Ag]$$

$$K_{SP} = [Ag]^2 [SO_4] = [Ag]^3 = 1.2 \cdot 10^{-5} \#$$

(c)

7

Calculate the solubility of Zinc Hydroxide ($\text{Zn}(\text{OH})_2$, Molar Mass=99.42).

($K_{sp} \text{Zn}(\text{OH})_2 = 4.5 \times 10^{-17}$)

- a. $2.2 \times 10^{-2} \text{ g/L}$
- b. $2.2 \times 10^{-8} \text{ g/L}$
- c. $8.3 \times 10^{-6} \text{ g/L}$
- d. $2.2 \times 10^{-6} \text{ g/L}$
- e. $2.2 \times 10^{-4} \text{ g/L}$



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Q 8) answer is (e)



$$K_{sp} = [\text{Zn}] [\text{OH}]^2$$

$$4.5 \times 10^{-17} = x (2x)^2$$

$$4.5 \times 10^{-17} = 4x^3$$

$$x = 2.2 \times 10^{-6} \text{ mol/L}$$

$2.2 \times 10^{-6} \text{ mol}$	99.42 g
L	1 mol

$$= 2.2 \times 10^{-4} \text{ g/L}$$

A certain compound has an enthalpy of vaporization equal 52.25 kJ and entropy of vaporization equal 122 J/K at its boiling point. Calculate the boiling point (in K) of acetic acid.

- a. 238 K
- b. 0.43 K
- c. 2.3 K
- d. 428 K
- e. 563 K

9)

$$\Delta S = \frac{\Delta H}{T} \rightarrow T = \frac{\Delta H}{\Delta S} = \frac{52.25 \text{ KJ} \cdot \text{K}}{0.122 \text{ KJ}}$$

$$= 428 \text{ K}$$

Which of the following is correct?

- a. A Lewis acid is a species that produces H_3O^+ ion
- b. A Lewis base is a species that produces OH^- ion
- c. A Bronsted-Lowry acid is a species that accepts OH^- ion
- d. A Bronsted-Lowry base is a species that accepts H_3O^+ ion
- e. A Bronsted-Lowry acid is a species that accepts OH^- ion

The answer is D

A sample of 5.40 g of potassium chloride (KCl) is dissolved in 54.60 g of water. What is the percent by mass of KCl in the solution?

- a. 22.0%
- b. 16.0%
- c. 8.4%
- d. 9.0%
- e. 92.8%

11)

Sample

H₂O

5.4 g KCl

54.6 g

5.4

5.4 + 54.6

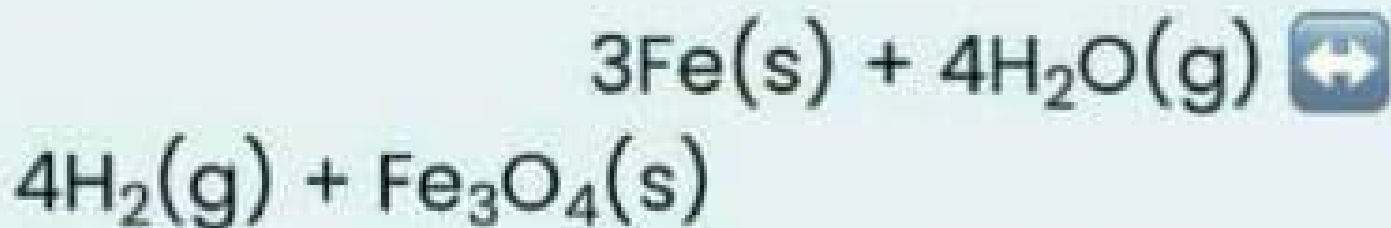
$\times 100\% = 9\%$

Which of the following results in a decrease in entropy?

- a. $\text{H}_2\text{O}(\text{s}) \rightarrow \text{H}_2\text{O}(\text{l})$
- b. $\text{N}_2(\text{aq}) \rightarrow \text{N}_2(\text{g})$
- c. $\text{NH}_3(\text{l}), 34.5^\circ\text{C} \rightarrow \text{NH}_3(\text{g}), 34.5^\circ\text{C}$
- d. Dissolving NaCl in water
- e. $\text{O}_2(\text{g}), 400 \text{ K} \rightarrow \text{O}_2(\text{g}), 300 \text{ K}$

The answer is E

Consider the reaction:



If the total pressure is increased suddenly by decreasing the volume, then:

- a. More $\text{Fe}(s)$ is produced.
- b. The reaction will proceed from left to right.
- c. The equilibrium constant increases
- d. No change occurs.
- e. More $\text{H}_2(g)$ is produced.

The answer is D

If we have the following values for reduction potential

Reduction Half reaction	$E^{\circ}(\text{V})$
$\text{Cl}_{2(\text{aq})} + 2\text{e}^{-} \rightarrow 2\text{Cl}^{-}_{(\text{aq})}$	1.36
$\text{I}_{2(\text{g})} + 2\text{e}^{-} \rightarrow 2\text{I}^{-}_{(\text{aq})}$	0.54
$\text{Br}_{2(\text{s})} + 2\text{e}^{-} \rightarrow 2\text{Br}^{-}_{(\text{aq})}$	1.09

Which is the BEST reducing agent?

- a. Chlorine
- b. Iodine
- c. Bromine
- d. Cannot determine from given information

The answer is c

A strip of iron is placed in a 1 M solution of iron(II) sulfate, and a strip of copper is placed in a 1 M solution of copper(II) chloride. The two solutions are connected with a salt bridge, and the two metals are connected by a wire.

<u>Reduction Half-Reaction</u>	<u>E° (V)</u>
$\text{Fe}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Fe}(\text{s})$	-0.41
$\text{Cu}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Cu}(\text{s})$	0.34

Which of the following takes place?

- a. Copper atoms will deposit at the cathode
 - b. The Fe(II) concentration of the iron half-cell decreases
 - c. Copper ions will increase
 - d. Iron will deposit at the iron electrode.
 - e. No spontaneous reaction will occur
- The answer is A

Which one of the following pairs of compounds have a dipole-dipole intermolecular forces.

- a. F_2 and C_6H_6
- b. I_2 and NO_3^-
- c. CH_4 and H_2O
- d. NH_3 and CCl_4
- e. HF and H_2O

The answer is E

What is the boiling point of a solution that contains 100.0 g of glucose ($C_6H_{12}O_6$; molar mass = 180.0 g/mol) in 900.0 g of H_2O ? k_b for water is $0.52\text{ }^\circ\text{C}/m$.

- a. $100.79\text{ }^\circ\text{C}$
- b. $100.32\text{ }^\circ\text{C}$
- c. $98.58\text{ }^\circ\text{C}$
- d. $99.68\text{ }^\circ\text{C}$
- e. $100.58\text{ }^\circ\text{C}$



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Q13) answer is (b)

$$m = \frac{n}{m(\text{kg})}$$

$$n = \frac{100}{180} = .56$$

C6H12O6

$$m = \frac{.56}{.9} = .62 \text{ mol/kg}$$

$$\Delta T = K_b m$$

$$100 - T_b = .52 \times .62$$

$$T_b = 100.322$$

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For a reaction to be unfavorable in all conditions, which of the following statements is correct:

- a. ΔH is positive, ΔG is positive, and ΔS is negative
- b. ΔH is negative, ΔG is negative, and ΔS is positive
- c. ΔH is negative, ΔG is positive, and ΔS is negative
- d. ΔH is negative, ΔG is positive, and ΔS is positive
- e. ΔH is negative, ΔG is negative, and ΔS is negative

The answer is A

Which of the following increases the solubility of a gas in a given solvent?

- a. Decreasing the partial pressure of the gas.
- b. Increasing the temperature
- c. Increasing the temperature of the solvent and decreasing the partial pressure of the gas simultaneously
- d. Increasing the partial pressure of the gas.
- e. Adding another gas

The answer is D

For the reaction: $2A + B \rightarrow C + D$
the rate law is:

$$\text{Rate} = k[A]^2 \quad \text{and} \quad k = 1.0 \times 10^{-3} \text{ L mol}^{-1} \cdot \text{s}^{-1}$$

If the initial concentration of A is 0.200 M, how long (in hours) will it take for the concentration to become 0.0200 M?

- a. 17.1
- b. 25.0
- c. 11.1
- d. 40.0
- e. 12.5



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Q20) answer is (e)

$$\frac{1}{[A]} = kt + \frac{1}{[A_0]}$$

[A]

[A₀]

$$\frac{1}{.02} = 1 \times 10^3 t + \frac{1}{.2}$$

$$45 = 10^3 t \Rightarrow t = 45000 \text{ s}$$

$$t = 12.5$$

A galvanic cell consists of a strip of iron that is placed in a 1 M solution of iron(II) sulfate and a strip of copper is placed in a 1 M solution of copper(II) chloride. Calculate the standard cell potential (emf) of this cell at 25°C.

Reduction Half-Reaction	E° (V)
$\text{Fe}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Fe}(\text{s})$	-0.41
$\text{Cu}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Cu}(\text{s})$	0.34

a. 0.07 V

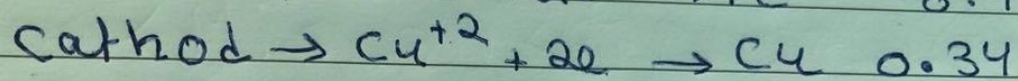
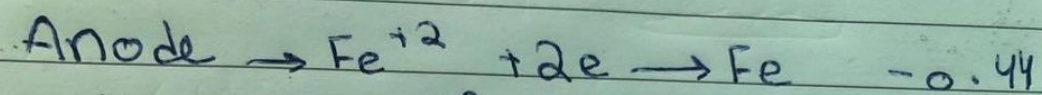
b. -0.07 V

c. 0.75 V

d. 0.41 V

e. -0.75 V

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$$E = 0.34 - (-0.44) = 0.78$$

The answer is c