Recitation Worksheet Seven: Exam Two Review

Name: | MyID:

Textbook:
Chemistry & Chemical Reactivity
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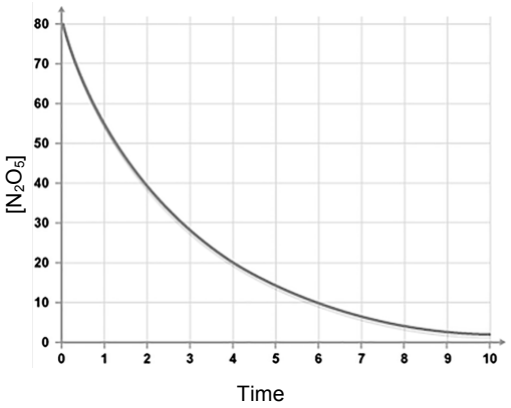
Instructions:
- This recitation worksheet is a review for Exam One.
- Exam coverage: Ch.14.4-14.7, 18.1-18.5, 13.1-13.3
- You **do not** need to submit it to Gradescope.
- The answer key has been posted with this worksheet to eLC.
- The **recitation session during the exam week (October 7-10) is still mandatory**. Your attendance will be recorded.
- A periodic table and formula sheet are attached to the end of this worksheet.

1. Using the graphical representation below of the concentration of N_2O_5 versus time for the reaction $N_2O_5(g) \longrightarrow NO_3(g) + NO_2(g)$, which of the statements is **false**?

A. The decomposition of N_2O_5 follows zero order kinetics.
B. It takes about 2 minutes for N_2O_5 to decrease to half of its original concentration.
C. The half-life of this reaction is independent on the original concentration of N_2O_5.
D. The rate for this reaction can be expressed as rate = k $[N_2O_5]$



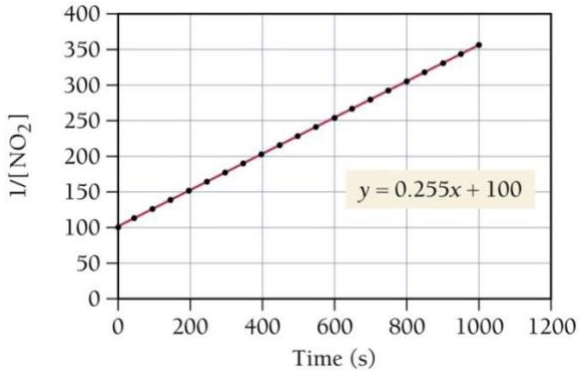
2. Carbon-14, which is present in all living tissue, radioactively decays via a first-order process. A one-gram sample of wood taken from a living tree gives a rate for carbon-14 decay of 13.6 counts per minute. If the half-life for carbon-14 is 5720 years, how old (in years) is a wood sample that gives a rate for carbon-14 decay of 11.9 counts per minute?

Years

3. When the reaction A → B + C is studied, a plot of ln[A]t vs. time gives a straight line with a negative slope. What is the order of the reaction?

A. Zero
B. First
C. Second
D. Third
E. More information is needed to determine the order.

4. Consider the following graph, which depicts the change in the concentration of NO over time.



If the initial concentration of NO_2 is 0.010 M, how long will it take for the NO_2 concentration to decrease to 10.% of its initial concentration?

s

5. In a second order reaction:
   I) the sum of the exponents in the rate law is equal to two.
   II) at least one of the exponents in the rate law is a two.
   III) the half-life is dependent on the initial concentration of the reactant species.
   IV) the half-life is independent of the initial concentration of the reactant species.
   V) k can be expressed as $M^{-2}\ s^{-1}$ or $M^{-2}\ min^{-1}$.

   ☐
   A. I and IV
   B. II and IV
   C. I, III, and V
   D. I and III
   E. II and III

6. The second-order reaction $2\ Mn(CO)_5 \rightarrow Mn_2(CO)_{10}$ has a rate constant equal to 3.0×10^9 L/mol·s at 25 °C. If the initial concentration of $Mn(CO)_5$ is 2.0×10^{-5} mol/L, how long will it take (in seconds) for 90.% of the reactant to disappear?

   ☐ s

7. A first order reaction is observed to be 87.5% complete in 1200 s. What is the half-life in seconds for this reaction?

   ☐ s

8. For question 7, a first-order reaction, how long does it take in seconds to reach 95% completion?

[ ] s

9. Experiment shows that the reaction below is first order: A → P Answer the questions based on the kinetic information in the table.

Time (s)	ln[A]
1.0	–1.659
2.0	–2.209

A. What is the **numerical** value of the rate constant for this reaction?

[ ] s^{-1}

B. What was the initial concentration of A?

[ ] M

C. What would the concentration of A be after 4.0 seconds?

[ ] M

D. What is the half-life (in seconds) for this reaction?

[ ] s

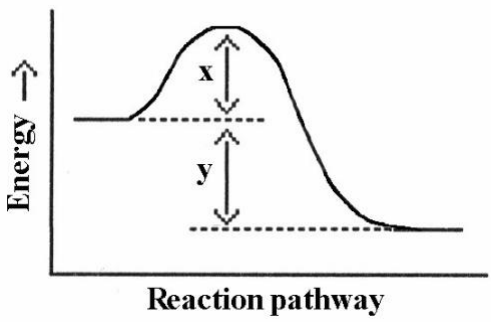
10. Data is collected for the reaction A → B + C, demonstrating a straight line with a positive slope when plotted as 1/[A] vs time. The reaction exhibits (select all the apply, use the letters with no commas):

A. a half-life independent of concentration
B. a half-life inversely proportional to concentration
C. a half-life directly proportional to concentration
D. a half-life proportional to k
E. a half-life inversely proportional to k
F. 0th order kinetics
G. 1st order kinetics
H. 2nd order kinetics

11. At a given temperature, a first-order reaction has a rate constant of 2.5×10^{-3} s^{-1}. How long will it take for the reaction to be 35% complete?

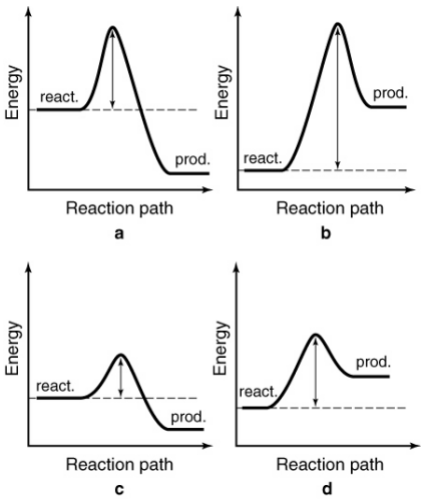
A. 420 s
B. 1600 s
C. 1400 s
D. 74 s
E. 170 s

12. Which energy difference in the energy profile below corresponds to the activation energy for the forward reaction?



A. x
B. y
C. x + y
D. x – y
E. y − x

13. The energy profiles for four different reactions are shown below. Which reaction requires the most energetic collisions to reach the transition state?



A. a
B. b
C. c
D. d

14. Consider the reaction:

$$2\ P + Q \longrightarrow 2\ R + S$$

The mechanism is proposed for this reaction:

$$P + P \rightleftharpoons T \text{ (fast)}$$
$$Q + T \longrightarrow R + U \text{ (slow)}$$
$$U \longrightarrow R + S \text{ (fast)}$$

Substances T and U are unstable intermediates. What rate law is predicted by this mechanism?

A. Rate = $k\,[P]^2$
B. Rate = $k\,[P][Q]$
C. Rate = $k\,[P]^2[Q]$
D. Rate = $k\,[P][Q]^2$
E. Rate = $k\,[U]$

15. The rate constant for a particular zero-order reaction is 0.075 M s^{-1}. If the initial concentration of reactant is 0.537 M it takes _____ s for the concentration to decrease to 0.100M.

[ ] s

16. A reaction occurs via the following sequence of elementary steps. What is the rate law based on this reaction mechanism?

[ ]

A + C + F → 2E (overall reaction)

1st step: A ⇌ B very fast

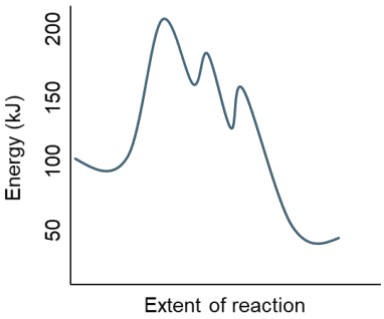
2nd step: B + C → D slow

3rd step: D + F → 2E fast

A. Rate = k $[E]^2$
B. Rate = k [B][C]
C. Rate = k [A][C][F]
D. Rate = k [A][C]
E. Rate = k [D]

Use the reaction coordinate below to answer questions 17, 18, and 19.

17. What type of mechanism would be consistent with this reaction coordinate? A ___ step mechanism with a slow ____ step.



A. One, first
B. One, third
C. Three, third
D. Three, first
E. Two, first

18. What is the activation energy for the reaction?

A. 50 kJ/mol
B. 100 kJ/mol
C. 150 kJ/mol
D. 175 kJ/mol
E. 200 kJ/mol

19. What is the enthalpy for the reaction?

A. 200 kJ/mol
B. 100 kJ/mol
C. −100 kJ/mol
D. 50 kJ/mol
E. −50 kJ/mol

20. The active ingredient in an over-the-counter pain killer analgesic decomposes with a rate constant, k = 9.05 × 10^{-4} day^{-1}. How many days does it take for 15% of the original ingredient to decompose?

A. 2096 days
B. 414 days
C. 365 days
D. 180 days
E. 78 days

21. A particular first-order reaction has a rate constant of $1.35 \times 10^2\ s^{-1}$ at 25.0 °C. What is the value of k at 95.0 °C if E_a = 55.5 kJ/mol?

[ ] s^{-1}

22. The rate constant for a reaction at 40.0°C is exactly 4 times that at 20.0°C. Calculate the activation energy for the reaction.

[ ]

A. 36.36 kJ/mol
B. 52.85 kJ/mol
C. 15.25 kJ/mol
D. 68.45 kJ/mol
E. 28.26 kJ/mol

23. Which of the potential energy diagrams represents an exothermic chemical reaction with a high activation energy and multiple steps?

[ ]

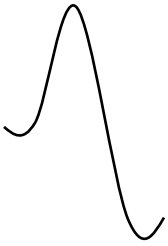
A. 

B. 

C. 

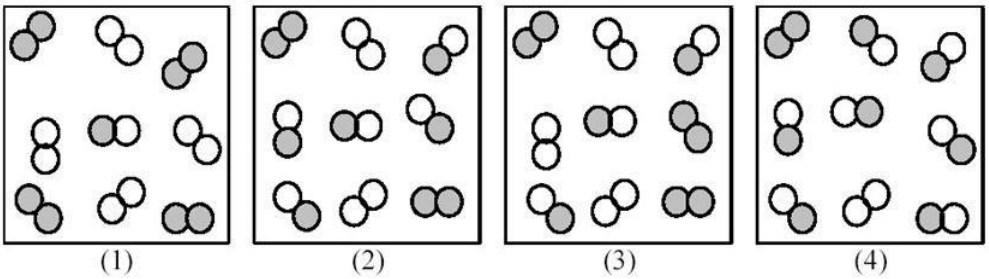
D. 

E. 

F. 

24. Consider the gas-phase reaction of A_2 (shaded spheres) and B_2 (unshaded spheres):

$A_2(g) + B_2(g) \rightleftharpoons 2\ AB(g)$ $\Delta G^\circ = +25$ kJ



Which of the above reaction mixtures has the **least** spontaneous forward reaction?

A. (1)
B. (2)
C. (3)
D. (4)

25. Without doing any calculations, determine whether the standard entropy change, ΔS° is positive or negative for each of the following reactions.

reaction 1: $S(s, \text{rhombic}) + O_{2(}g) \rightarrow SO_2(g)$
reaction 2: $2\ SO_2(g) + O_2(g) \rightarrow 2\ SO_3(g)$

A. ΔS° is positive for both reactions.
B. ΔS° is positive for reaction 1 but negative for reaction 2.
C. ΔS° is positive for reaction 2 but negative for reaction 1.
D. ΔS° is negative for both reactions.

26. Above what temperature does this reaction change from spontaneous to nonspontaneous?

$2\ H_2S(g) + 3\ O_2(g) \rightarrow 2\ SO_2(g) + 2\ H_2O(g)$ $\Delta H = -1036$ kJ; $\Delta S = -153.2$ J/K

A. 6.762×10^3 K
B. 158.7 K
C. 298 K
D. This reaction is nonspontaneous at all temperatures.
E. This reaction is spontaneous at all temperatures.

27. What is $\Delta G°_{rxn}$?

	$2\ O_3(g)$	$\rightarrow 3\ O_2(g)$
$\Delta G°_f$ (kJ/mol)	163.2	0

A. 326.2 kJ
B. -326.4 kJ
C. -163.2 kJ
D. 163.2 kJ
E. 54.4 kJ

28. For the reaction, $CO(g) + 2\ H_2(g) \rightarrow CH_3OH(g)$

$S°$ (J/mol K)	197.6	130.6	239.7

what is ΔS^o_{rxn}?

A. -88.5 J/mol · K
B. -176.7 J/mol · K
C. 219 J/mol · K
D. 176.7 J/mol · K
E. -219.1 J/mol · K

29. Suppose a chemical reaction is found to be spontaneous, but with $\Delta S_{sys} < 0$. Which of these statements is **TRUE**?

A. $\Delta S_{surr} < 0$ and its magnitude is $< \Delta S_{sys}$. In other words, the system loses entropy, and the surroundings also lose entropy. The loss by the surroundings is less than the loss by the system.

B. $\Delta S_{surr} < 0$ and its magnitude is $> \Delta S_{sys}$. In other words, the system loses entropy, and the surroundings also lose entropy. The loss by the surroundings is greater than the loss by the system.

C. $\Delta S_{surr} > 0$ and its magnitude is $< \Delta S_{sys}$. In other words, the system loses entropy, but the surroundings gain entropy. The gain by the surroundings is less than the loss by the system.

D. $\Delta S_{surr} > 0$ and its magnitude is $> \Delta S_{sys}$. In other words, the system loses entropy, but the surroundings gain entropy, and the gain by the surroundings outweighs the loss by the system.

E. An error has been made, as $S_{sys} > 0$ by necessity for a spontaneous process.

30. Which of these reactions will result in a **positive** ΔS_{sys}? (Select all that apply).

A. $CuSO_4 \cdot 5H_2O(s) \rightarrow CuSO_4(s) + 5H_2O(g)$

B. $AgNO_3(aq) + NaCl(aq) \rightarrow AgCl(s) + NaNO_3(aq)$

C. $14O_2(g) + 3NH_4NO_3(s) + C_{10}H_{22}(l) \rightarrow 3N_2(g) + 17H_2O(g) + 10CO_2(g)$

D. $H_2O(g) + CO_2(g) \rightarrow H_2CO_3(aq)$

E. $SiCl_4(g) + 2H_2O(g) \rightarrow SiO_2(s) + 4HCl(g)$

31. Nitrogen gas is allowed to react with oxygen to produce nitrogen dioxide gas at a constant temperature. Using the equation below and the information provided, what is the value of ΔS_{surr} at 298 K? Is this reaction spontaneous or non-spontaneous at this temperature?

$N_2(g) + 2O_2(g) \rightarrow 2NO_2(g)$ $\Delta H = +66.4$ kJ

A. $\Delta S_{surr} = +223$ J/K, reaction is non-spontaneous
B. $\Delta S_{surr} = -223$ J/K, reaction is non-spontaneous
C. $\Delta S_{surr} = -2656$ J/K, reaction is spontaneous
D. $\Delta S_{surr} = +66.4$ kJ/K, reaction is non-spontaneous
E. $\Delta S_{surr} = -223$ J/K, it is not possible to predict the spontaneity of this reaction without more information

32. Elemental boron can be formed by the reaction of boron trichloride with hydrogen.

$2BCl_3(g) + 3H_2(g) \rightarrow 2B(s) + 6HCl(g)$

Substance	$BCl_3(g)$	$H_2(g)$	$B(s)$	$HCl(g)$
$S°$ (J/K·mol)	?	130.6	5.9	186.8

If $\Delta S_{rxn}° = 161.8$J/K·mol, what is $S°$ for $BCl_3(g)$?

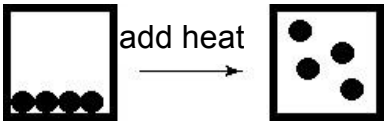
A. –18.2 J/K·mol
B. 18.2 J/K·mol
C. 289.5 J/K·mol
D. 370.4 J/K·mol
E. 579.0 J/K·mol

33. Which statement is true about the formation of $CaCO_3(s)$ from $CaO(s)$ and $CO_2(g)$ at 1.00 atm?

$$CaO(s) + CO_2(g) \rightarrow CaCO_3(s) \qquad \Delta H° = -178.7 \text{ kJ and } \Delta S° = -150.4 \text{ J/K}$$

A. The reaction is spontaneous at all temperatures.
B. The reaction is spontaneous at high temperatures.
C. The reaction is spontaneous at low temperatures.
D. The reaction is not spontaneous at any temperature.

34. Which is true for this process?



A. It is spontaneous at all temperatures
B. It is nonspontaneous at all temperatures
C. It is spontaneous at low temperatures
D. It is spontaneous at high temperatures
E. More information is needed.

35. The formation of water from the reaction of H_2 and O_2 at 298 K is a spontaneous process. What do you predict about the rate of this reaction?

$$2H_2(g) + O_2(g) \rightleftharpoons 2H_2O(l) \qquad \Delta H_{rxn} = -285.8 \text{ kJ/mol} \quad \Delta S_{rxn} = -327 \text{ J/K·mol}$$

A. The reaction rate is higher because this is an exothermic reaction
B. The reaction rate is lower because the entropy of the reaction is negative
C. In general, spontaneous reactions show higher reaction rate
D. The reaction rate is lower because both enthalpy and entropy changes of the reaction are negative.
E. Based on the given information you cannot predict the rate of this reaction

36. Calculate Gibbs free energy for the reaction:

$2A(g) + B(g) \rightarrow C(g)$. $\mathbf{\Delta_r G^o}$ = ____ kJ/mol

$A(g) + D_2(g) \rightarrow AD(g)$	$\Delta_r G^o = -246.4$ kJ/mol
$B(g) + AD(g) \rightarrow D_2(g) + AB(g)$	$\Delta_r G^o = 173.1$ kJ/mol
$C(g) + D_2(g) \rightarrow AB(g) + AD(g)$	$\Delta_r G^o = -1010.5$ kJ/mol

[ ] kJ/mol

37. At temperatures below 273 K, it is observed that liquid water spontaneously freezes to form solid ice. What are the signs (+ or −) of

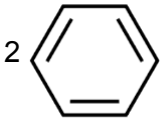
ΔS_{sys} _____ ΔS_{surr} _____ ΔS_{univ} _____

38. A sample of water is heated at a constant pressure of one atmosphere. At 260 K the sample is ice, and the sample consists of steam at 400 K. In which of the following 5 K temperature intervals would there be the greatest increase in the entropy of the sample?

[ ]

A. From 260 K to 265 K
B. From 275 K to 280 K
C. From 360 K to 365 K
D. From 370 K to 375 K

39. Consider the combustion of benzene:



2 (l) + 15 O_2 (g) → 12 CO_2(g) + 6 H_2O(g) $\Delta H_{rxn} = -3271$ kJ/mol

A. Calculate the entropy change (kJ/mol·K) in the surroundings associated with this reaction at 25.00 °C.

[ ] kJ/mol·K

B. Determine the sign (+ or −) of the entropy change for the system.

[ ]

C. Determine the sign (+ or −) of the entropy change for the universe.

[ ]

40. The dissolution of ammonium nitrate occurs spontaneously in water at 25°C. As NH_4NO_3 dissolves, the temperature of the water decreases. What are the signs of ΔH, ΔS, and ΔG for this process?

[ ]

A. ΔH > 0, ΔS < 0, ΔG > 0
B. ΔH > 0, ΔS > 0, ΔG > 0
C. ΔH > 0, ΔS > 0, ΔG < 0
D. ΔH < 0, ΔS < 0, ΔG < 0
E. ΔH < 0, ΔS > 0, ΔG > 0

41. Which of these would result in a positive change in entropy? (Select all that apply)

A. Adding AgCl to water
B. Heating up a beaker of ethanol from 20 °C to 30 °C
C. Water vapor condensing on a cold surface
D. Mixing HCl gas and NH_3 gas to form an ammonium chloride salt
E. Adding NH_4NO_3 to water in an ice pack
F. Adding NH_4Cl (aq) to a solution of NaOH(aq) and forming NaCl(aq), H_2O(l), and NH_3(g)
G. The synthesis of a protein from amino acids by ribosomes within cells

42. Calculate the Δ°G value for the reaction $2\ H_2(g) + O_2(g) \longrightarrow 2\ H_2O(l)$ using the information provided below.

$N_2(g) + 3\ H_2(g) \longrightarrow 2\ NH_3(g)$ $\quad \Delta G° = -33.0$ kJ/mol

$N_2(g) + O_2(g) \longrightarrow 2\ NO(g)$ $\quad \Delta G° = +173.1$ kJ/mol

$4\ NH_3(g) + 5\ O_2(g) \longrightarrow 4\ NO(g) + 6\ H_2O(l)$ $\quad \Delta G° = -1010.5$ kJ/mol

kJ/mol

43. What is the change in entropy that occurs when 22.0 g of acetone (C_3H_6O) freezes at its melting point (−94.8 °C). The enthalpy of vaporization, ΔH_{vap}, is 32.0 kJ/mol and the enthalpy of fusion, ΔH_{fus}, is 5.69 kJ/mol for acetone.

J/K

44. At 298 K, the formation of ammonia has a negative ΔS°_{sys}. Calculate ΔS°_{univ}, and state whether the reaction occurs spontaneously at this temperature.

$$N_2(g)+3\ H_2(g)\rightarrow 2\ NH_3(g) \quad \Delta S^\circ_{sys} = -197\ J/K$$

A. What is the ΔH°_{rxn}? ($\Delta H^\circ_f\ NH_3$ = -45.9 kJ/mol)

[ ] kJ

B. What is the ΔS_{surr}?

[ ] J/K

C. What is the calculated value of ΔS°_{univ}?

[ ] J/K

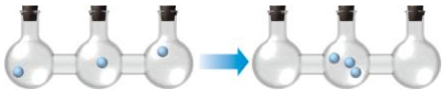
D. Is the reaction spontaneous (A) or non-spontaneous (B)

[ ]

45. Entropy usually increases when:

I. A molecule decomposes into two smaller molecules

II. A reaction that results in the increase in the number of moles of gas

III. 

IV. Vaporization of a liquid

A. I, II, III, and IV
B. I, II, and III
C. I, II, and IV
D. I and II
E. II only

[ ]

46. If a chemical transformation is determined to be spontaneous, however no transformation is observed, which reasons could be valid for this observation? (Select all that apply)

A. The transformation has a high activation energy
B. The transformation has a low activation energy
C. The transformation is exothermic
D. The transformation is endothermic
E. The transformation is only spontaneous at very high or very low temperatures.

47. What is the percent by mass of a KCl solution prepared by dissolving 23.4 g of KCl in 10.5 mol water?

A. 0.028%
B. 1.59%
C. 11.0%
D. 12.4%
E. None of the above

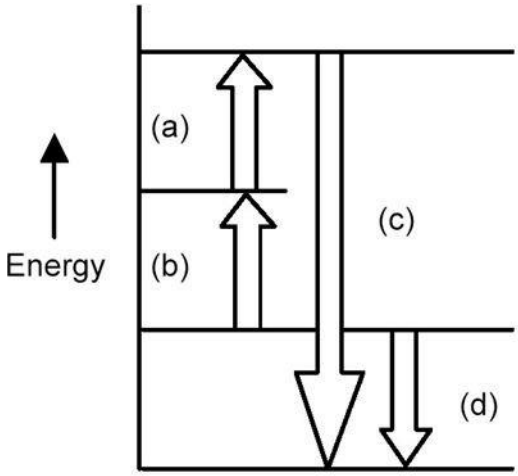
48. Brine is a common solution used in research labs, typically recognizable as having at least 1 inch of solid NaCl resting at the bottom of the container. Brine would be considered a _____ solution.

A. Concentrated
B. Dilute
C. Unsaturated
D. Saturated
E. Supersaturated

49. Arrows in this energy diagram represent enthalpy changes occurring in the exothermic formation of a solution:

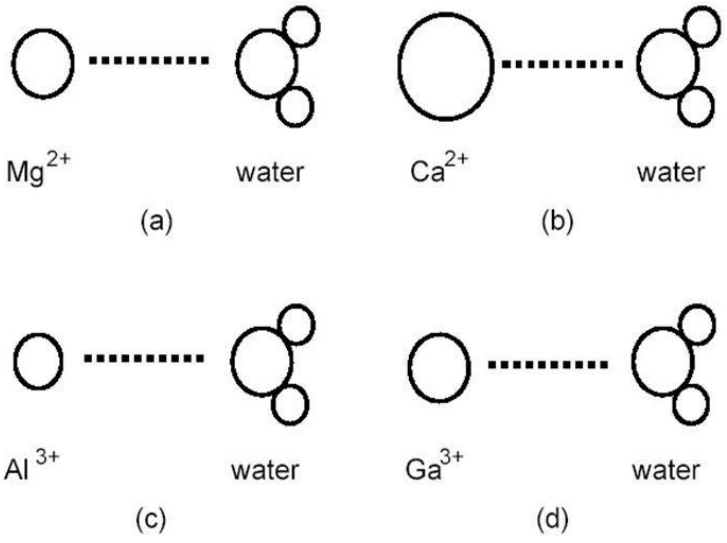
ΔHsoln = enthalpy of solution
ΔHsolute-solute = enthalpy change involving solute-solute interactions
ΔHsolute-solvent = enthalpy change involving solute-solvent interactions
ΔHsolvent-solvent = enthalpy change involving solvent-solvent interactions
Which arrow represents ΔH_{soln}?

A. arrow (a)
B. arrow (b)
C. arrow (c)
D. arrow (d)

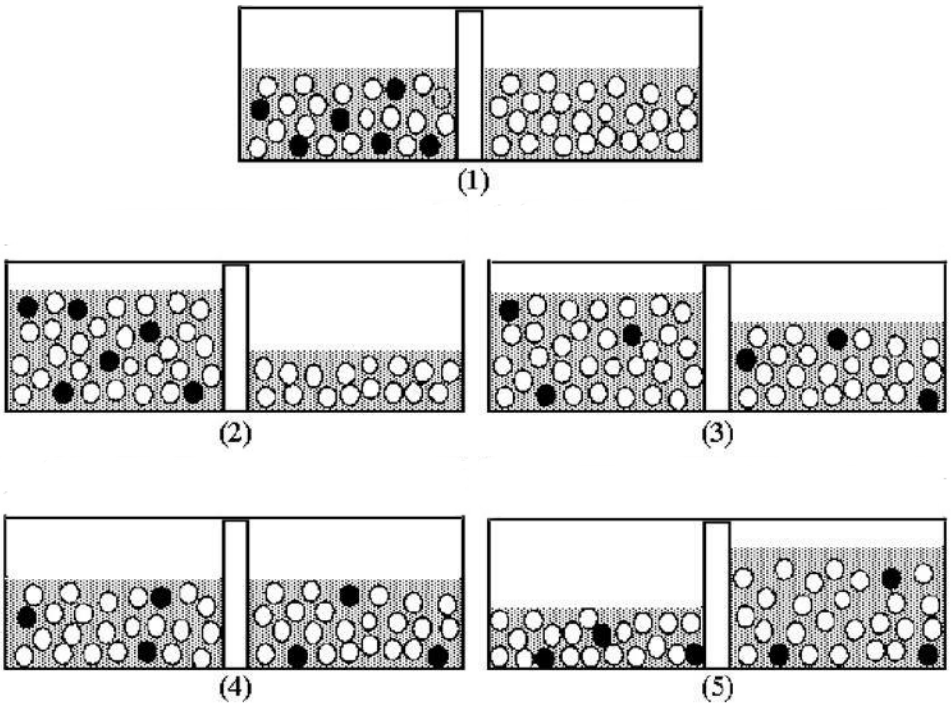


50. Which ion-dipole interaction results in the larger (more negative) hydration energy?

A. diagram (a)
B. diagram (b)
C. diagram (c)
D. diagram (d)

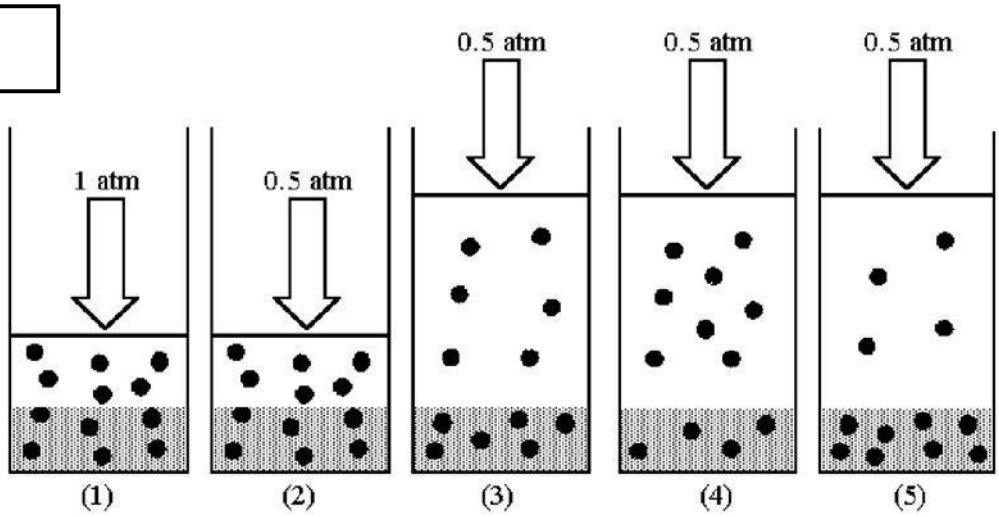


51. Drawing (1) shows a nonequilibrium system comprised of pure water separated from an aqueous solution by a semipermeable membrane. Shaded spheres represent solute particles and unshaded spheres represent water molecules. Which drawing (2)-(5) represents this system after equilibrium is reached?



A. drawing (2)
B. drawing (3)
C. drawing (4)
D. drawing (5)

52. Drawing (1) shows a system in which an equilibrium exists between dissolved and undissolved gas particles at P = 1 atm. According to Henry's law, if the pressure is decreased to 0.5 atm and equilibrium is restored, which drawing (2)-(5) best represents the equilibrium at 0.5 atm?



A. drawing (2)
B. drawing (3)
C. drawing (4)
D. drawing (5)

53. Isoamyl salicylate (*molar mass* = 208.25 g/mol) has a pleasant aroma and is used in perfumes and soaps. What is the molality of the solution if 117.2 g of isoamyl salicylate is dissolved in 950.0 mL of ethyl alcohol? Density of ethyl alcohol is 0.7893 g/mL.

m

54. Which of the statements is **true** for aqueous solutions of 3.0 *m* KBr and 3.0 *m* $Ni(NO_3)_2$?

A. The KBr solution has a lower freezing point and higher vapor pressure than the $Ni(NO_3)_2$ solution

B. The KBr solution has a lower freezing point and lower vapor pressure than the $Ni(NO_3)_2$ solution

C. The KBr solution has a higher freezing point and higher vapor pressure than the $Ni(NO_3)_2$ solution

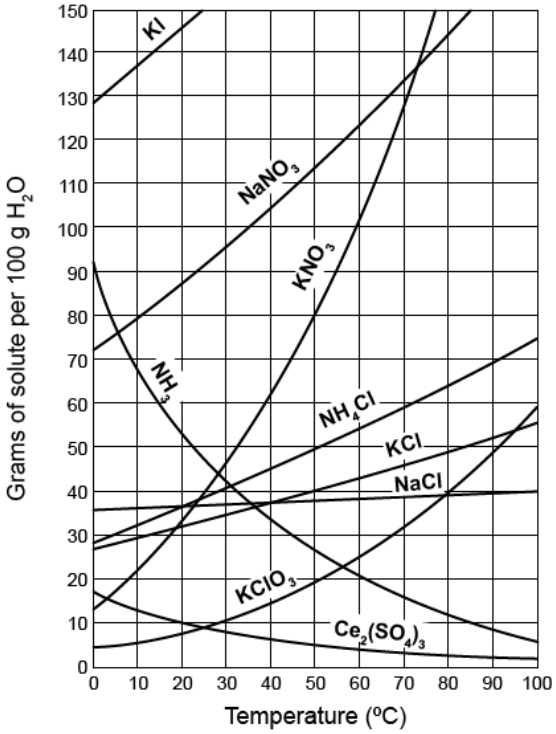
D. The KBr solution has a higher freezing point and lower vapor pressure than the $Ni(NO_3)_2$ solution

E. None of the statements are true

55. A handbook lists the value of the Henry's Law constant as 6.100×10^{-4} mol/L·atm for nitrogen, N_2, dissolved in water at 25 °C. Calculate the mole fraction of nitrogen in water at a nitrogen partial pressure of 292 torr. The density of this solution is 1.00 g/mL.

56. Which of these statements is true, after 40. g of NaCl is added to 100. g of water at 90 °C? (*Select all that apply*)

A. The solution is supersaturated at this temperature
B. The solution is saturated at this temperature
C. The change in the Gibbs free energy of the dissolution of the solute at this temperature is zero
D. The concentration of the solution increases when more NaCl is added at this temperature



57. A sample of homemade whiskey from a cheap backyard still has a mole fraction of ethanol of 0.350. What would be the mole fraction of the ethanol ***in the vapor*** of this sample at 40.0 °C? At 40.0 °C the vapor pressure of H_2O is 55.0 mm Hg and ethanol is 135 mm Hg.

58. A solution of sucrose (sugar) in water is in equilibrium with solid sucrose. If more solid sucrose is now added, with stirring,

A. the concentration of the solution will increase.
B. the concentration of the solution will decrease.
C. the concentration of the solution will remain the same.
D. the volume of solution will increase.
E. a supersaturated solution will be produced.

59. What is the molarity of a solution that is 26.0% by mass phosphoric acid (H_3PO_4) and that has a density of 1.155 g/mL? Molar mass of H_3PO_4 is 97.994 g/mol.

A. 2.30×10^{-3} M
B. 2.30 M
C. 2.65 M
D. 3.06 M
E. 0.265 M

60. What is the percent $CdSO_4$ by mass in a 1.00 molal aqueous $CdSO_4$ solution? Molar mass of $CdSO_4$ is 208.47 g/mol.

A. 0.001%
B. 0.10%
C. 17.2%
D. 20.8%
E. 24.4%

61. Below is a list of various solutes dissolved in water to give solutions with different molal concentrations. Which of the solutions below has the **lowest** freezing point?

A. 0.60 m CH2O
B. 0.010 m $Cd(NO_3)_2$
C. 0.30 m $HC_2H_3O_2$
D. 0.50 m $MgCl_2$
E. 0.20 m $Ca_3(PO_4)_2$

62. A solution of potassium hydroxide is in equilibrium with undissolved solute at 45 °C. What will happen if the temperature is raised to 50 °C? The solubility of potassium hydroxide increases as temperature increases.

A. the mass of undissolved KOH will increase.
B. the mass of undissolved KOH will decrease.
C. the mass of undissolved KOH will be unchanged.
D. the mass of water in the solution will increase.
E. the entropy of the system will decrease.

63. You have just discovered the new compound “Funorium”, and you want to determine if “Funorium” is an electrolyte or a non-electrolyte. You start by dissolving 0.941 g of “Funorium” in 29.88 mL of ethanol (C_2H_5OH) and determine that the boiling point of the solution is 79.87 °C. Is “Funorium” an electrolyte or a non-electrolyte? (The density of pure ethanol is 0.7892 g/cm^3, the boiling point is 78.37 °C, and K_b ethanol = 1.2 °C/*m*. The molar mass of “Funorium” is 70.01 g/mol)

A. Funorium is an electrolyte because its Van’t Hoff factor is greater than 1
B. Funorium is a non-electrolyte because its Van’t Hoff factor is 1
C. More information is needed

64. Gatorade contains 2.70 g of NaCl and 3.10 g sucrose ($C_{12}H_{22}O_{11}$) in 236.6 ml of the drink. What are the mole fractions of the NaCl and sucrose in the sports drink?
Note: assume that the density of Gatorade is 1.08 g/mL, molar mass: NaCl 58.44 g/mol, sucrose 342.3 g/mol, water 18.02 g/mol.

1. Mole fraction NaCl: [ ]

2. Mole fraction sucrose: [ ]

65. Cinnamaldehyde (molar mass = 132.15 g/mol) is used as a flavoring agent. What mass of cinnamaldehyde must be added to 175 g of ethanol to give a solution whose boiling point is 82.7°C? (K_b = 1.22°C/*m*, boiling point of pure ethanol = 78.5 °C.)

[ ]

A. 62.4 g
B. 67.8 g
C. 76.2 g
D. 78.5 g
E. 79.6 g

Formula Sheet

Length
1 kilometer = 0.62137 mile
1 inch = 2.54 centimeters (exactly)
1 Ångstrom = 1×10^{-10} meter

Energy
1 joule = 1 kg·m^2/s^2
1 calorie = 4.184 joules
1 Calorie = 1 kilocalorie = 1000 calories
1 L·atm = 101.325 joules

Pressure
1 pascal = 1 N/m^3 = 1 kg/m·s^2
1 atmosphere = 101.325 kilopascals = 760 mm Hg = 760 torr = 14.70 lb/in^2
1 bar = 1×10^5 Pa (exactly)

Temperature
0 K = −273.15°C
K = °C + 273.15
°C = (5/9)(°F − 32)

Mass
1 kg = 2.205 lbs

Volume
1 mL = 1 cm^3 = 1 cc

Constants
c = 2.998×10^8 m/sec
h = 6.626×10^{-34} J·sec^{-1}
R = 0.08206 L·atm/mol·K = 8.314 J/mol·K
Specific heat of water = 4.184 J/g·K
Mass of an electron: 9.109 x 10^{-31} kg
Mass of a proton: 1.673 x 10^{-27} kg
RH = 2.18 x 10^{-18} J
Specific heat of water = 4.184 J/g·K
STP = 273.15 K and 1 atm
Avogadro's number: 6.022×10^{23}

Equations
d (density) = m/V
$P_1V_1=P_2V_2$
$V_1/T_1=V_2/T_2$
$P_1V_1/n_1T_1=P_2V_2/n_2T_2$
PV=nRT
$(P + a(n^2/V^2))\cdot(V - nb) = nRT$
molar mass (M) = mRT/PV
density (d) = MP/RT
$x_A = n_A/n_{tot} = P_A/P_{tot} = V_A/V_{tot}$
$P_{tot} = P_A + P_B + \ldots$
$n_{tot} = n_A + n_B + \ldots$

$$\mu_{rms} = \sqrt{\frac{3RT}{M}}$$

$$\frac{Rate\ of\ effusion\ A}{Rate\ of\ effusion\ B} = \sqrt{\frac{MW_B}{MW_A}}$$

$Q = C \times \Delta T = c_{specific} \times m \times \Delta T$
$Q = n \times \Delta H\ (kJ/mol) = m \times \Delta H\ (kJ/g)$
$w = -P\Delta V$
$\Delta E = q + w$
$\Delta H° = \Sigma n\Delta Hf°(products) - \Sigma n\Delta Hf°(reactants)$
$\Delta H° = \Sigma n\Delta H°(bonds\ broken) - \Sigma n\Delta H°(bonds\ formed)$
$E=h\nu$
$c=\lambda\nu$
$\lambda = h/m\nu$

$$\Delta E = -2.18 \times 10^{-18} J(\frac{1}{n_f^2} - \frac{1}{n_i^2})$$

$$\ln\left(\frac{P_2}{P_1}\right) = \frac{\Delta H_{vap}}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$$

$C_g = kP_g$
$P_{solution}=P_{solvent}\ X_{solvent}$
$P_{solution}=\sum P_j=\sum P_j X_j$
$\Delta T_b = K_b m i$
$\Delta T_f = K_f m i$
$\pi = MRTi$

Thermodynamic and Electrochemistry

$S = k_b \times \ln(W)$
$k_b = 1.381 \times 10^{-23}\ J/K$
$\Delta S = q_{rev}/T$
$\Delta S_{surr} = q_{surr}/T = -q_{rev}/T$
$\Delta S_{univ} = \Delta S_{sys} + \Delta S_{surr}$
$\Delta S°_{rxn} = \Sigma \nu S°_{products} - \Sigma \nu S°_{reactants}$
$\Delta H°_{rxn} = \Sigma \nu H°_{products} - \Sigma \nu H°_{reactants}$
$\Delta G°_{rxn} = \Sigma \nu G°_{products} - \Sigma \nu G°_{reactants}$
$\Delta G = \Delta H - T\Delta S$
$\Delta G = \Delta G° + RT \cdot \ln Q$
$R=8.314\ J/mol.K$
$\Delta G° = -RT \cdot \ln K$
$\Delta G= -nFE_{cell}$
$F = 96485\ J/(V \cdot mol\ e^-)$
$E°_{cell} = RT/nF\ \ln K$
$E°_{cell} = (0.0257/n)\ \ln K = (0.0592/n)\ \log K$
$E_{cell} = E°_{cell} - (RT/nF)\ \ln Q$
$E_{cell} =E°_{cell} - (0.0257/n)\ \ln Q$
Electrolysis: Q (total charge) = I × t = n × F

Integrated Rate Laws & half-life

$$\ln\frac{[A]}{[A]_0} = -kt$$

$$\frac{1}{[A]} = kt + \frac{1}{[A]_0}$$

$$[A] = -kt + [A]_0$$

$$t_{1/2} = \frac{[A]_0}{2k}$$

$$t_{1/2} = \frac{\ln 2}{k} = \frac{0.693}{k}$$

$$t_{1/2} = \frac{1}{k[A]_0}$$

$$ln\frac{k_2}{k_1} = -\frac{\mathrm{E_a}}{\mathrm{R}}(\frac{1}{\mathrm{T_2}} - \frac{1}{\mathrm{T_1}})$$

Equilibrium and Acid / Base

$K_P = K_c \times (RT)^{\Delta n}$

$pH = -\log[H_3O^+]$

$K_w = 1.0 \times 10^{-14}$ at 25 °C

$K_w = [H_3O^+] \times [OH^-]$

$K_w = K_a \times K_b$

$pK_a = -\log[K_a]$

Buffer: $pH = pK_a + \log\frac{[A^-]}{[HA]}$

$$ln\frac{K_2}{K_1} = \frac{\Delta H^\circ_{rxn}}{R}(\frac{1}{T_1} - \frac{1}{T_2})$$

Periodic Table of the Elements

1												13	14	15	16	17	18
1 H 1.01	2																2 He 4.00
3 Li 6.94	4 Be 9.01											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
11 Na 22.99	12 Mg 24.31	3	4	5	6	7	8	9	10	11	12	13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.06	17 Cl 35.45	18 Ar 39.95
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.87	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.38	31 Ga 69.72	32 Ge 72.63	33 As 74.92	34 Se 78.97	35 Br 79.90	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.95	43 Tc [97]	44 Ru 101.07	45 Rh 102.91	46 Pd 106.42	47 Ag 107.87	48 Cd 112.41	49 In 114.82	50 Sn 118.71	51 Sb 121.76	52 Te 127.60	53 I 126.90	54 Xe 131.29
37 Cs 132.91	56 Ba 137.33		72 Hf 178.49	73 Ta 180.95	74 W 183.84	75 Re 186.21	76 Os 190.23	77 Ir 192.22	78 Pt 195.08	79 Au 196.97	80 Hg 200.59	81 Tl 204.38	82 Pb 207.2	83 Bi 208.98	84 Po [209]	85 At [210]	86 Rn [222]
87 Fr [223]	88 Ra [226]		104 Rf [267]	105 Db [268]	106 Sg [269]	107 Bh [270]	108 Hs [269]	109 Mt [277]	110 Ds [281]	111 Rg [282]	112 Cn [285]	113 Nh [286]	114 Fl [290]	115 Mc [290]	116 Lv [293]	117 Ts [294]	118 Og [294]

57 La 138.91	58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm [145]	62 Sm 150.36	63 Eu 151.96	64 Gd 157.25	65 Tb 158.93	66 Dy 162.50	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.05	71 Lu 174.97
89 Ac [227]	90 Th 232.04	91 Pa 231.04	92 U 238.03	93 Np [237]	94 Pu [244]	95 Am [243]	96 Cm [247]	97 Bk [247]	98 Cf [251]	99 Es [252]	100 Fm [257]	101 Md [258]	102 No [259]	103 Lr [262]