MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

1) A solid has a very high melting point, great hardness, and poor electrical conduction. This is a(n) ________ solid.
   A) covalent network  
   [Correct answer: Page 472]
   B) ionic
   C) metallic
   D) metallic and covalent network
   E) molecular

2) Which one of the following is most soluble in hexane (C\textsubscript{6}H\textsubscript{14})?  
   A) CH\textsubscript{3}CH\textsubscript{2}OH
   B) CH\textsubscript{3}CH\textsubscript{2}CH\textsubscript{2}CH\textsubscript{2}CH\textsubscript{2}OH  
   [Correct answer: Page 538]
   C) CH\textsubscript{3}CH\textsubscript{2}CH\textsubscript{2}OH
   D) CH\textsubscript{3}OH
   E) CH\textsubscript{3}CH\textsubscript{2}CH\textsubscript{2}CH\textsubscript{2}OH
3) Which of the following choices has the compounds correctly arranged in order of increasing solubility in water? (least soluble to most soluble)

A) CH$_4$ < NaNO$_3$ < CHCl$_3$
B) LiF < NaNO$_3$ < CHCl$_3$
C) CH$_3$OH < CI$_4$ < CHCl$_3$
D) CH$_3$OH < CH$_4$ < LiF
E) CCl$_4$ < CHCl$_3$ < NaNO$_3$

Correct answer
most non polar is CCl$_3$.
CHCl$_3$ is polar
NaNO$_3$ is ionic.

4) The concentration of nitrate ion in a solution that contains 0.900 M aluminum nitrate is ________ M.

A) 2.70
   you need to know Al(NO$_3$)$_3$
   CH 115
B) 0.900
C) 0.300
D) 0.450
E) 1.80

5) A saturated solution ________.

A) contains no double bonds
B) cannot be attained
C) contains as much solvent as it can hold
D) contains dissolved solute in equilibrium with undissolved solid
   Page 536
E) will rapidly precipitate if a seed crystal is added
6) Which of the following liquids will have the lowest freezing point?

A) pure H$_2$O
B) aqueous glucose (0.60 m)
C) aqueous FeI$_3$ (0.24 m) **0.72 m concentration of solute particles.**
D) aqueous KF (0.50 m) **Correct answer** **1.0 m concentration of solute particles.**
E) aqueous sucrose (0.60 m)

7) Which one of the following is not a valid expression for the rate of the reaction below?

$$4\text{NH}_3 + 7\text{O}_2 \rightarrow 4\text{NO}_2 + 6\text{H}_2\text{O}$$

A) $-\frac{1}{4} \frac{\Delta\text{[NH}_3]}{\Delta t}$
B) $\frac{1}{4} \frac{\Delta\text{[NO}_2]}{\Delta t}$
C) $-\frac{1}{7} \frac{\Delta\text{[O}_2]}{\Delta t}$
D) $\frac{1}{6} \frac{\Delta\text{[H}_2\text{O}]}{\Delta t}$
E) **All of the above are valid expressions of the reaction rate.**

8) The rate law of a reaction is rate = $k[D][X]$. The units of the rate constant are __________.

A) mol L$^{-1}$s$^{-2}$
B) mol L$^{-1}$s$^{-1}$
C) L$^2$ mol$^{-2}$s$^{-1}$
D) L mol$^{-1}$s$^{-1}$ **Correct Answer**

\[ k = \text{rate}/[D][X] = \frac{\text{moles}}{\text{L}/\text{s}} = \frac{1}{\text{moles}/\text{r}} \times \frac{\text{L}}{\text{moles} \times \text{s}} = \text{L s}^{-1} \text{moles}^{-1} \]
E) mol$^2$ L$^{-2}$s$^{-1}$
The data in the table below were obtained for the reaction:

\[ 2 \text{ClO}_2 (aq) + 2 \text{OH}^- (aq) \rightarrow \text{ClO}_3^- (aq) + \text{ClO}_2^- (aq) + \text{H}_2\text{O} (1) \]

<table>
<thead>
<tr>
<th>Experiment Number</th>
<th>[ClO₂] (M)</th>
<th>[OH⁻] (M)</th>
<th>Initial Rate (M/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.060</td>
<td>0.030</td>
<td>0.0248</td>
</tr>
<tr>
<td>2</td>
<td>0.020</td>
<td>0.030</td>
<td>0.00276</td>
</tr>
<tr>
<td>3</td>
<td>0.020</td>
<td>0.090</td>
<td>0.00828</td>
</tr>
</tbody>
</table>

9) What is the overall order of the reaction?  
A) 1  
B) 0  
C) 2  
D) 4  
E) 3  

The reaction is First order with respect to OH⁻ and second order with respect to ClO₂.  
Overall reaction rate is 1+2=3  
Page 586

The reaction \( A \rightarrow B \) is first order in \([A]\). Consider the following data.

<table>
<thead>
<tr>
<th>time (s)</th>
<th>[A] (M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>1.60</td>
</tr>
<tr>
<td>10.0</td>
<td>0.40</td>
</tr>
<tr>
<td>20.0</td>
<td>0.10</td>
</tr>
</tbody>
</table>

10) The half-life of this reaction is _________ s.  
A) 3.0  
B) 7.1  
C) 0.14  
D) 0.97  
E) 5 _______  
Correct Answer  
Just read the table for \([A]=0.8\text{M}\)

11) A reaction was found to be third order in A. Increasing the concentration of A by a factor of 3 will cause the reaction rate to _________.  
A) decrease by a factor of the cube root of 3  
B) increase by a factor of 9  
C) triple  
D) increase by a factor of 27  
Correct answer  
Page 586.
E) remain constant
12) At elevated temperatures, methylisonitrile (CH₃NC) isomerizes to acetonitrile (CH₃CN):

\[ \text{CH₃NC (g)} \rightarrow \text{CH₃CN (g)} \]

The reaction is first order in methylisonitrile. The attached graph shows data for the reaction obtained at 198.9°C.

The rate constant for the reaction is \( \text{________ s}^{-1} \).

A) \(-5.2 \times 10^{-5}\)  
B) +6.2  
C) \(+1.9 \times 10^4\)  
D) \(-1.9 \times 10^4\)  
E) \(+5.2 \times 10^{-5}\)

**Correct Answer**

**The slope of this line is \(-k\), the rate constant**.
13) Nitrogen dioxide decomposes to nitric oxide and oxygen via the reaction:

$$2\text{NO}_2 \rightarrow 2\text{NO} + \text{O}_2$$

In a particular experiment at 300°C, $[\text{NO}_2]$ drops from 0.0100 to 0.00650 M in 100 s. The rate of appearance of O$_2$ for this period is ________ M/s.

A) 7.0 $\times$ 10$^{-3}$
B) 1.8 $\times$ 10$^{-5}$

Correct answer

\[
\text{Rate} = \frac{\text{change in concentration}}{\text{change in time}} = \frac{(0.0100 - 0.0065) \text{ M}}{100} = 3.5 \times 10^{-5} \text{ M/s} = \text{Rate of disappearance of NO}_2
\]

\[
\text{Rate of appearance of Oxygen} = \frac{1}{2} \times \text{Rate of disappearance of NO}_2 = 1.89 \times 10^{-5}
\]

C) 7.0 $\times$ 10$^{-5}$
D) 3.5 $\times$ 10$^{-5}$
E) 3.5 $\times$ 10$^{-3}$
14) A sample of potassium nitrate (49.0 g) is dissolved in 101 g of water at 100 °C, with precautions taken to avoid evaporation of any water. The solution is cooled to 30.0 °C and no precipitate is observed. This solution is __________.

A) unsaturated
B) placated
C) supersaturated
D) saturated
E) hydrated

At 30 °C 100 g water can dissolve only 45 g KNO₃
What chemical equation is consistent with the data given above:

A) \( A \rightarrow 2C \)
   **Correct answer**
   As the key shows the wrong answer, and I failed to notice everyone is getting the points for this question.

B) \( A \rightarrow C \)

C) \( C \rightarrow A \)

D) \( C \rightarrow 2A \)
16) What is the osmotic pressure (in atm) of a 0.040 M solution of a non-electrolyte at 30.0 °C? 

\[ \text{P} = \frac{n}{V} \times \frac{RT}{M} \]

\[ 0.40 \text{ mol/L} \times \frac{0.0821 \text{ L atm/mol K}}{303 \text{ K}} \times 0.9950 \text{ atm} = \text{0.9950 atm} \]

17) A solution contains 150.8 grams of NaCl in 678.3 grams of water. Calculate the vapor pressure lowering (in torr) of the solution at 25.0 °C. (Note: the vapor pressure of pure water at 25.0 °C is 23.76 torr.)

\[ 150 \text{ g NaCl} \times \frac{1 \text{ mole}}{58.5 \text{ g}} = 2.5641 \text{ moles} \]

\[ 678.3 \text{ g H}_2\text{O} \times \frac{1 \text{ mole}}{18 \text{ g}} = 37.68 \text{ moles} \]

Mole fraction of water, \( X = \frac{37.68}{37.68 + 2.5641} = 0.9359 \)

\[ P_A = X P_o = 0.9359 \times 23.76 = 22.23 \text{ torr} \]

Change in pressure = 23.76 - 22.23 = 1.52 torr

The Version B:
18) For the reaction \( aA + Bb \rightarrow cC + dD \) the rate law is \( \text{Rate} = k[A]^m[B]^n \).

19) For the following reaction indicate how the rate of disappearance of each reactant is related to the rate of appearance of each product:

\[ 2N_2O (g) \rightarrow 2N_2(g) + O_2(g) \]

\[ \frac{1}{2} \frac{[\Delta N_2O]}{\Delta t} = \frac{1}{2} \frac{[\Delta N_2]}{\Delta t} = \frac{[\Delta O_2]}{\Delta t} \]
20) Consider the above graph of the concentration of a substance over time.

a. Is X a reactant or a product ________________________________
   
   **Product**

b. Why is the average rate of the reaction greater between 1 and 2 than between 2 and 3.

   **Because the amount of the reactant is reducing as the time goes by and the rate of the reaction is dependent on it.**
21) A solution of unknown nonvolatile electrolyte was prepared by dissolving 0.250 g of the substance in 40.0 g of CCl₄. The boiling point of the resultant solution was 0.357 °C higher than the pure solvent. Calculate the molar mass of the solute.

Kb for CCl₄ = 5.02 °C/m

\[ \text{Molality} = \frac{\Delta T_b}{K_b} = \frac{0.375 \degree C}{5.02 \degree C/m} = 0.0711 m \]

\[ \text{Molarity} = \frac{\text{moles of substance}}{\text{Kg of solvent}} \]

\[ \text{moles} = \text{Molality} \times \text{Kg of solvent} = 0.0711 \text{ m} \times 0.04 \text{ Kg} = 2.84 \times 10^{-3} \text{ moles} \]

\[ \text{Molar mass} = \frac{\text{mass}}{\text{moles}} = \frac{0.250 \text{ g}}{2.84 \times 10^{-3} \text{ moles}} = 88.0 \text{ g/mole of substance} \]

22) The decomposition of N₂O₅ in a solvent proceeds as follows:

\[ 2\text{N}_2\text{O}_5 \rightarrow 4\text{NO}_2 + \text{O}_2 \]

The rate is first order in N₂O₅. At 64°C, the rate constant is \(4.82 \times 10^{-3}/\text{s}\).

(a) Write the rate law of the reaction.

\[ R = k [\text{N}_2\text{O}_5] \]

(b) What is the rate of the reaction when \([\text{N}_2\text{O}_5]\) = 0.0240 M

\[ R = 4.82 \times 10^{-3}/\text{s} \times 0.0240 \text{ M} = 0.200 \text{ M/s} \]

\[ = 1.16 \times 10^{-4} \text{ M/s} \]

For version B

\[ R = 5.82 \times 10^{-3}/\text{s} \times 0.0240 \text{ M} = 0.13968 \text{ M/s} \]

\[ = 1.39 \times 10^{-4} \text{ M/s} \]
(c) What happens to the rate of the when the concentration of $\text{N}_2\text{O}_5$ is doubled to 0.0480M?

The rate doubles when the concentration of $\text{N}_2\text{O}_5$ doubles.

$$R = 4.82 \times 10^{-3} \text{ /s} \times 0.0480 \text{ M} = 2.31 \times 10^{-4} \text{ M/s}$$

Version B

The rate doubles when the concentration of $\text{N}_2\text{O}_5$ doubles.

$$R = 5.82 \times 10^{-3} \text{ /s} \times 0.0480 \text{ M} = 2.79 \times 10^{-4} \text{ M/s}$$
1) A
2) B
3) E
4) A
5) D
6) D
7) E
8) D
9) E
10) E
11) D
12) C
13) B
14) C
15) B
16) 1.0
17) 2.85
18) k[A]^n[B]^m
19)
20)
21)
22)