This print-out should have 30 questions. Multiple-choice questions may continue on the next column or page – find all choices before answering. V1:1, V2:1, V3:1, V4:1, V5:2.

Please make sure you write your version numbers on your scantron. Good luck!

**Mlib 65 7088**
14:01, general, multiple choice, > 1 min, fixed.  
001 (part 1 of 1) 6 points

The process of steam condensing to form liquid water is

1. an exothermic chemical reaction.

2. an endothermic phase change.

3. neither endothermic nor exothermic.

4. an exothermic phase change. **correct**

5. an endothermic chemical reaction.

**Explanation:**
Solid $\rightarrow$ liquid $\rightarrow$ gas is endothermic because each consecutive phase has more energy/heat. Thus gas $\rightarrow$ liquid $\rightarrow$ solid is exothermic because energy is conserved and is a state function. Phase changes are physical changes, not chemical changes.

**Mlib 04 4001**
16:04, basic, multiple choice, > 1 min, fixed.  
003 (part 1 of 1) 6 points

A decrease in temperature usually (decreases, increases, does not change) the solubility of salts in water.

1. decreases **correct**

2. does not change

3. increases

**Explanation:**
Most salts are less soluble at lower temperature.

**ChemPrin3e T08 30**
14:10, general, multiple choice, < 1 min, fixed.  
004 (part 1 of 1) 6 points

The phase diagram for a pure substance is given below.

What pressure must be applied to liquefy a sample at 425 K?

1. 350 atm
2. The sample cannot be liquefied at 425 K. **correct**

3. 150 atm

4. 50 atm

5. 250 atm

**Explanation:**

The phase diagram for a pure substance is given below.

The substance is stored in a container at 150 atm at 25°C. Describe what happens if the container is opened at 25°C.

1. The liquid in the container freezes.
2. The solid in the container sublimes.
3. The solid in the container melts.
4. The vapor in the container escapes.
5. The liquid in the container vaporizes. **correct**

**Explanation:**

The molar heat capacity of C₆H₆(ℓ) is 136 J/mol °C and of C₆H₆(g) is 81.6 J/mol °C. The molar heat of fusion for benzene is 9.92 kJ/mol and its molar heat of vaporization is 30.8 kJ/mol. The melting point of benzene is 5.5°C, its boiling point is 80.1°C, and its molecular weight 78.0 g/mol. How much heat would be required to convert 234 g of solid benzene (C₆H₆(s)) at 5.5°C into benzene vapor (C₆H₆(g)) at 100.0°C?

1. 157.468 kJ **correct**
2. 4931.72 kJ
3. 60.1968 kJ
4. 97.2715 kJ
5. 152.597 kJ

**Explanation:**

$m_{\text{benzene}} = 234 \text{ g}$

$T_1 = 5.5°C$

$T_2 = 100.0°C$

\[
\begin{align*}
234 \text{ g} & \times \frac{\text{mol}}{78.0 \text{ g}} = 3 \text{ mol} \\
C_6H_6(s)_{5.5°C} & \xrightarrow{\text{step 1}} C_6H_6(ℓ)_{5.5°C} \xrightarrow{\text{step 2}} C_6H_6(ℓ)_{80.1°C} \\
& \xrightarrow{\text{step 3}} C_6H_6(g)_{80.1°C} \xrightarrow{\text{step 4}} C_6H_6(g)_{100.0°C}
\end{align*}
\]

Step 1 : \( \frac{9.92 \text{ kJ}}{\text{mol °C}} \times 3 \text{ mol} = 29.76 \text{ kJ} \)

Step 2 : \( \frac{136 \text{ J}}{\text{mol °C}} \times (3 \text{ mol}) \times (80.1 - 5.5)°\text{C} = 30436.8 \text{ J} = 30.4368 \text{ kJ} \)

Step 3 : \( \frac{30.8 \text{ kJ}}{\text{mol °C}} \times (3 \text{ mol}) = 92.4 \text{ kJ} \)

Step 4 : \( \frac{81.6 \text{ J}}{\text{mol °C}} \times (3 \text{ mol}) \times (100.0 - 80.1)°\text{C} = 4871.52 \text{ J} = 4.87152 \text{ kJ} \)

Total = 29.76 kJ + 30.4368 kJ + 92.4 kJ + 4.87152 kJ = 157.468 kJ

**Mlib 04 4013**
For gases that do not react chemically with water, the solubility of the gas in water generally (decreases, increases) with an increase in the pressure of the gas and (decreases, increases) with increasing temperature.

1. increases; decreases correct

2. decreases; increases

3. increases; increases

4. decreases; decreases

**Explanation:**
An increase in pressure means that you have increased the concentration of gas above the solvent surface, thereby increasing the concentration of the gas in the solvent. Increasing the temperature will decrease the solubility of the gas.

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**Sparks solubility 001**

16:02, general, multiple choice, < 1 min, fixed.

008 (part 1 of 1) 6 points

C₆H₁₂ will most likely dissolve in which solvent?

1. H₂O

2. HF

3. NCl₃

4. CCl₄ correct

5. BaCl₂

**Explanation:**
C₆H₁₂ is a nonpolar molecule. Like dissolves like, so the solvent most likely to dissolve C₆H₁₂ will be nonpolar. CCl₄ is nonpolar.

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**Mlib 04 5041y**

17:02, general, multiple choice, > 1 min, fixed.

010 (part 1 of 1) 6 points

Consider two liquids A and B. The vapor pressure of pure A (molecular weight = 50 g/mol) is 225 torr at 25°C and the vapor pressure of pure B (molecular weight = 75 g/mol) is 90 torr at the same temperature. What is the total vapor pressure at 25°C of a solution that is 70% A and 30% B by weight?

1. 76 torr

2. 195 torr correct

3. 135 torr

4. 203 torr

5. 124 torr

6. 115 torr

---
7. 335 torr
8. 108 torr
9. 225 torr

Explanation:
For A,
\[ P^0 = 255 \text{ torr} \quad \text{MW} = 50 \text{ g/mol} \]
For B,
\[ P^0 = 90 \text{ torr} \quad \text{MW} = 75 \text{ g/mol} \]

The mole fractions are \( \frac{7}{9} \) for A and \( \frac{2}{9} \) for B.

\[ \left( \frac{7}{9} \right) (225) + \left( \frac{2}{9} \right) (90) = 175 + 20 = 195 \text{ torr} \]

ChemPrin3e T08 14
18:06, basic, multiple choice, < 1 min, fixed.

011 (part 1 of 1) 6 points
The vapor pressure of methanol at 25°C is 123 torr and its enthalpy of vaporization is 35.3 kJ·mol\(^{-1}\). Estimate the normal boiling point of methanol. Assume the enthalpy of vaporization is independent of temperature.

1. 450 K
2. 342 K correct
3. 315 K
4. 373 K
5. Not enough information is given.

Explanation:

ChemPrin3e T08 72
17:05, general, multiple choice, < 1 min, fixed.

013 (part 1 of 1) 6 points
An animal cell assumes its normal volume when it is placed in a solution with a total solute molarity of 0.3 M. If the cell is placed in a solution with a total solute molarity of 0.1 M,

1. water enters the cell, causing expansion. correct
2. water leaves the cell, causing contraction.
3. the escaping tendency of water in the cell increases.
4. no movement of water takes place.

Explanation:

Msci 14 1112
17:03, general, multiple choice, > 1 min, fixed.

014 (part 1 of 1) 6 points
If the boiling point elevation constant of water is 0.512°C/m, how many moles of sugar would
you put into 1 kg of water to get a boiling point change of about 2°C?

1. 1 mole
2. 2 moles
3. 3 moles
4. 4 moles **correct**
5. 5 moles

**Explanation:**

\[ K_b = 0.512°C/m \]

\[ \Delta T_b = 2°C \]

The boiling point elevation is

\[ \Delta T_b = K_b m, \]

where \( \Delta T_b \) is the increase in temperature above the boiling point, \( K_b \) is a solvent dependent constant and \( m \) is the molality of the solution. The number of moles needed for the BP increase of 2°C is

\[ m = \frac{\Delta T_b}{K_b} = \frac{2°C}{0.512°C/m} = 3.9 \approx 4 \frac{\text{mol}}{\text{kg}} \]

Consider the reaction

\[ \text{C(s)} + \text{CO}_2(\text{g}) \rightarrow 2 \text{CO(}g). \]

At equilibrium at a certain temperature, the partial pressures of CO(g) and CO_2(g) are 1.22 atm and 0.780 atm, respectively. Calculate the value of \( K \) for this reaction.

1. 3.13
2. 2.00
3. 1.91 **correct**
4. 1.56
5. 0.640

**Explanation:**

Consider the reaction

\[ \text{Ni(CO)}_4(\text{g}) \rightarrow \text{Ni(s)} + 4 \text{CO(g)}. \]

If the initial concentration of Ni(CO)_4(g) is 1.0 M, and \( x \) is the equilibrium concentration of CO(g), what is the correct equilibrium relation?

1. \( K_c = \frac{x^4}{1.0 - 4x} \)
2. \( K_c = \frac{x}{1.0 - \frac{4x}{x}} \)
3. \( K_c = \frac{x^4}{1.0 - \frac{x}{4}} \) **correct**
4. \( K_c = \frac{x^5}{1.0 - \frac{x}{4}} \)
5. \( K_c = \frac{4x}{1.0 - 4x} \)

**Explanation:**
21:11, general, multiple choice, > 1 min, normal.

018 (part 1 of 1) 6 points

\[ K_c = 50 \text{ at some temperature for the reaction} \]

\[ \text{H}_2(\text{g}) + \text{I}_2(\text{g}) \rightleftharpoons 2 \text{HI(}\text{g}) \].

If 27.5 mol of HI are introduced into a 10.0 liter vessel, how many moles of I\(_2\) are present at equilibrium?

1. 3.03162 mol correct
2. 3.63794 mol
3. 1.51581 mol
4. 30.3162 mol
5. 4.54742 mol
6. 6.06323 mol

Explanation:

\[ K_c = 50 \]

\[ n_{\text{HI}} = 27.5 \]

\[ [\text{HI}]_{\text{ini}} = \frac{27.5 \text{ mol}}{10 \text{ L}} = 2.75 \text{ M} \]

\[ \text{H}_2(\text{g}) + \text{I}_2(\text{g}) \rightleftharpoons 2 \text{HI(}\text{g}) \]

\[
\begin{array}{c|c|c|c}
\text{ ini, M} & x & x & -2x \\
\text{ eq, M} & x & x & 2.75 - 2x \\
\end{array}
\]

\[ K_c = \frac{[\text{HI}]^2}{[\text{H}_2][\text{I}_2]} = 50 \]

\[ \frac{(2.75 - 2x)^2}{x^2} = 50 \]

\[ \frac{2.75 - 2x}{x} = \sqrt{50} \]

\[ 2.75 - 2x = \sqrt{50} x \]

\[ x = 0.303162 \]

\[ n_{\text{I}_2} = (10.0 \text{ L}) [\text{I}_2] \]

\[ = (10.0 \text{ L}) \left(0.303162 \frac{\text{mol}}{\text{L}}\right) \]

\[ = 3.03162 \text{ mol} \]

21:10, general, multiple choice, < 1 min, fixed. 019 (part 1 of 1) 6 points

Suppose the reaction

\[ A + 3 \text{B} \rightarrow 2 \text{C} \]

has a value of \( K = 10.0 \) at a certain temperature. If 0.5 moles of A, 0.5 moles of B and 0.5 moles of C are placed in a 5 L solution, the reaction

1. shifts to the right.
2. shifts to the left. correct
3. is at equilibrium.
4. shift cannot be determined without the temperature.

Explanation:

\[ K = 10.0 \quad [\text{A}] = [\text{B}] = [\text{C}] = \frac{0.5 \text{ mol}}{5 \text{ L}} \]

\[ Q = \frac{[\text{C}]^2}{[\text{A}][\text{B}]^3} \]

\[ = \frac{(0.5 \text{ mol})^2}{\left(\frac{0.5 \text{ mol}}{5 \text{ L}}\right)^3} \]

\[ = 100 > K = 10.0 \]

\( Q > K \), therefore the reverse reaction will predominate until equilibrium is established and equilibrium shifts to the left.

Msci 17 0622

21:15, general, multiple choice, > 1 min, fixed. 020 (part 1 of 1) 6 points

An acetic acid solution is allowed to come to equilibrium:

\[ \text{CH}_3\text{COOH} + \text{H}_2\text{O} \rightleftharpoons \text{H}_3\text{O}^+ + \text{CH}_3\text{COO}^- \]

If some silver ion (Ag\(^+\)) is then added to the solution, solid silver acetate (CH\(_3\)COOAg) is formed.

The resulting amount of undissociated acetic acid (CH\(_3\)COOH) in the solution would be
1. unchanged from that in the original solution.
2. higher than that in the original solution.
3. lower than that in the original solution. correct
4. zero.

Explanation:
Precipitating out CH$_3$COOAg removes CH$_3$COO$^-$ from the equilibrium system and shifts the equilibrium to the right, dissociating more CH$_3$COOH to replace CH$_3$COO$^-$. 

Sparks equil 006
21:15, general, multiple choice, < 1 min, fixed. 021 (part 1 of 1) 6 points
The reaction

$$A + B \rightleftharpoons C + D$$

is at equilibrium. Increasing the temperature of the reaction causes more C and D to be formed. This reaction is

1. endothermic. correct
2. exothermic.
3. neither endothermic nor exothermic.
4. Cannot tell from the information given

Explanation:

Msci 17 1103
21:05, general, multiple choice, > 1 min, fixed. 022 (part 1 of 1) 6 points
The equilibrium constant $K_p$ is $5.00 \times 10^{17}$ at 25°C for the reaction

$$C_2H_4(g) + H_2(g) \rightleftharpoons C_2H_6(g).$$

From this information, calculate $\Delta G^0$ at 25°C.

1. 101 kJ/mol
2. $-101$ kJ/mol correct
3. $-43.9$ kJ/mol
4. $+43.9$ kJ/mol
5. insufficient information
6. $-996$ J/mol
7. $-517$ kJ/mol

Explanation:

$K_p = 5.00 \times 10^{17}$  $T = 25°C + 273 = 298 K$

$$\Delta G^0 = -RT \ln K$$

$$= (-8.314 \text{ J/mol} \cdot \text{K})(298 \text{ K}) \times \ln (5 \times 10^{17})$$

$$= -1.01 \times 10^5 \text{ J/mol}$$

$$= -101 \text{ kJ/mol}$$

Mlib 07 0057
22:04, basic, multiple choice, > 1 min, fixed. 023 (part 1 of 1) 6 points
Choose the pair of concentrations that cannot be in a given aqueous solution at 25°C.

1. $[H^+] = 10^{-3}$ M : $[OH^-] = 10^{-11}$ M
2. $[H^+] = 10^{-7}$ M : $[OH^-] = 10^{-7}$ M
3. $[H^+] = 10^{-14}$ M : $[OH^-] = 1$ M
4. $[H^+] = 10$ M : $[OH^-] = 10^{-15}$ M
5. All of these can exist correct

Explanation:

DAL 03 0406
22:04, general, multiple choice, < 1 min, fixed. 024 (part 1 of 1) 6 points
While sipping a refreshing glass of ice water, which of the following thoughts about the drink is incorrect?

1. pH = pOH = 7 correct
2. pH = pOH
3. pH > 7

4. pOH > 7

Explanation:
ph = pOH = 7 for pure water at 25°C.

After finding [OH⁻], you can find pH using either method below:
A) pOH = \log(1.81659 \times 10^{-5}) = 4.74074
pH = 14 - 4.74074 = 9.25926
or B) $K_w = [H^+][OH^-] = 1 \times 10^{-14}$
$[H^+] = \frac{K_w}{[OH^-]}$
$= \frac{1 \times 10^{-14}}{1.81659 \times 10^{-5}} = 5.50482 \times 10^{-10}$
pH = \log(5.50482 \times 10^{-10}) = 9.25926

4. pH = 9.26 correct

5. None of these

Explanation:
As mentioned, this is a weak base, so use the equation to calculate weak base [OH⁻] concentration:

$$[\text{OH}^-] = \sqrt{K_b C_b}$$
$$= \sqrt{(6.6 \times 10^{-9}) (0.05)}$$
$$= 1.81659 \times 10^{-5}$$

23:01, general, multiple choice, > 1 min, fixed. 027 (part 1 of 1) 6 points
A solution of 0.2 M boric acid is prepared as an eye wash. What is the approximate pH of this solution? For boric acid $K_a = 7.2 \times 10^{-10}$.

1. pH = 5 correct

2. pH = 3

3. pH = 4

4. pH = 6

5. pH = 7

Explanation:

22:07, general, multiple choice, < 1 min, fixed. 028 (part 1 of 1) 6 points
Of the four compounds HF, HClO₂, NaOH, Ba(OH)₂ which are either strong acids or strong bases in water?
1. All are either strong acids or strong bases.

2. None are strong acids nor strong bases.

3. HClO₂ and NaOH

4. NaOH

5. NaOH and Ba(OH)₂ correct

**Explanation:**
Memorize the strong acids and strong bases. All others are weak. Only NaOH and Ba(OH)₂ are strong; they are strong bases.

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**MiLib 07 1091**
22:09, general, multiple choice, > 1 min, fixed.

029 (part 1 of 1) 6 points
The pH of a human blood sample was measured to be 7.41. What is the \([\text{OH}^-]\) in this blood?

1. \(3.89 \times 10^{-8} \text{ mol/L}\)
2. \(2.57 \times 10^{-7} \text{ mol/L correct}\)
3. 6.59 mol/L
4. Cannot be determined from the information given.
5. \(6.05 \times 10^{-7} \text{ mol/L}\)
6. \(4.12 \times 10^{-7} \text{ mol/L}\)

**Explanation:**
\(\text{pH} = 7.41\)
\[
\text{pOH} = 14 - \text{pH} = 14 - 7.4 = 6.59
\]
\[
[\text{OH}^-] = 10^{-\text{pOH}} = 2.57 \times 10^{-7}
\]

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**Acid Strength 10 23**
23:01, general, multiple choice, > 1 min, wording-variable.

030 (part 1 of 1) 6 points

Arrange the acids
I) hydrogen selenate ion \((\text{HSeO}_4^-)\), \(pK_a = 1.92\);
II) phosphorous acid \((\text{H}_3\text{PO}_3)\), \(pK_{a1} = 2.00\);
III) phosphoric acid \((\text{H}_3\text{PO}_4)\), \(pK_a = 2.12\);
IV) selenous acid \((\text{H}_2\text{SeO}_3)\), \(pK_a = 2.46\);

in *decreasing* order of strengths.

1. I, II, III, IV correct
2. IV, III, II, I
3. I, II, IV, III
4. III, IV, II, I
5. I, III, II, IV
6. IV, II, III, I
7. I, III, IV, II
8. II, IV, III, I
9. None of these
10. Cannot be determined

**Explanation:**
The stronger the acid, the higher the \(K_a\) value and the lower the \(pK_a\) value:
\[
pK_a = -\log(K_a)
\]
\[
K_a = 10^{-pK_a}
\]

I. For the hydrogen selenate ion,
\[
K_a = 10^{-1.92} = 0.0120226
\]

II. For phosphorous acid,
\[
K_a = 10^{-2.00} = 0.01
\]

III. For phosphoric acid,
\[
K_a = 10^{-2.12} = 0.00758578
\]

IV. For selenous acid,
\[
K_a = 10^{-2.46} = 0.00346737
\]

\(\text{HSeO}_4^- > \text{H}_3\text{PO}_3 > \text{H}_3\text{PO}_4 > \text{H}_2\text{SeO}_3\)