Multiple Choice

1. Calculate the work done (in kJ) against atmospheric pressure of 1.0 atm when 500.0 g of zinc dissolves in excess HCl at 30.0°C according to:
   \[ \text{Zn(s)} + 2\text{HCl(aq)} \rightarrow \text{ZnCl}_2(\text{aq}) + \text{H}_2(\text{g}) \]
   A) -22.4   B) -19.3   C) -17.6   D) -15.2

2. A gas is compressed in a cylinder by a constant pressure of 10 atm from a volume of 10.0 L to 2.0 L. If the gas absorbs 250 J of heat from the surroundings. What are the values of q, w and \( \Delta E \) (in J)?

<table>
<thead>
<tr>
<th>q</th>
<th>w</th>
<th>( \Delta E )</th>
</tr>
</thead>
<tbody>
<tr>
<td>A)</td>
<td>+250</td>
<td>+20265</td>
</tr>
<tr>
<td>B)</td>
<td>+250</td>
<td>-18238</td>
</tr>
<tr>
<td>C)</td>
<td>-250</td>
<td>+20265</td>
</tr>
<tr>
<td>D)</td>
<td>+250</td>
<td>+18238</td>
</tr>
</tbody>
</table>

3. The solubility of nitrogen gas at 25°C and 522 mmHg is 4.7 \times 10^{-4} \text{ mol/L}. What is the value of Henry's law constant at 25°C in \text{ mol/L}??
   A) 6.8 \times 10^{-4}   B) 7.5 \times 10^{-4}   C) 8.2 \times 10^{-4}   D) 3.8 \times 10^{-4}

4. Heptane (C\(_7\)H\(_{16}\)) has a vapor pressure of 792 torr at 100°C. At this same temperature, octane (C\(_8\)H\(_{18}\)) has a vapor pressure of 352 torr. What will be the vapor pressure in torr of an ideal solution prepared from 25.0 g of heptane and 85.5 g of octane at 100°C?
   A) 653   B) 564   C) 462   D) 418

5. The vapor pressure of water at 20°C is 17.5 mmHg. What is the vapor pressure over a solution prepared from 200.0 g of table sugar (C\(_{12}\)H\(_{22}\)O\(_{11}\)) and 350.0 g water (in mmHg) at 20°C?
   A) 17.0   B) 16.5   C) 16.0   D) 15.5

6. What is the freezing point (in °C) of an aqueous solution of Glucose (C\(_6\)H\(_{12}\)O\(_6\)) that has a boiling point of 102.5°C (at 1.0 atm)? For water, \( K_b = 1.86 \text{ C/m} \) and \( K_b = 0.52 \text{ C/m} \).
   A) -0.7   B) -8.9   C) -6.3   D) -5.8

7. 0.102 g of a nonelectrolyte dissolved in 100.0 mL water has an osmotic pressure of 28.1 mmHg at 20°C. Calculate the molar mass of this compound (in g/mol).
   A) 297   B) 396   C) 548   D) 663

8. For the hypothetical reaction:
   \[ \text{A + 3B} \rightarrow 2\text{C} \]
   The rate appearance of C given by \( \Delta[C]/\Delta t \) may also be expressed as:
   A) ???   B) ???   C) ???   D) ???
9. For the reaction:

\[ \text{F}_2(\text{g}) + 2\text{Cl}_2\text{O}(\text{g}) \rightarrow 2\text{FClO}_2(\text{g}) + \text{Cl}_2(\text{g}) \]

The following initial rates of reaction have been measured for the given reagent concentrations:

<table>
<thead>
<tr>
<th>Experiment</th>
<th>F(_2) (M)</th>
<th>Cl(_2)O (M)</th>
<th>Rate (M/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.05</td>
<td>0.010</td>
<td>5.0×10(^{-4})</td>
</tr>
<tr>
<td>2</td>
<td>0.05</td>
<td>0.040</td>
<td>2.0×10(^{-3})</td>
</tr>
<tr>
<td>3</td>
<td>0.10</td>
<td>0.010</td>
<td>1.0×10(^{-3})</td>
</tr>
</tbody>
</table>

What of the following is the rate law for this reaction?

A) \(\text{rate} = k \left[\text{F}_2\right] \left[\text{Cl}_2\text{O}\right]^2\)
B) \(\text{rate} = k \left[\text{F}_2\right] \left[\text{Cl}_2\text{O}\right]\)
C) \(\text{rate} = k \left[\text{F}_2\right]^2 \left[\text{Cl}_2\text{O}\right]^2\)
D) \(\text{rate} = k \left[\text{F}_2\right]^2 \left[\text{Cl}_2\text{O}\right]\)

10. A certain first order reaction \(A \rightarrow B\) is 25% complete in 42 min at 25\(^\circ\)C. What is the half life of the reaction (in min)?

A) 84  B) 92  C) 101  D) 120

11. The activation energy \((E_a)\) for the following first-order reaction is 102 kJ/mol.

\[ \text{N}_2\text{O}_5(\text{g}) \rightarrow 2\text{NO}_2(\text{g}) + \frac{1}{2}\text{O}_2(\text{g}) \]

The value of the rate constant \((k)\) is \(1.35\times10^{-4}\) s\(^{-1}\) at 35\(^\circ\)C. What is the value of \(k\) at 0\(^\circ\)C in s\(^{-1}\) unit?

A) \(8.17\times10^{-7}\)  B) \(6.27\times10^{-6}\)  C) \(7.48\times10^{-5}\)  D) \(4.2\times10^{-4}\)

12. Consider the two gaseous equilibria:

\[ \text{SO}_2(\text{g}) + \frac{1}{2}\text{O}_2(\text{g}) \rightleftharpoons \text{SO}_3(\text{g}) \quad K_1 \]
\[ 2\text{SO}_3(\text{g}) \rightleftharpoons 2\text{SO}_2(\text{g}) + \text{O}_2(\text{g}) \quad K_2 \]

The values of the equilibrium constants \(K_1\) and \(K_2\) are related by:

A) \(K_2 = (K_1)^2\)  B) \(\left(K_2\right)^2 = K_1\)
C) \(K_2 = (K_1)^2\)  D) \(K_2 = (K_1)^{-1}\)

13. What are the values of \(K_p\) and \(K_c\) for the reaction:

\[ \text{H}_2\text{O}(l) \rightleftharpoons \text{H}_2\text{O}(g) \]

at 25\(^\circ\)C? Given the vapor pressure of water at 25\(^\circ\)C is 23.8 torr.

A) \(2.38\times10^{-2}\) atm, \(5.82\times10^{-1}\) mol/L  B) \(2.38\times10^{-2}\) atm, \(9.73\times10^{-5}\) mol/L  
C) \(3.13\times10^{-2}\) atm, \(7.66\times10^{-1}\) mol/L  D) \(3.13\times10^{-2}\) atm, \(1.28\times10^{-3}\) mol/L

14. Hydrogen iodide decomposes according to:

\[ 2\text{HI}(g) \rightleftharpoons \text{H}_2(g) + \text{I}_2(g) \quad K_c = 0.0156\text{ at }400\^\circ\text{C}\]
A 0.550 mol sample of HI was injected in a 2.0 L reaction vessel held at 400°C. Calculate (in mol/L) the concentration of H2 at equilibrium?

A) 0.055  B) 0.0275  C) 0.275  D) 0.22

15. For the reaction at equilibrium, which one of the changes below would cause the equilibrium to shift to the left:

\[
2\text{NOBr}(g) \rightleftharpoons 2\text{NO}(g) + \text{Br}_2(g) \quad \Delta H^\circ = 30 \text{ kJ}
\]

A) Remove some NO  
B) Add more NOBr  
C) Compress the gas mixture to a smaller volume  
D) Increase the temperature