Test Form 6

Instructions: You should have with you several number two pencils, an eraser, your 3" x 5" note card, a calculator, and your University ID Card. If you have notes with you, place them in a sealed backpack and place the backpack OUT OF SIGHT or place the notes directly on the table at the front of the room.

Fill in the front page of the Scantron answer sheet with your test form number (listed above), last name, first name, middle initial, and student identification number. Enter the test form number on your Scantron form, but leave the class section number blank.

This exam consists of 25 multiple-choice questions. Each question has four points associated with it. Select the best multiple-choice answer by filling in the corresponding circle on the rear page of the answer sheet. If you have any questions before the exam, please ask. If you have any questions during the exam, please ask the proctor. Open and start this exam when instructed. When finished, place your Scantron form and note card in the appropriate stacks. You may keep the exam packet, so please show your work and mark the answers you selected on it.

Abbreviated Solubility Rules:
Rule 1: All nitrates, group 1A metal salts and ammonium salts are soluble.
Rule 2: All carbonates, hydroxides, phosphates and sulfides are insoluble.
Rule 3: Rule 1 always takes precedent.

<table>
<thead>
<tr>
<th>R = 0.0821 ( \frac{L \cdot atm}{mol \cdot K} )</th>
<th>R = 8.314 ( \frac{kg \cdot m^2}{s^2 \cdot mol \cdot K} )</th>
<th>( \mu_{rms} = \sqrt{\frac{3RT}{Molar \ Mass}} )</th>
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<td>PV = nRT</td>
<td>760 Torr = 1 atm = 760 mm Hg</td>
<td>K = 273.15 + °C</td>
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<td>( \frac{PV_1}{n_1T_1} = \frac{PV_2}{n_2T_2} )</td>
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<td>milli (m) = 1/1000</td>
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<tr>
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<tr>
<td>Ice</td>
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<td>Steam</td>
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<td>Benzene</td>
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<td>Wood (typical)</td>
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**Periodic Table of the Elements**
1. Which of the following selections contains only acids?

   (A) CH₄, CH₃CH₃, CH₂CH₂CH₂CH₃, CH₃CH₂CH₂CH₃.
   (B) HNO₃, NaNO₃, HCl, NaCl.
   (C) NaOH, KOH, NH₄OH, Ca(OH)₂.
   (D) HNO₃, HCl, NH₃.
   (E) H₂SO₄, HNO₃, HCl, CH₃COOH.

2. Consider fuel cells. Which of the following is false?

   (A) A hydrogen fuel cell produces energy.
   (B) The hydrogen fuel cell demonstrated in class produced water.
   (C) The hydrogen fuel cell demonstrated in class contains platinum to facilitate the process.
   (D) The fuel cell consists of tiny chambers that allow hydrogen gas to explode.
   (E) The hydrogen fuel cell demonstrated in class used hydrogen and oxygen gases.

3. Consider the following compound:

   ![Chemical Structure](image)

   The compound is:

   (A) a strong acid.
   (B) weak acid.
   (C) a strong base.
   (D) a weak base.

4. A student places 116.9 grams of NaCl (s) into a 1.000-L volumetric flask and then fills to the mark with water. This is Solution #1. The student then dilutes 0.5000 liters of Solution #1 to a total volume of 1.000 liter. This is Solution #2.

   (A) The concentration of Solution #1 is 116.9 M; the concentration of Solution #2 is 233.8 M.
   (B) The concentration of Solution #1 is 116.9 M; the concentration of Solution #2 is 58.45 M.
   (C) The concentration of Solution #1 is 2.000 M; the concentration of Solution #2 is 1.000 M.
   (D) The concentration of Solution #1 is 2.000 M; the concentration of Solution #2 is 2.000 M.
   (E) The concentration of Solution #1 is 2.000 M; the concentration of Solution #2 is 4.000 M.

\[
\text{Solution } #1 \quad M_1 = \frac{\text{mol}}{L} = \frac{116.9 \ \text{g NaCl}}{58.45 \ \text{g/mol}} \times \frac{1.000 \ \text{mol}}{L} = 2.000 \ M
\]

\[
\text{Solution } #2 \quad M_1v_1 = M_2v_2 \quad (2.000 \ M)(0.5000 \ L) = (M_2)(1.000 \ L)
\]

\[
M_2 = 1.000 \ M
\]
5. A student calculates that 120.04 grams of carbon dioxide should theoretically be produced from the combustion of propane during a process. She actually recovers 112.5 grams of carbon dioxide. What is the percent yield for this process?

\[
\text{Percent Yield} = \left( \frac{\text{Actual}}{\text{Theoretical}} \right) \times 100\% = \left( \frac{112.5 \text{ g}}{120.04 \text{ g}} \right) \times 100\% = 93.72\% 
\]

(A) 7.540 \%
(B) 6.281 \%
(C) 6.700 \%
(D) 93.72 \%
(E) 17.54 \%

6. What is the mass percent composition of ethanol, \( \text{C}_2\text{H}_6\text{O} \)?

\[
\begin{align*}
\text{C} & = 2 \times 12.011 \text{ g/mol} = 24.022 \text{ g/mol} \\
\text{H} & = 6 \times 1.008 \text{ g/mol} = 6.047 \text{ g/mol} \\
\text{O} & = 1 \times 16.00 \text{ g/mol} = 16.00 \text{ g/mol}
\end{align*}
\]

\[
\begin{align*}
\text{C}_2\text{H}_6\text{O} & = 46.069 \text{ g/mol} \\
\% \text{ C} & = \frac{24.022 \text{ g/mol}}{46.069 \text{ g/mol}} \times 100\% = 52.14\% \\
\% \text{ H} & = \frac{6.047 \text{ g/mol}}{46.069 \text{ g/mol}} \times 100\% = 13.13\% \\
\% \text{ O} & = \frac{16.00 \text{ g/mol}}{46.069 \text{ g/mol}} \times 100\% = 34.73\%
\end{align*}
\]

(A) \% \text{ C} = 52.14\%
(B) \% \text{ H} = 13.13\%
(C) \% \text{ O} = 34.73\%
(D) \% \text{ C} = 26.07\%
(E) \% \text{ H} = 2.18\%

7. How many grams of \( \text{H}_2\text{O} \) (g) are produced from 440.96 g of propane and excess oxygen?

\[
\begin{align*}
\text{C}_3\text{H}_8 \text{ (g)} & + 5 \text{ O}_2 \text{ (g)} \rightarrow 3 \text{ CO}_2 \text{ (g)} + 4 \text{ H}_2\text{O (g)} \\
440.96 \text{ g} & \downarrow \text{(1)} \\
10.000 \text{ mol} & \rightarrow \text{(2)} \\
440.96 \text{ g} \text{ C}_3\text{H}_8 \left( \frac{1 \text{ mol}}{44.096 \text{ g}} \right) & = 10.000 \text{ mol C}_3\text{H}_8 \\
10.000 \text{ mol C}_3\text{H}_8 \left( \frac{4 \text{ mol H}_2\text{O}}{1 \text{ mol C}_3\text{H}_8} \right) & = 40.000 \text{ mol H}_2\text{O} \\
40.000 \text{ mol H}_2\text{O} \left( \frac{18.016 \text{ g}}{1 \text{ mol}} \right) & = 720.63 \text{ g H}_2\text{O} \text{(3)}
\end{align*}
\]

(A) 1763.8 g \text{H}_2\text{O (g) are produced.}
(B) 44.096 g \text{H}_2\text{O (g) are produced.}
(C) 720.63 g \text{H}_2\text{O (g) are produced.}
(D) 10.000 g \text{H}_2\text{O (g) are produced.}
(E) 180.16 \text{ H}_2\text{O (g) are produced.
8. A student mixes two solutions: \( \text{K}_3\text{PO}_4 \) (aq) and \( \text{Ca(NO}_3)_2 \) (aq). The solid precipitate formed is:

(A) \( \text{KNO}_3 \) (s).
(B) \( \text{Ca}_3(\text{PO}_4)_2 \) (s).
(C) \( \text{KOH} \) (s).
(D) \( \text{CaO} \) (s).
(E) \( \text{K}_3\text{PO}_4 \) (s).

Net Ionic Equation:

\[ 3 \text{Ca}^{2+} (aq) + 2 \text{PO}_4^{3-} (aq) \rightarrow \text{Ca}_3(\text{PO}_4)_2 (s) \]

The phosphate ion is insoluble (except when exclusively in the presence of a group 2A metal or ammonium ion).

9. A student obtains 25.00 mL of an HCl solution of unknown concentration. Upon titration, 18.74 mL of 0.09950 M NaOH are required for neutralization. Determine the concentration of the HCl solution.

\[ \text{HCl} + \text{NaOH} \rightarrow \text{NaCl} + \text{H}_2\text{O} \]

(HCl) \( \times 25.00 \text{ mL} = (18.74 \text{ mL} \times 0.09950 \text{ M}) \)

\[ \text{M}_{\text{HCl}} = 0.07459 \text{ M} \]

(A) 18.74 M.
(B) 0.07459 M.
(C) 13.41 M.
(D) 0.1327 M.
(E) 7.534 M.

10. A student obtains a 2.00 liter balloon at 20.0 °C. He cools the balloon to -20.0 °C. The volume of the balloon at -20.0 °C is:

\[ \frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2} \]

Balloon - constant \( P \)
Closed container - constant \( n \)

\[ \frac{V_1}{T_1} = \frac{V_2}{T_2} \]

\[ \frac{2.00 \text{ L}}{293.15 \text{ K}} = \frac{V_2}{253.15 \text{ K}} \]

\[ V_2 = 1.73 \text{ L} \]

(A) 1.00 L.
(B) 2.00 L.
(C) 1.16 L.
(D) 2.32 L.
(E) 1.73 L.

11. A student places 64.00 grams of oxygen gas (O\(_2\)) into a 3.000-L flask at 293.15 K. The pressure inside the flask is:

\[ P = \frac{nRT}{V} \]

\[ P = \frac{(64.00 \text{ g}) \frac{\text{g}}{32.00 \text{ g/mol}} \left(\frac{0.0821 \text{ L} \cdot \text{atm} \cdot \text{K}}{\text{mol} \cdot \text{K}}\right)(293.15 \text{ K})}{3.000 \text{ L}} = 16.05 \text{ atm} \]

(A) 513.4 atm.
(B) 35.03 atm.
(C) 16.05 atm.
(D) 7.978 atm.
(E) 0.2493 atm.
12. A student places 2.00 moles of $\text{O}_2$ (g) and 4.00 moles of $\text{CH}_4$ (g) into a 44.8-L flask at 273 K. The pressure of $\text{CH}_4$ (g) is:

\[
P_{\text{CH}_4} = \frac{n_{\text{CH}_4}RT}{V} = \left(4.00 \text{ mol} \times \frac{0.0821 \text{ L atm}}{\text{mol} \text{ K}} \times 273 \text{ K} \right) \div (44.8 \text{ L})
\]

\[
= 2.00 \text{ atm}
\]

(A) \( \frac{1}{3} \text{ atm.} \)
(B) \( 1.00 \text{ atm.} \)
(C) \( 2.00 \text{ atm.} \)
(D) \( 3.00 \text{ atm.} \)
(E) \( \frac{2}{3} \text{ atm.} \)

13. The root-mean-square speed of $\text{F}_2$ (g) at 1.00 atm and 293 K is:

\[
\mu_{\text{rms}} = \sqrt{\frac{3RT}{M}} = \sqrt{\frac{(3)(8.314 \text{ kg m}^2/\text{mol K})(293 \text{ K})}{38 \times 10^{-3} \text{ kg/mol}}}
\]

\[
= 438.54 \text{ m/s} = 439 \text{ m/s}
\]

(A) \( 13.9 \text{ m/s.} \)
(B) \( 439 \text{ m/s.} \)
(C) \( 514 \text{ m/s.} \)
(D) \( 1191 \text{ m/s.} \)
(E) \( 192 \text{ m/s.} \)

14. Consider the following five gases: $\text{H}_2$ (g) $\text{CO}_2$ (g) Ar (g) $\text{SF}_6$ (g) $\text{Cl}_2$ (g)

Of these, the gas molecule with the \textbf{greatest} velocity at room temperature is:

(A) $\text{H}_2$ (g).
(B) $\text{CO}_2$ (g).
(C) Ar (g).
(D) $\text{SF}_6$ (g).
(E) $\text{Cl}_2$ (g).
15. The reaction below takes place in a classroom (a constant pressure of 1.00 atm and a constant temperature of 273 K for both reactants and products).

\[
\begin{align*}
C_3H_8 (g) & \quad + \quad 5 \text{ O}_2 (g) \quad \rightarrow \quad 3 \text{ CO}_2 (g) & \quad + \quad 4 \text{ H}_2\text{O} (g) \\
2.00 \text{ L} & \quad \rightarrow \quad 6.00 \text{ L} \\
2.00 \text{ L} C_3H_8 (\quad \frac{3 \text{ L CO}_2}{1 \text{ L} C_3H_8}) & \quad = \quad 6.00 \text{ L CO}_2
\end{align*}
\]

When 2.00 L of C\textsubscript{3}H\textsubscript{8} (g) react,

(A) 2.00 L of CO\textsubscript{2} are formed.
(B) 3.00 L of CO\textsubscript{2} are formed.
(C) 4.00 L of CO\textsubscript{2} are formed.
(D) 5.00 L of CO\textsubscript{2} are formed.
(E) 6.00 L of CO\textsubscript{2} are formed.

16. A student places 3.388 g of a noble gas into a 2.00-L container at 293 K and measures the pressure to be 1.02 atm. This noble gas is:

(A) He.
(B) Ne.
(C) Ar.
(D) Kr.
(E) Xe.

\[
n = \frac{PV}{RT} = \frac{(1.02 \text{ atm})(2.00 \text{ L})}{(0.0821 \text{ L} \cdot \text{atm} \cdot \text{mol}^{-1} \cdot \text{K}^{-1})(293 \text{ K})} = 0.0848 \text{ mol}
\]

\[
\text{Molar Mass} = \frac{3.388 \text{ g}}{0.0848 \text{ mol}} = 39.95 \text{ g/mol}
\]

17. Consider a sealed balloon containing nitrogen gas. Which of the following is \textbf{false}?

(A) When the temperature is increased, the velocity of the gas molecules increases. \textbf{True}
(B) When the temperature is increased, the volume of the balloon increases. \textbf{True}
(C) When the temperature is increased, the moles of gas inside the balloon increases. \textbf{False}
(D) A 22.4-L balloon, at 1.00 atm, and 273.15 K contains one mole of nitrogen gas. \textbf{True}
18. Which of the following processes is endothermic?

(A) \(2 \text{C}_8\text{H}_{18} (l) + 25 \text{O}_2 (g) \rightarrow 16 \text{CO}_2 (g) + 18 \text{H}_2\text{O} (g). \) Combustion - exothermic
(B) \(\text{H}_2\text{O} (l) \rightarrow \text{H}_2\text{O} (s). \) Heat leaves the system when the water freezes
(C) \(\text{H}_2\text{O} (g) \rightarrow \text{H}_2\text{O} (l). \) Heat leaves the system
(D) \(\text{NH}_4\text{NO}_3 (s) \rightarrow \text{NH}_4\text{NO}_3 (\text{aq}). \) "Cold Pack"

19. How much heat is required to raise the temperature of 2500.0 grams of gold from 30.5 °C to 80.0°C?

\[ q = mc\Delta T = (2500.0 \text{ g}) \times 0.130 \text{ J/g°C} \times (80.0°C - 30.5°C) = 16087.5 \text{ J} = 16.1 \text{ kJ} \]

(E) 16.1 kJ

20. A system gives off 40 kJ of heat and does 30 kJ of work. The change in the energy of the system is:

\[ E = q + w = (-40 \text{ kJ}) + (-30 \text{ kJ}) \]

(A) -70 kJ.
(B) +70 kJ.
(C) -10 kJ.
(D) +10 kJ.
(E) 1.33 kJ.
21. Use the data in the table below to answer the following question:

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<tr>
<th></th>
<th>ΔH°f (kJ/mol)</th>
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<tr>
<td>CO₂(g)</td>
<td>-393.5</td>
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<td>C₃H₈(g)</td>
<td>-104.0</td>
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<tr>
<td>H₂O(l)</td>
<td>-285.9</td>
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What is ΔH° reaction for the following reaction?

\[
\begin{align*}
\text{C}_3\text{H}_8 (g) + 5 \text{O}_2 (g) & \rightarrow 3 \text{CO}_2 (g) + 4 \text{H}_2\text{O} (l) \\
(1\chi-104.0) + (5\chi) & \rightarrow (3\chi-393.5) + (4\chi-285.9) \\
\end{align*}
\]

\[
\Delta H^o = \text{products} - \text{reactants} = \\
\left[\left(3 \text{ mol} \ \text{CO}_2 \chi - 393.5 \frac{\text{kJ}}{\text{mol}} \ \text{CO}_2\right) + (4 \text{ mol} \ \text{H}_2\text{O} \chi - 285.9 \frac{\text{kJ}}{\text{mol}} \ \text{H}_2\text{O})\right] - \\
\left[\left(1 \text{ mol} \ \text{C}_3\text{H}_8 \chi - 104.0 \frac{\text{kJ}}{\text{mol}} \ \text{C}_3\text{H}_8\right) + (5 \text{ mol} \ \text{O}_2 \chi - 104.0 \frac{\text{kJ}}{\text{mol}} \ \text{O}_2)\right] = \\
-2324.1 \text{ kJ} + 104.0 \text{ kJ} = -2220.1 \text{ kJ}
\]

- (A) -783.4 kJ.
- (B) -2220.1 kJ.
- (C) -2428.1 kJ.
- (D) +2428.1 kJ.
- (E) +575.4 kJ.

22. Determine ΔH° for the reaction C(graphite) + 2 H₂(g) → CH₄(g), using:

\[
\begin{align*}
\text{C(graphite)} + \text{O}_2(g) & \rightarrow \text{CO}_2(g) \quad \Delta H^o = -393.5 \text{ kJ} (1) \\
\text{H}_2(g) + \frac{1}{2} \text{O}_2(g) & \rightarrow \text{H}_2\text{O}(l) \quad \Delta H^o = -285.8 \text{ kJ} (2) \\
\text{CH}_4(g) + 2 \text{O}_2(g) & \rightarrow \text{CO}_2(g) + 2 \text{H}_2\text{O}(l) \quad \Delta H^o = -890.3 \text{ kJ} (3)
\end{align*}
\]

- (A) -105.5 kJ.
- (B) -74.8 kJ.
- (C) -1570 kJ.
- (D) -211.0 kJ.
- (E) +211.0 kJ.

\[
\begin{align*}
\text{C(graphite)} + 2 & \text{H}_2(g) \rightarrow \text{CH}_4(g) \quad \Delta H^o = ? \\
\text{C(graphite)} + \text{O}_2(g) & \rightarrow \text{CO}_2(g) \quad \Delta H^o = -393.5 \text{ kJ} \\
2 \text{H}_2(g) + \frac{1}{2} \text{O}_2(g) & \rightarrow \text{H}_2\text{O} \quad \Delta H^o = -285.8 \text{ kJ} \\
\text{CO}_2(g) + 2 \text{H}_2\text{O}(l) & \rightarrow \text{CH}_4(g) + 2 \text{O}_2(g) \quad \Delta H^o = +890.3 \text{ kJ}
\end{align*}
\]

\[
\text{C(graphite)} + 2 \text{H}_2(g) \rightarrow \text{CH}_4(g) \quad \Delta H^o = -74.8 \text{ kJ}
\]
23. The heat of formation (ΔH°f) of NH₄Cl (s) is −315.4 kJ/mol. The chemical equation associated with this reaction is:

(A) NH₄ (s) + Cl (g) → NH₄Cl (s)
(B) ½ N₂ (g) + 2 H₂ (g) + ½ Cl₂ (g) → NH₄Cl (s)
(C) NH₄⁺ (aq) + Cl⁻ (aq) → NH₄Cl (s)
(D) NH₄⁺ (s) + Cl⁻ (s) → NH₄Cl (s)
(E) ½ N₂ (g) + 4 HCl (aq) → NH₄Cl (s) + 3/2 Cl₂ (g)

\[ \frac{1}{2} N₂(g) + 2 H₂(g) + \frac{1}{2} Cl₂(g) \rightarrow NH₄Cl \quad ΔH°f = -315.4 \text{ kJ} \]

24. When the following reaction is carried out in a flask, the flask feels HOT when held in the hands:

HCl (aq) + NaOH (aq) → NaCl (aq) + H₂O (l)  [This reaction is the system]

Which of the following is TRUE?

(A) Heat is transferred from the flask to the hand; this is an endothermic reaction.
(B) **Heat is transferred from the flask to the hand; this is an exothermic reaction.**
(C) Heat is transferred from the hand to the flask; this is an endothermic reaction.
(D) Heat is transferred from the hand to the flask; this is an exothermic reaction.

25. Which one of the following statements is FALSE?

(A) The CH 121 Final Exam is scheduled for Thursday, December 9 at 4:00pm.
(B) The CH 121 Final Exam is scheduled for Thursday, December 9 at 4:00pm.
(C) The CH 121 Final Exam is scheduled for Thursday, December 9 at 4:00pm.
(D) The CH 121 Final Exam is scheduled for Thursday, December 9 at 4:00pm.
(E) ΔH for a process is -322.3 kJ. The process is endothermic.

**Hint:**
The CH 121 Final Exam is scheduled for Thursday, December 9 from 4:00-5:50pm. Rooms will be assigned and posted near the conclusion of the term. There is no opportunity to reschedule the final exam.