Whose picture is this (circle one), and what is his connection to Chemistry 1A?

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Test-taking strategy: PLEASE READ THIS FIRST!
Write your name on all 9 pages. This test consists of two parts: multiple choice (answers to be circled and entered on the Scantron sheet) and short answer. In order to maximize your score on the exam:

- Do the questions you know how to do first, then, go back and answer the questions you skipped.
- Budget your time carefully -- don't spend too much time on any one problem.
- Show all work for which you want credit and don't forget to include units.
- The tear-out back page has some data and useful equations.
Section 1: Multiple Choice. 16 questions, 4 points each.

Instructions: For the following questions, circle the answer on the exam sheet and bubble in the correct answer on your Scantron sheet. There is only one correct answer per problem, so for each question fill in one bubble on your Scantron form.

1.) You are taking test version C. Please fill in bubble "C" on your Scantron sheet.

2-5. In the next four problems, consider the exothermic reaction:

\[ 2 \text{ZnS}(s) + 3 \text{O}_2(g) \rightarrow 2 \text{ZnO}(s) + 2 \text{SO}_2(g) \]

Which of the following five choices best describes how the given changes will affect the equilibrium state of this reaction?

A) More ZnS is produced.
B) More SO₂ is produced.
C) Less SO₂ and ZnS are produced.
D) More SO₂ and ZnS are produced.
E) No change occurs.

2.) The partial pressure of O₂(g) is increased.

3.) ZnO(s) is added to the system.

4.) The temperature is decreased.

5.) The volume of the reaction vessel is doubled.

6.) Which of the following conjugate acid-base pairs (see page 9 for Kₐ's) would buffer a solution most effectively at a pH of 7.0?

A) NH₄⁺, NH₃  B) HF, F⁻  C) H₂S, HS⁻  D) H₃O⁺, H₂O  E) HAc, Ac⁻

7.) Which of the following pH's might be found at the equivalence point of a titration of 0.1 M NH₃ (weak base) with 0.1 M HCl (strong acid)?

A) 1  B) 4  C) 7  D) 10  E) 13
8.) Using bond enthalpies (see page 9), estimate $\Delta H^\circ$ for the following reaction (in kJ·mol$^{-1}$). Ignore the C-H bonds (which are not shown).

\[ \text{C}=\text{C} \quad + \quad \text{C} \quad \rightarrow \quad \text{C} \quad = \quad \text{C} \quad = \quad \text{C} \quad = \quad \text{C} \]

A) -800 B) -550 C) -200 D) 200 E) 550

9-12. In the next four problems, choose which of the following five graphs best describes the behaviors listed below. Assume ideal gases for the last two problems (11 and 12).

9.) Energy in the surroundings as a function of time for an endothermic reaction.

10.) $[\text{H}_3\text{O}^+]$ as a function of $[\text{OH}^-]$ in an aqueous solution.

11.) $PV$ as a function of $T$.

12.) $u_{\text{rms}}$ as a function of the total kinetic energy, $E_k$.

13.) One mole of a hydrocarbon is combusted with oxygen to form 88 grams of CO$_2$ and 36 grams of H$_2$O. What is the molecular formula of the hydrocarbon?

A) CH$_2$ B) C$_2$H$_2$ C) C$_2$H$_4$ D) C$_2$H$_6$ E) C$_4$H$_{12}$

14.) $f(u)$

Pictured on the left is the distribution of molecular speeds for Ar at 300 K. At what temperature will N$_2$ have the same distribution curve?

A) 150 K B) 210 K C) 300 K D) 420 K E) 600 K
15.) A sample of CO₂ is isotopically enriched with ¹⁸O such that the ratio of ¹⁸O to ¹⁶O is 1 to 1. What will the mass spectrum of this CO₂ sample look like?

A)  B)  C)  D)  E) 

16.) The reaction described by the following equation is carried out in a balloon:

Ge(CO₃)₂(s) + 4 HI(ℓ) → GeI₄(s) + 2 CO₂(g) + 2 H₂O(ℓ)

If initially the balloon contains only 1 mole of Ge(CO₃)₂ and 1 mole of HI, what will be the approximate final volume of the balloon at STP?

A) 5 L  B) 10 L  C) 20 L  D) 30 L  E) 40 L

17.) Professor Pines inhaled 0.25 moles of N₂O (laughing gas) from a cylinder which originally contained 2.00 moles of N₂O at a pressure of 8.00 atm. Assuming an ideal gas at constant temperature, what is the new pressure inside the cylinder?

A) 1.00 atm  B) 2.50 atm  C) 4.00 atm  D) 7.00 atm  E) 9.15 atm

Section 2: Short Answer. 5 questions, 56 points total.

Answer the following five short answer questions. Partial credit will be given, so show your work whenever possible. Your final answers must be written in the boxes provided.

1.) (8 points) Circle the chromatogram below which best resolves the Zn and Fe spots. Then, in 20 words or less, explain your reasoning.

Explanation:
2.) (7 points) Draw the Lewis electron dot structure for ICl$_2$\textsuperscript{−}.

Lewis Dot Structure:

Name or describe the molecular structure for ICl$_2$\textsuperscript{−}.

Molecular Structure:

Consider the reaction of ICl$_2$\textsuperscript{−} with Cl$_2$ to form ICl$_4$\textsuperscript{−}. Explain in 20 words or less what happens to the Cl-I-Cl bond angles during the course of the reaction.

Answer:
3.) (13 points) Vitamin C is ascorbic acid (HC₆H₇O₆), for which Kₐ is 8.0x10⁻⁵. Calculate the pH of a solution made by dissolving a 50 mg tablet of pure vitamin C in water and diluting to a total volume of 10.0 mL.

\[ \text{pH} = \] 

Calculate the pH of a solution made by dissolving a 50 mg tablet of pure vitamin C in water and diluting to a total volume of 1 billion (10⁹) liters.

\[ \text{pH} = \] 

4.) (15 points) Instead of using glucose as a source of nutritional energy, some individuals use ethanol (CH₃CH₂OH) instead.

a.) Write a balanced equation for the combustion of ethanol with oxygen to form carbon dioxide and water.

b.) What is the ΔH° of combustion for 1.00 mole of ethanol?

\[ \Delta H^\circ = \] 

c.) A bottle of 80 proof vodka contains 4.0 moles of ethanol. How many bottles of vodka must an individual drink in one day to provide 1.00x10⁷ J of energy?

\[ \text{Ans:} \]
5.) (13 points) Consider the following reaction of hydrogen and carbon monoxide to form methanol:

\[
2 \text{H}_2(\text{g}) + \text{CO}(\text{g}) \rightleftharpoons \text{CH}_3\text{OH}(\text{g})
\]

a.) Write the equilibrium expression for this reaction.

\[K_p = \]

b.) At 25° C, the partial equilibrium pressures of H₂, CO, and CH₃OH are 1.2 atm, 2.8 atm, and 2.3 atm, respectively. What is the value of \(K_p\)?

\[K_p = \]

c.) If, at 25° C, the partial pressures of the three gases are instantaneously adjusted such that the partial pressures of H₂ and CO are both 2.0 atm and the partial pressure of CH₃OH is 2.2 atm, in which direction will the reaction proceed?

\[
\text{Answer:}
\]

Section 3: What's Wrong. 5 questions, 6 points each.

For this section, in no more than twenty words per response, state what is wrong with the following pictures. Note: only the first 20 words of each answer will be read!

1.) For the titration of a weak acid with a strong base (1 eq = 1 molar equivalent):

\[
\begin{array}{c}
\text{pH 7} \\
\text{13} \\
\text{1 eq moles of NaOH}
\end{array}
\]

\[
\text{Answer:}
\]
For this section, in no more than twenty words per response, state what is wrong with the following pictures. Note: only the first 20 words of each answer will be read!

2.) For the process $I_2(s) \rightarrow I_2(g)$ at equilibrium in a 1.0 L flask:

3.) For the titration of 0.1 M NaOH with 0.1 M HCl (1 eq = 1 molar equivalent):

4.) For the reaction: $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$

5.) A model which explains the smell of $C_6H_{12}O_2$ observed in the laboratory:
Standard Enthalpies of Formation (in kJ • mol⁻¹)

<table>
<thead>
<tr>
<th>Substance</th>
<th>ΔH°f (kJ/mol)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CH₃CH₂OH(ℓ)</td>
<td>-278</td>
</tr>
<tr>
<td>H₂O(g)</td>
<td>-242</td>
</tr>
<tr>
<td>CO₂(g)</td>
<td>-394</td>
</tr>
<tr>
<td>O(g)</td>
<td>249</td>
</tr>
</tbody>
</table>

Average Bond Enthalpies (in kJ • mol⁻¹)

<table>
<thead>
<tr>
<th>Bond</th>
<th>ΔH° (kJ/mol)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C - C</td>
<td>350</td>
</tr>
<tr>
<td>C - H</td>
<td>400</td>
</tr>
<tr>
<td>C = C</td>
<td>600</td>
</tr>
<tr>
<td>O = O</td>
<td>500</td>
</tr>
</tbody>
</table>

Ionization Constants of Acids (Kₐ) at 25°C

<table>
<thead>
<tr>
<th>Acid</th>
<th>Kam (moles/L)</th>
<th>Temperature (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrofluoric</td>
<td>6.6 x 10⁻⁴</td>
<td>25</td>
</tr>
<tr>
<td>Ascorbic</td>
<td>8.0 x 10⁻⁵</td>
<td>25</td>
</tr>
<tr>
<td>Acetic</td>
<td>1.8 x 10⁻⁵</td>
<td>25</td>
</tr>
<tr>
<td>Hydrosulfuric</td>
<td>9.1 x 10⁻⁸</td>
<td>25</td>
</tr>
<tr>
<td>Ammonium</td>
<td>5.6 x 10⁻¹⁰</td>
<td>25</td>
</tr>
</tbody>
</table>

Possibly Useful Information

Absolute T(K) = T(°C) + 273.15

ΔH°form = ΔH° products - ΔH° reactants

Kₐ = [H₃O⁺][A⁻] / [HA]

Kₐ = [OH⁻][HA] / [A⁻]

Kₐ = [H₃O⁺][OH⁻] = 1.0 x 10⁻¹⁴ at 25°C

pH = pKₐ - log([HA] / [A⁻])

\(\frac{[C]^e[D]^d}{[A]^p[B]^b} = K\) at equilibrium