READ THESE DIRECTIONS CAREFULLY BEFORE STARTING THE EXAMINATION!

It is extremely important that you fill in the answer sheet EXACTLY as indicated, otherwise your answer sheet may not be processed; ALL entries are to be made on SIDE 1 of the answer sheet. Use a #2 pencil (or softer); fill in the circles completely and firmly. Erasures must be complete. Use only the following categories:

<table>
<thead>
<tr>
<th>NAME:</th>
<th>Print your name starting at the first space, LAST NAME first, then a space, followed by your FIRST NAME, then another space, followed by your MIDDLE INITIAL. Fill in the correct circles below your printed name corresponding to the letters of your name; for the spaces, fill in the top blank circle.</th>
</tr>
</thead>
<tbody>
<tr>
<td>STUDENT NUMBER:</td>
<td>This is VERY IMPORTANT! Under IDENTIFICATION NUMBER, put in your 8 DIGIT STUDENT ID NUMBER (do not use the 9 at the beginning of your number) beginning in column A and continuing through column H, column I will be blank, (do NOT use column J at this time); be sure to fill in the correct circles (a common error to be avoided is mistaking &quot;0&quot; for &quot;1&quot;).</td>
</tr>
<tr>
<td>TEST FORM:</td>
<td>Fill in the &quot;3&quot; blank in the J column under IDENTIFICATION NUMBER (to indicate Hour Examination I).</td>
</tr>
<tr>
<td>SPECIAL CODES:</td>
<td>Use for course and section number; in positions K-P write in one of the following:</td>
</tr>
<tr>
<td>Dr. Richards</td>
<td>Sections 001-009, put 105111</td>
</tr>
<tr>
<td>Dr. Lynn</td>
<td>Sections 010-018, put 105222</td>
</tr>
<tr>
<td>Dr. Soult</td>
<td>Sections 019-027 (MWF 1:00 PM), put 105333</td>
</tr>
<tr>
<td>Dr. Soult</td>
<td>Sections 046-054 (TR 2:00 PM), put 105666</td>
</tr>
<tr>
<td>Dr. Woodrum</td>
<td>Sections 028-036, put 105444</td>
</tr>
<tr>
<td>Dr. DeRouchey</td>
<td>Sections 037-045, put 105555</td>
</tr>
<tr>
<td>Dr. Sunahori</td>
<td>Sections 401-409, put 105777</td>
</tr>
<tr>
<td>SIGNATURE:</td>
<td>You MUST sign the examination answer sheet (bubble sheet) on the line directly above your printed name. Use your legal signature.</td>
</tr>
</tbody>
</table>

Answering Questions:
Starting with answer "1" on SIDE 1, fill in the circle indicating the one best answer for each of the 30 questions in this examination. Your score is the sum of the appropriate credit for each response. On the day following the examination, an examination key will be posted on Blackboard.

Grading and Reporting:
The examination scores will be posted in Blackboard as soon as possible after the examination. If an error has occurred in scoring your answers, inform your instructor within 48 hours of the posting of your score.

BE SURE THAT YOUR TEST HAS 30 QUESTIONS, A PERIODIC TABLE, AND ONE SHEET OF SCRATCH PAPER. You may NOT use your own scratch paper during this examination. Cell phones, computer, and pagers are to be turned off and out of sight during the exam.
1. How much heat (in kilojoules) is required to increase the temperature of a 5.00 kg block of silver by 4.50 °C? The specific heat capacity of silver is 0.235 (J/g·°C).

A. 5.290 kJ  
B. 0.261 kJ  
C. 2.590 kJ  
D. 5.625 kJ

2. If a 1.0 kg granite rock is heated to 200 °C and then dropped into a cooking pot containing 5.00 × 10² mL of tea at 25 °C, what is the final temperature of the tea? Specific heat capacities: granite = 0.790 J/g °C and tea = 4.18 J/g °C. Assume the density of tea is 1.00 g/mL.

A. 30.5 °C  
B. 108 °C  
C. 57.4 °C  
D. 158 °C

3. How much work (in J) is done when a cylinder expands from 2.50 L to 3.80 L under an external pressure of 3.00 atm?

A. −395 J  
B. −1.14 × 10³ J  
C. −3.85  
D. −3.85 × 10⁻² J

4. Which one of the following reactions is an exothermic reaction?

A. Ice cubes are melted.  
B. Natural gas is burned on a stove.  
C. Water is boiled.  
D. Dry ice is evaporated.
5. The following reaction has a $\Delta H_{\text{rxn}}$, of $-851.5$ kJ.

$$\text{Fe}_2\text{O}_3(\text{s}) + 2\text{Al}(\text{s}) \rightarrow \text{Al}_2\text{O}_3(\text{s}) + 2\text{Fe}(\text{s})$$

What is the change in enthalpy if 45.2 g of solid Al are completely reacted?

A. $-125$ kJ  
B. $-713$ kJ  
C. $-654$ kJ  
D. $-1485$ kJ

6. Determine the enthalpy change for the following reaction (the combustion of ammonia)

$$4\text{NH}_3(\text{g}) + 5\text{O}_2(\text{g}) \rightarrow 4\text{NO}(\text{g}) + 6\text{H}_2\text{O}(\text{l})$$
given the following thermochemical equations:

$$\text{N}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{NO}(\text{g}) \quad \Delta H = 180.6 \text{ kJ}$$
$$\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightarrow 2\text{NH}_3(\text{g}) \quad \Delta H = -91.8 \text{ kJ}$$
$$2\text{H}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{H}_2\text{O}(\text{g}) \quad \Delta H = -483.7 \text{ kJ}$$

A. $-233.9$ kJ  
B. $-710.8$ kJ  
C. $-499.6$ kJ  
D. $-906.3$ kJ

7. Use the enthalpies of formation (provided in the table) to calculate the $\Delta H^\circ_{\text{rxn}}$ of the reaction:

$$2\text{NH}_3(\text{g}) + 3\text{Cl}_2(\text{g}) \rightarrow \text{N}_2(\text{g}) + 6\text{HCl}(\text{g})$$

Given:

<table>
<thead>
<tr>
<th>Substance</th>
<th>$\Delta H^\circ_{\text{f}}$ (kJ/mol)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NH$_3$</td>
<td>$-46.19$</td>
</tr>
<tr>
<td>HCl</td>
<td>$-92.30$</td>
</tr>
</tbody>
</table>

A. $-138.5$ kJ  
B. $-461.4$ kJ  
C. $-46.11$ kJ  
D. $0$ kJ
8. What is the frequency associated with light with a wavelength of 642 nm?

A. $4.67 \times 10^5$ Hz  
B. $4.67 \times 10^{14}$ Hz  
C. $4.67 \times 10^{-4}$ Hz  
D. $4.67 \times 10^{4}$ Hz

9. DVD players use lasers that emit red light with a wavelength of 650 nm to read and write data. What is the energy of a mole of photons of the light?

A. $3.50 \times 10^{-19}$ J  
B. $8.65 \times 10^{-31}$ J  
C. $4.32 \times 10^{4}$ J  
D. $1.84 \times 10^{5}$ J

10. The discrete lines in the emission spectrum of hydrogen results from which of the following?

A. Electrons transitioning between states  
B. Radioactive decay  
C. Clockwise rotation about the nucleus  
D. Ionization

11. What speed must an electron travel to have a de Broglie wavelength of 30.0 pm? The mass of an electron is $9.109 \times 10^{-31}$ kg.

A. $3.00 \times 10^8$ m/s  
B. $4.19 \times 10^4$ m/s  
C. $2.42 \times 10^7$ m/s  
D. $9.98 \times 10^6$ m/s
12. In an experiment, three different colors of light (orange, green, violet) are shined upon a metal surface. The following observations were made:

1) no photoelectrons were observed
2) photoelectrons with kinetic energies of 155 kJ/mol were observed
3) photoelectrons with kinetic energies of 55 kJ/mol were observed

Match the observation with the color of light.

A. 1) violet; 2) orange; 3) green
B. 1) green; 2) violet; 3) orange
C. 1) orange; 2) green; 3) violet
D. 1) orange; 2) violet; 3) green

13. What happens to the energy of an electron in an orbital as the principle quantum number $n$ becomes larger?

A. The energy decreases (becomes more negative).
B. The energy remains constant.
C. The energy increases (becomes less negative).
D. Not enough information is provided to answer the question.

14. If $n = 2$, what are the possible angular momentum quantum numbers?

A. $l = 0, 1$
B. $l = 1, 2$
C. $l = 0, 1$
D. $l = -1, 0, 1$

15. How many orbitals in the $n = 3$ energy level can have an $m_l$ value of 0?

A. 1
B. 2
C. 3
D. 5
16. One of the lines of the emission spectrum of hydrogen occurs at 397 nm. It results from
the transition from an excited state to the \( n = 2 \) level. What is the principal quantum
number of the upper level?

A. 4  C. 7
B. 5  D. 9

17. Which one of the following could have the following quantum numbers:

\[ n = 4, l = 2 \]

A.  
B.  
C.  
D.  

18. If the first 3 quantum numbers of two electrons are the same (i.e. they are in the same
orbital), what are the spin quantum numbers for these electrons?

A. \( \frac{1}{2}, \frac{1}{2} \)  C. \( -\frac{1}{2}, -\frac{1}{2} \)
B. 1, -1  D. \( \frac{1}{2}, -\frac{1}{2} \)

19. Which set of quantum numbers is **not** allowed

A. \( n = 1, l = 0, m_l = 0, m_s = +\frac{1}{2} \)  C. \( n = 3, l = 1, m_l = 0, m_s = +\frac{1}{2} \)
B. \( n = 1, l = 0, m_l = 0, m_s = -\frac{1}{2} \)  D. \( n = 1, l = 1, m_l = 0, m_s = +\frac{1}{2} \)
20. What is the most accurate approximation of the effective nuclear charge on the valence electrons of silicon?

A. +1  
B. +2  
C. +3  
D. +4  

21. Which one of the following elements will be diamagnetic?

A. carbon  
B. magnesium  
C. nitrogen  
D. chromium  

22. Which one of the following is the correct electron configuration for the ground state selenium atom?

A. 1s²2s²2p⁶3s²3p⁶4s²4d¹⁰4p⁴  
B. [Ar]4s²3d¹⁴  
C. 1s²2s²2p⁶3s²3p⁶3d¹⁰4s²4p⁴  
D. 1s²2s²3s²3p⁶3d¹⁰4s²4p⁴  

23. What is the electron configuration for chromium?

A. [Ar] 4s¹3d⁵  
B. [Kr] 4s¹3d⁶  
C. [Ar] 4s²3d⁴  
D. [Ar] 4s²4p⁴  

24. Which one of the following has the smallest atomic radius?

A. Cl  
B. S  
C. Se  
D. Br  

25. What is the electron configuration for Cu²⁺?

A. [Ar]4s¹3d¹⁰  
B. [Ar]3d⁹  
C. [Ar]4s²3d⁹  
D. [Ar]4s²3d⁷
26. The following elements easily form either cations or anions. Rank the most common ionic form of these elements in order of increasing size (smallest to largest). Make sure you are using the ionic form of these elements in your answer.

Beryllium, Chlorine, Magnesium, Tellurium

A. Be < Mg < Cl < Te  
B. Te < Cl < Be < Mg  
C. Be < Cl < Mg < Te  
D. Mg < Be < Cl < Te

27. Which one of the following has elements listed in order of increasing first ionization energy?

A. chlorine, sulfur, oxygen  
B. potassium, rubidium, cesium  
C. fluorine, oxygen, nitrogen  
D. silicon, phosphorus, oxygen

28. For which one of the following atoms is the addition of an electron the most energetically favorable?

A. Li  
B. Al  
C. K  
D. O

29. Which of the following is considered a renewable energy source?

A. Coal  
B. Natural Gas  
C. Solar  
D. Petroleum

30. Which one of the following would represent a possible set of quantum numbers \[n, l, m, ms\] for the electron removed to yield the first ionization energy of aluminum?

A. \[2, 2, 2, \frac{1}{2}\]  
B. \[3, 1, -1, \frac{1}{2}\]  
C. \[1, 0, 0, \frac{1}{2}\]  
D. \[3, 0, 0, \frac{1}{2}\]
1. A  
2. C  
3. A  
4. B  
5. B  
6. D  
7. B  
8. B  
9. D  
10. A  
11. C  
12. D  
13. C  
14. A  
15. C  
16. C  
17. C  
18. D  
19. D  
20. D  
21. B  
22. C  
23. A  
24. A  
25. B  
26. A  
27. D  
28. D  
29. C  
30. B