Directions: (1) Put your name, S.I.D. number and signature on the free response part of the exam where indicated. 
(2) Each multiple choice question is actually 2 questions on your scanning sheet. If you are sure of an 
answer, put the same answer down for both questions for 5 pts. If you cannot decide between two 
answers, put one answer down for one question and the other answer down for the other question. 
If you get one correct you'll get half credit for 2.5 pts. If there is an ambiguous multiple choice 
question, use the last page to explain your answer. 
(3) Do NOT write on the envelope.
(4) Bubble in OPTION A on the scanning sheet IF you want your grade posted. 
(5) When finished, put the free response answers in the envelope with the scanning sheet. You can 
keep the multiple choice part - the answers will be given to you as you leave. 
(6) There are a total of 29 questions (17 actual questions).

PART 1

1&2. Which isotope has in its nucleus 30 protons and 34 neutrons? 
   (a) $^{64}\text{Gd}$  (b) $^{34}\text{Zn}$  (c) $^{64}\text{Zn}$  (d) $^{30}\text{Se}$  (e) $^{64}\text{Se}$

3&4. Which of the following name/formula combinations is INCORRECT? 
   (a) iron(III) hypoiodite Fe(IO$_3$)$_3$  
   (b) dichlorine heptoxide Cl$_2$O$_7$  
   (c) tin(II) dichromate SnCr$_2$O$_7$  
   (d) cobalt(II) bromide CoBr$_2$  
   (e) chromium(III) phosphide CrP

5&6. What is the oxidation number of bromine in the ion, BrO$_4$? 
   (a) +2  (b) +3  (c) +6  (d) +7  (e) +8
7&8. Which of the following are examples of strong electrolytes?

(1) HClO₂  (2) NaBr  (3) NH₄Br  (4) Cu(OH)₂  (5) Fe(NO₃)₂  (6) H₂CO₂

(a) 2, 3, 5  (b) 2, 4, 6  (c) 1, 2, 5  (d) 2, 4  (e) another combination

9&10. Which statement regarding the "gold foil" experiment is FALSE?

(a) It was performed by Rutherford and his research group early in this century.
(b) Most of the alpha particles passed through the foil undeflected.
(c) The alpha particles were repelled by electrons.
(d) It suggested the nuclear model of the atom.
(e) It suggested that atoms are mostly empty space.

11&12. What is the maximum number of electrons in orbitals that have \( n=5 \) and \( l=3 \)?

(a) 5  (b) 7  (c) 10  (d) 14  (e) 2

13&14. On a far and distant world, an element, Petium (named after my dog, Petie, was discovered to have an atomic weight of 120.0 g/mol. Petium has 2 isotopes. The heavier isotope has a mass of 124.0 g/mol, and the lighter isotope has a mass of 118.0 g/mol. What is the percent abundance of the lighter isotope?

(a) 67 %  (b) 35 %  (c) 63 %  (d) 33 %  (e) 65 %
15&16. Which of the following statements is FALSE concerning the magnetic quantum number?

(a) It is designated by $m_l$.
(b) The values of the magnetic quantum number for the $p$ energy sublevel are $-2, -1, 0, 1$, and $2$.
(c) Its values are integers in the range: $-l, -l + 1, \ldots 0, \ldots +l$.
(d) It is one of $3$ quantum numbers that define an orbital in an atom.
(e) The number of values of the magnetic quantum number for an energy sublevel gives the number of orbitals in that same energy sublevel.

17&18. The group in the periodic table represented by the outer electron configuration of $ns^2np^4$ is:

(a) Group IIA  (b) Group IIIA  (c) Group IVA  (d) Group VIA  (e) Group VIIA

19&20. Consider the following reaction:

$$\text{HNO}_2(\text{aq}) \xrightarrow{\text{H}^+(\text{aq}) + \text{NO}_2^-\text{(aq)}}$$

Which one of the following statements is false?

(a) $\text{H}^+$ and $\text{NO}_2^-$ ions are produced in a 1:1 ratio when $\text{HNO}_2$ is dissolved in water.
(b) When solutions of $\text{HCl}$ and $\text{NaNO}_2$ are mixed, some $\text{HNO}_2$ is produced.
(c) $\text{HNO}_2$ is considered to be a weak acid.
(d) The reaction is reversible.
(e) The double arrows indicate that $\text{HNO}_2$ is only very slightly soluble in water.
21&22. Which of the following statements is TRUE given the following net ionic equation?

\[ \text{HClO(aq) } + \text{OH}^{-}(aq) \rightarrow \text{ClO}^{-}(aq) + \text{H}_2\text{O(l)} \]

(a) The base in this reaction is a weak electrolyte.
(b) HClO is a strong acid.
(c) This could be the net ionic equation for HClO reacting with Fe(OH)$_2$.
(d) This reaction is classified as a precipitation reaction.
(e) The salt produced could be NaClO.

23&24. The chief ore of zinc is the sulfide, ZnS. The ore is concentrated by flotation and then heated in air, which converts the ZnS to ZnO:

\[ 2\text{ZnS} + 3\text{O}_2 \rightarrow 2\text{ZnO} + 2\text{SO}_2 \]

What mass of zinc sulfide is required to react with 100 g of oxygen gas according to this equation, assuming the reaction goes 100% to completion?

(a) 157 g  (b) 203 g  (c) 275 g  (d) 366 g  (e) 489 g
25. Sketch the following orbitals. Label the relevant axes.

(a) $s$ orbital  
(b) $p_y$ orbital  
(c) $d_{x^2-y^2}$ orbital

26. Consider the reaction: $\text{H}_2\text{CO}_3 + \text{Al} \rightarrow \text{H}_2 + \text{Al}_2(\text{CO}_3)_3$

(2 pts) Balance the equation. Note: you do not need a balanced equation to do the rest of this problem.

(2 pts) Which is the element being reduced? ________________

(2 pts) The element changes in oxidation number from ____ to ____.

(2 pts) The reducing agent is ________________.
27. Write the correct ground state electron configurations for the following elements and tell if they are diamagnetic or paramagnetic. Give an acceptable set of 4 quantum numbers to the last electron added to an atom of the element.

(a) cobalt, Co

(b) thallium, Tl

28. In class we had a demonstration of the emission lines of hydrogen. One of those lines was red with a wavelength of 6563 Å. It corresponded to a photon emitted when an electron fell from the n=3 to the n=2 principle energy level.

How much energy (in joules) could be released if one excited electron went from the n=3 energy level to the n=2 energy level? (1 Å = 1 x 10^{-10} m)
29. (a) Write the formula unit, total ionic and net ionic equations for the precipitation reaction between barium acetate and potassium carbonate. (Note: there will be deductions if you forget to put the correct phase and charges for all species.)

(b) Show all the major species present in the beaker before the reaction occurs and after the reaction is finished. You don't need to include water.

BEFORE

AFTER