1. The laser emits photons with $\lambda = 700$ nm. How many photons from this laser would be required to heat 19.0 g of pure solid lead (specific heat capacity = 0.127 J/°C•g) from 25°C to its melting point (327°C)?

   (1) $2.56 \times 10^{21}$ photons  
   (2) $5.18 \times 10^{20}$ photons  
   (3) $9.51 \times 10^{23}$ photons  
   (4) $5.15 \times 10^{23}$ photons  
   (5) $6.62 \times 10^{19}$ photons

2. The concentration of LiOH is 0.50 M. If 25 mL of LiOH is needed to titrate 40 mL of HNO₃ (nitric acid) what is the concentration of HNO₃?

   1) 0.03125 M HNO₃  
   2) 0.8 M HNO₃  
   3) 0.3125 M HNO₃  
   4) 0.08 M HNO₃  
   5) 1.00 M HNO₃
3. In which of the following equations are the base and conjugate base (proposed bases are underlined) incorrectly labeled?

(1) HCl + H₂O → Cl⁻ + H₃O⁺
(2) H₃PO₄⁻ + H₂O → H₃PO₄ + OH⁻
(3) CN⁻ + H₂O → HCN + OH⁻
(4) CH₃COOH + H₂O → CH₃COO⁻ + H₃O⁺
(5) HCO₃⁻ + H₂O → H₂CO₃ + OH⁻

4. A certain element (X) has the following valence electron configuration: [A]ns²np⁵ and element M has the following valence electron configuration: [B]ns². Let A and B = the number of core electrons for Y and M respectively and n = the energy level. If an ionic compound was made between M and Y, what would the chemical formula most likely look like?

(1) MX  (2) M₂X  (3) MX₂  (4) M₂X₃  (5) M₃X₄
5. Rank the following ions in order of increasing ionization energy: O$^{2-}$, Mg$^{2+}$, F$^-$, Na$^+$

1) O$^{2-}$ < Mg$^{2+}$ < F$^-$ < Na$^+$
2) Mg$^{2+}$ < O$^{2-}$ < Na$^+$ < F$^-$
3) Mg$^{2+}$ < Na$^+$ < F$^-$ < O$^{2-}$
4) O$^{2-}$ < F$^-$ < Na$^+$ < Mg$^{2+}$
5) O$^{2-}$ < F$^-$ < Mg$^{2+}$ < Na$^+$

6. Which of the following ground state ions is/are paramagnetic?

(1) Fe$^{2+}$ (2) Zn$^{2+}$ (3) Cu$^+$ (4) Ni$^{2+}$ (5) V$^{3+}$

1) 1 and 4 only  2) only 1, 4, and 5  3) only 1  4) only 2 and 3  5) only 2, 4 and 5
7. Select the false statement below:

1) Fe has 2 outer electrons, 8 valence electrons, and 18 core electrons
2) Fe$^{2+}$ is more paramagnetic (has more unpaired electrons) than Fe$^{3+}$
3) Fe$^{3+}$ is isoelectronic with Mn$^{2+}$
4) none of these ions (Fe$^{2+}$, Fe$^{3+}$, Mn$^{2+}$) have any electrons in the 4s subshell
5) Fe$^{3+}$ is predicted to be a stronger potential oxidizing agent (can be reduced more) than Fe$^{2+}$

8. Which of the following substances exhibits hydrogen-bonding intermolecular forces in its liquid state?

(1) CH$_3$NH$_2$  (2) CH$_3$OCH$_3$  (3) CH$_3$F  (4) H$_2$S  (5) (CH$_3$)$_3$N
9. Select the pair of substances in which the one with the lowest normal boiling point is listed first.

(1) C\(_7\)H\(_{16}\), C\(_5\)H\(_{12}\) (2) Xe, Kr (3) H\(_2\)O, H\(_2\)S (4) CH\(_3\)CH\(_2\)OH, CH\(_3\)OCH\(_3\) (5) CF\(_4\), CCl\(_4\)

10. Which of the following fluorine-containing molecules or ions exhibits a tetrahedral molecular geometry?

(1) ClF\(_4^+\) (2) XeF\(_4\) (3) SF\(_4\) (4) BF\(_4^-\) (5) IF\(_4^-\)
11. Which molecule has the strongest intermolecular force?

(1) NH$_3$ - H-Bonding 
(2) SO$_3$ - Dipole-Dipole 
(3) HBr - H-Bonding 
(4) HBr – Dipole-Dipole 
(5) NH$_3$ - Dispersion

12. What is the correct molecular geometry of the following, respectively:

\( \text{ClF}_4^+, \text{COCl}_2, \text{XeF}_4, \text{SF}_6, \text{ClF}_5 \)

(1) See-Saw, Trigonal Planar, Square Planar, Octahedral, Square Pyramidal 
(2) Tetrahedral, Trigonal Planar, Octahedral, Trigonal bipyramidal, Trigonal bipyramidal 
(3) Pyramidal, Trigonal planar, planar, See-saw, See-Saw 
(4) Trigonal Planar, Trigonal pyramidal, Square Planar, Tetrahedral, Seesaw 
(5) Seesaw, Bent, Square planar, Trigonal planar, Trigonal pyramidal
13. When 200 mL of 0.100 M NH₃ solution is added to 300 mL of an unknown NH₃ solution, the final concentration of NH₃ in the mixture is 0.700 M. What was the molarity of NH₃ in the unknown solution?

1) 0.200 M  2) 0.600 M  3) 0.700 M  4) 0.800 M  5) 1.1 M

14. If volumes are additive and 80.0 mL of 0.40 M sodium chloride is mixed with 120 mL of a calcium chloride solution to give a new solution in which [Cl⁻] is 0.52 M, what is the concentration of the calcium chloride used to make the new solution?

1) 0.60 M  2) 0.30 M  3) 0.072 M  4) 0.036 M  5) 0.52 M
15. Which of the following quantum numbers (n, l, ml, ms) could be assigned to a valence electron in the ground state electron configuration of a neutral Calcium atom?

1) 2, 1, 1, +½  2) 3, 0, 0, +½  3) 3, 2, 2, +½  4) 4, 0, 0, +½  5) 4, 3, 3, +½

16. Citric acid is a triprotic acid found in citrus fruits. A 40.00 mL solution containing an unknown concentration of citric acid is titrated with 22.62 mL of 0.2000 M NaOH solution. Calculate the molarity of the citric acid solution.

(1) 0.1131 M  (2) 0.07224 M  (3) 0.03770 M  (4) 0.1768 M  (5) 0.05655 M
17. Rank the following five ions in order of increasing ionic radius: Na, Na⁺, Cs⁺, Ar, Br⁻

(1) Na < Na⁺ < Cs⁺ < Ar < Br⁻
(2) Cs⁺ < Na⁺ < Na < Ar < Br⁻
(3) Br⁻ < Na⁺ < Cs⁺ < Ar < Na
(4) Na⁺ < Cs⁺ < Ar < Na < Br⁻
(5) Br⁻ < Na < Ar < Cs⁺ < Na⁺

18. Which of the following shows the molecules in order from most polar to least polar?

(1) CH₄ > CF₂Br₂ > CF₂H₂ > CBr₄ > CBr₂H₂
(2) CF₂Br₂ > CF₂H₂ > CBr₂H₂ > CH₄ = CBr₄
(3) CF₂H₂ > CBr₂H₂ > CF₂Br₂ > CH₄ = CCl₄
(4) ClF₃ > XeF₄ > NBr₃ > BF₃ > CS₂
(5) CH₄ > CHCl₃ > CHCl₂ > CHCl₃ > CCl₄
19. Which of the following bonds is the most polar?

1) N – Cl
2) H – C
3) O – F
4) Cl – Br
5) C – O

20. Which of the following have a trigonal planar molecular shape?

I) CO$_3$$^2$-
II) BF$_3$
III) NH$_3$

(1) I only (2) I and II only (3) I and III (4) II and III (5) All of them

GOOD LUCK, SMILE ON THE EXAM, and remember to love your moles: all 6.022*10$^{23}$ of them!

-Teaching Center