靜宜大學 103 學年度碩士班招生考試試題

學系：應用化學系　　科目：綜合化學

I. Select ***correct answer*** of following questions:

1. Methane and oxygen react to form carbon dioxide and water. What mass of water is formed if 3.2 g of methane reacts with 12.8 g of oxygen to produce 8.8 g of carbon dioxide?
   A) 7.2 g
   B) 8.8 g
   C) 14.8 g
   D) 16.0 g

2. Which of the following statements is **not** a postulate of Dalton's atomic theory?
   A) Each element is characterized by the mass of its atoms.
   B) Atoms are composed of protons, neutrons, and electrons.
   C) Chemical reactions only rearrange atomic combinations.
   D) Elements are composed of atoms.

3. The reaction $Pb(NO_3)_2(aq) + K_2SO_4(aq) \rightarrow PbSO_4(s) + 2\ KNO_3(aq)$ is best classified as a(n)
   A) acid-base neutralization reaction.
   B) oxidation-reduction reaction.
   C) precipitation reaction.
   D) single replacement reaction.

4. In a solution prepared by mixing CH_3OH with H_2O the major species present are
   A) CH_3OH and H_2O
   B) CH_3OH, H^+, and OH^-
   C) CH_3^+, OH^-, and H_2O
   D) CH_3O^-, H^+, and H_2O

5. Write a balanced net ionic equation for the reaction of $AgNO_3(aq)$ with $Cu(s)$.
   A) $AgNO_3(aq) + Cu(s) \rightarrow Ag(s) + CuNO_3(aq)$
   B) $Ag^+(aq) + Cu(s) \rightarrow Ag(s) + Cu^+(aq)$
   C) $2\ AgNO_3(aq) + Cu(s) \rightarrow 2\ Ag(s) + CuNO_3(aq)$
   D) $2Ag^+(aq) + Cu(s) \rightarrow 2\ Ag(s) + Cu^{2+}(aq)$

6. Which pair of compounds is insoluble in water?
   A) $AgNO_3$ and KNO_3
   B) Na_2S and CuS
   C) $(NH_4)_2SO_4$ and AgI
   D) $PbSO_4$ and $Pb_3(PO_4)_2$

7. The greater the energy of a photon, the
   A) longer the wavelength and the higher the frequency.
   B) longer the wavelength and the lower the frequency.
   C) shorter the wavelength and the higher the frequency.
   D) shorter the wavelength and the lower the frequency.

8. Which of the following is **not** true?
A) All moving objects have wave characteristics.
B) For objects moving at a given speed, the larger the mass, the shorter the wavelength.
C) The de Broglie relation and the Heisenberg uncertainty principle apply only to small particles.
D) The Heisenberg uncertainty principle is an inequality.

9. Which ion has the **smallest** ionic radius?
A) Li^+
B) Na^+
C) K^+
D) Rb^+

10. Which bond should have the highest bond dissociation energy?
A) N-N
B) N=N
C) N≡N
D) All three bonds should have about the same dissociation energy.

11. The compound ICl contains
A) ionic bonds.
B) nonpolar covalent bonds.
C) polar covalent bonds, with partial negative charges on the Cl atoms.
D) polar covalent bonds, with partial negative charges on the I atoms.

12. How many lone pairs of electrons are on the P atom in PF_3?
A) 0
B) 1
C) 2
D) 3

13. The volume of 350. mL of gas at 25°C is decreased to 125 mL at constant pressure. What is the final temperature of the gas?
A) -167°C
B) 8.9°C
C) 70°C
D) 561°C

14. Which of the following ionic compounds would be expected to have the highest lattice energy?
A) NaCl
B) KCl
C) RbCl
D) LiCl

15. An electron in a *5f* orbital can have a wave function with which of the following set of quantum numbers, (*n, l, ml, ms*)?
A) (5, 1, −1, −1/2)
B) (5, 3, 3, 1/2)
C) (5, 4, 1, −1/2)
D) (5, 0, 0, 1/2)

16. What is the ground-state electron configuration of Cu?
A) $[Ar]4S^2 4P^6 3d^2$
B) $[Ar]4s^1 3d^{10}$
C) $[Ar]4s^1 3d^9$
D) $[Ar]4s^2 3d^9$

17. Which is the most acceptable hybrid orbital for oxygen in CO_2?
A) sp
B) sp^2
C) sp^3
D) dsp^3

18. Arrange the ions N^{3-}, O^{2-}, Mg^{2+}, Na^+, and F^- in order of increasing ionic radius, starting with the smallest first
A) N^{3-}, O^{2-}, F^-, Na^+, Mg2+
B) Mg^{2+}, Na^+, F^-, O^{2-}, N^{3-}
C) N^{3-}, Mg^{2+}, O^{2-}, Na^+, F^-
D) N^{3-}, O^{2-}, Mg^{2+}, F^-, Na^+

19. Which descriptions for MO diagram are appropriate for Li_2 and Be_2.
A) both are stable and diamagnetic
B) Be_2 is stable and diamagnetic, but Li_2 is unstable
C) Li_2 is stable and diamagnetic, but Be_2 is unstable
D) Be_2 is stable and paramagnetic, but Li_2 is unstable.

20. How much heat is absorbed when 30.00 g of C(*s*) reacts in the presence of excess $SO_2(g)$ to produce $CS_2(l)$ and $CO(g)$ according to the following chemical equation?

$$5\ C(s) + 2\ SO_2(g) \rightarrow CS_2(l) + 4\ CO(g) \qquad \Delta H° = +239.9\ kJ$$

A)119.9 kJ
B)239.9 kJ
C)1439 kJ
D) 599.2 kJ

21. The reaction $4\ Ag(s) + O_2(g) \rightarrow 2\ Ag_2O(s)$ favors Ag_2O at low temperature, but it favors Ag and O_2 at high temperatures. How can this be explained in terms of ΔH and ΔS?
A)ΔH is positive and ΔS is negative
B)ΔH is positive and ΔS is positive
C)ΔH is negative and ΔS is negative
D)ΔH is negative and ΔS is positive

22. Which of the following gases has the highest average speed at 400K?
A) N_2O_4
B) CO_2
C) SF_6
D) UF_6

23. Which has a dipole moment?
A) SO_2
B) CO_3^{2-}
C) CO_2
D) SO_4^{2-}

24. Iron crystallizes in a body-centered cubic cell having an edge length of 287 pm. What is the density of iron in g/cm^3.
A) 11.9
B) 7.85
C) 1.99
D) 15.9

25. Acetaldehyde decomposes at 750 K: $CH_3CHO \rightarrow CO + CH_4$. The reaction is first order in acetaldehyde and the half-life of the reaction is found to be 530 seconds. What is the rate constant for the reaction at this temperature?
A) $7.6 \times 10^2\ s^{-1}$
B) $2.7 \times 10^2\ s^{-1}$
C) $1.3 \times 10^{-3}\ s^{-1}$
D) $2.7 \times 10^{-3} s^{-1}$

II. Explain the following terms (15 %)

i. First law of thermodynamics
ii. Second law of thermodynamics
iii. Van der waals equation
iv. Definition of entropy
v. Rault's Law (Ideal solution)

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III. A sample of 3.0 mol Ar is originally confined in 10 L at 300 *K* and undergo adiabatic expansion against a constant external pressure of 760 torr until the volume has increased to 50 L. Calculated the ***internal energy change (ΔU)*** and ***work (w)*** = ? (6 %).

IV. Draw a pressure-temperature (P-T) ***phase diagram of pure CO_2.*** (4 %)

V. Predict the ***CO frequency*** with ***increasing in order*** of following complexes .6%
$[Mn(CO)_6]^+$, $[Ti(CO)_6]^{2-}$, $[Cr(CO)_6]$, $[V(CO)_6]^-$

VI. $[Fe(CN)_6]^{3-}$ exhibits two sets of charge transfer absorptions, one of lower intensity in the visible region of the spectrum, and one of higher intensity in the ultraviolet. $[Fe(CN)_6]^{4-}$, however, shows only the high intensity charge-transfer in the ultraviolet. Explain. 7%

VII. Calculate ***LFSE*** of following complexes and predict the ***number unpair electrons***. 12%
a. $[Fe(CN)_6]^{4-}$　b. $[Co(H_2O)_6]^{2+}$　c. $[CrF_6]^{3-}$　d. $[RhCl_6]^{3-}$