國立嘉義大學 101 學年度基礎學科學力競賽試題卷

科目：化學(化學系)　　題型：選擇題　　配分：100%

1. The density of lead is 11.35 g/mL. The experimental values obtained for the density of lead are 10.9, 11.5, and 11.8 g/mL. Which one of the best describes this collection of data?
   (A) accurate (B) precise (C) both A and B (D) not enough information
2. Which of the following numbers has the fewest number of significant figures?
   1235 0.30001 12000 0.00800
   (A) 1235 (B) 0.30001 (C) 12000 (D) 0.00800
3. Consider the numbers 23.68 and 4.12. The sum of these numbers has ____ significant figures, and the product of these numbers has ____ significant figures.
   (A) 3, 3 (B) 4, 4 (C) 3, 4 (D) 4, 3
4. Which of the following is the greatest mass?
   (A) 2.0×10^2 mg (B) 10.0 dg (C) 1.0×10^5 μg (D) 2.0×10^2 cg
5. $^{40}_{20}Ca^{2+}$ has
   (A) 20 protons, 20 neutrons, and 18 electrons
   (B) 20 protons, 20 neutrons, and 20 electrons
   (C) 20 protons, 22 neutrons, and 18 electrons
   (D) 22 protons, 18 neutrons, and 18 electrons
6. Which of the following pairs is incorrect?
   (A) NH_4Br, ammonium bromide (B) K_2CO_3, potassium carbonate (C) $BaPO_4$, barium phosphate, (D) CuCl, copper (I) chloride
7. What is the coefficient for water when the following equation is balanced?
   $As(OH)_3(s) + H_2SO_4(aq) \rightarrow As_2(SO_4)_3(aq) + H_2O(l)$
   (A) 12 (B) 6 (C) 4 (D) 2
8. Consider the following reaction: $2A + B \rightarrow 3C + D$
   3.0 mol A and 2.0 mol B react to form 4.0 mol C. What is the percent yield of this reaction?
   (A) 67% (B) 75% (C) 89% (D) 100%
9. How many of the following salts are expected to be insoluble in water?
   Sodium sulfide barium nitrate ammonium sulfate potassium phosphate
   (A) none (B) 1 (C) 2 (D) 3
10. In accordance with the solubility rules, which of the following will occur when solutions containing about 0.1 g of $Pb(NO_3)_2$(aq) and KI(aq) /100 mL are mixed?
    (A) KNO_3 will precipitate; Pb^{2+} and I^- will be spectator ions. (B) No precipitate will form (C) $Pb(NO_3)_2$ will precipitate; K^+ and I^- will be spectator ions. (D) PbI_2 will precipitate; K^+ and NO_3^- will be spectator ions.
11. All of the following are weak acids except
    (A) HCNO (B) HBr (C) HF (D) HNO_2
12. As the volume of a gas decreases, the pressure increases due to
    (A) an increase in temperature of the gas molecules.
    (B) a decrease in the density of the gas system.
    (C) an increase in the number of collisions occurring per unit time.
    (D) a decrease in the kinetic energy of the gas molecules.
13. Of energy, work, enthalpy, and heat, how many are state functions?
    (A) 1 (B) 2 (C) 3 (D) 4
14. When an hydrogen electron makes transition from n = 3 to n = 1, which of the following statement is true?
    I. Energy is emitted.
    II. Energy is absorbed.
    III. The electron loses energy.
    IV. The electron gains energy.
    V. The electron cannot make this transition.
    (A) II, III (B) V (C) I, III (D) II, III
15. How many electrons in an atom can have the quantum numbers n = 4, l = 2?
    (A) 14 (B) 12 (C) 5 (D) 10
16. Order the elements, S, Cl, and F in the terms of increasing ionization energy.
    (A) S, Cl, F (B) Cl, F, S (C) F, S, Cl (D) F, Cl, S
17. Which of the following statements about quantum theory is incorrect?
    (A) The energy and position of an electron cannot be determined simultaneously.
    (B) Lower energy orbitals are filled with electrons before higher energy orbitals.
    (C) When filling orbitals of equal energy, two electrons will occupy the same orbital before filling a new orbital.
    (D) No two electrons can have the same four quantum numbers.
18. The small, but important, energy differences between 3*s*, 3*p*, and 3*d* orbitals are due mainly to
    (A) the number of electrons they can hold (B) their principal quantum number (C) the Heisenberg uncertainty principle (D) the penetration effect
19. In the gaseous phase, which of the following diatomic molecules would be the most polar?
    (A) LiF (B) CsF (C) NaCl (D) CsCl
20. Which of the following has the smallest radius?
    (A) F^- (B) Ne (C) O^{2-} (D) Mg^{2+}
21. Which of the following ionic compounds has the largest lattice energy?
    (A) BaO (B) BeO (C) CsI (D) NaBr

Draw the Lewis structures of the molecules below and use them to answer the questions from 22 to 24.

I. BH_3 II. NO_2 III. SF_6 IV. O_3 V. PCl_5

22. Which of the molecules obeys the octet rule?
    (A) IV (B) III (C) II (D) I
23. How many of the molecules have no dipole moment?
    (A) 1 (B) 2 (C) 3 (D) 4

24. Which of these molecules show resonance?
(A) I, II (B) II, IV (C) II, V (D) III, IV

25. The molecular structure of OF_2 is
(A) pyramidal (B) bent (C) Octahedral (D) trigonal plannar

26. The bond angles about the carbon atom in the formaldehyde molecule, $H_2C{=}O$, are about:
(A) 120° (B) 60° (C) 109° (D) 90°

27. The hybridization of the central atom in NO_3^- is
(A) p^3 (B) sp^2 (C) sp^3 (D) sp

28. As the bond order of a bond increases, the bond energy_____and the bond length_____.
(A) increases, increases (B) decreases, decreases (C) increases, decreases (D) decreases, increases

29. What is the bond order of He_2^+?
(A) 0 (B) ½ (C) 1 (D) 1½

30. If four orbitals on one atom overlap four orbitals on a second atom, how many molecular orbitals will form?
(A) 1 (B) 4 (C) 8 (D) 16

31. The fact that O_2 is paramagnetic can be explained by
(A) the Lewis structure of O_2 (B) resonance (C) hybridization of atomic orbitals in O_2 (D) the molecular orbital diagram for O_2

32. How many of the following help determine whether or not a solution forms?
I. the polarities of the solute and solvent
II. the densities of the solute and solvent
III. the probability of the mixed state (of the solution)
IV. the energies needed for the solution formation to occur
V. the state of matter of the solute (solid, liquid, gas)
(A) 1 (B) 2 (C) 3 (D) 4

33. Which of the following is the correct order of boiling points for KNO_3, CH_3OH, C_2H_6, Ne?
(A) Ne < CH_3OH < C_2H_6 < KNO_3 (B) KNO_3 < CH_3OH < C_2H_6 < Ne (C) Ne < C_2H_6 < KNO_3 < CH_3OH (D) Ne < C_2H_6 < CH_3OH < KNO_3

34. For the following solution, describe the deviation with respect to Raoult's Law.
hexane (C_6H_{14}) and chloroform ($CHCl_3$)
(A) relatively ideal (B) positive deviation (C) negative deviation (D) more information needed

35. A solution of hydrogen peroxide is 23.3% H_2O_2 by mass and has a density of 1.11 g/cm^3. The molarity of the solution is :
(A) 7.14 M (B) 0.259 M (C) 7.60 M (D) 7.93 M

36. Rank the following compounds according to increasing solubility in water.
I. $CH_3{-}CH_2{-}CH_2{-}CH_3$
II. $CH_3{-}CH_2{-}O{-}CH_2{-}CH_3$
III. $CH_3{-}CH_2{-}OH$
IV. $CH_3{-}OH$
(A) I<III<IV<II (B) I<II<IV<III (C) I<II<III<IV (D) III<IV<II<I

37. Which of the following solutions would have the highest osmotic pressure?
(A) 0.2 M NaBr, sodium bromide (B) 0.2 M $CaCl_2$, calcium chloride
(C) 0.3 M CH_3COOH, acetic acid (D) 0.3 M $C_6H_{12}O_6$, glucose

38. Given the following acids and K_a values:

$HClO_4$	HOAc	HCN	HF
1×10^{7}	1.76×10^{-5}	4.93×10^{-10}	3.53×10^{-4}

What is the order of increasing base strength?
(A) CN^-, F^-, OAc^-, ClO_4^- (B) CN^-, OAc^-, F^-, ClO_4^-
(C) ClO_4^-, OAc^-, CN^-, F^- (D) ClO_4^-, F^-, OAc^-, CN^-

39. The dihydrogenphosphate ion, $H_2PO_4^-$, has both a conjugate acid and a conjugate base. These are, respectively:
(A) H_3PO_4, PO_4^{3-} (B) H_3PO_4, HPO_4^{2-} (C) $H_2PO_4^-$, HPO_4^{2-} (D) HPO_4^{2-}, PO_4^{3-}

40. A buffer solution is prepared by dissolving 0.3 mol of $NaC_2H_3O_2$ and 0.6 mol of $HC_2H_3O_2$ in water. Which substance will show a decrease in concentration when a strong base is added?
(A) Na^+ (B) $C_2H_3O_2^-$ (C) $HC_2H_3O_2$ (D) H_3O^+

41. Consider a solution consisting of the following two buffer systems:
$H_2CO_3 \rightleftharpoons HCO_3^- + H^+$ $pK_a = 6.4$
$H_2PO_4^- \rightleftharpoons HPO_4^{2-} + H^+$ $pK_a = 7.2$
At pH 6.4, which one of the following is true of the relative amounts of acid and conjugate base present?
(A) $[H_2CO_3] > [HCO_3^-]$ and $[H_2PO_4^-] > [HPO_4^{2-}]$
(B) $[H_2CO_3] = [HCO_3^-]$ and $[H_2PO_4^-] > [HPO_4^{2-}]$
(C) $[H_2CO_3] = [HCO_3^-]$ and $[HPO_4^{2-}] > [H_2PO_4^-]$
(D) $[HCO_3^-] > [H_2CO_3]$ and $[HPO_4^{2-}] > [H_2PO_4^-]$

42. In the reaction $P_4(s) + 10Cl_2(g) \rightarrow 4PCl_5(s)$, the reducing agent is
(A) Chlorine (B) PCl_5 (C) phosphorus (D) Cl^-

43. How much heat is required to raise the temperature of a 4.48-g sample of iron (specific heat = 0.450 J/g°C) from 25.0°C to 79.8°C?
(A) 1.98 J (B) 246 J (C) 110 J (D) 546 J

44. The freezing point of helium is –270°C. The freezing point of xenon is –112°C. Both of these are in the noble gas family. Which of the following statements is supported by these data?
(A) Helium and xenon form highly polar molecules. (B) As the molecular weight of the noble gas increases, the freezing point decreases. (C) The London dispersion forces between the helium molecules are less than the London dispersion forces between the xenon molecules. (D) None of these.

45. Which of the following compounds has the lowest viscosity?
(A) $CCl_4(l)$ (B) $N_2(g)$ (C) $H_2O(l)$ (D) $CH_3{-}(CH_2)_{25}{-}CH_3(l)$

46. Four identical 1.0-L flasks contain the gases He, Cl_2, CH_4, and NH_3, each at 0°C and 1 atm pressure. For which gas do the molecules have the highest average velocity?
(A) He (B) Cl_2 (C) CH_4 (D) NH_3

47. In which case must a reaction be spontaneous at all temperatures?
(A) ΔH is positive, ΔS is positive. (B) $\Delta H = 0$, ΔS is negative. (C) $\Delta S = 0$, ΔH is positive. (D) ΔH is negative, ΔS is positive.

48. Which of the following statements is true?

(A) The total energy and entropy of the universe are both increasing.

(B) The total energy of the universe is increasing, but the entropy is constant.

(C) The total energy of the universe increases, while the entropy decreases.

(D) The total energy of the universe is constant, but the entropy is increasing.

49. You have two salts, AgX and AgY, with very similar K_{sp} values. You know that K_a for HX is much greater than K_a for HY. Which salt is more soluble in acidic solution?

(A) AgX (B) AgY (C) They are equally soluble in acidic solution. (D) Cannot be determined by the information given.

50. The most likely reason for colloidal dispersion is _____.

(A) the Tyndall effect (B) coagulation (C) emulsion formation (D) electrostatic repulsion