科目名稱	普通化學B	類組代碼	共同考科
		科目碼	E0018

※本項考試依簡章規定所有考科均「不可」使用計算機。　　　本科試題共計　4　頁

一、選擇題: (單選，不到扣，　共 40 題; 每題 2.5 分, 共 100 分)

1. Which among the following represent a set of isotopes? Atomic nuclei containing
   I. 20 protons and 20 neutrons.　II. 21 protons and 19 neutrons.　III. 22 neutrons and 18 protons.
   IV. 20 protons and 22 neutrons.　V. 21 protons and 20 neutrons.

   (A) I, II, III ; (B) III, IV ; (C) I, V ; (D) I, IV and II, V ; (E) No isotopes are indicated.

2. Which of the following is *not* the correct chemical formula for the compound named?
   (A) $Al(OH)_2$　aluminum hydroxide ; (B) LiCN　　lithium cyanide ;
   (C) Fe_2O_3　　iron(III) oxide ; (D) ZnS zinc sulfide ; (E) $Mg(C_2H_3O_2)_2$　　magnesium acetate

3. Indium has atomic number 49 and atomic mass 114.8 g. Naturally occurring indium contains a mixture
   of indium-112 and indium-115 in an atomic ratio of approximately

   (A) 25/75. ; (B) 6/94. ; (C) 50/50. ; (D) 94/6. ; (E) 75/25.

4. Which of the following compounds has the same percent composition by mass as styrene, C_8H_8?
   (A) acetylene, C_2H_2 ; (B) benzene, C_6H_6 ; (C) cyclobutadiene, C_4H_4 ;
   (D) α-ethyl naphthalene, $C_{12}H_{12}$; (E) all of these.

5. When the equation $NH_3 + O_2 \rightarrow NO + H_2O$ is balanced with the smallest set of integers,
   the sum of the coefficients is
   (A) 4 ; (B) 12 ; (C) 14 ; (D) 19 ; (E) 24

6. What is the net ionic equation for the reaction of aqueous sodium hydroxide with aqueous nitric
   acid?
   (A) $Na^+(aq) + OH^-(aq) + H^+(aq) + NO_3^-(aq) \rightarrow Na^+(aq) + NO_3^-(aq) + H_2O(l)$;
   (B) $Na^+(aq) + OH^-(aq) + H^+(aq) + NO_3^-(aq) \rightarrow NaOH(s) + HNO_3(l)$;
   (C) $H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$; (D) $NaOH(aq) + HNO_3(aq) \rightarrow NaNO_3(aq) + H_2O(l)$;
   (E) $Na^+(aq) + OH^-(aq) \rightarrow NaOH(s)$

7. Which of the following reactions does *not* involve oxidation-reduction?
   (A) $CH_4 + 2O_2 \rightarrow 2H_2O + CO_2$; (B) $Mg + 2HI \rightarrow MgI_2 + H_2$;　(C) $2Na + 2H_2O \rightarrow 2NaOH + H_2$

   (D) $MnO_2 + 4HI \rightarrow I_2 + 2H_2O + MnI_2$;　(E) $LiOH + HCl \rightarrow H_2O + LiCl$

8. How many of the following gases at STP are less dense than air at STP?
   　　　　　NH_3, He, Kr, and F_2
   (A) 1 ; (B) 2 ; (C) 3 ; (D) 4 ; (E) 0

9. The ratio of average kinetic energies per ideal gas molecule (H_2 : SO_2) at the same temperature and
   pressure. (S: 32 ; O: 16; H: 1)

   (A) 1.0 ; (B) 0.18 ; (C) 32 ; (D) 5.6 ; (E) none of these.

10. Consider the equation $2A(g) \rightleftharpoons 2B(g) + C(g)$. At a particular temperature, $K = 1.6 \times 10^4$.
If you mixed 5.0 mol B, 0.10 mol C, and 0.0010 mol A in a 1-L container, in which direction would
The reaction initially proceeds?
(A) To the left. ; (B) To the right. ; (C) The above mixture *is* the equilibrium mixture. ;
(D) We cannot tell from the information given. ; (E) none of these.

11. The acids $HC_2H_3O_2$ and HF are both weak, but HF is a stronger acid than $HC_2H_3O_2$. HCl is a
strong acid. Order the following according to base strength.
(A) $F^- > C_2H_3O_2^- > H_2O > Cl^-$; (B) $Cl^- > F^- > C_2H_3O_2^- > H_2O$; (C) $C_2H_3O_2^- > F^- > Cl^- > H_2O$;
(D) $C_2H_3O_2^- > F^- > H_2O > Cl^-$; (E) none of these.

12. Calculate $[H^+]$ in a 0.012 M solution of HCN, $K_a = 6.2 \times 10^{-10}$.
(A) $2.3 \times 10^{-4}\,M$; (B) $2.7 \times 10^{-6}\,M$; (C) $3.7 \times 10^{-9}\,M$; (D) $6.2 \times 10^{-10}\,M$; (E) $3.0 \times 10^{-7}\,M$.

13. Methyl orange is an indicator with a K_a of 1×10^{-4}. Its acid form, HIn, is red, while its base form,
In^-, is yellow. At pH 6.0, the indicator will be
(A) red. ; (B) orange. ; (C) yellow. ; (D) blue. ; (E) not enough information.

14. Suppose you add 45 J of heat to a system, let it do 10. J of expansion work, and then return the
system to its initial state by cooling and compression. Which statement is true for this process?
(A) $\Delta H < \Delta E$; (B) $\Delta H = 70.$ J ; (C) The change in the internal energy for this process is zero.
(D) The work done in compressing the system must exactly equal the work done by the system in
the expansion step. ; (E) All the statements are false.

15. Which of the following statements is true for a monatomic ideal gas?
(A). $C_v < C_p$; (B) $C_v = C_p + R$; (C) $C_p = 1.5\,R$; (D) C_v is temperature dependent ; (E) none of these.

16. Consider the dissociation reaction of the acid HF. $HF(aq) \rightarrow H^+(aq) + F^-(aq)$;
Why is ΔS negative?
(A) Each HF molecule produces two ions when it dissociates. ; (B) The ions are hydrated. ;
(C) The reaction is expected to be exothermic, and ΔS thus should be negative. ;
(D) The reaction is expected to be endothermic, and ΔS thus should be negative. ; (E) none of these.

17. ΔS_{surr} is _____ for exothermic reactions and _____ for endothermic reactions.
(A) $> 0, < 0$; (B) $< 0, > 0$; (C) $< 0, < 0$; (D) $> 0, > 0$; (E) cannot tell.

18. For the reaction $A + B \rightarrow C + D$, $\Delta H^\circ = +40$ kJ and $\Delta S^\circ = +50$ J/K. Therefore, the reaction under
standard conditions is
(A) spontaneous at temperatures less than 10 K. ; (B) spontaneous at temperatures greater than 800 K. ;
(C) spontaneous only at temperatures between 10 K and 800 K. ; (D) spontaneous at all temperatures ;
(E) nonspontaneous at all temperatures.

19. If a reducing agent M reacts with an oxidizing agent Q^{2+} to give M^{2+} and Q, and the equilibrium
constant for the reaction is 1.0, then what is the E° value for the oxidation–reduction reaction
at 25°C ?
(A) -1.0 V ; (B) 1.0 V ; (C) 0.03 V ; (D) 0.0 V ; (E) -0.03 V

20. The standard potential for the reaction $Zn + 2Ag^+ \rightarrow Zn^{2+} + 2Ag$ is 1.56 V. Given that the standard reduction potential for $Ag^+ + e^- \rightarrow Ag$ is 0.80 V, determine the standard reduction potential for $Zn^{2+} + 2e^- \rightarrow Zn$.
    (A) 0.76 V ; (B) 0.04 V ; (C) −0.38 V ; (D) −0.04 V; (E) −0.76 V

21. On a planet where the temperature is so high, the ground state of an electron in the hydrogen atom is $n = 3$. What is the ratio of ionization energy on this planet to that on earth?
    (A) 1 : 3 ; (B) 3 : 1 ; (C) 1 : 9 ; (D) 9 : 1; (E) 1 : 1

22. How many electrons can be described by the quantum numbers $n = 3$, $l = 1$, $m_l = -1$?
    (A) 0 ; (B) 2 ; (C) 4 ; (D) 9 ; (E) 1

23. An element has the electron configuration $[Kr] 4d^{10}5s^25p^2$. The element is a(n)
    (A) lanthanide. ; (B) actinide. ; (C) transition element. ; (D) nonmetal. ; (E) metal.

24. Which of the following molecules has a nonzero dipole moment?
    (A) CH_4 ; (B) SiF_4 ; (C) CS_2 ; (D) SO_3 ; (E) PBr_3

25. As indicated by Lewis structures, which of the following would probably *not* exist as a stable molecule?
    (A) C_3H_4 ; (B) CH_3OH ; (C) C_2H_2; (D) CH_3O ; (E) CH_2O.

26. How many of the following compounds exhibit resonance?
        O_3　　SO_2　　NF_3　　CCl_4
    (A) 0 ; (B) 1 ; (C) 2 ; (D) 3 ; (E) 4

27. Which statement about N_2 is *false*?
    (A) The oxidation state is +3 on one N and −3 on the other. ; (B) It is a gas at room temperature. ;
    (C) It has one sigma bond and two pi bonds between the two atoms. ;
    (D) It can combine with H_2 to form NH_3. ; (E) It has two pairs of nonbonding electrons.

28. Which of the following is paramagnetic?
    (A) O_2^- ; (B) O_2^+ ; (C) O_2 ; (D) N_2. ; (E) At least two of these are paramagnetic.

29. For a reaction $aA \rightarrow$ products, $[A]_0 = 4.0\ M$, and the first three successive half-lives are 48, 96, and 192 min. The order of this reaction in A is
    (A) 0 ; (B) 1 ; (C) 2 ; (D) 3 ; (E) none of these.

30. The rate law for a reaction is found to be Rate = $k[A]^2[B]$. Which of the following mechanisms gives this rate law?
    I.　$A + B \rightleftharpoons E$ (fast)　;　$E + B \rightarrow C + D$ (slow)
    II.　$A + B \rightleftharpoons E$ (fast)　;　$E + A \rightarrow C + D$ (slow)
    III.　$A + A \rightarrow E$ (slow)　;　$E + B \rightarrow C + D$ (fast)
    (A) I only ; (B) II only ; (C) III only ; (D) II and III. ; (E) I and III.

31. Which of the following is the correct order of boiling points for $NaNO_3$, C_2H_5OH, C_2H_6, and Ne?
   (A) $Ne < C_2H_5OH < C_2H_6 < NaNO_3$; (B) $NaNO_3 < C_2H_5OH < C_2H_6 < Ne$;
   (C) $Ne < C_2H_6 < NaNO_3 < C_2H_5OH$; (D) $Ne < C_2H_6 < C_2H_5OH < NaNO_3$;
   (E) $C_2H_6 < Ne < C_2H_5OH < NaNO_3$.

32. The normal boiling point of liquid X is less than that of Y, which is less than that of Z. Which of the following is the correct order of increasing vapor pressure of the three liquids at STP?
   (A) X, Y, Z (B) Y, X, Z ; (C) X, Z, Y ; (D) Z, Y, X ; (E) Y, Z, X.

33. The triple point of CO_2 is at 5.2 atm and –57°C. Under atmospheric conditions of $P = 630$ torr, $T = 23°$ C, solid CO_2 will
   (A) sublime. ; (B) melt. ; (C) remain solid. ; (D) boil. ; (E) in equilibrium with liquid.

34. A liquid-liquid solution is called an ideal solution if
   I. it obeys $PV = nRT$. ; II. it obeys Raoult's law.
   III. solute-solute, solvent-solvent, and solute-solvent interactions are very similar.
   IV. solute-solute, solvent-solvent, and solute-solvent interactions are quite different.
   (A) I, II, III ; (B) I, II, IV ; (C) I, II ; (D) I, IV ; (E) II, III.

35. When a nonvolatile solute is added to a volatile solvent, the solution vapor pressure _____, the boiling point _____, the freezing point _____, and the osmotic pressure across a semipermeable membrane _____.
   (A) decreases, increases, decreases, increases. ; (B) decreases, decreases, increases, decreases. ;
   (C) increases, decreases, increases, decreases. ; (D) increases, increases, decreases, increases. ;
   (E) decreases, increases, decreases, decreases.

36. Which of the following complexes shows geometric isomerism?
   (A) $[Co(H_2O)_5Cl]SO_4$; (B) $[Co(H_2O)_6]Cl_3$; (C) $[Co(H_2O)_5Cl]Cl_2$; (D) $K[Co(H_2O)_2Cl_4]$;
   (E) $Na_3[CoCl_6]$

37. How many unpaired electrons are there in the complex ion $[Co(NO_3)_6]^{4-}$? For this ion, the nitrate ligands produce a very strong crystal field. (Co: $[Ar] 3d^7 4s^2$)
   (A) 5 ; (B) 3 ; (C) 1 ; (D) 2 ; (E) 4

38. The Cs-131 nuclide has a half-life of 30 years. After 120 years, about 3 g remain. The original mass of the Cs-131 sample is closest to
   (A) 96 ; (B) 48 ; (C) 36 ; (D) 24 ; (E) 12

39. In which of the following lists do all members have a C=O bond?
   (A) ester, aldehyde, secondary alcohol, ketone ; (B) any alcohol, ether, ester ;
   (C) secondary alcohol, ketone, aldehyde ; (D) carboxylic acid, ether, tertiary alcohol ;
   (E) ester, aldehyde, ketone

40. What is the complementary nucleic acid sequence for the DNA sequence GAC TAC GTT GGC?
   (A) GAC TAC GTT GGC ; (B) TCA GCA TGG CTA ; (C) CGA GTG CAT CAG ;
   (D) CTG ATG CAA CCG ; (E) GCG AAG GGG TTG