單一選擇題：（第1、2二題各2分；3-34每題3分）

1. Arrangement of following according to expected value for b (volume correction value) in van der Waal's equation?

    (A). He < HF < H_2O < CO_2 < SF_6
    (B). He < H_2O < HF < CO_2 < SF_6
    (C). He < HF < CO_2< H_2O < SF_6
    (D). He < HF < H_2O < SF_6 < CO_2
    (E). SF_6 < H_2O < CO_2 < HF < He

2. Put the following gases in order form smallest to the largest according to van der Waal's constant a (pressure correction value)?

    (A). H_2 < Ne < N_2 < CH_4 < H_2O
    (B). Ne < N_2 < H_2 < CH_4 < H_2O
    (C). Ne < H_2 < N_2 < CH_4 < H_2O
    (D). Ne < H_2 < N_2 < H_2O < CH_4
    (E). CH_4 < H_2O < N_2 < H_2 < Ne

3. The rate of effusion of freon-12 to freon-11 is 1.07:1. The molar mass of freon-11 is 137.4 g/mol. What is the molar mass, in g/mol of freon-12?

    (A). 147.0
    (B). 142.1
    (C). 132.8
    (D). 128.4
    (E). 120.0

4. For the hypothetical reactions 1 and 2.

    1. $A_2(g) + B_2(g) \leftrightarrow 2\,AB(g)$　　$K_1 = 10^2$
    2. $2\,A_2(g) + C_2(g) \leftrightarrow 2\,A_2C\,(g)$　　$K_2 = 10^{-4}$
    3. $A_2C(g) + B_2(g) \leftrightarrow 2\,AB(g) + \tfrac{1}{2}\,C_2(g)$　　What is the value for K for reaction 3?

    (A). 10^{-4}
    (B). 10^{-2}
    (C). 10^2
    (D). 10^4
    (E). 10^6

5. Which of the following statements is true?

    (A) A system at a state of chemical equilibrium is microscopically static and macroscopically dynamic.
    (B) Catalysts are no effective means of changing the position of an equilibrium.
    (C) The concentration of the products equals that of reactants and is constant at equilibrium.
    (D) When heat is added to an exothermic reaction, the reaction shifts toward products.
    (E) The equilibrium constant is independent of temperature.

6. In pure liquid ammonia, the equilibrium concentrations of both $[NH_4^+]$ and $[NH_2^-]$ are 3×10^{-14} M at 25^0C. Which of the following equations holds for liquid ammonia solutions at 25^0C?

    (A) $pNH_4^+ + pNH_2^- = 13.5$
    (B) $pNH_4^+ = pNH_2^- = 13.5$
    (C) $pNH_4^+ = 27.0$
    (D) $pNH_4^+ = 27.0 - pNH_2^-$
    (E) $pNH_4^+ = \log [pNH_4^+]$

7. For nitrous acid, HNO_2, $K_a = 4.0 \times 10^{-4}$. Calculate the pH of 0.25 M HNO_2.

    (A) 1.56
    (B) 2.00
    (C) 2.30
    (D) 3.40
    (E) 3.70

8. Calculate the concentrations of $[PO_4^{3-}]$ of a 5.0 M H_3PO_4 solution.
    ($K_{a1} = 7.5 \times 10^{-3}$, $K_{a2} = 6.2 \times 10^{-8}$, $K_{a3} = 4.8 \times 10^{-13}$)

    (A) 0.19 M
    (B) 0.72 M
    (C) 7.5×10^{-3} M
    (D) 6.2×10^{-8} M
    (E) 1.6×10^{-19} M

（背面仍有題目，請繼續作答）

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9. A 25.0 mL of 0.10 M NH_3 is titrated with 0.15 M HCl. What is the pH of the solution after 15.00 mL of acid have been added to the ammonia solution? ($K_b = 1.8 \times 10^{-5}$)

   (A) 10.21 　　(B) 9.30 　　(C) 9.21 　　(D) 8.30 　　(E) 7.00

10. Which of the following compounds has the lowest solubility in mol/L in water?

    (A) $Al(OH)_3$ 　$K_{sp} = 2 \times 10^{-32}$ 　(B) $Sn(OH)_2$ 　$K_{sp} = 3 \times 10^{-30}$ 　(C) CdS 　$K_{sp} = 1.0 \times 10^{-28}$
    (D) $PbSO_4$ 　$K_{sp} = 1.3 \times 10^{-8}$ 　(E) MgC_2O_4 　$K_{sp} = 8.6 \times 10^{-5}$

11. Which of the following properties is (are) intensive properties?

    I. mass 　　II. temperature 　　III. volume 　　IV. concentration 　　V. energy
    (A) I, III, and V 　(B) II only 　(C) II and IV 　(D) III and IV 　(E) II and V

12. Using Hess's Law and equations 1-3 below, find $\Delta H°$ at 25° C for the oxidation of C_2H_5OH (l).

    $C_2H_5OH(l) + 3\ O_2(g) \rightarrow 3\ H_2O(l) + 2\ CO_2(g)$ 　　$\Delta H°$ = _____ kJ

    $C_2H_4(g) + 3\ O_2(g) \rightarrow 2\ CO_2(g) + 2\ H_2O(l)$ 　　　　$\Delta H° = -1411$ kJ

    C (graphite) $+ 3\ H_2(g) + (1/2)\ O_2(g) \rightarrow C_2H_5OH(l)$ 　　$\Delta H° = -278$ kJ

    $C_2H_4(g) + H_2O(l) \rightarrow \ C_2H_5OH(l)$ 　　　　　　$\Delta H° = -44$ kJ

    (A). -1367 kJ 　(B). 1367 kJ 　(C). 1733 kJ 　(D). -1089 kJ 　(E). 1089 kJ

13. At 1 atm, a metal M melt at 1060 ^{0}C. Estimate the ΔS^0 (J/Kmol) of process M(s) $\rightarrow$ M(l), if the molar heat of melting is 213 kJ/mol. (R = 8.3145 J K^{-1} mol^{-1})

    (A) 0 　　(B) 71 　　(C) 108 　　(D) 160 　　(E) 201

14. The temperature of 2.00 mol Ne(g) is increased form 25 ^{0}C to 200 ^{0}C at constant pressure. Calculate the change in the entropy (J/K) of neon. Assume ideal behavior.

    (A) 51.9 　　(B) 86.4 　　(C) 19.2 　　(D) 11.5 　　(E) 0

15. $Pb + PbO_2 + 2\ HSO_4^- + 2H^+ \rightarrow 2\ PbSO_4 + 2\ H_2O$ 　　For such a cell $E°$ is 2.04 V. Calculate $\Delta G°$ at 25°C.

    (A) -787 kJ 　(B) -98 kJ 　(C) -394 kJ 　(D) -197 kJ 　(E) -0.121 kJ

16. Consider an electrochemical cell with a cobalt electrode immersed in 1.0M Co^{2+} and a lead electrode immersed in 1.0M Pb^{2+}.

    $Co^{2+} + 2e^- \rightarrow Co$ 　$E° = -0.28$ V

    $Pb^{2+} + 2e^- \rightarrow Pb$ 　$E° = -0.13$ V

    If $[Co^{2+}]_0$ is 0.0010 M and $[Pb^{2+}]_0$ is 0.10 M, calculate E.

    (A) 0.15 V 　(B) 0.091V 　(C) 0.21 　(D) 0.27 　(E) 0.35

17. If a particle is confined to a one-dimension box of length 300 pm, for Ψ_4 the particle is most likely to be found at

    (A) 50.5 pm 　(B) 100 pm 　(C) 150 pm 　(D) 187.5 pm 　(E) 300 pm

18. What is the probability of finding an electron in a small region of an atom 1s orbital $\Psi_{1S} = e^{-2r/a_0}$ at a distance a_0 from the nucleus relative to the probability of finding it in the same small region located at $3a_0$ from the nucleus?
(A) 0.018   (B) 5.2   (C) 14   (D) 55   (E) 2980

19. From the spectrum of hydrogen atom, the first and second lines are 121.6 nm and 102.6 nm, respectively. What will be wavelength (nm) of the third line?
(A) 99   (B) 97   (C) 91   (D) 87   (E) 84

20. Give the following elements and four values of possible first ionization energies: F, Ne, Mg, S and 2080, 1680, 1000, 736 kJ/mol, match the atoms with their first ionization energies.
(A) F (2080), Ne (1680), Mg (1000), and S (736)
(B) F (2080), Ne (736), Mg (1680), and S (1000)
(C) F (1680), Ne (2080), Mg (1000), and S (736)
(D) F (1680), Ne (2080), Mg (736), and S (1000)
(E) F (2080), Ne (1000), Mg (1680), and S (736)

21. The reaction $2 NO_{(g)} + O_{2(g)} \rightarrow 2 NO_{2(g)}$ with the proposed mechanism
$$NO_{(g)} + O_{2(g)} \leftrightarrow NO_3 \qquad \text{Fast equilibrium}$$
$$NO_{3(g)} + O_{2(g)} \rightarrow 2 NO_{2(g)} \qquad \text{Slow reaction}$$
What is the rate law of this reaction?
(A) $k[NO]^2[O_2]$ (B) $k[NO]^2$ (C) $k[NO][O_2]$
(D) $k[NO][O_2]^2$ (E) $k[NO][NO_3]$

22. For a second –order reaction: $2A \rightarrow$ product, the instantaneous rate of reaction for $[A] = 0.5$ mol L^{-1} is 2.5 mol L^{-1} s^{-1}. The half-life (sec) of reaction with $[A]_0 = 0.7$ mol L^{-1} is ?
(A) 0.251   (B) 0.142   (C) 0.0693   (D) 0.0512   (E) 0.341

23. What is the hybridization of the central Xe atom in the molecule $XeCl_2$?
(A) sp   (B) sp^2 (C) sp^3 (D) dsp^3 (E) d^2sp^3

24. Which of the following is predicted by the MO model to be unstable diatomic species?
(A) H_2^+ (B) H_2^- (C) Be_2 (D) B_2 (E) C_2

25. Which of the following species has the highest bond order?
(A). NO   (B). CN^- (C). N_2^+ (D). O_2 (E). O_2^-

26. The transition metal complex that would not exhibit the Jahn-Teller effect is
(A). $[Ti(H_2O)_6]^{3+}$ (B). $[Cu(H_2O)_6]^{2+}$ (C). $[FeF_6]^{3-}$ (D). $[CoF_6]^{3-}$ (E) $[Co(H_2O)_6]^{2+}$

27. Which of the following is (are) paramagnetic?
I. $Ni(CO)_4$ II. $[NiCl_4]^{2-}$ III. $[Fe(H_2O)_6]^{2+}$ IV. $[Fe(CN)_6]^{4-}$ V. $[V(H_2O)_6]^{3+}$
(A) I, II, III   (B) II, III, IV   (C) I, II, IV
(D) I, III, IV   (E) II, III, V

（背面仍有題目,請繼續作答）

28. The enthalpy of vaporization for water is 40.7 kJ/mol. (T_b = 100 ^{0}C, R = 8.3145 J/K mol) Then the boiling point of water at 520 torr is _____$^\circ$C____
   (A) 12.5 $^\circ$C   (B) 81.3°C   (C) 89.5°C   (D) 91.8°C   (E) 99.2°C

29. Which of following statements is correct for nickel, which has a cubic closest packed unit cell, with density of 6.84 g/cm^3. (Ni = 58.7 g/mol)
   I. The number of Ni atoms per unit cell is 2.
   II. The number of Ni atoms per unit cell is 4.
   III. The cubic edge length is 3.85×10^{-8} cm.
   IV. The radius of Nickel is 1.36×10^{-8} cm.
   V. The radius of Nickel is 2.72×10^{-8} cm.
   (A) I, III, IV   (B) I, III, V   (C) II, III, IV
   (D) II, III, V   (E) I, V

30. The osmotic pressure of a solution saturated with a salt M_3X_2 is 2.64×10^{-2} atm at 25° C. Calculate k_{sp} value for M_3X_2, assuming ideal behavior.
   (A) 5.08×10^{-17} (B) 4.7×10^{-19} (C) 5.32×10^{-18}
   (D) 2.35×10^{-18} (E) 1.5×10^{-18}

31. Which types of processes are likely when the neutron-to-proton ratio in a nucleus is too low?
   I. α decay   II. β decay   III. positron production   IV. electron capture
   (A) I, II   (B) II, III   (C) III, IV
   (D) II, III, IV   (E) II, IV

32. The Cs-131 nuclide has a half-life of 30 years. After 120 years, about 3 grams remain. The original mass of the Cs-131 sample is closest to_____grams.
   (A). 12.00   (B). 24.00   (C). 36.00   (D). 42.00   (E). 48.00

33. Which of following statements is correct for the compound below is the carbon skeleton (minus any hydrogen atoms) of

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      C−C
       |
C−C−C−C−C−C−C
       |       |
      C−C      C
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   I.   a $C_{12}H_{26}$
   II. a substituted octane
   III. a compound with 3 tertiary carbons
   IV   a compound with 3 secondary carbons
   V.   . a compound with 2 isopropyl groups
   (A) I, II, III   (B) II, III, IV   (C) III, IV, V
   (D) II, IV, V   (E) I, II, III, IV

34. Which of the following is optically active (i.e., chiral)?
   (A) 2-chloropropane   (B) 3-chloropentane   (C) 3,3-dichlorohexane
   (D) $[CoCl_6]^{3-}$ (E) $[Co(en)_3]^{3+}$