(單選題) **1-32** 題每題 **3** 分, 第 **33** 題 **4** 分, 總分 **100** 分

1. Equilibrium is reached in chemical reactions when
(a) the rates of the forward and reverse reactions become equal.
(b) the concentrations of reactants and products become equal.
(c) the temperature shows a sharp rise.
(d) all chemical reactions stop.
(e) the forward reaction stops.

2. Which of the following will NOT make a buffered solution?

(a) 100 mL of 0.1 M Na_2CO_3 and 50 mL of 0.1 M HCl.
(b) 100 mL of 0.1 M $NaHCO_3$ and 25 mL of 0.2 M HCl.
(c) 100 mL of 0.1 M Na_2CO_3 and 75 mL of 0.2 M HCl.
(d) 50 mL of 0.2 M Na_2CO_3 and 5 mL of 1.0 M HCl.
(e) 100 mL of 0.1 M Na_2CO_3 and 50 mL of 0.1 M NaOH.

3. K_{sp} for the following salts are ZnS: 2.5×10^{-22}, CuS 8.5×10^{-45}, Ag_2S: 1.6×10^{-49}, Bi_2S_3: 1.1×10^{-73}. The solubility is in an order of

(a) CuS > ZnS > Bi_2S_3 > Ag_2S
(b) Bi_2S_3 > Ag_2S > CuS > ZnS
(c) ZnS > CuS > Ag_2S > Bi_2S_3
(d) ZnS > Bi_2S_3 > Ag_2S > CuS
(e) Ag_2S > ZnS > Bi_2S_3 > CuS

4. For the titration of 50 mL of 0.1 M $HC_2H_3O_2$ with 0.1 M NaOH, which of the following indicator is the most suitable indicator?
(a) Cresol Red (pKa = 1.5)
(b) Methyl Orange ((pKa = 3.8)
(c) Methyl Red (pKa = 4.5)
(d) Phenolphthalein (pKa = 9.0)
(e) Alizarin Yellow R (pKa = 11)

5. A solution contains the ions Ag^+, Pb^{2+}, and Ni^{2+}. Dilute solutions of NaCl, Na_2SO_4, and Na_2S are available to separate the positive ions from each other. To separate the ions, in which order should the solutions be added?
(a) Na_2SO_4, NaCl, Na_2S
(b) Na_2SO_4, Na_2S, NaCl
(c) Na_2S, NaCl ,Na_2SO_4
(d) NaCl ,Na_2S, Na_2SO_4
(e) NaCl , Na_2SO_4 Na_2S

6. Which element does not belong to the family or classification indicated?
(a) Br, halogen
(b) He, noble gas
(c) Fe, transition metal
(d) Rb, alkali metal
(e) Te, Lanthanide

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7. For a spontaneous reaction, which of the following statements is correct?
(a) The entropy change of the system must be > 0
(b) The entropy change of the surrounding must be > 0
(c) The total entropy change must be < 0
(d) the entropy change in the isolated system must be > 0
(e) the change of the system free energy must be > 0.

8. Which of the following is the correct order of molecules from the most to the least polar?
(a) $CH_4 > CF_2Cl_2 > CF_2H_2 > CCl_4 > CCl_2H_2$
(b) $CH_4 > CF_2H_2 > CF_2Cl_2 > CCl_4 > CCl_2H_2$
(c) $CF_2Cl_2 > CF_2H_2 > CCl_2H_2 > CH_4 = CCl_4$
(d) $CF_2H_2 > CCl_2H_2 > CF_2Cl_2 > CH_4 = CCl_4$
(e) $CF_2Cl_2 > CF_2H_2 > CCl_4 > CCl_2H_2 > CH_4$

9. Which molecule has the smallest bond angle?
(a) H_2O
(b) HCN
(c) NH_3
(d) CH_4
(e) BF_3

10. The hybridization of the central atom in SeF_4 is
(a) sp
(b) sp^2
(c) sp^3
(d) dsp^3
(e) d^2sp^3

11. Which of the following is NOT the correct chemical formula for the compound named?

(a) hydrocyanic acid	HCN
(b) calcium sulfate	$CaSO_4$
(c) beryllium oxide	BeO
(d) nickel (II) peroxide	Ni_2O
(e) ammonium chromate	$(NH_4)_2CrO_4$

12. You find a compound composed only of element X and hydrogen, and know that it is 91.33% element X by mass. Each molecule has 2.67 times as many H atoms as X atoms. What is element X ?
(a) C
(b) Ne
(c) Si
(d) Cl
(e) Cu

13. A 51.24-g sample of $Ba(OH)_2$ is dissolved in enough water to make 1.20 liters of solution. How many mL of this solution must be diluted with water in order to make 1.00 liter of 0.100 molar $Ba(OH)_2$?
(a) 400 mL

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(b) 333 mL
(c) 278 mL
(d) 1.20×10^3 mL
(e) none of these

14. The purity of a sample containing zinc and weighing 0.198 g is determined by measuring the amount of hydrogen formed when the sample reacts with an excess of hydrochloric acid. The determination shows the sample to be 84.0% zinc. What amount of hydrogen (measured at STP) was obtained?
(a) 0.152 L
(b) 0.0330 g
(c) 3.42×10^{-3} mole
(d) 1.53×10^{21} molecules
(e) 1.53×10^{21} atoms

15. For the reaction below, $K_p = 1.16$ at 800℃.
$CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$
If a 20.0-gram sample of $CaCO_3$ is put into a 10.0-liter container and heated to 800℃, what percent of the $CaCO_3$ will react to reach equilibrium?
(a) 14.6%
(b) 65.9%
(c) 34.1%
(d) 100.0%
(e) None of these

16. A monoprotic weak acid when dissolved in water is 0.92% dissociated and produces a solution with pH = 3.42. Calculate K_a of the acid.
(a) 1.4×10^{-7}
(b) 2.8×10^{-3}
(c) 3.5×10^{-6}
(d) Need to know the initial concentration of the acid
(e) None of these

17. You have two salts, AgX and AgY, with very similar K_{sp} values. You also 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.

18. The K_f for the complex ion $Ag(NH_3)_2^+$ is 1.7×10^7. The K_{sp} for AgCl is 1.6×10^{-10}. Calculate the molar solubility of AgCl in 1.0 M NH_3.
(a) 5.2×10^{-2}
(b) 4.7×10^{-2}
(c) 2.9×10^{-3}
(d) 1.3×10^{-5}
(e) 1.7×10^{-10}

19. Determine the pH of a solution prepared by mixing the following:

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25.0 mL of 0.200 M HCl
75.0 mL of 0.100 M NaOH
50.0 mL of 0.200 M NaH_2PO_4

For H_3PO_4 $K_{a1} = 7.5 \times 10^{-3}$, $K_{a2} = 6.2 \times 10^{-8}$, and $K_{a3} = 4.8 \times 10^{-13}$

(a) 1.65
(b) 4.25
(c) 4.32
(d) 5.18
(e) 6.73

20. The triple point of iodine is at 90 torr and 115° C. This means that liquid I_2
(a) is more dense than $I_2(s)$.
(b) cannot exist above 115° C.
(c)cannot exist at 1 atmosphere pressure.
(d) cannot have a vapor pressure less than 90 torr.
(e) can exist at pressure of 10 torr.

21. A first-order reaction is 35% complete at the end of 55 minutes. What is the value of the rate constant?
(a) 1.9×10^{-3} min^{-1}
(b) 36 min^{-1}
(c) 89 min^{-1}
(d) 7.8×10^{-3} min^{-1}
(e) none of these

22. Specify the hybridization of the nitrogen atom in each of the following, in order.
NO_3^- N_2 NO_2^+
(a) sp^3 , sp , sp
(b) sp^2 , sp , sp^2
(c) sp^2 , sp , sp^3
(d) sp^3 , sp^2 , sp^3
(e) none of the above

23. Which of the following is paramagnetic?
(a) B_2
(b) C_2
(c) H_2
(d) N_2
(e) At least two of the above are paramagnetic.

24. Using the following data reactions

	ΔH^0(kJ)
$H_2(g) + Cl_2(g) \rightarrow 2HCl(g)$	-184
$H_2(g) \rightarrow 2H(g)$	432
$Cl_2(g) \rightarrow 2Cl(g)$	239

Calculate the energy of an H-Cl bond
(a) 770 kJ
(b) 856 kJ
(c) 518 kJ

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(d) 326 kJ
(e) 428 kJ

25. What is the probability of finding a particle in a one-dimensional box in energy level n = 4 between x = L/4 and x = L/2? (L is the length of the box.)

(a) 12.5%
(b) 25%
(c) 33%
(d) 37.5%
(e) 50%

26. The reduction potentials for Au^{3+} and Ni^{2+} are as follows:

$Au^{3+} + 3\,e^- \rightarrow Au \quad E^0 = +1.50V$

$Ni^{2+} + 2\,e^- \rightarrow Ni \quad E^0 = -0.23V$

Calculate ΔG^0 (at 25°C) for the reaction:

$2Au^{3+} + 3Ni \rightarrow 3Ni^{2+} + 2Au$

(a) -5.00×10^2 kJ
(b) $+5.00 \times 10^2$ kJ
(c) –2140 kJ
(d) $+1.00 \times 10^3$ kJ
(e) -1.00×10^3 kJ

27. One mole of an ideal gas at 25°C is expanded isothermally from 5.0 L to 10.0 L under such conditions that no work is produced in the surroundings. Which statement is correct?

(a) $\Delta S_{gas} = 0$
(b) $\Delta S_{gas} = R\ln(2/298)$
(c) $\Delta S_{univ} = 0$
(d) $\Delta S_{surr} = 0$
(e) $\Delta S_{gas} = \Delta S_{surr}$

28. At constant pressure, the following reaction

$2\,NO_2(g) \rightarrow N_2O_4(g)$

is exothermic. The reaction (as written) is

(a) always spontaneous.
(b) spontaneous at low temperatures, but not high temperature.
(c) spontaneous at high temperatures, but not low temperature.
(d) never spontaneous.

29. At a given temperature, you have a mixture of benzene and toluene. The mole fraction of benzene in the vapor above the solution is 0.590. Assuming ideal behavior, calculate the mole fraction of toluene in the solution.
(vapor pressure of pure benzene=745 torr, vapor pressure of pure toluene=290 torr)

(a) 0.213
(b) 0.778
(c) 0.641

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(d) 0.359
(e) 0.590

30. What reason is given for the stability of C-C, N-N, and O-O bonds, compared to the instability of Si-Si, P-P, and S-S bonds?
(a) Their metallic character varies greatly.
(b) Large differences in their ionization energies.
(c) Large differences in their electronegativties.
(d) Large differences in their abilities to form strong π bonds.

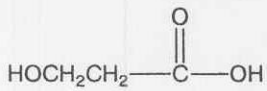
31. F_2 is a better oxidizing agent than Cl_2 in gas phase principally because:

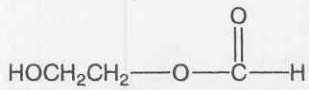
(a) F_2 has a weaker bond than Cl_2
(b) F_2 has a strong bond than Cl_2
(c) The electron affinity of F is greater than that of Cl
(d) The electronegativties of Cl is greater than that of F
(e) The ionization energy of F is greater than that of Cl

32. A coordination compound of Cu^{2+} can be described as $Cu(NH_3)_xSO_4$ and is known to contain 29.9% NH_3. The value of x is:
(a) 2
(b) 3
(c) 4
(d) 6
(e) none of these

33. Referring to the structures below, which statement is true?

I. 

II. 

III. 

(a) I and II have different molecular formulas.
(b) I and III are structural isomers of each other.
(c) II and III are stereoisomers of each other.
(d) II and III are different conformations of the same compound.
(e) I and III are the same compound.

試題隨卷繳回