

編號: 6 系所: 地科系、化工系、材料系、環工系 科目: 普通化學

本試題是否可以使用計算機: 可使用, 不可使用 (請命題老師勾選)

說明: 答案一律寫在答案紙上; 請依序作答, 並標明題號。

一、選擇題(單選題)共25題, 每小題2%。

- How many of the following did Dalton not discuss in his atomic theory?
I. Isotopes, II. Ions, III. Protons, IV. Neutrons, V. electrons
a) 1 b) 2 c) 3 d) 4 e) 5
- Which of the following statements are true?
I. The number of protons is the same for all neutral atoms of an element.
II. The number of electrons is the same for all neutral atoms of an element.
III. The number of neutrons is the same for all neutral atoms of an element.
a) I, II, and III are all true b) Only I and II are true c) Only II and III are true
d) Only I and III are true. e) I, II, and III are all false.
- The average mass of a boron atom is 10.81. If you were able to isolate a single boron atom, what is the chance that you would randomly get an atom with mass 10.81?
a) 0% b) 0.81% c) about 11% d) 10.81%
e) greater than 50%
- 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. In order to effect separation, the solutions should be added in which order?
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
- Under which of the following conditions does a gas behave most ideally?
a) STP b) $P = 1.00 \text{ atm}$, $T = 100.0^\circ\text{C}$ c) $P = 0.50 \text{ atm}$, $T = 100.0^\circ\text{C}$
d) $P = 0.50 \text{ atm}$, $T = 0.0^\circ\text{C}$ e) $P = 2.00 \text{ atm}$, $T = -100.0^\circ\text{C}$
- Consider the following equilibrium:
$$\text{H}_2(\text{g}) + \text{I}_2(\text{s}) \rightleftharpoons 2\text{HI}(\text{g}) \quad \Delta H = +68.0 \text{ kJ/mol}$$

Which of the following statements about the equilibrium is false?
a) If the system is heated, the right side is favored. b) This is a heterogeneous equilibrium.
c) If the pressure on the system is increased by changing the volume, the left side is favored.
d) Adding more $\text{H}_2(\text{g})$ increases the equilibrium constant.
e) Removing HI as it forms forces the equilibrium to the right.
- As water is heated, its pH decreases. This means that
a) the water is no longer neutral b) $[\text{H}^+] > [\text{OH}^-]$ c) $[\text{OH}^-] > [\text{H}^+]$
d) a and b are correct e) none of these
- A student titrates an unknown weak acid, HA , to a pale pink phenolphthalein endpoint with 25.0 mL of 0.100 M NaOH . The student then adds 13.0 mL of 0.100 M HCl . The pH of the resulting solution is 4.7. Which of the following is true?
a) The pK_a of the acid is greater than 4.7. b) The pK_a of the acid is less than 4.7.
c) The pK_a of the acid is 4.7. d) At pH 4.7, half the conjugate base, A^- , has been converted to HA .

(背面仍有題目, 請繼續作答)

編號： 6 系所：地科系、化工系、材料系、環工系 科目：普通化學

本試題是否可以使用計算機：可使用，不可使用（請命題老師勾選）

9. If a student performs an endothermic reaction in a calorimeter, how does the calculated value of ΔH differ from the actual value if the heat exchanged with the calorimeter is not taken into account?
- ΔH_{calc} would be more negative because the calorimeter always absorbs heat from the reaction.
 - ΔH_{calc} would be less negative because the calorimeter would absorb heat from the reaction.
 - ΔH_{calc} would be more positive because the reaction absorbs heat from the calorimeter.
 - ΔH_{calc} would be less positive because the reaction absorbs heat from the calorimeter.
 - ΔH_{calc} would equal the actual value because the calorimeter does not absorb heat.
10. For which process is ΔS negative?
- evaporation of 1 mol of $\text{CCl}_4(\text{l})$
 - mixing 5 mL ethanol with 25 mL water
 - compressing 1 mol Ne at constant temperature from 1.5 atm to 0.5 atm
 - raising the temperature of 100 g Cu from 275 K to 295 K
 - grinding a large crystal of KCl to powder
11. Choose the correct statement given the following information:
- $$\text{Fe}^{3+}(\text{aq}) + \text{e}^- \rightarrow \text{Fe}^{2+}(\text{aq}) \quad E^\circ = 0.77 \text{ volt}$$
- $$\text{Fe}(\text{CN})_6^{3-} + \text{e}^- \rightarrow \text{Fe}(\text{CN})_6^{4-} \quad E^\circ = 0.36 \text{ volt}$$
- $\text{Fe}^{2+}(\text{aq})$ is more likely to be oxidized than Fe^{2+} complexed to CN^- .
 - $\text{Fe}^{3+}(\text{aq})$ is more likely to be reduced than Fe^{3+} complexed to CN^- .
 - Complexation of Fe ions with CN^- has no effect on their tendencies to become oxidized or reduced.
 - Both a and b are true
 - None of these is true.
12. Which of the following statements about quantum theory is *incorrect*?
- The energy and position of an electron cannot be determined simultaneously.
 - Lower energy orbitals are filled with electrons before higher energy orbitals.
 - When filling orbitals of equal energy, two electrons will occupy the same orbital before filling a new orbital.
 - No two electrons can have the same four quantum numbers.
 - All of these are correct.
13. Atoms having greatly differing electronegativities are expected to form:
- no bonds
 - polar covalent bonds
 - nonpolar covalent bonds
 - ionic bonds
 - covalent bonds
14. Which of the following molecules has a dipole moment?
- SCl_6
 - BH_3
 - CO_2
 - OF_2
 - None of the above has a dipole moment.
15. Which of the following molecules or ion has a lone pair of electrons on the central atom?
- $$\text{CH}_3^+, \text{CH}_3^-, \text{BeCl}_2, \text{XeO}_4, \text{PCl}_5$$
- CH_3^+
 - XeO_4
 - BeCl_2
 - CH_3^-
 - PCl_5
16. Which of the following has the central atom that is dsp^3 hybridized?
- SF_4^-
 - SCl_4
 - CCl_4
 - SF_6
 - none of the above

編號： 6 系所：地科系、化工系、材料系、環工系 科目：普通化學

本試題是否可以使用計算機：可使用，不可使用（請命題老師勾選）

17. The reaction, $2A + B \rightarrow C$, has the following proposed mechanism:
 Step 1: $A + B \rightarrow D$ (fast equilibrium); Step 2: $D + B \rightarrow E$; Step 3: $E + A \rightarrow C + B$
 If step 2 is the rate-determining step, then the rate of formation of C should equal:
 a) $k[A]$ b) $k[A]^2[B]$ c) $k[A]^2[B]^2$ d) $k[A][B]$ e) $k[A][B]^2$
18. In cubic closest packed solids, what percentage of space is occupied by the spheres?
 a) 43.8% b) 52.4% c) 68.0% d) 74.0% e) none of these
19. 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) II, III d) II, IV e) I, III, IV
20. 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 electronegativities.
 d) Large differences in their abilities to form strong pi bonds.
21. F_2 is a better oxidizing agent than Cl_2 in the gas phase principally because:
 a) F_2 has a weaker bond than Cl_2 . b) F_2 has a stronger bond than Cl_2 .
 c) the electron affinity of F is greater than that of Cl.
 d) the electronegativity of Cl is greater than that of F.
 e) the ionization energy for F is greater than that for Cl.
22. Which of the following is paramagnetic?
 a) $Zn(H_2O)_6^{2+}$ b) $Co(NH_3)_6^{3+}$ (strong field) c) $Cu(CN)_3^{2-}$
 d) $Mn(CN)_6^{3-}$ (strong field) e) none of these
23. Which of the following processes decreases the atomic number by 1?
 a) gamma-ray production b) alpha-particle production
 c) beta-particle production d) positron production
 e) none of these
24. Which of the following statement regarding beta emission is wrong?
 a). The mass number of the decaying nucleus remains constant.
 b). Beta particle is more penetrating than α -particle, it is commonly emitted by TV set.
 c). The net effect of this decay is to increase the N/Z ratio
 d). The particle is an electron, the emitting nucleus does not contain electrons.
25. A student gave a molecule the following name:
 2-ethyl-3-methyl-5-isopropylhexane
 However, his TA pointed out that, although the molecule could be correctly drawn from this name, the name violates the systematic rules. What is the correct (systematic) name of the molecule?
 a) 3,4-dimethyl-6-isopropylheptane b) 2-isopropyl-4,5-dimethylheptane
 c) 3,4,6,7-tetramethyloctane d) 1,2-diethyl-3,6,7-trimethylheptane
 e) 2,3,5,6-tetramethyloctane

(背面仍有題目,請繼續作答)

編號： 6 系所：地科系、化工系、材料系、環工系 科目：普通化學

本試題是否可以使用計算機： 可使用， 不可使用（請命題老師勾選）

二、說明題與計算題；計算題要列出計算過程。

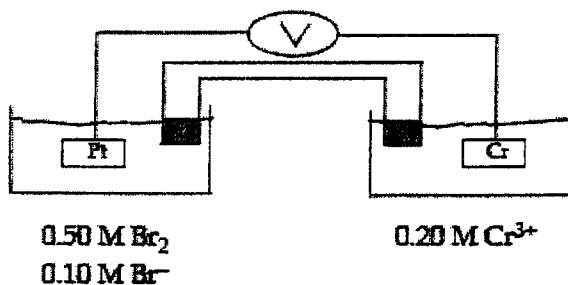
1. a). Arrange the following according to expected value for b (volume correction value) in van der Waal's equation. Why is this correction needed for real gas. (6%)

He, CO₂, H₂O, HF, SF₆.

- b). Arrange the following according to expected value for a (pressure correction value) in van der Waal's equation. Why is this correction needed for real gas. (6%)

H₂, N₂, CH₄, Ne, H₂O.

2. Consider the galvanic cell shown below (the contents of each half-cell are written beneath each compartment):



The standard reduction potentials are as follows;



- a). What is E° for this cell? (6%)
- b). What is the value of E for this cell at 25°C? (6%)
3. A buffered solution contains 0.25 M NH₃ ($K_b = 1.8 \times 10^{-5}$) and 0.40 M NH₄Cl.
- a). Calculate the pH of this solution. (5%)
- b). Calculate the pH of the solution that results when 0.10 mol of gaseous HCl is added to 1.0 L of the buffered solution from part a. (6%)
4. When phosphorous reacts with excess chlorine gas, the compound phosphorous pentachloride (PCl₅) is formed. In the gaseous and liquid states this substance consists of PCl₅ molecule, but in solid state it consists 1:1 mixture of PCl₄⁺ and PCl₆⁻ ions. Describe the geometric structures of PCl₅, PCl₄⁺, and PCl₆⁻. (15%)