

系所組別： 生命科學系

考試科目： 普通化學

考試日期： 0713 · 節次： 3

※ 考生請注意：本試題 可 不可 使用計算機

請將答案寫在答案紙上，並清楚地註明題號

一、單選題 (2% each)

1. Compound 1 has a composition of 46.7 mass % of element A and 53.3 mass % of element B. A and B also form a second binary compound (compound 2). If the compositions of the two compounds are consistent with the law of multiple proportions, which of the following compositions could be that of compound 2?
- A. 23.4 mass % A; 76.6 mass % B B. 30.4 mass % A; 69.6 mass % B
C. 33.3 mass % A; 66.7 mass % B D. 53.3 mass % A; 46.7 mass % B
E. 73.3 mass % A; 26.7 mass % B

2. Atoms X, Y, Z, and R have the following nuclear compositions:



Which two are isotopes?

- A. X & Y B. X & R C. Y & R
D. Z & R E. X & Z
3. Select the incorrect statement about elements and compounds.
- A. All ionic compounds are neutral.
B. Some elements exist as molecules.
C. The bonding in compounds may be covalent or ionic.
D. The molecular formula of a compound provides more information than the structural formula.
E. Among the elements, there are more metals than non-metals.
4. Which, if any, of the following properties applies to weak acids?
- A. They are strong electrolytes.
B. They are excellent conductors of electricity.
C. When dissolved in water, they do not ionize completely.
D. All of these choices are correct.
E. None of these choices is correct.
5. At very high pressures (~ 1000 atm), the measured pressure exerted by real gases is greater than that predicted by the ideal gas equation. This is mainly because
- A. such high pressures cannot be accurately measured.
B. real gases will condense to form liquids at 1000 atm pressure.
C. gas phase collisions prevent molecules from colliding with the walls of the container.
D. of attractive intermolecular forces between gas molecules.
E. the volume occupied by the gas molecules themselves becomes significant.

(背面仍有題目,請繼續作答)

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- A. $w < 0, \Delta E = 0$ B. $w > 0, \Delta E > 0$ C. $w > 0, \Delta E < 0$
 D. $w < 0, \Delta E > 0$ E. $w < 0, \Delta E < 0$

7. Which one of the following relationships is always correct?

- A. potential energy + kinetic energy = constant B. $E = q + w$
 C. $\Delta E = \Delta H - P\Delta V$ D. $H = E + PV$ E. $\Delta H = q_v$

8. Atomic orbitals developed using quantum mechanics

- A. describe regions of space in which one is most likely to find an electron.
 B. describe exact paths for electron motion.
 C. give a description of the atomic structure which is essentially the same as the Bohr model.
 D. allow scientists to calculate an exact volume for the hydrogen atom.
 E. are in conflict with the Heisenberg Uncertainty Principle.

9. Which one of the following statements about orbital energies is incorrect?

- A. In the hydrogen atom, the energy of an orbital depends only on the value of the quantum number n .
 B. In many-electron atoms the energy of an orbital depends on both n and l .
 C. Inner electrons shield outer electrons more effectively than do electrons in the same orbital.
 D. The splitting of sublevels in many-electron atoms is explained in terms of the penetration effect.
 E. The energy of a given orbital increases as the nuclear charge Z increases.

10. Which of the following electron configurations is not possible for an atom in an excited state?

- A. $1s^2 2s^2 2p^6 3s^2 3p^6 3d^1 4s^1 4p^1$ B. $1s^2 2s^2 2p^6 3s^1 3p^5$
 C. $1s^2 2s^2 2p^6 3s^2 3p^2 3d^2$ D. $1s^2 2s^2 2p^6 3s^2 3p^6 3d^1 4s^2$
 E. $1s^2 2s^2 2p^6 3s^2 3p^6 3d^1 4s^1 4p$

11. When two atoms form a covalently-bonded diatomic molecule, the distance between the nuclei at which the potential energy is at a minimum is called

- A. the bond energy. B. the bond length. C. the molecular diameter.
 D. the covalent radius. E. the covalent diameter.

12. When PCl_5 solidifies it forms PCl_4^+ cations and PCl_6^- anions. According to valence bond theory, what hybrid orbitals are used by phosphorus in the PCl_4^+ cations?

- A. sp B. sp^2 C. sp^3
 D. $sp^3 d$ E. $sp^3 d^2$

13. Which of the following statements relating to molecular orbital (MO) theory is incorrect?

- A. Combination of two atomic orbitals produces one bonding and one antibonding MO.
 B. A bonding MO is lower in energy than the two atomic orbitals from which it is formed.
 C. Combination of two $2p$ orbitals may result in either σ or π MOs.
 D. A species with a bond order of zero will not be stable.
 E. In a stable molecule having an even number of electrons, all electrons must be paired.

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14. What types of forces exist between molecules of CO_2 ?

- A. hydrogen bonding only. B. hydrogen bonding and dispersion forces.
 C. dipole-dipole forces only. D. dipole-dipole and dispersion forces.
 E. dispersion forces only.

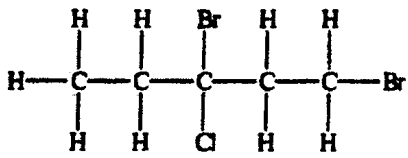
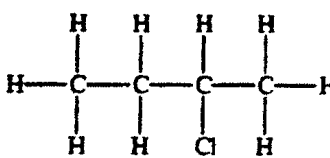
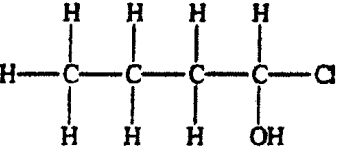
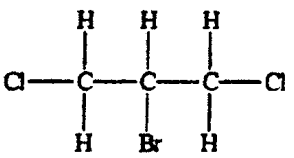
15. Which of the following ions will be expected to have the most negative heat of hydration, ΔH_{hydr} ?

- A. Na^+ B. Cs^+ C. Ca^{2+}
 D. F^- E. I^-

16. Which of the following pairs of elements exhibit similar physical and chemical behaviors ("diagonal relationships")?

- A. H and Be B. Na and Be C. Be and Al
 D. B and Mg E. Li and Al

17. Which compound, if any, will not be optically active?

- A. 
- B. 
- C. 
- D. 
- E. They are all optically active.

18. The reaction of bromine with an alkene such as cyclopentene is a good laboratory test for the presence of a double bond in a compound. What type of reaction is it?

- A. addition B. elimination C. substitution
 D. displacement E. reduction

19. When the reaction $\text{A} \rightarrow \text{B} + \text{C}$ is studied, a plot $1/[\text{A}]$, vs. time gives a straight line with a positive slope. What is the order of the reaction?

- A. zero B. first C. second
 D. third E. More information is needed to determine the order.

20. Which of the following has an effect on the magnitude of the equilibrium constant?

- A. removing products as they are formed B. adding more of a reactant
 C. adding a catalyst D. increasing the pressure, in a gas-phase reaction
 E. change in temperature

(背面仍有題目,請繼續作答)

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When the temperature of a sample of pure water is raised above 25°C,

- A. the hydronium ion concentration will be greater than the hydroxide ion concentration.
- B. the hydronium ion concentration will be less than the hydroxide ion concentration.
- C. the value of K_w will increase.
- D. the hydronium ion concentration could change to $1.0 \times 10^{-10} M$.
- E. the hydroxide ion concentration could change to $1.0 \times 10^{-10} M$.

22. Which, if any, of the following aqueous mixtures would be a buffer system?

- A. CH_3COOH , NaH_2PO_4
- B. H_2CO_3 , HCO_3^-
- C. H_2PO_4^- , HCO_3^-
- D. HSO_4^- , HSO_3^-
- E. None of these choices is correct.

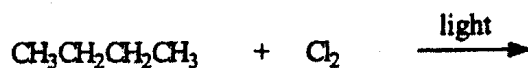
23. Which of the following statements about voltaic and electrolytic cells is correct?

- A. The anode will definitely gain weight in a voltaic cell.
- B. Oxidation occurs at the cathode of both cells.
- C. The free energy change, ΔG , is negative for the voltaic cell.
- D. The electrons in the external wire flow from cathode to anode in an electrolytic cell.
- E. None of these choices is correct.

24. An isotope with a high value of N/Z will tend to decay through

- A. α decay.
- B. β decay.
- C. positron decay.
- D. electron capture.
- E. γ decay.

25. Identify the principal organic product of the reaction between butane and chlorine.



- A. CH_3Cl
- B. $\text{CH}_3\text{CH}_2\text{Cl}$
- C. $\text{CH}_3\text{CHClCH}_3$
- D. $\text{CH}_3\text{CH}_2\text{CHClCH}_3$
- E. None of the above

二、非選擇題

1. What is meant by the *capacity of a buffer*? How do the following buffers differ in capacity? How do they differ in pH? (12%)
 - a. 0.01 M acetic acid and 0.01 M sodium acetate
 - b. 0.1 M acetic acid and 0.1 M sodium acetate
 - c. 1.0 M acetic acid and 1.0 M sodium acetate

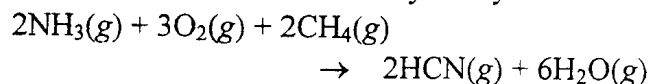
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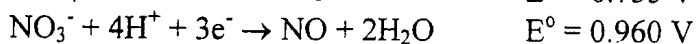
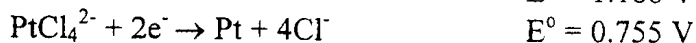
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2. Hydrogen cyanide is produced industrially by the following exothermic reaction, which is under 1000 °C and catalyzed by Pt-Rh:



Is the high temperature needed for the thermodynamic or for kinetic reason? Account for your answer. (10%)

3. Consider the following half-reactions:



Explain why platinum metal will dissolve in aqua regia (a mixture of hydrochloric acid and nitric acids) but not in either concentrated nitric acid or concentrated hydrochloric acid individually. (10%)

4. Does the complex ion $[\text{Co}(\text{NH}_3)\text{Br}(\text{en})_2]$ exhibit geometrical isomerism? Does it exhibit optical isomerism? (10%)
5. Draw the following incorrectly named compounds and name them correctly. (8%)
- 2-ethyl-3-methyl-5-isopropylhexane
 - 2-ethyl-4-tert-butylpentane
 - 3-methyl-4-isopropylpentane
 - 2-ethyl-3-butyne