

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）

一、單選題（每題三分，共 75%，答錯不倒扣。請將答案依序寫在答案卷上）

1. An example of the use of technology is:
(A) the measurement of the surface temperature of the sun (B) the conversion of the element silicon into computer chips (C) a determination of the amounts of sodium and chlorine in 50 g of sodium chloride (D) designing an experiment to determine the speed of light in pure water (E) determining whether a solution of sucrose in hydrogen peroxide will conduct an electric current
2. Deuterium: (A) has an atomic number 2 (B) contains 2 neutrons in its atomic nucleus (C) has two electrons in shells around the nucleus (D) is twice as abundant as proton (E) is an isotope of tritium
3. Adding a proton to the nucleus of a halogen produces:
(A) an alkali metal (B) an alkaline earth metal (C) an isotope of the halogen (D) the isotope of the element that lies to the halogen's immediate left in the Periodic Table (E) an inert gas
4. A covalent bond forms as:
(A) one electron is shared between two atoms (B) one electron is transferred from the valence shell of one atom into the valence shell of another atom (C) two electrons are shared between two atoms (D) two electrons are transferred from the valence shell of one atom into the valence shell of another atom (E) a cation and an anion combine to form a compound
5. Binding energy is the energy equivalent of an atom's:
(A) atomic number (B) mass number (C) number of valence electrons (D) mass defect (E) neutron/proton ratio
6. The IUPAC name of isopentane is:
(A) 2-methylpentane (B) 3-methylpentane (C) 2-methylbutane (D) 3-methylbutane (E) 1,1-dimethylpropane
7. Which one of the following hydrocarbons has the lowest boiling point (is most volatile)?
(A) decane (B) pentane (C) heptane (D) octane (E) hexane
8. Fats and oils are examples of:
(A) ketones (B) aldehydes (C) alcohols (D) esters (E) hydrocarbons
9. The compound among the following that is not a disaccharide is:
(A) sucrose (B) lactose (C) maltose (D) dextrose (E) cellobiose
10. Chirality refers to:
(A) the number of substituents on a given carbon (B) the number of rings present in a molecule (C) the distinction between the carbonyl group of an aldehyde and the carbonyl group of a ketone (D) the "handedness" of a molecule (E) the ratio of hydrogens to oxygens in a molecule
11. A base not found in the RNA molecule is:
(A) uracil (B) cytosine (C) thymine (D) adenine (E) guanine

(背面仍有題目,請繼續作答)

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12. Mixing 40.0 mL of a 4.00 M sodium chloride solution with 20.0 mL of a 5.00 M calcium chloride solution results in a solution with a chloride ion concentration of
(A) 4.33 M (B) 4.50 M (C) 6.00 M (D) 6.50 M (E) 7.00 M
13. One mole of an ideal gas at 25°C is expanded isothermally and reversibly from 125 L to 250 L. Which of the following statement is correct?
(A) $\Delta S_{\text{gas}} = 0$ (B) $\Delta S_{\text{gas}} = R \ln 2$ (C) $\Delta S_{\text{univ}} = 0$ (D) $\Delta S_{\text{surr}} = 0$ (E) $\Delta S_{\text{gas}} = \Delta S_{\text{surr}}$
14. Which form of electromagnetic radiation has the shortest wavelengths?
(A) gamma rays (B) microwaves (C) radio waves (D) infrared radiation (E) x-rays
15. What type of structure does the XeOF₂ molecule have?
(A) pyramidal (B) tetrahedral (C) T-shaped (D) trigonal planar (E) Octahedral
16. What is the hybridization of the central I atom in the molecule ICl₅?
(A) sp (B) sp² (C) sp³ (D) dsp³ (E) d²sp³
17. Which of the following species has the largest dissociation energy?
(A) O₂ (B) O₂⁻ (C) O₂²⁻ (D) O₂⁺ (E) O₂²⁺
18. Which of the following is the correct order of boiling points for KNO₃, CH₃OH, C₂H₆, Ne?
(A) Ne < CH₃OH < C₂H₆ < KNO₃ (B) KNO₃ < CH₃OH < C₂H₆ < Ne (C) Ne < C₂H₆ < KNO₃ < CH₃OH (D) Ne < C₂H₆ < CH₃OH < KNO₃ (E) C₂H₆ < Ne < CH₃OH < KNO₃
19. The triple point of iodine is at 90 torr and 115°C. This means that liquid I₂
(A) is more dense than I_{2(s)} (B) cannot exist above 115°C (C) cannot exist above 1 atmosphere pressure (D) cannot have a vapor pressure less than 90 torr (E) can exist at pressure of 10 torr
20. Which statement about hydrogen bonding is true?
(A) hydrogen bonding is the intermolecular attractive forces between two hydrogen atoms in solution. (B) The hydrogen bonding capabilities of water molecules cause butane to be more soluble in water than methanol (C) Hydrogen bonding of solvent molecules with a solute will not affect the solubility of the solute (D) Hydrogen bonding interactions between molecules are stronger than the covalent bonds within the molecule. (E) Hydrogen bonding arises from the dipole moment created by the unequal sharing of electrons within certain covalent bonds within a molecule.
21. What compounds are useful in breathing apparatus and air supply packs?
(A) oxides (B) peroxides (C) superoxides (D) akoxides (E) epxoides
22. What ions are very important for the proper functioning of biologic systems, such as nerves and muscles?
(A) silicon ions (B) alkali metal ions (C) oxygen ions (D) sulfur ions (E) nitrogen ions
23. Which of the following element has the smallest ionization energy?
(A) N (B) P (C) As (D) Sb (E) Bi
24. The complex FeL₆²⁺, where L is a neutral ligand, is known to be diamagnetic. The number of d electrons in this complexion is : (A) 4 (B) 5 (C) 6 (D) 7 (E) 8

編號： 31 系所：生命科學系學士班

科目：普通化學

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25. Which of the following transition metals is a component of vitamin B₁₂?

(A) manganese (B) chromium (C) cobalt (D) copper (E) zinc

二、非選擇題（每題五分、共 25%，計算請列式，沒有列式僅給答案將不予計分）

1. A sample of solid NH₄NO₃ was placed in an evacuated container and then heated so that it decomposed explosively according to the equation: NH₄NO_{3(s)} ⇌ N₂O_(g) + 2 H₂O_(g); at equilibrium the total pressure in the container was found to be 3.30 atm at a temperature of 500°C, Calculate K_p.

2. Calculate the [H⁺] in a 100 mM solution of HCN, K_a = 6.4 × 10⁻¹⁰.

3. Construct the molecular orbital energy-level diagram for nitric oxide (NO) and calculate the bond order.

4. Chlorine dioxide (ClO₂), which is produced by the reaction



has been tested as a disinfectant for municipal water treatment, calculate the equilibrium constant K at 25°C for the production of ClO₂. (ClO₂ + e⁻ → ClO₂⁻, ε° = 0.954 V; Cl₂ + e⁻ → 2Cl⁻, ε° = 1.36 V; F = 96,485 C/mol e⁻, R = 8.3145 Jmol⁻¹K⁻¹)

5. Phosphorus-32 is a commonly used radioactive nuclide in biochemical research, particularly in studies of nucleic acids. The half-life of phosphorus-32 is 14.3 days. What mass of phosphorus-32 is left from an original sample of 175 mg of Na₃³²PO₄ after 35.0 days? (Na = 23, O = 16, ³²P = 32)