115BE02

國立臺北科技大學115學年度碩士班招生考試

系所組別：3602

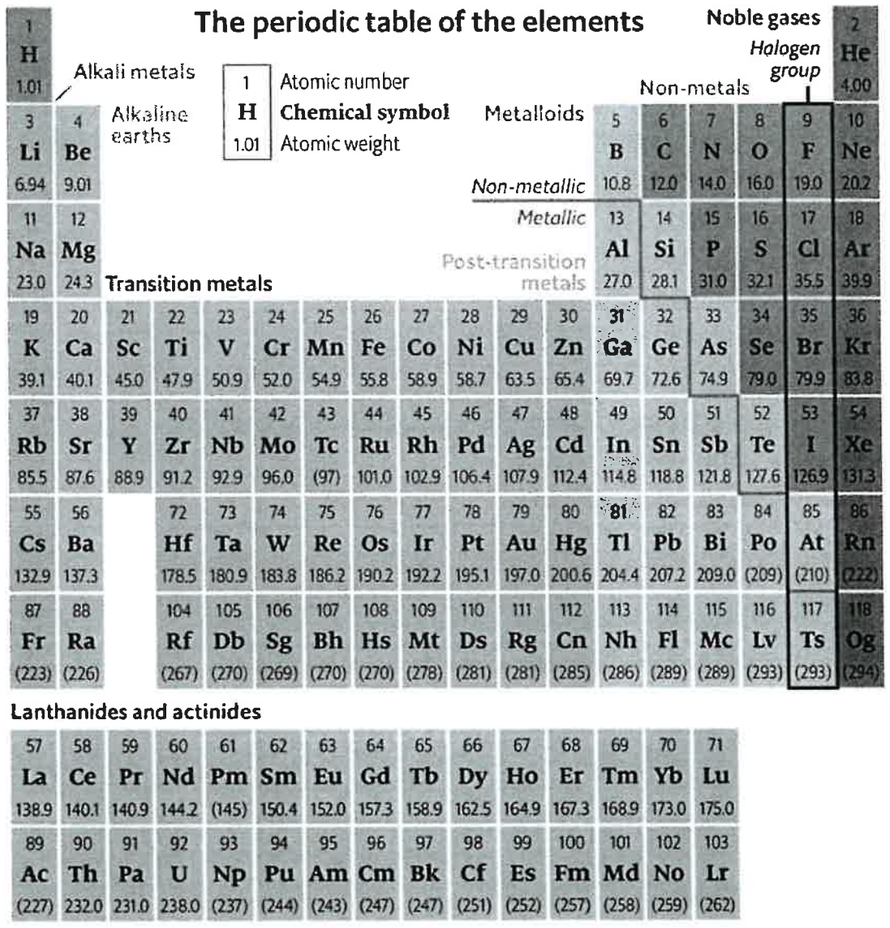
化學工程與生物科技系生化與生醫工程碩士班

第一節　普通化學　試題（選考）

注意事項：

1. 本試題共 50 題，每題 2 分，共 100 分。
2. 不必抄題，作答時請將試題題號及答案依照順序寫在答案卷上。
3. 全部答案均須在答案卷之答案欄內作答，否則不予計分。

Choose the **BEST** answer of the multiple-choice questions



1. The freezing point of helium is approximately –270°C. The freezing point of xenon is –112°C. Both of these are in the noble gas family. Which of the following statements is supported by these data?
   A) Helium and xenon form highly polar molecules.
   B) As the molar mass of the noble gas increases, the freezing point decreases.
   C) The London forces between the helium molecules are less than the London forces between the xenon molecules.
   D) The London forces between the helium molecules are greater than the London forces between the xenon molecules.
   E) none of these
2. Given the reaction $A(g) + B(g) \rightleftharpoons C(g) + D(g)$. You have the gases A, B, C, and D at equilibrium. Upon adding gas A, the value of equilibrium constant K
   A) increases because when A is added, more products are made, increasing the product-to-reactant ratio
   B) decreases because A is a reactant, so the product-to-reactant ratio decreases
   C) does not change because A does not figure into the product-to-reactant ratio
   D) does not change as long as the temperature is constant
   E) depends on whether the reaction is endothermic or exothermic
3. Which of the following is correct for a saturated hydrocarbon that contains five carbon atoms?
   A) C_5H_{12}
   B) C_5H_{10}
   C) C_5H_{14}
   D) C_5H_6
   E) C_5H_7
4. Which of the following processes is a physical change?
   A) Burning gasoline
   B) Cooking an egg
   C) Decomposing meat
   D) Rusting iron
   E) Evaporating water
5. Assume that vinegar is a 0.852 M solution of acetic acid (CH3COOH) in water. What volume of 0.2136 M NaOH would be needed to completely neutralize 5.68 mL of vinegar?
   A) 4.84 mL
   B) 1.21 mL
   C) 1.42 mL
   D) 22.7 mL
   E) 4.00 mL

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6. Which of the following is a homogeneous mixture?
   A) Pure water
   B) Gasoline
   C) Sodium chloride
   D) Soil
   E) Copper metal

7. Which of the following statements **best** describes the movement of electrons in a p orbital?
   A) The electrons move along the outer surface of the p orbital, similar to a "figure 8" type of movement.
   B) The electrons move within the two lobes of the p orbital, but never beyond the outside surface of the orbital.
   C) The electrons are concentrated at the center (node) of the two lobes.
   D) The electrons are moving in only one lobe at any given time.
   E) The electron movement cannot be exactly determined.

8. Convert: 17.5°F = _____ °C.
   A) 27.50
   B) 26.10
   C) -8.06
   D) 89.10
   E) 290.5

9. A certain balloon will pop if it expands to a volume greater than 16.0 L. The balloon is currently filled with air at a volume of 8.0 L. You heat the balloon such that the temperature measured in degrees Celsius doubles. Which of the following statements best describes what happens?
   A) The balloon will expand to a volume greater than 16.0 L and pop.
   B) The balloon will expand to a volume less than 16.0 L and not pop.
   C) The balloon will expand to a volume of 16.0 L and pop.
   D) The balloon will expand to a volume of 16.0 L and not pop.
   E) None of above.

10. Equal masses (in grams) of hydrogen gas and oxygen gas are reacted to form water. Which substance is limiting?
   A) Oxygen gas is limiting.
   B) Hydrogen gas is limiting.
   C) Water is limiting.
   D) Nothing is limiting.
   E) 2 More information is needed to answer this question.

11. Something done to test a hypothesis that produces new observations is called a(n)
   A) observation
   B) measurement
   C) theory
   D) natural law
   E) experiment

12. Teflon is an example of a
   A) copolymer
   B) homopolymer
   C) dimer
   D) two of these
   E) none of these

13. Alpha particles are
   A) electrons
   B) protons
   C) neutrons
   D) helium nuclei
   E) X rays

14. What is the correct name of the compound that has a metal ion containing 24 electrons and the most stable ion for sulfur?
   A) Iron(II) sulfate
   B) Iron(III) sulfide
   C) Chromium(II) sulfide
   D) Nickel(III) sulfate
   E) Iron(II) sulfide

15. Rank the following compounds from lowest to highest boiling point.
   A) $H_2O < CH_3OH < C_2H_6 < CH_4$
   B) $C_2H_6 < CH_4 < CH_3OH < H_2O$
   C) $CH_4 < C_2H_6 < CH_3OH < H_2O$
   D) $CH_4 < C_2H_6 < H_2O < CH_3OH$
   E) $CH_4 < CH_3OH < C_2H_6 < H_2O$

16. The solubility of $Pb(OH)_2$ in water at a certain temperature is 6.7×10^{-6} mol/L. The value of K_{sp} of $Pb(OH)_2$ at this temperature is
   A) 1.2×10^{-15}
   B) 1.1×10^{-5}
   C) 6.7×10^{-6}
   D) 1.9×10^{-14}
   E) none of these

17. Which of the following statements is false?
    A) The process of splitting a heavy nucleus into two nuclei with smaller mass numbers is called fission.
    B) A beta particle is a particle with the same mass as the electron but opposite charge.
    C) Nitrogen can be changed into oxygen by bombarding it with alpha particles.
    D) Archaeologists use radioactivity to determine the age of some artifacts and rocks.
    E) All of the above statements are true.

18. What is the pH of a solution prepared by dissolving 93.1 g NaOH in enough water to make 3.4 L of solution?
    A) 13.84
    B) 0.16
    C) 14.16
    D) 11.80
    E) none of these

19. A nitric acid solution containing 71.0% HNO_3 (by mass) has a density of 1.42 g/mL. How many moles of HNO_3 are present in 1.98 L of this solution?
    A) 62.8 mol
    B) 31.7 mol
    C) 22.3 mol
    D) mol
    E) one of these

20. The cesium-137 nuclide has a half-life of 30 years. After 90 years, about 9 g remains. The original mass of the cesium-137 is closest to
    A) 70 g
    B) 50 g
    C) 90 g
    D) 80 g
    E) 60 g

21. Which of the following statements are true of real gases?
    A) A real gas behaves more like an ideal gas at high pressures and low temperatures.
    B) The individual gas particles have no volume.
    C) The individual gas particles are not attracted to one another.
    D) The particles collide with the walls of its container and exert pressure.
    E) The kinetic energy of the gas particles is directly proportional to the temperature of the gas in degrees Celsius.

22. The oxidation state of the phosphorus in $Mg_3(PO_4)_2$ is
    A) 0
    B) +2
    C) +4
    D) +5
    E) +6

23. Which of the following is named **correctly**?
    A) HCl(aq); hypochlorous acid
    B) $(NH_4)_3PO_3$; ammonium phosphate
    C) H_2SO_3(aq); sulfuric acid
    D) NH_3; ammonium ion
    E) HNO_3(aq); nitric acid

24. The volume of a sample of gas is 531.6 mL at STP. What volume will the sample occupy at 0.0°C and 950.0 torr?
    A) 664.5 mL
    B) 425.3 mL
    C) 389.6 mL
    D) 537.3 mL
    E) none of these

25. Which of the following elements is the most electronegative one?
    A) C
    B) Ge
    C) Pb
    D) Si
    E) Sn

26. The Lewis structure for which of the following contains the **greatest** number of lone pairs of electrons?
    A) CH_4
    B) HF
    C) F_2
    D) H_2O
    E) H_2

27. Which one has a planar structure?
    A) SO_3^{2-}
    B) NF_3
    C) H_3O^+
    D) CH_4
    E) CO_3^{2-}

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28. Using the following thermochemical data, calculate ΔHf° for the reaction,

$$2Cr(s) + 3/2O_2(g) \rightarrow Cr_2O_3(s).$$

$2CrCl_3(s) + 3H_2O(l) \rightarrow Cr_2O_3(s) + 6HCl(g)$ $\quad \Delta H^{\circ} = 276.9$ kJ/mol

$2Cr(s) + 3Cl_2(g) \rightarrow 2CrCl_3(s)$ $\quad \Delta H^{\circ} = -1113.0$ kJ/mol

$4HCl(g) + O_{2(g)} \rightarrow 2Cl_2(g) + 2H_2O(l)$ $\quad \Delta H^{\circ} = -202.4$ kJ/mol

A) 633.7 kJ/mol
B) –1038.5 kJ/mol
C) 1592.3 kJ/mol
D) –1187.5 kJ/mol
E) –1139.7 kJ/mol

29. Which of the following ionic compounds is **soluble** in water?
A) $Ca_3(PO_4)_2$
B) $Mg_3(PO_4)_2$
C) $(NH_4)_3PO_4$
D) $AlPO_4$
E) Cu_3PO_4

30. We usually use the term ____ for all forms of electromagnetic radiation.
A) energy
B) photons
C) radiation
D) light
E) none of these

31. All of the following are clues that a chemical reaction has taken place **except**
A) A color change occurs.
B) A solid forms.
C) The reactant is smaller.
D) Bubbles form.
E) A flame occurs.

32. The yet undiscovered element with atomic number 119 would be a member of
A) the halogens
B) the transition elements
C) the noble gases
D) the Group 3A elements
E) none of these

33. Vinegar contains carbon, hydrogen, and oxygen with percent masses of 40.01% C and 6.70% H. If the molar mass of vinegar is about 60 g/mol, what is its molecular formula?
A) CH_2O
B) $C_3H_7O_3$
C) C_3H_8O
D) $C_2H_{20}O$
E) $C_2H_4O_2$

34. Which of the following is arranged correctly in order of increasing distance from Earth's surface?
A) mesosphere < troposphere < stratosphere < thermosphere
B) troposphere < mesosphere < stratosphere < thermosphere
C) troposphere < mesosphere < thermosphere < stratosphere
D) troposphere < stratosphere < mesosphere < thermosphere
E) mesosphere < troposphere < thermosphere < stratosphere

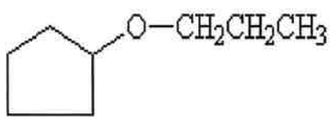
35. Which of the following processes is **endothermic**?
A) water droplets condensing on a soda can on a hot summer day
B) an ice pack getting cold (due to ammonium nitrate dissolving in water)
C) hermite reaction between iron(III) oxide and aluminum (flames are observed)
D) freezing water to make ice cubes
E) none of the above are endothermic processes

36. The source of energy for red blood cells is
A) amino acids.
B) lactate.
C) fatty acids.
D) glycerol.
E) glucose.

37. Vapor pressure can be described as
A) the temperature at which bubbles of vapor appear in a liquid
B) the pressure exerted on the Earth by the particles in the air
C) the temperature at which the vapor pressure of a liquid equals atmospheric pressure
D) the pressure exerted by a gas above the surface of its liquid
E) the pressure within the lungs during inhalation

38. Absolute zero is
A) the freezing point of water using the Celsius scale.
B) the boiling point of liquid nitrogen.
C) the temperature on the Kelvin scale corresponding to 32 °F.
D) the coldest temperature possible.
E) the freezing point of liquid nitrogen.

39. What is the common name of this compound?



A) cyclopentyl propyl ether
B) cyclopentyl propyl ketone
C) 1-cyclopropyl-1-propylalcohol
D) propylcyclopentanol
E) 3-cyclopentylpropanol

40. _____ is a phenomenon that may be caused by the burning of fossil fuels, which increases the carbon dioxide content in the Earth's atmosphere.
A) Acid rain
B) The greenhouse effect
C) Infrared radiation
D) The ozone problem
E) None of these

41. Refer to the following equation: $4NH_3(g) + 7O_2(g) \rightarrow 4NO_2(g) + 6H_2O(g)$
How many moles of ammonia will be required to produce 10.9 mol of water?
A) 4.36 mol
B) 10.9 mol
C) 7.27 mol
D) 5.45 mol
E) none of these

42. Which of the following compounds is **incorrectly** named?
A) NH_4Br: Ammonium bromide
B) K_2CO_3: Potassium carbonate
C) $BaPO_4$: Barium phosphate
D) CuCl: Copper(I) chloride
E) MnO_2: Manganese(IV) oxide

43. Which of the following is an example of a **quantitative** observation?
A) The piece of metal is longer than the piece of wood.
B) Solution 1 is much darker than solution 2.
C) The liquid in beaker A is blue.
D) The liquid's temperature is 60 °C.
E) Both A and D are quantitative observations.

44. Which of the following is **true** about a system at equilibrium?
A) The concentration(s) of the reactant(s) is equal to the concentration(s) of the product(s).
B) No new product molecules are formed.
C) The concentration(s) of reactant(s) is constant over time.
D) The rate of the reverse reaction is equal to the rate of the forward reaction and both rates are equal to zero.
E) None of these choices are true.

45. Which of the following statements is **incorrect**?
A) Dalton's statement "All atoms of a given element are identical" is no longer accepted because of the existence of isotopes and ions.
B) Dalton's theory states that elements are made of tiny particles called atoms.
C) According to Rutherford, the number of protons is the same as the number of electrons.
D) According to Rutherford, the nucleus must have a positive charge to balance the negative charge of the electrons.
E) None of these

46. What is the most **abundant** element on the Earth (including the crust, oceans, and atmosphere)?
A) silicon
B) oxygen
C) hydrogen
D) carbon
E) iron

47. A substance that, when dissolved in water, produces a solution that conducts electric current very efficiently is called
A) a strong electrolyte
B) a weak electrolyte
C) a strong ion
D) an electrical solute
E) none of these

48. For the reaction $H_2(g) + Cl_2(g) \rightleftarrows 2HCl(g)$, $K_c = 5.14 \times 10^{25}$ at a temperature of 391 K. What is *Kp* at this temperature?
A) 5.14×10^{25}
B) 1.65×10^{27}
C) 1.60×10^{24}
D) 5.30×10^{28}
E) 5.00×10^{22}

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49. The average mass of a boron atom is 10.81. Assuming you were able to isolate only one boron atom, the chance that you would randomly get one with a mass of 10.81 is
    A) greater than 50%
    B) 10.81%
    C) about 11%
    D) 0.81%
    E) 0%

50. Which of the following aqueous solutions contains the **greatest** number of ions in solution?
    A) 2.0 L of 2.00 M calcium chloride
    B) 3.0 L of 2.00 M potassium chloride
    C) 2.0 L of 2.00 M sodium phosphate
    D) 2.0 L of 2.50 M sodium chloride
    E) 1.0 L of 4.00 M potassium carbonate