

國立中興大學

110 學年度

碩士班考試入學招生

試 題

學系：生醫工程研究所

科目名稱：基礎科學

# 重要資訊

- 考科 [基礎科學] 內容有：A 類－生物、B 類－化學、C 類－物理。

- 考生應自選一類作答。

- A 類－生物：第 2-4 頁。
- B 類－化學：第 5-6 頁。
- C 類－物理：第 7-11 頁。

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A 類 - 生物

多選題 (60%)，每題的答案均超過一個選項，每題 4 分

1. Which of the following statements regarding DNA are correct?
  - A. Its full name is deoxyribonucleic acid
  - B. It is a blueprint for all genetic information contained within an organism
  - C. They consist of two strands, arranged in a double helix
  - D. The bases in DNA are Adenine ( 'A' ), Thymine ( 'T' ), Guanine ( 'G' ) and Cytosine ( 'C' )
2. Which of the following statements regarding RNA are correct?
  - A. They only have one strand
  - B. They are variable in length
  - C. They contain ribose sugar molecules, without the hydroxyl modifications of deoxyribose
  - D. RNA is more resistant to damage from UV light than DNA.
3. Which of the following statements regarding the Central Dogma are correct?
  - A. Genetic information are passing from DNA to RNA
  - B. Gene expression has two key stages - transcription and translation
  - C. DNA to make new RNA (transcription)
  - D. RNA to make new proteins (translation)
4. Which amino acids are known to have basic side chains?
  - A. Arginine
  - B. Lysine
  - C. Alanine
  - D. Histidine
5. Which amino acids are known to have acidic side chains?
  - A. Aspartic acid
  - B. Glutamic acid
  - C. Proline
  - D. Valine
6. Which amino acids are known to have aromatic side chains?
  - A. Tyrosine
  - B. Phenylalanine
  - C. Tryptophane
  - D. Glycine

A 類 - 生物

7. Which of the following are STOP codon in an DNA sequence?
  - A. TAG
  - B. UAA
  - C. TAA
  - D. TGA
8. Which of the following statements are correct regarding cell nucleus?
  - A. Contain most of a cell' s DNA
  - B. Most mammalian cells contain one nucleus
  - C. It is where DNA transcription take place
  - D. It is where DNA replication take place
9. Which of the following statements are correct regarding mitochondria?
  - A. They are double-membrane bound organelles
  - B. They are known as the powerhouse of a cell
  - C. One cell can contain many mitochondria
  - D. They contain DNA
10. Which of the following statements are correct regarding lysosomes?
  - A. They contain hydrolytic enzymes that can break down many kinds of biomolecules
  - B. They are known as the waste disposal system of a mammalian cell
  - C. The pH level inside a lysosome is ~4.5 to 5
  - D. A mammalian cell can contain more than one lysosome
11. Platelets are a unique cell type in our body because:
  - A. They have no nucleus
  - B. They are the smallest of the three major types of blood cells
  - C. They are incapable of cell division (mitosis)
  - D. Their main functions are prevention and control of bleeding
12. Which of the following statement regarding red blood cells are correct:
  - A. They pick up oxygen from the lungs and deliver it to tissues elsewhere
  - B. They pick up carbon dioxide from other tissues and unload it in the lungs
  - C. They contain hemoglobin
  - D. They have no nucleus

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A 類 - 生物

13. What cells are part of innate immune system?
  - A. Monocytes
  - B. Macrophages
  - C. Neutrophils
  - D. Natural killer (NK) cells
14. What cells are part of adaptive immune system?
  - A. CD4 T cells
  - B. CD8 T cells
  - C. B cells
  - D. Antibodies
15. Unique features of antibodies include:
  - A. They recognize a specific antigen
  - B. They can be classified as IgA, IgD, IgE, IgG and IgM
  - C. They contain two Fab regions and a Fc region
  - D. They are synthesized by B cells

簡答題 (40% , 每題 10 分)

1. Please explain the differences between mitosis and meiosis
2. Why the understanding of medicine is important in biomedical engineering?
3. Please explain what is tissue engineering and why it is important?
4. Please explain how polymerase chain reaction (PCR) works

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## B 類 - 化學

一、選擇題 60%(複選題；最少一答案，最多三答案)

- Which of the following properties indicate strong intermolecular forces in a liquid? (A) low vapor pressure (B) low conductivity (C) high acidity (D) high viscosity.
- Which of the following phase changes are endothermic? (A) freezing (B) sublimation (C) photosynthesis (D) melting.
- Which of the following molecules have same geometries with  $\text{NH}_2^-$ ? (A)  $\text{H}_2\text{S}$ , (B)  $\text{N}_2\text{O}$  (C)  $\text{ClO}_2$  (D)  $\text{H}_2\text{O}$
- Which of the following species have negative electron affinity values? (a) H (b) Be (c) F (d) Ne.
- Organic compounds of formulas  $\text{C}_n\text{H}_{2n}$  ( $n \leq 8$ ) must be (a) saturated hydrocarbons (b) unsaturated hydrocarbons (c) aromatic hydrocarbons (d) aliphatic hydrocarbons
- Which of the following substances is/are bent? (a)  $\text{N}_2\text{O}$  (b)  $\text{O}_3$  (c)  $\text{ClNO}$  (d)  $\text{CO}_2$
- Classify the solid state of following substances as ionic solids (a) fructose, (b) graphene, (c)  $\text{CaI}_2$ , (d) Ammonium chloride
- A protein molecule (a) is polar and always water-soluble (b) contain no sulfur atom (c) has many peptide bonds within it (d) can form intramolecular hydrogen bond
- Which is/are correct for the following description: (a) The electrical conductivity of pure silicon crystal is lower than silicon with phosphorus impurity. (b) A silicon crystal is an amorphous solid. (c) Silicon with phosphorus impurity is a N-type semiconductor. (d) The boiling point of  $\text{PH}_3$  is lower than that of  $\text{SiH}_4$ .
- Which of the following are the central assumptions for the ideal gas and the kinetic molecular theory of gases? (A) molecules have negligible volume. (B) molecules have negligible mass. (C) collisions between gas particles are completely elastic. (D) gas is composed of very large number molecules
- Which is/are correct for the following isoelectronic species (a) increasing ionic radius:  $\text{Mg}^{2+} < \text{Na}^+ < \text{F}^- < \text{O}^{2-}$  (b) increasing ionic radius  $\text{O}^{2-} < \text{F}^- < \text{Na}^+ < \text{Mg}^{2+}$ . (c) increasing ionization energy:  $\text{O}^{2-} < \text{F}^- < \text{Na}^+ < \text{Mg}^{2+}$  (d) increasing ionization energy:  $\text{Mg}^{2+} < \text{Na}^+ < \text{F}^- < \text{O}^{2-}$
- The chemical formula of allene (propadiene) is  $\text{H}_2\text{CCCH}_2$  (a) is gas compound (b) is a planar molecule (c) there are three structural isomer once substituting chlorine (Cl atoms) for two of the hydrogen atoms of allene. (d) follow (c), there are also three geometric isomer.
- Select the correct description: (a) there are two aromatic isomers for  $\text{C}_6\text{H}_4\text{BrCl}$  (b) The systemic name of the compound  $(\text{CH}_3)_3\text{C}(\text{CH}_2)_6\text{CH}_3$  is 2,2-dimethylnonane (c) Ethanol + sodium metal  $\rightarrow$  diethyl ether (ethoxyethane) (d) there are two asymmetric (chiral) carbon atoms in  $\text{CH}_3\text{CH}(\text{OH})\text{CH}(\text{CH}_3)\text{CH}_2\text{OH}$
- Which of the following compound does not have a carbonyl group? (a)  $\text{CH}_3\text{COOH}$  (b)  $\text{CH}_3\text{COOCH}_3$  (c)  $\text{C}_2\text{H}_5\text{OCH}_3$  (d)  $\text{CH}_3\text{COH}$

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## B 類 - 化學

15. Which is/are correct for the following description: (a) There is not only one triple point in the phase diagram of  $\text{H}_2\text{O}$ . (b). In a phase diagram, the slope of the curve between solid and gas may be negative. (c) For a pure substance, it is impossible to find a condition under which four phases can be in equilibrium with one another. (d) The liquid and gas phases of a substance become indistinguishable when  $T > T_c$  and  $P > P_c$ . (The subscript "c" means critical) Which of the following are the central assumptions for the ideal gas and the kinetic molecular theory of gases? (A) molecules have negligible volume. (B) molecules have negligible mass. (C) molecules move in straight lines some specific directions. (D) gas is composed of very large number molecules.

## 二、問答題 40%(可中英文作答)

16. A compound contains 59.96% carbon, 13.42% hydrogen, and 26.62% oxygen by mass. At  $120^\circ\text{C}$  and 750 torr, 2.00 L of the gaseous compound has a mass 3.68 g. What is molecular formula of the compound? ( $R = 8.314 \text{ J}\cdot\text{mol}^{-1}\cdot\text{K} = 0.08205 \text{ L}\cdot\text{atm}\cdot\text{mol}^{-1}\cdot\text{K} = 8.314 \text{ L}\cdot\text{kPa}\cdot\text{mol}^{-1}\cdot\text{K} = 0.08314 \text{ L}\cdot\text{bar}\cdot\text{mol}^{-1}\cdot\text{K}$ ) (10%)
17. Use the thermodynamic data at  $25^\circ\text{C}$  to solve the following problems. Here, all the gases involved in the reaction behave like ideal gases, their molar heat capacities do not contain any vibrational contributions. Thermodynamic data at  $25^\circ\text{C}$  (assume that  $\Delta H_f^\circ$  and  $S^\circ$  are independent of temperature)

	$\Delta H_f^\circ (\text{kJ}\cdot\text{mol}^{-1})$	$S^\circ (\text{J}\cdot\text{K}^{-1}\cdot\text{mol}^{-1})$	$\Delta G_f^\circ (\text{kJ}\cdot\text{mol}^{-1})$
$\text{C}_2\text{H}_4(\text{g})$	52.4	219.3	68.4
$\text{C}_2\text{H}_2(\text{g})$	227.4	200.9	209.9
$\text{CO}_2(\text{g})$	-393.5	213.6	-394.4
$\text{CO}(\text{g})$	-110.5	197.9	-137.3
$\text{H}_2\text{O}(\text{l})$	-285.8	69.95	-237.1
$\text{H}_2\text{O}(\text{g})$	-241.83	188.8	-228.6

- (a) Please calculate  $\Delta H_{\text{rxn}}^\circ$  at  $25^\circ\text{C}$ . (b) Please calculate  $\Delta U_{\text{rxn}}^\circ$  at  $25^\circ\text{C}$ . (c) Now, 2 mole of ethylene is put into an adiabatic closed chamber with 3 mole of oxygen gas at  $25^\circ\text{C}$  and the reaction is initiated by a spark. Please predict the final composition of gases, and the final temperature of the chamber when the reaction completes. (15%)
18. Give brief answers for the following questions: (10 % total)
- Please define "blackbody radiation".
  - What is "Planck's quantum hypothesis"?
  - What is the dual nature (duality) of the electromagnetic radiation?
  - What is the de Broglie hypothesis?
  - What is the definition of Heisenberg uncertainty principle?
19. Please describe the role of chemistry in biomedical engineering field: (5%)

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C 類 - 物理

Section I: Multiple Choice questions (question may have multiple answers; 27 questions; 81 points in total)

1. The SI unit of electricity is

- A) Ampere.
- B) Volt.
- C) Coulomb.
- D) Watt.

2. Unit of electric current

- A) Ampere.
- B) Volt.
- C) Coulomb.
- D) Watt.

3. Unit of resistance:

- A) Ampere.
- B) Volt.
- C) Ohm.
- D) Watt.

4. Unit of power:

- A) Ampere.
- B) Volt.
- C) Ohm.
- D) Watt.

5. Unit of magnetic field:

- A) Tesla.
- B) Gauss.
- C) Watt.
- D) Coulomb.

6. Unit of inductance:

- A) Tesla.
- B) Gauss.
- C) Watt.
- D) Henry.



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## C 類 - 物理

7. The SI unit of force is  
A) Newton.  
B) Joule.  
C) Watt.  
D) Farad.
8. A light bulb draws 300mA from its 1.5V battery. What is the resistance of the bulb?  
A)  $0.45\Omega$ .  
B)  $1\Omega$ .  
C)  $3\Omega$ .  
D)  $5\Omega$ .
9. Calculate the resistance of a 40W headlight designed for 12 V.  
A)  $0.28\Omega$ .  
B)  $0.3\Omega$ .  
C)  $3.3\Omega$ .  
D)  $3.6\Omega$ .
10. A coil has a resistance  $R = 1\Omega$  and an inductance of 0.3H. Determine the current in the coil if 120V dc is applied to it.  
A) 0.3A.  
B) 1.06A.  
C) 120A  
D)  $133\Omega$ .
11. The device that converts alternating current (AC) to direct current (DC) is  
A) Inverter.  
B) Converter.  
C) Rectifier  
D) Amplifier.
12. An inductor with inductance of 30mH is connected in series to a 90V ac (rms) 500Hz source. What is the reactance of the inductor?  
A)  $15\Omega$ .  
B)  $94\Omega$ .  
C)  $3000\Omega$   
D)  $15000\Omega$ .

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C 類 - 物理

13. A device that stores electric charge is called a  
A) Battery.  
B) Capacitor.  
C) Resistor.  
D) Generator.
14. Visible light has  
A) Frequency ( $2 \times 10^{14} \text{ Hz} \sim 9 \times 10^{14} \text{ Hz}$ ).  
B) Frequency ( $4 \times 10^{14} \text{ Hz} \sim 7.5 \times 10^{14} \text{ Hz}$ ).  
C) Wavelength ( $9.0 \times 10^{-7} \text{ m} \sim 2.0 \times 10^{-7} \text{ m}$ ).  
D) Wavelength ( $7.5 \times 10^{-7} \text{ m} \sim 4.0 \times 10^{-7} \text{ m}$ ).
15. Looking at the mirror, you notice that your image appears enlarged. What type of mirror is this?  
A) Plane.  
B) Concave.  
C) Convex.  
D) All of above.
16. Red + Green + Blue = ?  
A) Black.  
B) White.  
C) Maroon.  
D) Dark Blue.
17. Which radiation has the lowest frequency in the electromagnetic spectrum?  
A) X-rays.  
B) Gamma rays.  
C) Ultraviolet rays.  
D) Radio rays.
18. The wavelength of a 60Hz electromagnetic wave is  
A)  $3 \times 10^6 \text{ m}$ .  
B)  $4 \times 10^6 \text{ m}$ .  
C)  $5 \times 10^6 \text{ m}$ .  
D)  $6 \times 10^6 \text{ m}$ .

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## C 類 - 物理

19. The speed of light is  
A)  $3 \times 10^8$  m/s.  
B)  $3 \times 10^8$  s/m.  
C)  $3 \times 10^8$  ms.  
D)  $3 \times 10^8$  cm/s.
20. A man presses more weight on earth at:  
A) Sitting position.  
B) Standing position.  
C) Lying position.  
D) None of these.
21. Product of Force and Velocity is called:  
A) Work.  
B) Power.  
C) Energy.  
D) Momentum.
22. Which law is also called the law of inertia?  
A) Newton's first law.  
B) Newton's second law.  
C) Newton's third law.  
D) All of these.
23. Suppose the force of gravity on the Earth is  $10 \text{ m/s}^2$  and on the Moon it is  $2 \text{ m/s}^2$ . If the weight of an object on the Earth is 200 N. What will be its weight on the Moon?  
A) 40N.  
B) 80N.  
C) 120N.  
D) 160N.
24. An object has mass of 50 kg. What will be its weight at a location where force of gravity is  $6 \text{ m/s}^2$ ?  
A) 100N.  
B) 200N.  
C) 300N.  
D) 400N.

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C 類 - 物理

25. The electric motor converts

- A) Electrical energy into mechanical energy.
- B) Mechanical energy into electrical energy.
- C) Electrical energy into light energy.
- D) None of these.

26. If we add salt to the pure water, its boiling point will

- A) Increase.
- B) Decrease.
- C) Remain same.
- D) None of these.

27. In Celsius scale, the temperature “Absolute zero” is equivalent to

- A)  $-273^{\circ}\text{C}$
- B)  $0^{\circ}\text{C}$
- C)  $100^{\circ}\text{C}$
- D)  $273^{\circ}\text{C}$

Section II: Questions and Answers (The answer can be written in Chinese; 2 questions; 19 points in total)

28. Why plan to study Biomedical Engineering? (5 Marks)

29. What is the application of artificial intelligence in biomedical engineering? (14 marks)