

國立中興大學

109 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

請同學於生物、化學、物理試卷中自選一科作答，請於答案卷作答

第 一 部 份：生物

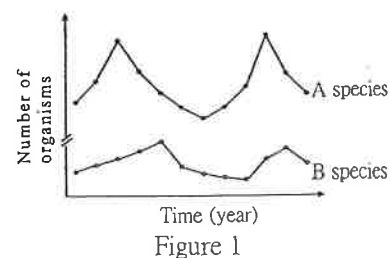
一、單選題 (30%)，每題 5 分

- Mitochondria and chloroplasts are both organelles in which cells process energy. Which of the following is correct?
 - Both of mitochondria and chloroplasts have DNA
 - Glucose breakdown occurs in the mitochondria
 - Chloroplast cannot produce ATP
 - Chloroplasts are unique to plants, and mitochondria are unique to animals
- Spirulina is a kind of blue-green bacteria, while Chlorella is a kind of green algae. Spirulina and chlorella are considered to be rich in nutrients needed by the human body. Which of the following statements about the two is correct?
 - Both have chloroplasts
 - Both produces oxygen via photosynthesis reaction
 - The cell walls of both are mainly composed of peptidoglycan
 - Spirulina is a bacterium and Chlorella is a plant in a three-domain system
- Which of the following cells is not directly related to the cytoskeleton's physiological effect?
 - Cell division
 - Fermentation
 - Sperm movement
 - Endocytosis (phagocytosis)
- Which organ is mainly made of red blood cells?
 - Bone marrow
 - Spleen
 - Liver
 - Kidney
- Which of the following classes of muscle is voluntary?
 - Skeletal muscle
 - Smooth muscle
 - Cardiac muscle
 - All of the three muscles

6. Figure 1 is a graph showing the changes in the number of organisms A and B in an ecosystem in the past 12 years.

Which one of the following organisms are most likely to be A and B?

- A—aphid; B—Ladybug
- A—Lion; B—Antelope
- A—ant; B—aphid
- A—Clownfish; B—Anemone



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二、多選題 (30%)，每題的答案均超過一個選項，每題 5 分

1. Which of the following mammal's organs or tissues can be divided into cortex and medulla?
(A) Kidney
(B) Adrenal gland
(C) Thyroid
(D) Cerebellum
2. Which of the following statements are true about comparing DNA to RNA?
(A) Both contain deoxyribose and phosphate
(B) DNA is usually double-stranded and RNA is single-stranded
(C) DNA contains five carbon sugars and RNA contains six carbon sugars
(D) DNA contains thymine and RNA contains uracil
3. Which of the following creatures have an imprinting behavior?
(A) Pheasant
(B) Wolf
(C) Goat
(D) Salmon
4. Which of the followings are congenital genetic diseases?
(A) Rheumatoid arthritis
(B) AIDS
(C) Hemophilia
(D) Huntington's disease
5. Which following amino acids are human essential amino acids?
(A) Phenylalanine (Phe)
(B) Valine (Val)
(C) Threonine (Thr)
(D) Tryptophan (Trp)
6. Which of the following types of viruses are closely related to the occurrence of cancer?
(A) Papilloma virus
(B) Hepatitis B virus
(C) Avian influenza virus
(D) Adenovirus

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本科目試題共 11 頁

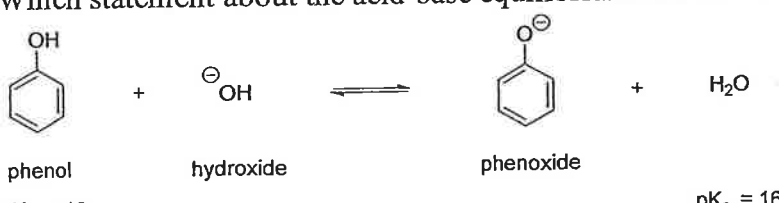
三、非選題 / 問答題 (40%)，中 / 英文皆可

1. Is the virus a creature or not? Please describe your opinions.
2. What is "vitamin"? Please explain the roles of vitamins in the human body.
3. What are your ideas about biomedical engineering to the human life improvements?
4. In your opinion, how to apply 5G/AI in medical engineering field?

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第 **二** 部 份：化學

一、選擇題 30%

- Which of the following is *not* a unit in the SI system? (A) meter (B) calorie (C) ampere (D) Kelvin (E) candela
- Which separation technique is based on differences in the affinity of the substances to be separated? (A) filtration (B) distillation (C) solvent extraction (D) paper chromatography (E) None of the above
- A species with 12 protons and 10 electrons is (A) Mg^{2+} (B) Ne^{2+} (C) Mg (D) Ti^{2+} (E) Ne^{2-}
- Which statement about the acid-base equilibrium shown above is **incorrect**?


phenol + hydroxide \rightleftharpoons phenoxide + H_2O
 $\text{pK}_a = 10$ $\text{pK}_a = 16$

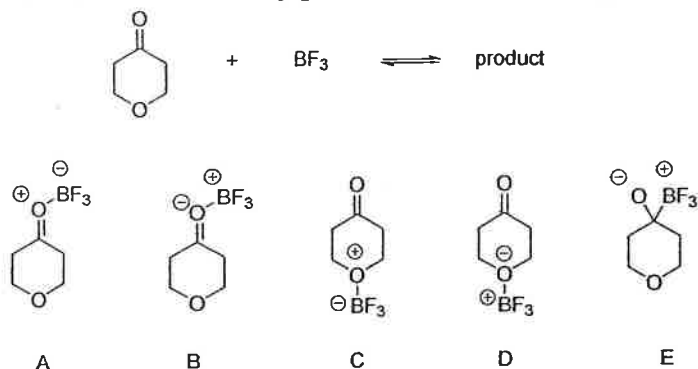
 - the equilibrium favors the products
 - water is a conjugate acid in this equilibrium
 - hydroxide is the strongest base present
 - phenol is 6 times more acidic than water
 - the negative charge in the phenoxide is resonance stabilized
- Which form of electromagnetic radiation has the longest wavelengths? (A) radio waves (B) x-rays (C) infrared radiation (D) microwaves (E) gamma rays
- Which of the following has a zero dipole moment? (A) NH_3 (B) HCN (C) PCl_5 (D) SO_2 (E) H_2O
- Which of the following molecules contains the shortest C–C bond? (A) C_2H_4 (B) C_2H_2 (C) C_2H_6 (D) C_2Cl_4 (E) a and d
- For an acid-base reaction, 2 M $\text{Al}(\text{OH})_3$ has a normality of 6 N. This is best explained because:
 - The equivalent mass is 6 times the molar mass.
 - The mole fraction is equal to 6 when aluminum hydroxide is mixed with water.

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本科目試題共11頁

- (C) Each mole contains 3 moles of hydroxide ions that can react with 3 moles of hydrated protons.
 (D) The normality is always three times stronger than the concentration of a solution.
 (E) At least two of the above statements are correct.

9. What is the most likely product of the following Lewis acid-base reaction?



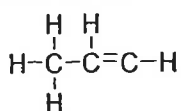
10. Naturally occurring copper exists in two isotopic forms: ^{63}Cu and ^{65}Cu . The atomic mass of copper is 63.55 amu. What is the approximate natural abundance of ^{63}Cu ? (A) 63% (B) 90% (C) 80% (D) 50% (E) 70%

二、複選題 30%

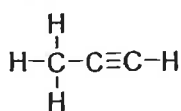
- What qualities do protein molecules have? (A) Polar and water-soluble (B) may contain S atoms (C) has many peptide bonds (D) can form intramolecular hydrogen bonds.
- Which of the following is correct (A) Ion radius: $\text{Mg}^{2+} < \text{Na}^+ < \text{F}^- < \text{O}^{2-}$ (B) Ion radius: $\text{O}^{2-} < \text{F}^- < \text{Na}^+ < \text{Mg}^{2+}$ (C) Ionization energy: $\text{Mg}^{2+} < \text{Na}^+ < \text{F}^- < \text{O}^{2-}$ (D) Ionization energy: $\text{O}^{2-} < \text{F}^- < \text{Na}^+ < \text{Mg}^{2+}$.
- Which of the following is a conjugate acid/base pair? (A) HCl/OCl^- (B) $\text{NH}_4^+/\text{NH}_3$ (C) $\text{H}_3\text{O}^+/\text{OH}^-$ (D) $\text{H}_2\text{SO}_4/\text{HSO}_4^-$ (E) more than one of these
- H_2O has a boiling point of 100°C , HF has a boiling point of 19.5°C , and NH_3 has a boiling point of -33°C . The differences are largely due to intermolecular (A) van der Waals force (B) hydrogen bonding (C) non-polar interactions (D) none of above mentioned.
- Which of the following are pure substances (A) 24K gold (B) 18K gold (C) air (D) gasoline (E) diamond.
- Protein can form a specific structure within tertiary or quaternary structure. What kind of force(s) is (are) used? (A) Hydrogen bond (B) Van der Waals force (C) Electrostatic attraction Force (D) none of above mentioned.

7. Which of the following is fat-soluble vitamins (A) Vitamin A (B) Vitamin D (C) Vitamin E (D) Vitamin K (E) none of above mentioned.

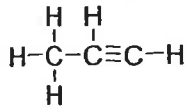
8. Based on the octet rule, which of the following line-bond structures is/are correct?



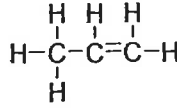
A



B

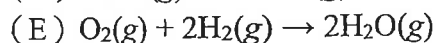
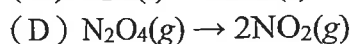
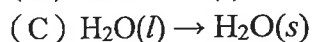
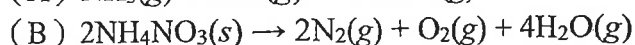


C



D

9. For which of the following processes would ΔS° be expected to be positive?



10. Which of the following statements concerning equilibrium is (are) true?

(A) A system moves spontaneously toward a state of equilibrium.

(B) Equilibrium in molecular systems is dynamic, with two opposing processes balancing one another.

(C) A system that is disturbed from an equilibrium condition responds in such a way as to restore equilibrium.

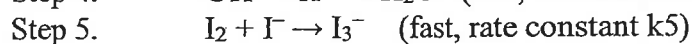
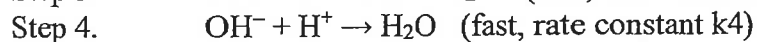
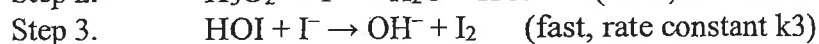
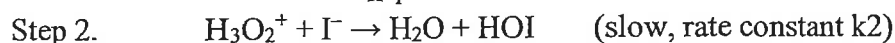
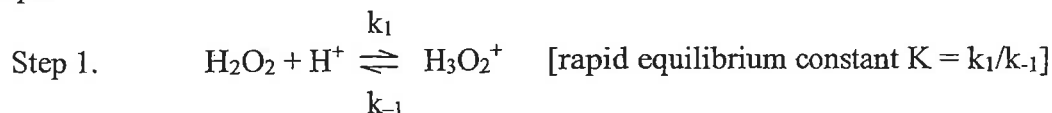
(D) The value of the equilibrium constant for a given reaction mixture is the same regardless of the direction from which equilibrium is attained.

(E) The equilibrium constant is independent of temperature.

三、問答題 40% (可用中文回答)

1. A sample of helium gas has been contaminated with argon gas. At 1 atm and 25°C, the density of the mixture is 0.200 g/L. What is the volume percent helium in the sample? (5%)

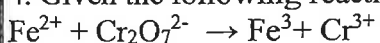
2. Under certain conditions the reaction $\text{H}_2\text{O}_2 + 3\text{I}^- + 2\text{H}^+ \rightarrow \text{I}_3^- + 2\text{H}_2\text{O}$ occurs by the following series of steps:



Which of the steps would be called the rate-determining step? (2%) explain why? (3%)

3. Determine the percent dissociation of a 0.18 M solution of hypochlorous acid, HClO . The K_a for the acid is 3.5×10^{-8} . (10%)

4. Given the following reaction in acidic media:



Please balance the reaction. (5%)

5. Please describe the application of Chemistry in the field of biomedical engineering. (15%)

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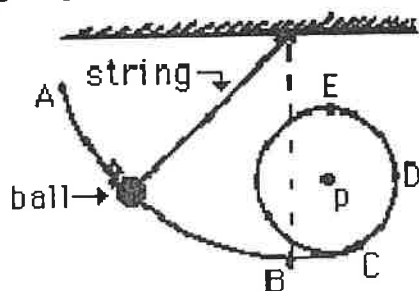
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第三部份：物理

A. Single Choice (50%, 10 questions)

1. The combination of all frequencies of visible light makes (A) ultraviolet light; (B) transparency; (C) infrared light; (D) black light; (E) white light.
2. The principle of floatation states that _____. (A) the object displaces a weight of fluid less than its own weight; (B) the object displaces just enough water that it overcomes the buoyant force; (C) the object displaces a weight of fluid equal to its own weight; (D) the object displaces a weight of fluid greater than its own weight; (E) the object displaces a density of fluid equal to its own.
3. A ball moving at 5 m/s with a momentum of 12 kgm/s. What is the mass of the ball? (A) 0 kg; (B) 2.4kg; (C) 12 kg; (D) 30 kg; (E) 60 kg.
4. How much does a 1-kg object weigh on Earth? (A) 9.8 N; (B) 4.45 N; (C) 98 N; (D) 0.98 N; (E) More information is needed.
5. What is the standard unit of weight in physics? (A) Pounds; (B) Newtons; (C) Kilograms; (D) Pascals; (E) Meters.
6. While on Mars, you drop your Martian detector while climbing out of the rover. If you're standing on a platform 8 meters from the ground and the acceleration due to gravity on Mars is -3.8 m/s^2 , how long does it take for the Martian detector to hit the ground? (A) 210 s; (B) 21 s; (C) 2.1 s; (D) 13 sec; (E) 1.3 sec.
7. A small ball tied to a string swings without air resistance, beginning from rest at point A. The string snags on a nail at point P, causing the ball to move in a small circle.



The ball has maximum potential energy at point (A) A; (B) B; (C) C; (D) D; (E) E.

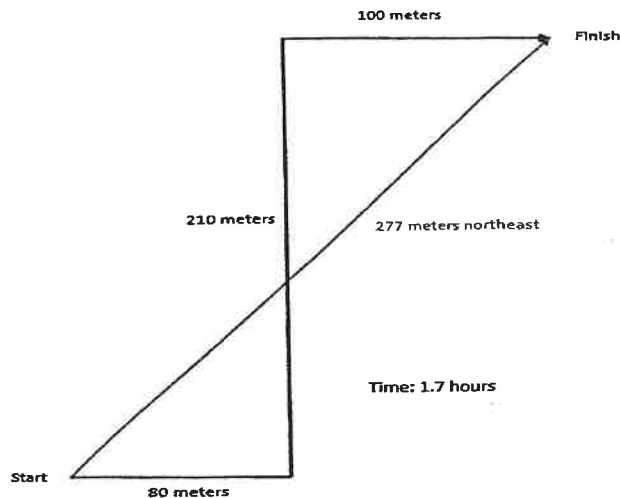
8. In Question 7, the ball has maximum kinetic energy at point (A) A; (B) B; (C) C; (D) D; (E) E.
9. In Question 7, the ball has maximum speed at point (A) A; (B) B; (C) C; (D) D; (E) E.
10. An iron rod becomes magnetic when (A) the net spins of its electrons are in the same direction. (B) positive ions accumulate at one end and negative ions at the other end. (C) its atoms are aligned having plus charges on one side and negative charges on the other. (D) its electrons stop moving and point in the same direction. (E) none of these.

B. Multiple Choice (10%, 2 questions)

1. Which of following descriptions in "Electrostatics and Electric Current" are correct. (A) To say that an object is electrically polarized is to say its charges have been rearranged. (B) When a car is struck by lightning, the resulting electric field inside the car is zero. (C) Charge carriers in a metal are electrons rather than protons because electrons are loosely bound. (D) In a common dc circuit, electrons move at speeds of a fraction of a centimeter per second. (E) The source of electrons in an ordinary electrical circuit is the electrical conduction itself.
2. Which of following descriptions are correct. (A) Your weight is actually the gravitational attraction between you and the Earth. (B) An object at rest, moving at constant velocity or in mechanical equilibrium has zero acceleration. (C) If an object of constant mass experiences a constant net force, it will have a constant acceleration. (D) When a body falls freely under gravity, then the work done by the gravity is negative. (E) For a body moving in a circular path, the work done by the centripetal force is constant.

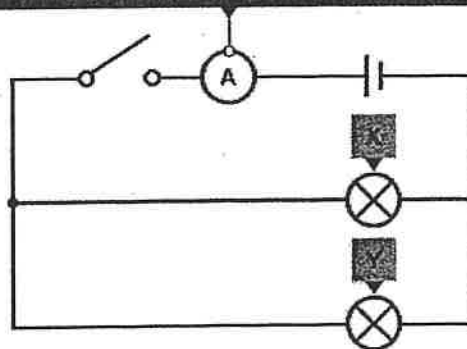
C. Problem Sets (40%, 4 questions)

1. Calculate the average velocity for the course, if you walked the black line in 1.7 hours. (5%)

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2. (A) Give a reason why lamps are connected in parallel in household lighting circuits. (2%)
 (B) The following circuit is set up to investigate the power of **different** lamps when they are

The ammeter reads 0.75 A with the switch closed



connected in parallel:

Describe how the power of lamp X can be determined, naming any components required. (3%)

(C) You will need to recall equations to answer the following questions:

- (1) The power of lamp X is 2.5 W and its resistance is $10\ \Omega$. Calculate the current through it. (3%)
 - (2) The ammeter reading is 0.75 A. Use this information to calculate the resistance of lamp Y. (3%)
 - (3) Calculate the ratio of the power of lamp X to the power of lamp Y. Show your working. (3%)
3. A gardener pushes a lawn roller through a distance of 20 m. If he applies a force of 20 kg weight in a direction inclined at 60° to the ground, find the work done by him. ($g=9.8\ \text{m/s}^2$) (6%)

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本科目試題共 **11** 頁

4. Please think about how to apply the knowledge of “Physics” in the Biomedical Engineering.
(15%)