

# 國立中山大學九十二學年度轉學生招生考試試題

科目：微積分【物理系二年級、電機系二年級、海工系二年級】

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Full marks are 100; the marks are indicated within questions.

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I. (15) Give the definition of the indefinite integral, and describe the relation between it and the definite integral (i.e., the fundamental theorem of Calculus).

II. (15) Find the limit

$$\lim_{x \rightarrow \infty} (\sqrt{x + \sqrt{x}} - \sqrt{x}).$$

III. (15) Let the function

$$f(x) = \frac{(1+x)(2+x) \cdots (9+x)}{(1-x)(2-x) \cdots (9-x)}.$$

Find the derivative  $f'(0)$ .

IV. (15) Find the limit

$$\lim_{h \rightarrow 0} \frac{1}{h} \int_x^{x+h} \frac{du}{u + \sqrt{u^2 + 1}}.$$

V. (20) Let  $S$  be the closed domain by rotating two curves:  $y = x^2$  and  $y = 2 - x^2$ . Find the volume of  $S$ .

VI. (20) Prove that the functions  $r^n \cos n\theta$  and  $r^n \sin n\theta$  satisfy the Laplace equation,

$$\Delta u = \frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} = 0,$$

where  $(r, \theta)$  are the polar coordinates,  $x = r \cos \theta$  and  $y = r \sin \theta$ .

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科目：普通物理【機電系二年級、海工系二年級】

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1. In Fig.1, two uniform disks have mass  $m$  and  $3m$  and equal radii  $R$ . They are mounted as shown on the same vertical axis with frictionless bearings. The upper disk is given an initial angular velocity  $\omega_0$  and then allowed to fall on to the lower disk, which is initially at rest. Friction between the disk surfaces causes them to rotate together with a common rotating speed  $\omega$ . In terms of given symbols, find a) the final angular speed  $\omega$  and b) the total amount of frictional thermal energy generated. (12%)

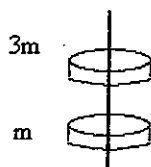


Fig. 1

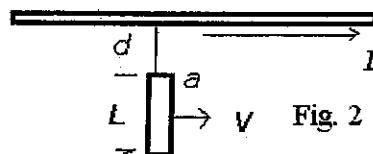


Fig. 2

2. A 30.0 kg projectile is fired at an angle of 60.0 degree above the horizontal and with a velocity of magnitude 200m/s. At the highest point of its trajectory the projectile explodes into two fragments with equal mass, one of which falls vertically with 1.0m/s speed. How far from the point of firing does the other fragment strike the ground? (12%)
3. A 3.0g bullet is fired horizontally to two blocks on a frictionless table. The bullet penetrates the first 1.5kg block and leaves with speed 0.6m/s. And then it strikes the second 2.1kg block and stays in the block. The final speed of the second block is 1.3m/s. Find the initial speed of the bullet. (13%)
4. The long, straight wire in Fig.2 carries constant current  $I$ . A metal rod with length  $L$  is moving at constant velocity  $V$ . Point  $a$  is a distance  $d$  from the wire. Find the *emf* induced in the rod. (12%)
5. Light of wavelength 440 nm passes through a double slit, yielding a diffraction pattern whose graph of intensity  $I$  versus deflection angle  $\theta$  is shown Fig.3. Calculate a) the slit width and b) the slit separation. (12%)

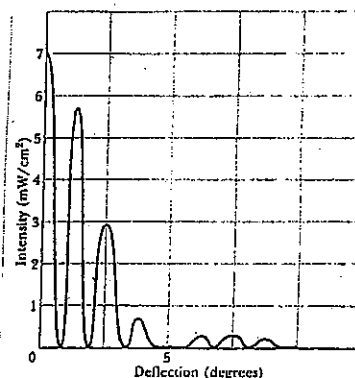
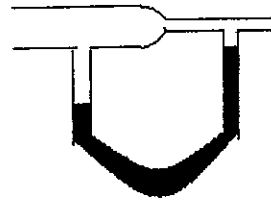
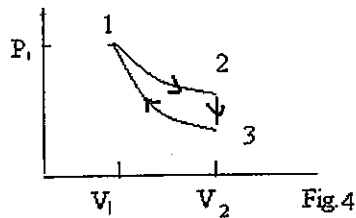


Fig. 3

6. A wave traveling along a string of density  $16\text{g/m}$  is described by the wave equation  $y(x,t) = 2.5 \sin[(7.5\text{m}^{-1}x - (110\text{rad/s})t]\text{cm}$ . Find a) the tension on the string, b) the power transmitted by the wave. (12%)

7. One mole of monatomic ideal gas under the processes in Fig.4 where  $V_2 = 3.0V_1$  and 1-2 isothermal, 2-3 constant volume, and 3-1 adiabatic. Find a)  $P_2, P_3,$  and  $T_3$  b)  $W, Q,$  and  $\Delta S$  in three processes respectively. All quantities are written in terms of  $P_1, V_1,$  and gas constant  $R$ . (15%)



8. The horizontal section of pipe shown in Fig.5 has a cross-section area of  $40.0\text{ cm}^2$  at the wider portion and  $10.0\text{ cm}^2$  at the constriction. Water is flowing in the pipe, and the discharge from the pipe is  $4.00 \times 10^{-3}\text{ m}^3/\text{s}$ . Find the difference in height between the mercury columns in the U-shape tube. ( $\rho = 13.6 \times 10^3\text{ kg/m}^3$ ) (12%)

# 國立中山大學九十二學年度轉學生招生考試試題

科目：普通化學【海工系二年級】

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## MULTIPLE CHOICE (單選)

- Which of the following processes does not represent a chemical change?
  - iron rusting
  - reaction of sodium metal with water
  - dissolving sugar in water
  - souring of milk
  - leaves changing color
- Which of the following is not an example of matter?
  - wood
  - water
  - air
  - light
  - atoms
- In the metric system the prefix micro represents the multiple
  - $10^{-1}$
  - $10^{-2}$
  - $10^{-3}$
  - $10^{-6}$
  - $10^{-9}$
- A chlorine-oxygen compound is found to have a chlorine to oxygen mass ratio of 1.109. Which of the following chlorine to oxygen mass ratios is possible for a different chlorine-oxygen compound?
  - 1.000
  - 1.214
  - 2.428
  - 4.437
  - 5.014
- An iron-56 nucleus contains:(atomic number of iron is 26)
  - 56 protons
  - 56 neutrons
  - 26 protons and 26 neutrons
  - 56 protons and 56 neutrons
  - 26 protons and 30 neutrons
- What is the mass number of an isotope of lead(atomic number 82) that has 126 neutrons?
  - 126
  - 252
  - 82
  - 208
  - none of these
- Calculate the molecular mass of xenon tetrafluoride,  $\text{XeF}_4$ , a colorless, crystalline compound at room temperature.  $\text{Xe} = 131.30$ ,  $\text{F} = 18.99$ .
  - 150.3
  - 207.3
  - 601.2
  - 1023.3
  - 169.3
- Which statement is not correct regarding a mole?
  - A mole of  $^{12}\text{C}$  atoms contains  $6.02 \times 10^{23}$  atoms.
  - A mole of  $\text{O}_2$  gas contains the same number of molecules as a mole of  $\text{H}_2$  gas.
  - Exactly 12 g of carbon-12 is one mole of carbon-12.
  - A mole of  $\text{O}_2$  gas has the same mass as a mole of  $\text{N}_2$  gas.
  - The mass of one  $^{12}\text{C}$  atom is  $12.0/6.02 \times 10^{23}$  g.

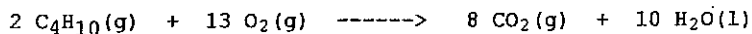
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科目：普通化學【海工系二年級】

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9. When 0.225 mol butane,  $C_4H_{10}$ , is burned with excess oxygen how many moles of oxygen are consumed?



- a) 0.225  
b) 0.900  
c) 13.0  
d) 1.46  
e) 6.50
10. Consider a 1.00-L solution containing 85.5 g  $Al_2(SO_4)_3$  (FW = 342.15) and 21.3 g  $Na_2SO_4$  (FW = 142.06). What are the molar concentrations of aluminum, sodium, and sulfate ions, respectively?  
 $[Al^{3+}]$ ,  $[Na^+]$ ,  $[SO_4^{2-}]$
- a) 0.25      0.15      0.40  
b) 0.50      0.75      0.15  
c) 0.50      0.75      0.90  
d) 0.50      0.30      0.90  
e) 0.25      0.30      0.15
11. Which one of the following substances would you expect to be a nonelectrolyte in aqueous solution?
- a) HBr  
b)  $CH_3COOH$   
c) KI  
d)  $CH_3CH_2OH$   
e)  $NH_3$
12. A 25.00 mL sample of an aqueous solution of  $Ba(OH)_2$  requires 18.45 mL of 0.01500 M  $HCl(aq)$  for its neutralization. What is the molarity of the  $Ba(OH)_2$  solution?
- a) 0.01107  
b) 6.919  
c)  $5.535 \times 10^{-3}$   
d) 0.02214  
e) 13.84
13. Consider the following gas phase reaction:
- $$2NO + O_2 \longrightarrow 2NO_2$$
- 400 mL of NO at STP is reacted with 500 mL of  $O_2$  at STP. Calculate the volume of the reaction mixture at STP after the reaction goes to completion.
- a) 700 mL  
b) 800 mL  
c) 900 mL  
d) 1300 mL  
e) 100 mL
14. Which of the following best describes an unopened can of ice-cold Coca Cola?
- a) an open system  
b) a closed system  
c) an isolated system  
d) a system at thermal equilibrium  
e) the surroundings
15. A system absorbs a given quantity of heat and does a given quantity of work. Which of the following choices correctly indicates the signs for q and w?
- a) q, w  
b) -q, -w  
c) q, -w  
d) -q, w  
e) q = w = 0

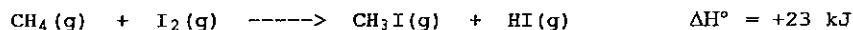
# 國立中山大學九十二學年度轉學生招生考試試題

科目：普通化學【海工系二年級】

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16. Consider the following thermochemical equation:



What energy change occurs when 2.4 mole of  $\text{CH}_4$  reacts?

- a) 23 kJ is released
  - b) 23 kJ is absorbed
  - c) 55 kJ is released
  - d) 55 kJ is absorbed
  - e) 9.6 kJ is absorbed
17. When 10 g samples of the following materials absorb 100 J of heat, the temperature increase indicated is observed. Which material has the largest specific heat?
- a) water 2 K
  - b) wood 6 K
  - c) copper 26 K
  - d) cement 11 K
  - e) glass 12 K
18. The two particles that comprise the nucleus of an atom are:
- a) protons and electrons
  - b) neutrons and electrons
  - c) alpha particles and neutrons
  - d) protons and neutrons
  - e) electrons and gamma rays
19. Calculate the frequency, in  $\text{s}^{-1}$ , of ultraviolet radiation that has a wavelength of 248 nm.
- a) 82.7
  - b) 248
  - c)  $8.27 \times 10^{10}$
  - d)  $1.21 \times 10^{15}$
  - e) 121
20. Which of the following types of electromagnetic radiation would have the longest wavelength?
- a) x-rays
  - b) UV
  - c) visible
  - d) IR
  - e) microwaves
21. Which of the following electron transitions will produce a photon of the longest wavelength in the Bohr hydrogen atom?
- a)  $n=3$  to  $n=4$
  - b)  $n=4$  to  $n=1$
  - c)  $n=4$  to  $n=2$
  - d)  $n=1$  to  $n=5$
  - e)  $n=4$  to  $n=3$
22. According to the Aufbau principle which sublevel is filled after the 5s sublevel?
- a) 5p
  - b) 4f
  - c) 3d
  - d) 4d
  - e) 5d
23. What is the major factor driving the formation of  $\text{NaCl}(\text{s})$  from  $\text{Na}(\text{s})$  and  $\text{Cl}_2(\text{g})$ ?
- a) The attraction of a single positive Na ion for a single negative Cl ion.
  - b) The low ionization energy of the sodium atom.
  - c) The high electron affinity of chlorine atoms.
  - d) The favorable lattice energy for NaCl.
  - e) The low heat of sublimation for sodium atoms.

國立中山大學九十二學年度轉學生招生考試試題

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24. Predict which of the following bonds would be the longest.

- a) H-H
- b) C-H
- c) C-C
- d) C=C
- e) C≡C

25. Predict whether the SO<sub>2</sub> molecule is polar or nonpolar.

- a) polar
- b) nonpolar
- c) impossible to tell

26. What is the best description of the bond between a carbon atom and a bromine atom in carbon tetrabromide?

- a) sp<sup>3</sup>- 4p
- b) sp<sup>2</sup>- 2p
- c) sp<sup>2</sup> - 4p
- d) sp - 4p
- e) sp<sup>3</sup> - 2p

27. How many of the following variables will cause a change in the vapor pressure above a liquid in a closed container?

amount of the liquid	pressure of the container
surface area of the liquid	
temperature of the liquid	
volume of the container	

- a) 0
- b) 1
- c) 2
- d) 3
- e) 4

28. Consider a closed container containing a liquid and its vapor. Which statement is incorrect?

- a) The vapor exerts a pressure called the vapor pressure.
- b) Increasing the temperature of the liquid would lead to a greater vapor pressure.
- c) Evaporation and condensation will eventually cease after a constant pressure has been attained.
- d) Decreasing the volume of the container at constant temperature would cause increased condensation until the pressure of the vapor was once again the same as it had been.
- e) The rate of evaporation is equal to the rate of condensation.

29. Which of the following statements about water is incorrect?

- a) The boiling point is much higher than expected.
- b) There are much stronger intermolecular forces due to hydrogen bonding.
- c) Solid (ice) is more dense than liquid (water).
- d) The solid-liquid line in the phase diagrams has a negative slope.
- e) Ice can sublime at temperatures below 0°C.

30. Which notion is incorrect?

- a) Dispersion forces are present in all molecular substances.
- b) The greater the dipole moment, the stronger the dipole-dipole forces.
- c) The polarizability of elongated molecules is greater than that of compact, more spherical molecules.
- d) Polar molecules always have higher boiling points than nonpolar molecules.
- e) Hydrogen bonding leads to the strongest intermolecular forces.

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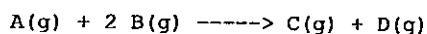
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31. USP ethanol is an aqueous solution containing 95.0% ethanol by volume. At 20°C pure ethanol has a density of 0.789 g/ml and the USP ethanol, 0.813 g/ml. How many grams of water are present in 100.0 mL of USP ethanol?
- 95.0
  - 5.0
  - 2.4
  - 6.3
  - can't determine from given information
32. A 0.750 L bottle of a French Merlot is said to contain 12.5% alcohol by volume. How much of the liquid, in mL, in the bottle is water?
- 82.0
  - 93.8
  - 656
  - 574
  - density is required
33. The normal freezing point of cyclohexane is 6.55°C. When 0.458 g of benzophenone is dissolved in 15.0 g of cyclohexane, the freezing point is found to be 3.19°C. What is the experimental molar mass of benzophenone?  $K_f$  cyclohexane = 20.0°C m<sup>-1</sup>
- 160
  - 182
  - 360
  - 89.3
  - 18.0
34. In the reaction, A ----> Products, the initial concentration of A is 0.86 M, and 40 s later, 0.78 M. What is the initial rate of this reaction in M·min<sup>-1</sup>?
- $1.2 \times 10^{-1}$
  - $2.0 \times 10^{-3}$
  - $2.2 \times 10^{-2}$
  - $2.0 \times 10^{-2}$
  - $4.1 \times 10^{-2}$

35. Initial rate data were obtained for the following reaction:



Experiment	initial [A], Mol/L	initial [B], Mol/L	initial rate
1	0.15	0.10	$4.5 \times 10^{-1}$
2	0.30	0.10	1.8
3	0.15	0.20	$9.0 \times 10^{-1}$

What is the rate law for the reaction?

- rate = k [A]
  - rate = k [A] [B]
  - rate = k [A]<sup>2</sup> [B]
  - rate = k [A]<sup>2</sup> [B]<sup>3</sup>
  - rate = k [A] [B]<sup>2</sup>
36. The reaction of O<sub>3</sub> with Cl· is believed to occur by the mechanism shown below. In this mechanism, Cl· is:
- $$O_3 + Cl\cdot \text{ ----> } ClO\cdot + O_2$$
- $$ClO\cdot + O \text{ ----> } Cl\cdot + O_2$$
- The catalyst.
  - An intermediate.
  - A product of the overall reaction.
  - A reactant in the overall reaction.
  - The activated complex.



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科目：普通化學【海工系二年級】

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37. For which of the following values of  $K_C$  will the equilibrium mixture consist almost entirely of reactants?
- 0.030
  - 1.00
  - $1 \times 10^{-8}$
  - 30
  - $4 \times 10^8$
38. A mixture is prepared with  $[CO] = 0.035$ ,  $[Cl_2] = 0.015$ , and  $[COCl_2] = 0.95$ . It is known that  $K_C$  for the equilibrium  $CO(g) + Cl_2(g) \rightleftharpoons COCl_2(g)$  is  $1.2 \times 10^3$  at  $400^\circ C$ . Predict what will happen.
- The reaction is at equilibrium so no net reaction occurs.
  - The reaction occurs in the forward direction.
  - The reaction occurs in the reverse direction.
  - It is impossible to predict without more information.
39. At a particular temperature  $K_C = 54$  for the reaction  $H_2(g) + I_2(g) \rightleftharpoons 2 HI(g)$
- 1 mole of HI is placed in a 3.0-L container. What would be the equilibrium concentration of HI?
- 0.035
  - 0.071
  - 0.26
  - 0.30
  - 0.33
40. The pH of a 0.24 M solution of dimethylamine is 12.01. Calculate the  $K_b$  value for dimethylamine.
- 0.24
  - 0.18
  - $4.3 \times 10^{-2}$
  - $4.4 \times 10^{-4}$
  - none of these
41. At  $50^\circ C$ , the solubility of lead sulfate is  $1.5 \times 10^{-4}$  M. Calculate the  $K_{sp}$  at this temperature.
- $1.6 \times 10^{-8}$
  - $2.3 \times 10^{-8}$
  - $1.5 \times 10^{-4}$
  - $7.6 \times 10^{-1}$
  - $1.4 \times 10^{-1}$
42. Which process is accompanied by a decrease in entropy for the system?
- water evaporates
  - dry ice sublimates
  - ethanol condenses
  - sodium chloride dissolves
  - wax melts
43. The ultimate criterion for spontaneity of a process is:
- the change in internal energy of the process
  - the change in enthalpy
  - the change in entropy
  - the change in free energy for the process
  - the change in numbers of moles of gaseous species

# 國立中山大學九十二學年度轉學生招生考試試題

科目：普通化學【海工系二年級】

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44. The radius of the alkali metals...
- increases as you ascend the group.
  - increases as you descend the group.
  - stays the same throughout the group.
  - is inversely related to the ionic radius.
  - is smaller than the radius of the alkaline earth metals.
45. Within a given period, which of the following groups has the largest atomic radius?
- 3A
  - 4A
  - 5A
  - 6A
  - 7A
46. Which of these metals is not a transition element?
- Zr
  - Mo
  - Os
  - Pb
  - Hg
47. What is the ground state electron configuration of Ni ?
- [Ar] 3d<sup>8</sup>
  - [Ar] 4d<sup>8</sup>
  - [Ar] 4s<sup>2</sup> 3d<sup>6</sup>
  - [Ar] 3d
  - [Ar] 4s<sup>2</sup> 4d<sup>6</sup>
48. Which is the correct formula for potassium hexacyanoferrate(II)?
- K[FeCN]<sub>6</sub>
  - K<sub>2</sub>[Fe(CN)<sub>6</sub>]
  - K[Fe(CN)<sub>6</sub>]
  - K<sub>4</sub>[Fe(CN)<sub>6</sub>]
  - K<sub>6</sub>[Fe(CN)<sub>6</sub>]
49. The component of the upper atmosphere that is effective in absorbing UV radiation is:
- N<sub>2</sub>
  - Ar
  - O<sub>3</sub>
  - CO<sub>2</sub>
  - O<sub>2</sub>
50. What wavelength range not absorbed by the ozone layer is considered to be responsible for causing sunburns, eye damage, and skin cancer?
- 230 - 290 nm
  - 290 - 320 nm
  - 330 - 410 nm
  - 420 - 550 nm
  - 560 - 720 nm