國立成功大學 106 學年度碩士班招生考試試題

系　　所：材料科學及工程學系

考試科目：物理與化學

考試日期：0213，節次：1

※ 考生請注意：本試題可使用計算機。　請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

物理與化學共 50 題選擇題，每題答對得 2 分，答錯倒扣 0.5 分；滿分 100 分，倒扣至 0 分為止。

1. Regarding the handness in molecules, which of following descriptions is correct?
   (a) A carbon atom is viewed as a stereocenter when being bonded to four different groups.
   (b) A molecule is classified to have chiral center(s) if it contains a plane of symmetry.
   (c) A molecule that is identical to its mirror image is a kind of stereoisomer.
   (d) CH_2F_2 is a typical chiral molecule.

2. The features of conjugated polymers is related to
   (a) the flexible backbone with significant polarity.
   (b) the alternative attachment of polar side groups.
   (c) the lack of double bonds.
   (d) electronic interactions between neighboring double bonds vis the overlap of p orbitals.

3. Considering the properties of benzene molecules, which of the following descriptions is correct?
   (a) Each carbon has a p orbital parallel to the plane of the six-membered ring.
   (b) The cycling conjugation of the benzene molecules results in the equivalence of the six carbon-carbon bonds.
   (c) Benzene shows most of the reactivity characteristic of alkenes.
   (d) Benzene molecules prefer to undergo electrophilic addition reaction.

4. What makes aromatic compound either activating or deactivating?
   (a) The common characteristic of all deactivating groups is that they make the rings more polar.
   (b) The common characteristic of all activating groups is that they withdraw electrons from the rings.
   (c) The common characteristic of all activating groups is that they donate electrons to the ring.
   (d) The common characteristic of all deactivating groups is that they make the rings less polar.

5. Regarding the infrared spectroscopy of organic molecules,
   (a) it is able to detect the match of the frequency of infrared radiation with the frequency of symmetry vibration of nonpolar molecules.
   (b) it is able to reflect the match of the frequency of infrared radiation with the asymmetry frequency of molecular vibration.
   (c) it is related to the delocalization of electrons upon the conjugated molecular structure.
   (d) it is not able to distinguish the cyclohexanol from cyclohexanone molecules.

6. Which of the following is the most abundant element in limestones?
(a) Si (b) Al (c) Ca (d) Fe

7. Which of the following best describes the hybrids used by S in the sulfite ion, SO_3^{2-}?
(a) sp^3 (b) sp^2 (c) sp (d) dsp^2

8. Which of the following diatomic species do you expect to have the longest bond length?
(a) O_2^- (b) NO^+ (c) CO (d) O_2^+

9. Calculate the following rations for a gas as at Kelvin temperature T_1 and T_2, where $2T_2=T_1$, mean free path at T_1/mean free path at T_2
(a) 0.5 (b) 1.0 (c) 1.5 (d) 2.0

10. For a particle in a cubic box, how many degenerate energy levels have energy equal to $14h^2/8mL^2$?
(a) 6 (b) 8 (c) 10 (d) 12

11. Naturally occurring chlorine is 75.53% ^{35}Cl, which has an atomic mass of 34.969 amu, and 24.47% ^{37}Cl, which has a mass of 36.966 amu. Calculate the average atomic mass of chlorine.
(a) 34.5 amu. (b) 35.46 amu. (c) 37.01 amu. (d) 35.1 amu.

12. The energy difference between the 3p and the 3s orbitals is 2.107 eV, for example. Calculate the wavelength of radiation that would be absorbed in exciting the 3s electron to the 3p state (1 eV = 1.6 x 10^{-19} J).
(a) 390 nm. (b) 590 nm. (c) 780 nm. (d) 190 nm.

13. A typical simple infrared spectrophotometer covers a wavelength range from 3 to 15 μm. Express its range in wavenumbers.
(a) 666.7 to 3333 cm^{-1}. (b) 3333 to 666.7 cm^{-1}. (c) 333 to 66. 7 cm^{-1}. (d) 1111 to 222.3 cm^{-1}.

14. What is the oxidation number of the central metal in $[Co(NH_3)_5Cl](NO_3)_2$?
(a) +3. (b) -3. (c) +2. (d) -1.

15. Predict the number of unpaired electrons in six-coordinate high spin and low spin complexes of Fe^{3+}, respectively.
(a) 5 and 1. (b) 3 and 2. (c) 1 and 5. (d) 0 and 2.

16. Predict the shift in equilibrium position that will occur for the following process when the volume is reduced: $PCl_{3(g)} + Cl_{2(g)} = PCl_{5(g)}$
(a) to the right (b) to the left (c) unchanged (d) all correct

17. Which of the following mixture is homogeneous?
(a) salt with sugar (b) water with gasoline (c) oxygen with nitrogen (d) dust with air

18. Is $H_2(g)$ capable of reducing $Ag^+(aq)$?
(a) yes (b) no (c) both (d) none of the above

19. Which of the following elements should not be able to reduce Ni^{2+} ions to nickel metal?
(a) Al (b) Zn (c) Mg (d) Cu

20. Which of the following metals has the lowest melting point?
(a) tungsten (b) iron (c) copper (d) tin

21. Which compound is an ether?
(a) Ethylene glycol (b) Epoxy (c) Nitrophenol (d) Cyclohexanone

22. Which following element and its symbol is correct?
(a) Argon (Ag) (b) Ruthenium (Ru) (c) Potassium (Pt) (d) Titanium (Ta)

23. What is the best way to remove the oxygen gas that is dissolved in the water?
(a) Stirring (b) Cooling (c) Pressurizing (d) Purging with nitrogen gas

24. What is the unit to the Electron Affinity?
(a) kJ/cm^2 (b) kJ/cm^3 (c) KJ/mol (d) KJ/g

25. For an ethane, the σ bond length between two C (carbon) atoms is about 0.154 nm. The σ bond length between C and H (hydrogen) is estimated to be:
(a) 0.109 nm (b) 0.154 nm (c) 0.198 nm (d) 0.541 nm

26. A certain string has a linear mass density of 0.25 kg/m and is stretched with a tension of 25N. One end is giving a sinusoidal motion with frequency 5Hz and amplitude 0.01m. At time t=0 the end has zero displacement and is moving in the +y-direction. Find the position of the point at x=0.25m at time t=0.1s.
(a) 0.00707m (b) 0.01414m (c) 0.02121m (d) 0.02828m

27. Two charges are located on the positive x-axis of a coordinate system. Charge $q_1 = 2*10^{-9}C$ is 2cm from the origin, and charge $q_2 = -3*10^{-9}C$ is 4cm from the origin (the electrical constant $k \approx 9*10^9 Nm^2C^{-2}$). What is the total force exerted by these two charges on a charge $q_3 = 5*10^{-9}C$ located at the origin?
(a) $-2.25*10^{-4}N$ (b) $-1.41*10^{-4}N$ (c) $0.84*10^{-4}N$ (d) $1.68*10^{-4}N$

28. Two positive point charges, each of magnitude q, are fixed on the y-axis at the points y=+*a* and y=-*a*. Suppose a positively charged particle of charge q' and mass m is placed precisely at the origin and is displaced slightly in the direction of the y-axis, what will happen?
(a) It remains at rest
(b) It oscillates about the origin, along the x-axis
(c) It accelerates away from the origin along the x-axis
(d) It moves along the x-axis with constant velocity.

29. A particle having a mass of 0.5g carries a charge of $2.5*10^{-8}$ C. The particle is given an initial horizontal velocity of $6*10^{-4}m/s$. What is the magnitude and direction of the minimum magnetic field that will keep the particle moving in a horizontal direction?
(a) 2.37T, perpendicular to direction of *v*
(b) 2.37T, parallel to direction of *v*
(c) 3.27T, perpendicular to direction of *v*
(d) 3.27T, parallel to direction of *v*.

30. A mass of 100kg suspended from a wire whose unstretched length l_0 is 4m is found to stretch the wire by 0.004m. The cross-sectional area of the wire, which can be assumed constant, is $0.1cm^2$. If the load is pulled down a small additional distance and released, find the frequency at which it will vibrate.
(a) 7.88Hz (b) 6.78Hz (c) 49.5Hz (d) 42.6Hz

31. A mass of 100kg suspended from a wire whose unstretched length l_0 is 4m is found to stretch the wire by 0.004m. The cross-sectional area of the wire, which can be assumed constant, is $0.1cm^2$. What is the Young's modulus of this wire?
(a) $10^{10}Pa$ (b) $10^{12}Pa$ (c) $9.8*10^{10}Pa$ (d) $9.8*10^{12}Pa$

32. A hollow cylinder of mass *M* and inner and outer radii R_1 and R_2, what is the moment of inertia bout the axis of symmetry?
(a) $\frac{1}{2}M(R_2^2 - R_1^2)$ (b) $\frac{1}{2}M(R_2^2 + R_1^2)$ (c) $\frac{1}{4}M(R_2^2 - R_1^2)$ (d) $\frac{1}{4}M(R_2^2 + R_1^2)$

33. An electron has energy of 8.27×10^5 eV. What is its de Broglie wavelength.
(a) 1.90 pm. (b) 1.50 pm. (c) 3.3 pm. (d) 0.75 pm.

34. If the bond energy for H_2^+ is 2.65 eV, the bond energy for H_2 is
(a) less than 5.3 eV. (b) more than 5.3 eV. (c) also 2.65 eV. (d) less than 2.65 eV.

35. When two objects separated by a distance of r, then the van der Waals forces is approximately proportional to
(a) r^{-4} (b) r^{-5} (c) r^{-6} (d) r^{-7}

36. The mean free path of free electrons in a metal at room temperature is approximately
(a) 10^2 nm. (b) 10^1 nm. (c) 10^3 nm. (d) 10^{-2} nm.

37. Which of the following cannot be attributed to van der Waals forces?
(a) ionic bond. (b) friction. (c) surface tension. (d) adhesion.

38. Which of the following is incorrect?
(a) Classical physics fails in explaining blackbody radiation but explains the internal energy's variation with T.
(b) Classical physics fails in explaining not only blackbody radiation but also the internal energy's variation with T.
(c) Plank's radiation formula includes quantum idea.
(d) Plank's radiation formula uses classical statistics.

39. The J=0 to J=1 absorption frequency for CO and reduced mass of CO are respectively 1.15×10^{11} Hz and 1.14×10^{-26} kg. What is the bond length?
(a) 0.113 nm. (b) 0.232 nm. (c) 0.391 nm. (d) 0.039 nm.

40. Which of the following cannot a quantized quantity?
(a) angular momentum. (b) photo energy. (c) electron energy. (d) electron position.

41. Unpolarized light of intensity I_0 is incident on a polarizing filter, and the emerging light strikes a second polarizing filter with its axis at 45° to that of the first. Determine the intensity of the emerging beam.
(a) I_0 (b) 1/2 I_0 (c) 1/4 I_0 (d) 1/8 I_0

42. For a certain cathode material used in a photoelectric-effect experiment, a stopping potential of 3.0 V was required for light of wavelength 300 nm, 2.0 V for 400 nm, and 1.0 V for 600 nm. Determine the work function for this material.
(a) 0.5eV (b) 0.6 eV (c) 0.8 eV (d) 1.0 eV

43. X-rays are produced in a tube operating at 50 kV. After emerging from the tube, some x-rays strike a target and are Compton-scattered through an angle of 20°. What is the wavelength of the scattered x-rays?
(a) 2.481×10^{-11} m (b) 2.491×10^{-11} m (c) 2.496×10^{-11} m (d) 2.499×10^{-11} m

44. An electron of a wavelength of 10^{-10} m is accompanied by a certain speed? Through what potential difference must the electron be accelerated to acquire this speed.
(a) 50 V (b) 100 V (c) 150V (d) 200 V

45. A sodium atom in one of the "resonance levels" remains in that state for an average time of 1.6×10^{-8} s before making a transition to the ground state by emitting a photon of wavelength 589 nm and energy 2.109 eV. What is the uncertainty in energy of the resonance level?
(a) 4.11×10^{-8} eV (b) 4.11×10^{-9} eV (c) 4.11×10^{-10} eV (d) 4.11×10^{-11} eV

46. A glass flask of volume 200 cm^3 is just filled with mercury at 20 °C. How much mercury overflows when the temperature of the system is raised to 100 °C? The coefficient of volume expansion of the glass and mercury is $1.2 \times 10^{-5}(C°)^{-1}$ and $18 \times 10^{-5}(C°)^{-1}$, respectively.
(a) 2.59 cm^3 (b) 2.69 cm^3 (c) 2.79 cm^3 (d) 2.89 cm^3

47. How many nanometers are in one centimeter?
(a) 10^6 (b) 10^7 (c) 10^8 (d) 10^9

48. The index of refraction of glass is 1.51. What is the speed of light in the crystal?
(a) 1.51 times bigger than air (b) 2.28 times smaller than air
(c) Doesn't change (d) 1.51 smaller than air

49. Most metals contain d-state electrons, which of the following quantum number describe the d-state electrons?
(a) Principal quantum no. n = 2
(b) Orbital quantum no. l = 2
(c) Magnetic quantum no. ml = 2
(d) Spin magnetic quantum number ms = 2

50. An emf is induced by a changing magnetic flux in the operation of all of the following EXCEPT
(a) a motor
(b) a transformer
(c) an eddy current brake
(d) an electric generator