國立成功大學 107 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：0205，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. Which analytical technique reveals the stereoisomers to the organic molecule?
   (a) Geiger counter　(b) Polarimeter　(c) Refractometer　(d) Mass spectrometry

2. The hydrolysis of an anhydride gives:
   (a) one aldehyde group　(b) two aldehyde groups
   (c) one carboxylic acid group　(d) two carboxylic acid groups

3. A heterocyclic aromatic compound is:
   (a) a five-membered aromatic ring
   (b) an aromatic compound without conjugated π electrons
   (c) an aromatic compound with only two conjugated π electrons
   (d) an aromatic compound with at least two different elements in its conjugated system

4. Which description about a "leaving group" in S_N2 reaction is CORRECT?
   (a) a good leaving group is a stable anion
   (b) a good leaving group is a small atom
   (c) the leaving group departures before the addition of the nucleophile (Nu)
   (d) a leaving group is also a protecting group

5. Grignard reagents are organic synthesis for making?
   (a) carbon-to-oxygen bonding　(b) carbon-to-nitrogen bonding
   (c) carbon-to-carbon bonding　(d) carbon-to-hydrogen bonding

6. Which of the Fe^{3+} or Ni^{3+} ions would you expect to be a stronger oxidizing agent?
   (a) Fe^{3+}　(b) Cannot compare　(c) Ni^{3+}　(d) The same

7. The half-life of cobalt-60 is 5.3 year. How much of a 1.0 mg sample of cobalt-60 is left after 15.9 year period?
   (a) 0.25 mg　(b) 0.125 mg　(c) 0.5 mg　(d) 0.0625 mg

8. Which one of the 0.1 M solutions of C_2H_5OH, $HC_2H_3O_2$, and $NaC_2H_3O_2$, in water will cause of the light bulb to glow most brightly?
   (a) C_2H_5OH　(b) $NaC_2H_3O_2$　(c) $HC_2H_3O_2$　(d) The same

9. What is the chemical symbol for the ion with 22 protons and 18 electrons?
(a) Ar (b) Ti^{4+} (c) Ti^{2+} (d) Ca^{2+}

10. What is the characteristic wavelength of an electron with a velocity of 5.97×10^{6} m/s? (The mass of the electron is 9.11×10^{-28} g)
(a) 0.22 nm (b) 2.4 nm (c) 12.2 nm (d) 0.122 nm

11. Which of the following substances is most likely to exist as a gas at room temperature and normal atmospheric pressures: P_4O_{10}, Cl_2, AgCl, or I_2?
(a) P_4O_{10} (b) AgCl (c) I_2 (d) Cl_2

12. Arrange the following compounds: H_2O, NaH, AsH_3 and HI in the order of increasing acid strength.
(a) NaH<AsH_3< H_2O<HI (b) NaH< H_2O< AsH_3<HI (c) HI<AsH_3<H_2O<NaH (d) H_2O<NaH<AsH_3<HI

13. About the ultraviolet spectroscopy,
(a) it is related to the match of UV radiation energy with the energy levels of a pi electron in an unsaturated molecule.
(b) usually there are several peaks according to different energy levels of electrons.
(c) it can be used to estimate the concentration of conjugated polymers in saturated solutions.
(d) it is able to illustrate the wavelength of emitted light from studied sample via the transition of electrons from excited state to ground state.

14. For a polar covalent bond,
(a) it is not directional because two bonding electrons are equally shared by two bonded atoms.
(b) it is directional because two bonding electrons can be only equally shared by two bonded atoms along a certain direction.
(c) it is directional and two bonding electrons are not equally shared by two bonded atoms.
(d) it is not directional although two bonding electrons are not equally shared by two bonded atoms.

15. For a functional group having a carbon atom singly bonded to an electronegative atom,
(a) this carbon atom is likely to bear a partial positive charge.
(b) bonding electrons are to be delocalized within this functional group.
(c) it appears as an essential part of ester molecules.
(d) it appears as an essential part of ketone molecules.

16. Regarding the cis-trans isomers,
    (a) they can be converted to each other by the rotation along single bond.
    (b) it is related to the conformational change of linear alkenes.
    (c) it is also found in 1,4-dimethylcyclohexane.
    (d) they usually have similar chemical stability.

17. By using an Arrhenius plot,
    (a) we are able to calculate the reaction rate from the slope.
    (b) we are able to calculate the activation energy from the slope.
    (c) we are able to calculate the reaction rate from the intercept.
    (d) we are able to calculate the activation energy from the intercept.

18. In the CO_2 molecule,
    (a) it requires sp hybridization of carbon atom to results in two hybrid orbitals arranged at 180^o degrees.
    (b) it requires sp^2 hybridization of carbon atom to results in two hybrid orbitals arranged at 180^o degrees.
    (c) each oxygen atom can be assumed to be sp hybridized.
    (d) each oxygen atom has one effective nonbonding pairs of electrons around it.

19. Considering the vapor pressures of solutions,
    (a) significant solvent-solute interactions are usually able to enhance the vapor pressure.
    (b) the dissolution of nonvolatile solute is not to modify the vapor pressures of solvent molecules.
    (c) any solution that obeys Beers law is called the ideal solution.
    (d) the dissolution of nonvolatile solute basically decreases the vapor pressures of solvent molecules.

20. Which form of electromagnetic radiation has the longest wavelength?
    (a) gamma rays (b) radio waves (c) x-rays (d) microwaves

21. Which atom has the lowest ionization energy?
    (a) N (b) F (c) O (d) Ne

22. Which ion has the least radius?
    (a) Al^{3+} (b) Mg^{2+} (c) Ca^{2+} (d) Na^{+}

23. The carbonate of which alkali metal is used in treatment of manic-depressive illness?
    (a) Na (b) K (c) Li (d) Cs

24. All of the following are state function except
(a) enthalpy (b) internal energy (c) heat (d) pressure

25. Which of the following wave properties is proportional to energy for electromagnetic radiation?
(a) velocity (b) wavenumber (c) wavelength (d) amplitude

26. Which of the following compound is most likely to crystallize in the crystal system called pervoskites?
(a) $MgCl_2$ (b) $BaTiO_3$ (c) CsCl (d) $MgAl_2O_4$

27. A uniform sphere of radius *R* and mass *M*, what is the moment of inertia (axis through center)?
(a) $\frac{8}{15}MR^5$ (b) $\frac{8}{15}MR^2$ (c) $\frac{2}{5}MR^5$ (d) $\frac{2}{5}MR^2$

28. Small blocks, each of mass m, are clamped at the ends and at the center of a light rigid rod of length L. Compute the moment of inertia of the system about an axis perpendicular to the rod and passing through a point one-quarter of the length from one end. Neglect the moment of inertia of the rod.
(a) $5ml^2/16$ (b) $7ml^2/16$ (c) $9ml^2/16$ (d) $11ml^2/16$

29. A solid sphere (mass *M*, radius *R*) rolls without slipping down a plane inclined at angle θ to the horizontal. What is the acceleration of its center?
(a) $\frac{2}{7}g\sin\theta$ (b) $\frac{3}{7}g\sin\theta$ (c) $\frac{4}{7}g\sin\theta$ (d) $\frac{5}{7}g\sin\theta$

30. The synchrotron radiation facility is a
(a) high precision STM (b) high energy electron source
(c) high resolution TEM (d) high intensity XRD source

31. Work function is defined as:
(a) The minimum energy for an electron to escape from a particular metal surface.
(b) A distribution of a set of measurements in which the experimental errors are random.
(c) The work needed to remove an electron from an atom which is in its ground state.
(d) The greater the quantum number, the closer quantum physics approaches classical physics.

32. A pendulum of length with a bob of mass *m* is oscillating with small amplitude. Which of the following changes in the pendulum would double its period?
(a) Quadrupling the length of the pendulum
(b) Doubling the initial force used to set the pendulum in motion
(c) Doubling the amplitude of the pendulum's swing
(d) Quadrupling the mass *m* of the bob

33. A solid conducting sphere carries a charge +Q. Which of the following are true of the electric field E and the electric potential V inside the sphere?
(a) E = 0 and V= 0 (b) E = 0 and V ≠ 0 (c) E ≠ 0 and V= 0 (d) E ≠ 0 and V ≠ 0

34. For a particle to behave as a de Broglie wave, what is the following is required?
(a) with spin (b) carry charge (c) with momentum (d) massless

35. In a given process, 12 joules of heat is added to an ideal gas and the gas does 8 joules of work. Which of the following is true about the internal energy of the gas during this process?
(a) It has increased by 20 joules. (b) It has increased by 4 joules.
(c) It has not changed. (d) It has decreased by 4 joules.

36. A piece iron turns red hot at 1000 ^{o}C, this phenomenon is due to which of the following effect
(a) Phosphorescence effect (b) Photoelectric effect
(c) Black body radiation effect (d) Photodiode effect

37. An experiment is performed to measure the specific heat of copper. A lump of copper is heated in an oven, then dropped into a beaker of water. To calculate the specific heat of copper, the experimenter must know or measure the value of all of the quantities below EXCEPT the
(a) mass of the water
(b) original temperatures of the copper and the water
(c) final (equilibrium) temperature of the copper and the water
(d) time taken to achieve equilibrium after the copper is dropped into the water

38. Which of the following statements is correct as described in Rutherford's experiment
(a) small fraction of α particles went through the thin Au foil
(b) small fraction of α particles scattered through very small angles
(c) none of the α particles went through the foil
(d) most α particles scattered through very large angles

39. Which of the following is true of the magnetic field produced by a current in a long, straight wire?
(a) The field is uniform.
(b) The field increases in strength as the distance from the wire increases.
(c) The field lines are directed parallel to the wire, but opposite to the direction of the current.
(d) The field lines form circles about the wire.

40. A copper wire has a resistance R when it is at a temperature T. The wire is melted and all of the metal is used to reform it into a new copper wire 4 times as long. What is the resistance of the new wire at temperature T?
(a) 2R (b) 0.5 R (c) 4R (d) 16R

41. A particle having a charge q = 3 x 10^{-9} C moves from point a to point b along a straight line, a total distance d = 0.5 m. The electric field is uniform along this line, in the direction from a to b, with magnitude E = 200 N C^{-1}. Determine the work done on it by the field.
(a) 3 x 10^{-9} J (b) 30 x 10^{-9} J (c) 300 x 10^{-9} J (d) 600 x 10^{-9} J

42. A copper conductor of square cross section 1 mm on a side carries a constant current of 20 A. The density of free electrons is 8 x 10^{28} electrons per cubic meter. Find the drift velocity.
(a) 0.8 x 10^{-2} m s^{-1} (b) 1.6 x 10^{-2} m s^{-1} (c) 0.8 x 10^{-3} m s^{-1} (d) 1.6 x 10^{-3} m s^{-1}

43. An electron beam moves through a region of space where there is a uniform magnetic field of magnitude 2.0 T, with direction along the positive z axis. The electrons have velocity of magnitude 3 x 10^{5} m s^{-1}, in the xz-plane, at an angle of 30° to the positive z-axis. Find the force on an electron.
(a) + (4.8 x 10^{-14} N) j (b) - (4.8 x 10^{-14} N) j (c) + (9.6 x 10^{-14} N) j (d) - (9.6 x 10^{-14} N) j

44. A cylindrical conductor of circular cross section has a radius a and a resistivity ρ and carries a constant current I. What are the magnitude and direction of the H-vector at the same point?
(a) $\rho I/\pi a^2$, parallel to wire (b) $Ir/2\pi a^2$, parallel to wire
(c) $\rho I/\pi a^2$, perpendicular to wire (d) $Ir/2\pi a^2$, perpendicular to wire

45. How many times, roughly, is the electron-proton electric attraction greater than the electron-proton gravitational attraction?
(a) 10^{25} (b) 10^{60} (c) 10^{30} (d) 10^{40}

46. A particle is traveling in the positive x-direction at a constant speed of 0.8C. When a force of 10 N is applied to the particle also in the positive x-direction, the acceleration of the particle is 0.216 m/s^2. What is the weight of the particle? (C is the speed of light.)
(a) 1.5 mg (b) 10 kg (c) 25 g (d) 2 g

47. The maximum frequency in an x-ray machine with acceleration voltage being 25KV is
(a) 2.08 x 10^{17} Hz (b) 3.03 x 10^{16} Hz (c) 6.05 x 10^{18} Hz (d) 1.01 x 10^{20} Hz

48. Which of the following term can be defined as the means of quantifying the amount of charge stored on two equally and oppositely charged objects?
(a) Electric field (b) Electric force (c) Electric potential (d) Capacitance

49. Which of the following term can be defined as the slope of a velocity-time graph?
(a) Displacement (b) Speed (c) Acceleration (d) Position

50. Which of the products of nuclear reactions listed below is released during the Alpha decay?
(a) ${}_{2}^{4}\mathrm{He}$ (b) ${}_{1}^{1}\mathrm{P}$ (c) ${}_{0}^{1}\mathrm{n}$ (d) ${}_{-1}^{0}\mathrm{e}$