國立成功大學

111學年度碩士班招生考試試題

編　號：91

系　所：材料科學及工程學系

科　目：物理與化學

日　期：0219

節　次：第 1 節

備　註：可使用計算機

※ 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. Photon absorption by matter can produce (a) photoelectric effect, (b) Compton effect, (c) pair production, or (d) all of the above.

2. The lattice energy of NaI is -686 kJ/mol, and the enthalpy of hydration is -694 kJ/mol. What is the enthalpy of solution per mole of solid NaI? (a) +8 kJ/mol (b) +16 kJ/mol (c) -16 kJ/mol (d) -8 kJ/mol.

3. The Bragg's law can be described as $2d\sin\theta = n\lambda$, where n is (a) the quantum number, (b) the order of the scattered beam, (c) the order of the incident beam, or (d) the order of crystal planes.

4. Which of the following alcohols does not have the formula $C_5H_{12}O$? (a)1-Pentanol (b)2-Methyl-1-butanol (c)3-Methyl-1-butanol (d)3-Methyl-1-pentaol.

5. A 10 kg particle travels at a constant speed of 0.8C. (C is the speed of light.)　If 10 N is applied to the particle in the direction of the travel, what is the acceleration of the particle? (a) 0.216, (b) 0.6, (c) 1, (d) 0.506 m/s^2.

6. Which compound of the followings has a boing point closest to that of argon? (a)NaCl (b)CCl_4 (c)H_2O (d)F_2

7. The current in the windings on a toroid is 2.0 A. There are 400 turns and the mean circumferential length is 40 cm. With the aid of a search coil and charge-measuring instrument, the magnetic field is found to be 1.0 T. Calculate the relative permeability. (a) 398 (b) 399 (c) 400 (d) 401.

8. The speed of a chemical reaction (a) is constant no matter what the temperature is.　(b) is independent of the amount of contact surface of a solid involved.　(c) between gases should in all cases be extremely rapid because the average kinetic energy of the molecules is great. (d) between ions in aqueous solution is extremely rapid because there are no bonds that need to be broken.

9. In an R-L-C series circuit, R = 250 Ω, L = 0.5 H, and C = 0.02 μF. What is the resonant frequency of the circuit? (a) 1588 Hz (b) 1590 Hz (c) 1592 Hz (d) 1594 Hz.

10. When the system A + B ⇌ C + D is at equilibrium,　(a) the sum of the concentrations of A and B must equal the sum of the concentrations of C and D.　(b) the forward reaction has stopped.　(c) neither the forward nor the reverse reaction has stopped.　(d)　both the forward and the reverse reactions have stopped.

11. Suppose 1 kg of water at 100 $^\circ$C is placed in thermal contact with 1 kg of water at 0 $^\circ$C. What is the total change in entropy? (a) +24 cal.K^{-1} (b) -20 cal.K^{-1} (c) +20 cal.K^{-1} (d) -24 cal.K^{-1}.

12. In 0.10 M, which of the following order is correct in increasing Ph? (a)NaI<HF<HI<NaF (b)HI<HF<NaI<NaF (c)HBr<KBr<NH$_3$<NH$_4$Br (d) NH$_4$Br <KBr<NH$_3$< HBr.

13. A Carnot heat engine is operating between two reservoirs, one at 27 $^\circ$C and the other at 127 $^\circ$C. What is the efficiency of the Carnot heat engine?　(a) 25%　(b) 50%　(c) 75%　(d) 90%

14. What is the expected product formed from the reaction between 2-butene and Cl_2? (a) 1-chlorobutane (b) 2-chlorobutane　(c) 2,3-dichlorobutane (d) 2,2-dichlorobutane.

15. Water, H_2O, can be converted into H_2 and O_2 by electrolysis. How many moles of these gases result from the electrolysis of 1.8 L of water at 20 °C? (a) H_2 100 moles and O_2 50 moles. (b) H_2 200 moles and O_2 100 moles. (c) H_2 50 moles and O_2 100 moles. (d) H_2 100 moles and O_2 200 moles.

16. For a process to be spontaneous at high temperatures only, (a) the ΔS is positive, and the ΔH is negative (b) the ΔS is positive, and the ΔH is positive as well. (c) the ΔS is negative, and the ΔH is negative as well. (d) the ΔS is negative, and the ΔH is positive.

17. For the principal quantum number $n=5$, how many different values can the orbital quantum number l have? (a) 5 (b) 4 (c) 3 (d) 2.

18. The electrolyte in automobile lead storage batteries is a 3.75 M sulfuric acid solution with the density of 1.230 g/ml. The mole fraction of sulfuric acid is (a) 0.479 (b) 0.299 (c) 0.0726 (d) 0.0921.

19. A 5-kg mass and a 1-kg mass rest on a horizontal frictionless surface and are joined by a spring with a spring constant of 50N/m. Suppose this spring is compressed and tied in that state by a spring. If the string is burned when the system is at rest, the two masses will separate until the spring tension pulls them together again, continuing to oscillate in this fashion toward and away from each other. Find the period of oscillation (a)0.811s (b)0.888s (c)1.987s (d)2.176s.

20. As the crystallization temperature of water is decreased by the addition of sodium chloride, it is because (a) the free energy of liquid amorphous state of water is decreased. (b) the free energy of solid crystalline state of water is decreased. (c) The free energy of liquid amorphous state of water is increased. (d) the free energy of solid crystalline state of water is increased.

21. A low-flying airplane skims the ground at a speed of 200m/s as it approaches a stationary observer. A loud horn whose fundamental frequency is 400 Hz is carried on the airplane. What frequency does the ground observer hear? (a)400Hz (b)600Hz (c)635Hz (d)971Hz.

22. Nearly the behavior of ideal solution is observed when (a) the vapor pressure of solution is equal to 0. (b) the equilibrium concentration is reached. (c) the interactions among solute and solvent are absent. (d) the solute–solute and solute-solvent interactions are very similar.

23. A small air bubble is at the center of a large glass sphere that has a reflective index n and radius R. Determine how far the air bubble appears to be from the surface of the sphere. (a)R/n (b) R (c)nR (d)$(n-1)R$

24. The physical property of a molecule that is seemingly repelled from a mass of water is called (a) lyotropic (b) lyophilized (c) hydrophobic (d) hydrophilic.

25. What is the drift speed of the conduction electrons in a copper wire with radius r = 900 μm when it has a uniform current i = 17 mA? Assume that each copper atom contributes one conduction electron to the current and that the current density is uniform across the wire's cross section.(the density of copper is 8.96×10^3 kg/m³, the molar weight of copper is 63.54×10^{-3} kg/mol) (a) 4.9×10^1 m/s (b) 4.9×10^{-3} m/s (c) 4.9×10^{-7} m/s, (d) 4.9×10^{-10} m/s.

26. Which description below is INCORRECT: (a) pH is a logarithmic scale used to specify the acidity or basicity of an aqueous solution (b) pOH is a logarithmic scale used to specify the oxygen concentration (c) pKa is

an acid dissociation constant measuring the strength of an acid in solution (d) pKb is a basic dissociation constant measuring the strength of a base in solution.

27. A force of magnitude F=12.0 N applied to an 8.00 kg block at a downward angle of θ =30.0°. The coefficient of static friction between block and floor is 0.700; the coefficient of kinetic friction is 0.400. What is the magnitude of the frictional force on the block? (a) 59.08 N (b) 33.76 N (c) 54.88 N (d) 4.2 N.

28. Which description about m.p., b.p., and f.p. is INCORRECT: (a) f.p. stands for "fire point" (b) volatile solvent have relatively low b.p. (c) b.p. is higher than m.p. (d) volatile solvent usually has low f.p.

29. Which of the following one is the correct statement? (a) The kinetic frictional force and drag force are conservation force(b) a conservative force transfer energy from kinetic energy to thermal energy (c) a conservative force is path independent (d) The net work done by a nonconservative force on a particle moving around any closed path is zero.

30. A normal alkyl C_8H_{18} is named: (a) *n*-octane (b) *n*-heptane (c) *n*-augustane (d) *n*-nonane.

31. Nuclear forces are (a) always attractive, (b) always repulsive, (c) either attractive or repulsive, (d) comparable to or smaller than the Coulomb force.

32. When the reaction occurs in a liquid solution, the solid formed is called (a) additive (b) suspension (c) precipitate (d) mixture.

33. When water is boiled under a pressure of 2 atm, the heat of vaporization is 2.20×10^6 J.kg^{-1} and the boiling point is 120 °C. At this pressure, one kilogram of water has a volume of 10^{-3} m^3, and one kilogram of steam a volume of 0.824 m^3. Compute the increase in internal energy. (a) 2.00×10^6 J (b) 2.01×10^6 J (c) 2.02×10^6 J (d) 2.03×10^6 J.

34. What is the orbital designation for the subshell with the principle quantum number (n) = 5 and azimuthal quantum number (l) = 1? (a) 5s　(b) 5p　(c) 5d　(d) 4p.

35. Two moles of an ideal gas undergo a reversible isothermal expansion from 0.02 m^3 to 0.04 m^3 at a temperature of 300 K. What is the change in entropy of the gas? (a) 11.4 J.K^{-1} (b) 11.5 J.K^{-1} (c) 11.6 J.K^{-1} (d) 11.7 J.K^{-1}.

36. Please arrange the following atoms of O, S, and F in order of increasing size. (a) F < O < S　(b) F < S < O (c) O < F < S　(d) S < O < F.

37. If the electron of a hydrogen atom is in the second excited state, what is its orbital radius? (Here a_0 is the Bohr radius) (a) $2a_0$　(b) $4a_0$　(c) $9a_0$　(d) $16a_0$.

38. What is the respective oxidation state of the underlined element in $\underline{P}_2O_5$ and $\underline{Cr}_2O_7{}^{2-}$. (a) +6 and +5　(b) +5 and +7 (c) +2 and +2　(d) +5 and +6.

39. A particle is trapped in a potential well with infinitely high potential. If the lowest energy of the particle is E_1, what is its second lowest energy?　(a) $5E_1$　(b) $4E_1$　(c) $3E_1$　(d) $2E_1$.

40. Consider the electronic configurations of the following transition metal ions. Please choose the one that has a different coordination number compared to others. **Note:** Scandium ($4s^23d^1$), iron ($4s^23d^6$), silver ($5s^14d^{10}$), and cobalt ($4s^23d^7$). (a) Sc^{3+} (b) Fe^{2+} (c) Ag^+ (d) Co^{3+}.

41. An organ pipe opened at both ends has a fundamental frequency of 110Hz, what is the length of the pipe if the sound in air is 340m/s? (a)0.386m (b) 0.773m (c)1.55m (d)3.30m.

42. In a concentration cell shown in the right figure, please judge which one of the phenomena below is incorrect. (a) $E^o_{cell} = 0V$ if the ion concentrations on both compartments are the same. (b) the right Ag electrode is a cathode. (c) current flows from right to left. (d) The left Ag electrode is a cathode.
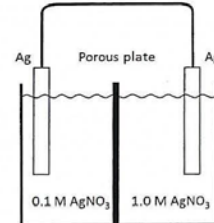
43. A solenoid has length L = 1.23 m and inner diameter d = 3.55 cm, and it carries a current i = 5.57 A. It consists of five close-packed layers, each with 850 turns along length L. What is B at its center? (permeability constant = $4\pi \times 10^{-7}$ T-m/A)(a) -24.2 mT (b) 24.2 mT (c) 4.8 mT (d) -4.8 mT.

44. Assume that the tube with mercury and the other tube with solvent/mercury both reach equilibrium with vacuumed volume and the atmosphere pressure after flipping upside down and inserting into a tank with mercury. Referring to the picture below and the communication vessel principle, please choose one of the four solvents with the largest saturated vapor pressure at room temperature.
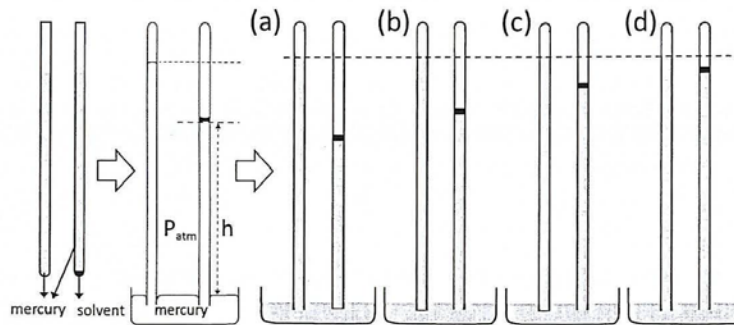
45. A cockroach with mass m rides on a disk of mass 6.00m and radius R.　The disk rotates like a merry-go-round around its central axis at angular speed of 1.5 rad/s.　The cockroach is initially at radius r=0.8R, but then it crawls out to the rim of the disk.　Treat the cockroach as a particle.　What then is the angular speed of the system?　(a) 2.49 rad/s (b) 1.43 rad/s (c) 1.82 rad/s (d) 1.37 rad/s.

46. Consider the electronic configurations and the corresponding coordination numbers of the following transition metal ions. Please choose the one that has a linear ligand arrangement. **Note:** copper ($4s^1 3d^{10}$), iron ($4s^2 3d^6$), silver ($5s^1 4d^{10}$), and cobalt ($4s^2 3d^7$). (a) Cu^{2+} (b) Fe^{2+} (c) Ag^+ (d) Co^{2+}.

47. A merry-go-round revolves at a constant angular speed of 0.50 rad/s in a counter-clockwise direction when viewed from above.　A 40-kg rider walks tangentially (in the same direction the merry-go-round is moving) at a constant speed of 2m/s relative to the merry-go-round, maintaining a constant radius of 2m from the axis.　Analyze the situation in the rotating frame to find the magnitude and direction of the total force of friction on the rider? (a)180N, radially outward (b) 180N, radially inward (c) 80N, radially outward (d) 20N, radially outward.

48. Which one is a heat resistant polymer? (a) polyethylene　(b) polyimide　(c) polystyrene　(d) polyacrylonitrile.

49. The magnetic flux through a coil of wire containing two loops changes at a constant rate from -58 Wb to 38 Wb in 0.42 s. What is the emf induced in the coil? (a) -460 V (b) -46 V (c) -4.6 V (d) -0.46 V.

50. Which description about radicals is INCORRECT: (a) paired valence electron (b) recombination to each other (c) relocated (transferring) easily (d) triggering radical polymerization.