96 學年度材料科學工程學系碩士班入學考試

科目　理工測驗一　　　　科目代碼　0601　　共　13　頁

注意事項：

1.本科共有 80 題，皆為 5 選 1 的單選題；答對一題得 2.5 分，答錯一題倒扣 0.625 分，未答者不計分。

2.作答時，請以 2B 鉛筆在【答案卡】上畫卡。

3.考試時間為 100 分鐘。

1. 下列敘述何者為真？ (a)電荷可以靜止在導體球中心 (b)電荷可以在靜止介電球中心 (c)電荷不可以在導體球內移動 (d)電荷不可以在介電球內移動 (e)電荷不可以靜止在導體球表面

2. 一帶+q 無限長的圓棒導體，其半徑為 r，設空間一點 P，其柱面座標為(R, θ, Z)且 R>r，下列敘述何者為真？ (a)P 點的電位與 R 成反比 (b)P 點的電場強度在 R 方向與 R^2 成反比 (c)P 點的電場強度在 θ 方向與 R^2 成反比 (d)P 點的電場強度在 Z 方向與 R^2 成反比 (e)以上皆非

3. 電容器由兩平行面板組成，兩面板的截面積為 A，相距為 d，其面板間充滿相對介電常數 ε_r 的介質，有關電容器的特性，下列敘述者為真？(a)若兩個電容器串聯，其等效電容值比個別任一電容值都大 (b)d 愈大，則電容值愈大 (c)ε_r 介於 0 與 1 之間 (d)當電容器與電阻器，開關及直流電源構成迴路時，其電容器充電的速度為固定 (e)A 愈大，則電容值愈大

4. 有關金屬電阻的特性，下列敘述何者為假？ (a)溫度愈高，金屬的導電率愈大 (b)溫度愈大，金屬的電阻率愈大 (c)溫度愈高，金屬原子的振動愈大 (d)金屬線愈長，電阻愈大 (e)金屬線的截面積愈大，愈容易導電

5. 有關電磁場的特性，下列敘述何者為真？ (a)電場和磁場均會改變電子運動速率大小，但不會改變方向 (b)電場和磁場均會改變電子運動方向，但不會改變速度大小 (c)電場改變電子運動速度方向，但不會改變速度大小，然而磁場則相反 (d)電場改變電子運動速度大小，但不會改變速度方向，然而磁場則相反 (e)電場對電子不做功，但磁場則相反

6. 如圖 1 所示，電子沿著路徑經過兩個均勻磁場區 B_1 和 B_2，下列敘述何者為真？ (a)$B_1 > B_2$ (b)B_1 的方向朝下，B_2 朝上 (c)電子經過區域 B_1 花的時間多於 B_2 區 (d)電子經過區域 B_2 花的時間與區域 B_1 相同 (e)$B_1 < B_2$ 且 B_1 朝上
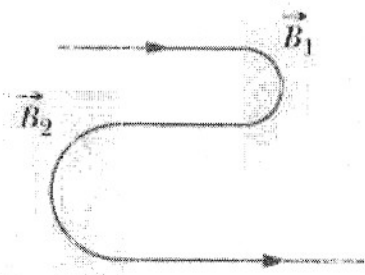

圖 1

7.圖 2(a),(b),(c)和(d)分別由四條平行且具有相同電流大小的導線組成，但電流方向不同
（註：●和×分別表示電流方向朝上和朝下），則在方形中心磁場強度為 (a)a=b=c=d
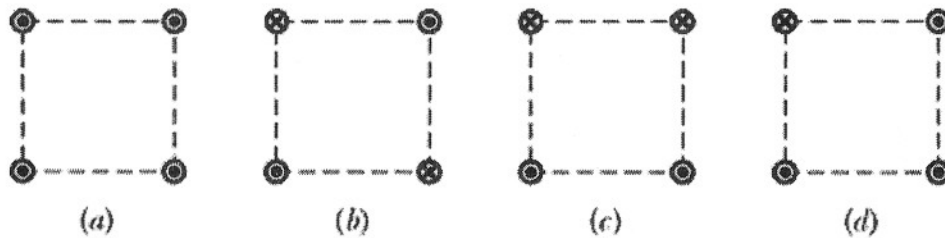(b)a＞b＞c＞d (c)a＜b＜c＜d (d)a=b＞d＞c (e)c＞d＞a=b

圖 2

8.下列電路在理想狀態下，何者能量不會消失？ (a)電阻器和電容器構成的迴路 (b)電阻器和電感器組成的迴路 (c)電容器和電感器組成的迴路(d)電阻器、電容器和電感器構成的迴路 (e)以上皆非

9.電磁學理論，馬克斯威爾方程式告訴我們，下列敘述何者為假？ (a)電場隨時間變化會產生磁場 (b)磁場不隨時間變化會產生電場 (c)電荷可以單獨存在於真空中 (d)磁場隨時間變化會產生電場 (e)電場不隨時間變化會產生磁場

10.有關電磁波的特性，下列敘述何者為假？ (a)電磁波為橫波 (b)電場與磁場比為光速 (c)電場與磁場均為常數，與時間無關 (d)電磁波的能量與電場強度成正比 (e)電荷做加速度時會產生電磁波

11.圖 3 為一示意圖，說明一個木偶位於球面鏡前 O 處，球面鏡置於虛線長方形內，設 I_1,I_2,I_3 和 I_4 為木偶 O 可能成像的位置和方向(注意：圖內 I_1,I_2,I_3 和 I_4 的位置和像大小並非真正的距離和高度)，則 (a)木偶 O 不可能成像在 I_1 和 I_3 上 (b)若球面鏡為凹面鏡，成像的位置可能在 I_2 和 I_4 (c) 若球面鏡為凸面鏡，成像的位置可能為 I_2 (d) I_3 可能為實像 (e)以上皆非
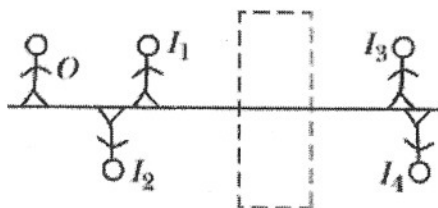

圖 3

12.有關光的特性，下列敘述何者為假？　(a)光可以同時表現粒子和波的性質　(b)光是橫波　(c)光是電磁波　(d)雷射光為同調的(coherent)光源　(e)白光是由不同顏色的光混合而成

13.設一脈波從一密度 ρ_1 的繩子朝另一密度 ρ_2 的繩子前進，當脈波碰到兩繩子的接點時，下列敘述何者為真？　(a)若 $\rho_1 > \rho_2$，則有部份波反射，且反射波旳相位角轉移半個波長　(b)若 $\rho_1 > \rho_2$，則有部份波進入密度 ρ_2 的繩子，並且相位角轉移半個波長　(c)若 $\rho_1 = \rho_2$，則有部份波反射，且反射波的相位角轉移半個波長　(d)若 $\rho_1 < \rho_2$，則有部份波反射，且反射波的相位角轉移半個波長　(e)若 $\rho_1 < \rho_2$，則有部份波進入密度 ρ_2 的繩子，且相位角轉移半個波長

14.無線電波沿著建築物會繞射，而可見光不會，其原因為無線電波為　(a)平面波　(b)波長較可見光波短　(c)波長較可見光波長　(d)幾乎單頻率　(e)調幅

15.下雨後出現彩虹，是因為光經過雨滴時　(a)被吸收　(b)產生干涉　(c)產生繞射　(d)產生反射　(e)產生折射

16.駐波　(a)必須縱波，不能橫波　(b)由兩個前進方向相反，類似的波所組成　(c)必須橫波，不能縱波　(d)波速為其前進波速度的兩倍　(e)在任意一點的位移不隨時間改變

17.下列何者為波動方程式？

$(a)\ \dfrac{\partial^2 \phi}{\partial x^2} + \dfrac{\partial^2 \phi}{\partial y^2} = \rho$　　　　$(b)\ \dfrac{\partial^2 \phi}{\partial x^2} + \dfrac{\partial^2 \phi}{\partial y^2} = \dfrac{\partial \phi}{D \partial t}$

$(c)\ \dfrac{\partial^2 \phi}{\partial x^2} - \dfrac{\partial^2 \phi}{\partial y^2} = \dfrac{\partial^2 \phi}{\partial z^2}$　　　　$(d)\ \dfrac{\partial^2 \phi}{\partial x^2} = \dfrac{\partial^2 \phi}{v^2 \partial t^2}$

$(e)\ -\dfrac{h^2}{8m\pi^2} \dfrac{\partial^2 \phi}{\partial x^2} + V\phi = i\dfrac{h}{2\pi} \dfrac{\partial \phi}{\partial t}$

18.一條拉緊的弦，兩端固定，以基本頻率(Fundamental Frequency)做振動，若要使頻率加倍，則弦的張力必須變成原來的　(a)2 倍　(b)4 倍　(c)0.5 倍　(d)$\sqrt{2}$ 倍　(e)$1/\sqrt{2}$ 倍

19.一聲源同時發出同方向四個波，分別為

$s_1(x,t) = 5\cos(2\pi x - 300\pi t),$

$s_2(x,t) = 5\cos(2\pi x - 300\pi t + 0.6\pi),$

$s_3(x,t) = 5\cos(2\pi x - 300\pi t + \pi),$

$s_4(x,t) = 5\cos(2\pi x - 300\pi t + 1.6\pi),$

其合成波的振幅為　(a)20　(b)15　(c)10　(d)5　(e)0

20.電磁學理論馬克斯威方程式分別為

1. $\oiint \vec{E} \cdot d\vec{A} = q/\varepsilon_o$ 2. $\oiint \vec{B} \cdot d\vec{A} = 0$ 3. $\oint \vec{E} \cdot d\vec{s} = -d\Phi_B / dt$ 4 $\oint \vec{B} \cdot d\vec{s} = \mu_o i + \mu_o \in_o d\Phi_E / dt$

若磁荷被發現後，則上面四個方程式，那些方程式須要修正？   (a)只有 1   (b)只有 2
(c)只有 2 和 3   (d)只有 2 和 4   (e)只有 1 和 3

21. Acceleration means that when a body accelerates its velocity changes in   (a) magnitude,
(b) magnitude or direction, or both,   (c) mass,   (d) volume,   (e) shape

22. The wavelength at which the energy density is a maximum is related to the temperature by
(a) Charles law, $K = c.\lambda_{max}.v.l$ (m.K),   (b) energy conservation law $D = QdT/dv$,
(c) zeeman effect,   (d) work energy theorem,
(e) Wien's displacement law $\lambda_{max}T = 2.898 \times 10^{-3}$ m.K

23. Which of following is correct,
(a) Wien's radiation law is irrational for energy at long wavelength, because energy density does not
increase with temperature, accordingly, Lord Rayleigh (1900) proposed a new expression $\mu_\lambda(T) = CT\lambda^{-4}$, where $\mu_\lambda(T)$ is spectral energy density, $C = 8\pi k$, k is Boltzmann's constant,
(b) in an inertial reference frame, a body subject to no net force will either stay at rest or move at variable
velocities,
(c) the drag force for a falling stone in air is described as $F_D = kv^3$,
(d) Newton's second law for a falling stone can be described as $mg - kv = m(dv/dt)$,
(e) spectrum of cavity radiation can be precisely described by Planck's radiation law, $\mu\lambda = 8\pi kc\lambda^{-3}/e^{hc/\lambda kt}$

24. In order to describe the atomic model of hydrogen Bohr made two postulates,
(a) electron moves only in zigzag orbits and radiation only occurs when an electron goes from n =1 to n
= 3 (odd number),
(b) electron moves only in certain circular orbits and radiation only occurs when an electron goes from
one allowed orbit to another lower energy with radiated frequency h$f = E_m - E_n$, where E_m and E_n
are energies of two states,
(c) electron moves only in certain circular orbits and radiation can only occur when an electron jump
from one allowed orbit to next higher orbit with radiated frequency h$f = E_m - E_n$, where E_m and E_n
are energies of two states,
(d) two electrons in 1s orbit and spins are in parallel,
(e) one electron in 1s orbit only and spin is equal to 1/2

25. Which of following is correct,
   (a) the friction of ice on ice depends on both temperature and sliding speed. At low temperature (-40°C), the static coefficient is 0.45 and drops as temperature rises,
   (b) When a bicycle is pedaled the bottom of rear wheel is pushed forward against road,
   (c) The phenomenon of Stick-Slip occurs when the relative speed of the sliding surfaces is high and when one of the objects cannot vibrate,
   (d) force of friction is proportional to load and contact area,
   (e) the force of static friction opposes the tendency of block to move relative to the surfaces. Kinetic friction occurs when both surfaces and block are welded

26. Which of following is correct,
   (a) the energy of an oscillator is quantized in steps of hf, where h and f Planck's constant and frequency, so energy of nth level is $E = n\lambda_{max}hf$,
   (b) The energy of electromagnetic radiation of frequency f is quantized in unit of $En = \lambda c$ and each quantum of energy is called photon,
   (c) When a photon is scattered by a free electron the change in wavelength of photon is given by $\Delta\lambda = (h/m_oc)(1 - \cos\theta) = 0.00243$ nm $- (1 - \cos\theta)$,
   (d) the energy levels of electron in hydrogen atom are given by $En = -(eV/n^3)$,
   (e) electron can be excited to higher states either by adsorption of photon of correct frequency or collision with uncleus

27. When a particle of mass m and charge q is accelerated from rest by a potential V, its kinetic energy is A and de Broglie relation is B,
   (a) $A = p/2m$, $B = \lambda = h/(2mqV)^{1/2}$,
   (b) $A = p^2/2m$, $B = \lambda = h/(mqV)^{1/3}$,
   (c) $A = p^2/m$, $B = \lambda = h/(mqV)^2$,
   (d) $A = p^2/2m$, $B = \lambda = h/(2mq)^2$,
   (e) $A = p^2/2m$, $B = \lambda = h/(2mqV)^{1/2}$

28. One dimensional time dependent Schrödinger wave equation is expressed as
   (a) $d^2\psi/dx^2 + 2m(E - U)\psi/\hbar^2 + \lambda = 0$,
   (b) $d^2\psi/dx^2 + 2m(E - U)\psi/\hbar^2 = 0$,
   (c) $d^2\psi/dx^2 + 2m(E - U)\psi/\hbar^2 + fm = 0$,
   (d) $d^2\psi/dx^2 + 2m(E - U)\psi/\hbar^2 + m/f = 0$,
   (e) $d^2\psi/dx^2 + 2m(E - U)\psi/\hbar^2 - f/m^2 = 0$

29. De Broglie combined the quantum theory and special relativity to relate the wavelength λ with a particle's linear momentum $p = mv$ by

(a) $\lambda = h/2pm$,   (b) $\lambda = 2hm/p$,   (c) $\lambda = h^2/p$,   (d) $\lambda = h/p^{1/2}$,   (e) $\lambda = h/p$

30. The Heisenberg uncertainty principle means that uncertainties in position and in momentum are related by (a) $\Delta\chi\Delta p \geq h$,   (b) $\Delta\chi\Delta p < h$,   (c) $\Delta\chi\Delta p > h$,   (d) $\Delta\chi\Delta p^2 \geq h$,   (e) $\Delta\chi\Delta p^{1/2} \propto h$

31. The allowed energy levels of a particle with mass of m confined to an impenetrable one dimensional box of length L are

(a) $E_n = n^2h^2/mL^{1/2}$, $n = 1, 2, 3..$ (b) $E_n = n^2h^{1/2}/4mL^2$, $n = 1, 2, 3$.

(c) $E_n = n^2h^2/8mL^2$, $n = 1, 2, 3$.   .(d) $E_n = n^2h/mL^2$, $n = 1, 2, 3$.   .(e) $E_n = n^2h^{2/3}/3mL^2$, $n = 1, 2, 3...$

32. A particle is at $x = 5$ m at $t = 2$s and has a velocity $v = 10$m/s. Its acceleration is constant at -4m/s^2, so initial position x_0 at $t = 0$s is

(a) $x_0 = 48$ m,   (b) $x_0 = -52$ m,   (c) $x_0 = -18$ m,   (d) $x_0 = -23$ m,   (e) $x_0 = 32$ m...

33. The Kepler's third law is expressed as

(a) $T^2 = 4\pi^2r^3/GM = kr^3$, where T, r, G, M and k are temperature, green constant, free energy, mass and Boltzmann's constant,

(b) $T^2 = 4\pi^2r^3/GM = kr^3$, where T, r, G, M and k are temperature, quality factor, Gibb free energy, mass and Boltzmann's constant,

(c) $T^2 = 4\pi^2r^3/GM = kr^3$, where T, r, G, M and k are period of orbit, radius of circuiting body, gravity, mass of moving body and constant,

(d) $T = 4\pi^2r^3/GM = kr^{3/2}$, where T, r, G, M and k are temperature, green constant, free energy, mass and Boltzmann's constant,

(e) $T^{1/2} = 4\pi r^2/GM = kr^3$, where T, r, G, M and k are temperature, green constant, free energy, mass and Boltzmann's constant,

34. The peak in the radiation from the sun occurs at about 500 nm, so what is the sun's surface temperature (assume that radiation is a black body),

(a) $T = 4500$ k,   (b) $T = 36000$ K,   (c) $T = 5000$ K,   (d) $T = 5800$ K,

(e) $T = 12000$ K

35. UV light of wavelength at 207 nm causes photoemission from a surface and stopping potential is 2 V, so what are the work function (ϕ in eV) and maximum speed of photoelectrons (v_{max} in m/s),
    (a) ϕ = 2 eV, v_{max}= 6 ×10^5 m/s,　　　　(b) ϕ = 2.5 eV, v_{max}= 5 ×10^5 m/s,
    (c) ϕ = 12 eV, v_{max}= 7 ×10^5 m/s,　　　(d) ϕ = 4 eV, v_{max}= 6 ×10^5 m/s,
    (e) ϕ = 4 eV, v_{max}= 8 ×10^5 m/s

36. An electron is in an excited state (n = 3), so what is the highest frequency that can be radiated,
    (a) $f = 2.92 \times 10^{15}$ Hz,　　　(b) $f = 4.3 \times 10^{13}$ Hz ,　　　(c) $f = 3 \times 10^{16}$ Hz,
    (d) $f = 4 \times 10^{15}$ Hz,　　　(e) $f = 5.34 \times 10^{12}$ Hz

37. Which of following is correct,
    (a) light is wave-particle duality,
    (b) angular momentum of an electron is quantized based on mvr = nf,
    (c) the energy levels of electron in hydrogen atom is -18/n^2 eV,
    (d) electron-electron collision cannot cause electron excitation to higher energy levels,
    (e) the maximum energy needed to extract an electron from surface is called surface potential

38. Which of following is correct,
    (a) zero-point energy means n = 0,
    (b) the quantity ψ^2 is called probability density,
    (c) probability of finding the particle within a volume dV is ψ^2/dV,
    (d) three quantum numbers are needed to describe an electron in an atom,
    (e) two electrons in the same atom can have the same quantum numbers

39. What is the de Broglie wavelength of an electron accelerated from rest by a potential difference of 54 V,
    (a) λ = 0.4 nm,　　　(b) λ = 12 nm,　　　(c) λ = 0.167 nm,　　　(d) λ = 1.3 nm,　　　(e) λ = 0.67 nm

40. The conservation of mass is replaced by the conservation of mass-energy and equation is expressed as
    (a) p = mv,　　　(b) $E^2 = p^2c^2$,　　　(c) p = mv^2,　　　(d) E = mc^2,　　　(e) E = p/mv$^{1/2}$

41. Atom A has 30 protons, 32 neutrons and 30 electrons. Atom B has 30 protons, 28 neutrons and 30 electrons. Atom A and B are
    (a)Isotopes (b)Isobars (c) Isomers (d) Isoneutrons (e) Isothermo

42. A solution of copper sulfate is treated with zinc metal. How many grams of copper are produced if 2.9 g of zinc are consumed? (a) 2.9g (b)2.8g (c)5.7 g (d)3.7g (e)5.8

43. Determine the average oxidation number of carbon in $C_6H_{12}O_6$ (glucose).
    (a) -2 (b) +4 (c) +2 (d) 0 (e) -4

44. A strong base is one that
    (a)Dissociates completely into water molecules
    (b)Dissociates completely into hydrogen and hydride ions
    (c)Dissociates completely into hydrogen ions and anions
    (d)Dissociates completely into hydroxide ions and cations
    (e)Dissociates completely into hydroxide ions and anions

45. A 50.0 L cylinder at temperature of 47 ℃ and a pressure of 50.0 atm contains how many molecules per cm^3?
    (a) $1.15*10^{22}$ (b) $2.30*10^{22}$ (c) $2.30*10^{19}$ (d) $6.75*10^{18}$ (e) $1.15*10^{21}$

46. How much heat will be evolved if 56.08 g of calcium oxide reacts with sulfuric acid according to the following reaction? (atomic weight of Ca and O is 40.078 and 15.999, respectively)

    $CaO_{(s)}$ + $H_2SO_{4(g)}$ ⟶ $CaSO_{4(s)}$ + $H_2O_{(l)}$ $\Delta H° = ?$

    $Ca_{(s)}$ + $1/2O_{2(g)}$ ⟶ $CaO_{(s)}$ $\Delta H° = -152$ kJ/mol

    $Ca_{(s)}$ + $S_{(s)}$ + $2O_{2(g)}$ ⟶ $CaSO_{4(s)}$ $\Delta H° = -1434$ kJ/mol

    $H_{2(g)}$ + $1/2O_{2(g)}$ ⟶ $H_2O_{(l)}$ $\Delta H° = -286$ kJ/mol

    $H_{2(g)}$ + $S_{(s)}$ + $2O_{2(g)}$ ⟶ $H_2SO_{4(g)}$ $\Delta H° = -814$ kJ/mol

    (a) -2960 kJ (b) -754 kJ (c) -10774 kJ (d) 754 kJ (e) 10774 kJ

47. The pauli exclusion principle states:
    (a)The position and velocity of an electron can never be known precisely at the same time.
    (b)No two electrons in the system can have the same quantum numbers.
    (c)The spin number must be -1/2 for the first electron in an orbital and 1/2 for the second one.
    (d)The azimuthal number can never be the same for two electrons in two identical orbital of two different atoms.
    (e)The electron orbitals are waves, rather than spheres.

48. Chemical bonds between two atoms result because:

(a) The atoms can thus achieve a state of higher energy.

(b) The atoms can thus achieve a state of lower energy.

(c) The atoms fit together nicely.

(d) The atoms can react better when bonded.

(e) Share all their electrons.

49. How many valence electrons dose selenium have?

(a) 7　　　 (b) 4　　　 (c) 3　　　 (d) 5　　　 (e) 6

50. The bond order for C_2 is:

(a) 0　　　 (b) 2　　　 (c) 2.5　　 (d) 3　　　 (e) 1

51. The smallest repeating unit of the lattice is called:

(a) unit cell　　　 (b) unit lattice　　　 (c) cell　　　 (d) unit crystal　　　 (e) smallest unit

52. If the conduction band of metallic chromium nano particle was a pure 3d band with 10,000 chromium ions situated in it, how many conduction electrons would this cluster have?

(a) 10　　　 (b) 10,000　　　 (c) 40,000　　　 (d) 50,000　　　 (e) 60,000

53. Which of the following molecules would be most soluble in CH_3CH_3

(a) CH_4　　 (b) KI　　　 (c) HI　　　 (d) CH_3NH_2　　　 (e) CH_3OH

54. How will increasing the pressure of a gas affect the solubility of the gas in a solvent?

(a) depends on temperature　　 (b) decrease it　　 (c) no effect

(d) depends on pressure　　 (e) increase it

55. To determine whether data from different experiments correspond to a zero-order rate expression, a plot of what variables will yield a straight line?

(a) [X] vs. 1/t　　 (b) [X] vs. t　　 (c) 1/[X] vs. t　　 (d) $[X]^3$ vs. 1/t　　 (e) ln[X] vs. 1/t

56. Which one of the following statements is not true about catalytic creaking?

(a) It is a process that breaks down large molecules by breaking carbon-carbon bonds

(b) It is conducted at high temperatures

(c) It is easier to control than pyrolysis.

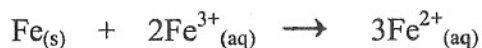(d) It can also include hydrocracking.

(e) It reacts fast and completely.

57. In the process of roasting, sulfur can be separated from zinc by:

(a) oxidizing sulfur and removing elemental zinc

(b) oxidizing both sulfur and zinc

(c) oxidizing zinc and removing elemental sulfur

(d) oxidizing zinc and removing hydrated sulfur

(e) oxidizing sulfur and removing zinc oxide

58. Calculate $E°$ for the following reaction:

$$Fe_{(s)} + 2Fe^{3+}_{(aq)} \longrightarrow 3Fe^{2+}_{(aq)}$$
$$Fe^{3+}_{(aq)} + e^- \longrightarrow Fe^{2+}_{(aq)} \quad E° = 0.77V$$
$$Fe^{2+}_{(aq)} + 2e^- \longrightarrow Fe_{(s)} \quad E° = -0.41V$$

(a) 1.18 V   (b) -0.36 V   (c) 1.59 V   (d) -0.05 V   (e) 1.95 V

59. In a lead-storage battery, what element, or compound serves as anode?

(a) lead   (b) hydrogen sulfate   (c) lead oxide   (d) hydrogen   (e) hydrogen sulfite

60. A state of higher entropy means:

(a) A lower number of possible arrangements

(b) A higher number of possible arrangements

(c) Lower probabilities to reach a possible state

(d) Lower probabilities to be reached

(e) Higher probabilities to reach a possible state

61. Which statement about semiconductor nanoparticles such as CdS is incorrect?

(a) Relative intensities of the peaks in the XRD pattern may be different.

(b) Band gap of the material may decrease due to quantum confinement.

(c) Absorption band may blue-shift.

(d) Emission band may blue-shift.

(e) Widths of the peaks in the XRD pattern may become broader.

62. In the unit cell of sphalerite, Zn^{2+} ions occupy half the tetrahedral holes in a face-centered cubic lattice of S^{2-} ions. The number of formula units of ZnS in the unit cell is:
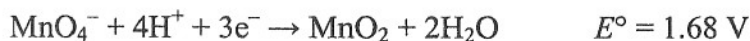
(a) 8   (b) 6   (c) 4   (d) 2   (e) 1

63. Which statement about gold nanostructures is incorrect?

(a) They give surface plasmon resonance absorption.

(b) Capping agents are usually required for their size- and shape-controlled synthesis.

(c) Alkylthiol molecules form strong bonding onto the gold nanoparticle surface.

(d) Gold nanoparticles with different shapes show various colors.

(e) Interparticle plasmon coupling effect is usually observed when gold nanoparticles are far apart.

64. Which of the following is the strongest oxidizing agent?

$MnO_4^- + 4H^+ + 3e^- \rightarrow MnO_2 + 2H_2O$ $E° = 1.68$ V

$I_2 + 2e^- \rightarrow 2I^-$ $E° = 0.54$ V

$Zn^{2+} + 2e^- \rightarrow Zn$ $E° = -0.76$ V

(a)MnO_4^- (b) I_2 (c) Zn^{2+} (d) Zn   (e) MnO_2

65. When the substances in the equation below are at equilibrium at pressure P and temperature T, how can the equilibrium be shifted to favor the products?

$CuO(s) + H_2(g) \leftrightarrow Cu(s) + H_2O(g)$ Change in enthalpy = −2.0 kJ
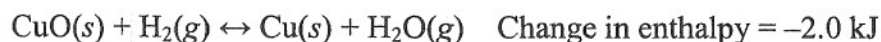
(a) increase the pressure by adding an inert gas such as nitrogen

(b) increase the pressure by means of a moving piston at constant temperature

(c) allow some gas to escape at constant pressure and temperature

(d) decrease the temperature

(e) add a catalyst

66. Which of the following compounds has the lowest solubility in mol/L in water at 25 °C?

(a) Ag_3PO_4 $K_{sp} = 1.8 \times 10^{-18}$ (b) $Sn(OH)_2$ $K_{sp} = 5 \times 10^{-26}$ (c) CdS $K_{sp} = 3.6 \times 10^{-29}$

(d) $Al(OH)_3$ $K_{sp} = 2 \times 10^{-33}$ (e) $CaSO_4$ $K_{sp} = 6.1 \times 10^{-5}$

67. Given: $Cu_2O(s) + ½O_2(g) \rightarrow 2CuO(s)$ $\Delta H° = -144$ kJ

$Cu_2O(s) \rightarrow Cu(s) + CuO(s)$ $\Delta H° = +11$ kJ
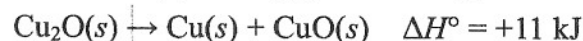
Calculate the standard enthalpy of formation of CuO(s).

(a) −166 kJ   (b) −299 kJ   (c) +299 kJ   (d) +155 kJ   (e) −155 kJ

68. In which case must a reaction be spontaneous at all temperatures?

(a) ΔH is positive, ΔS is positive.

(b) $\Delta H = 0$, ΔS is negative.

(c) $\Delta S = 0$, ΔH is positive.

(d) ΔH is negative, ΔS is positive.

(e) none of these.

69. Which of the following has a C=O bond?

 (a) ester, aldehyde, ketone

 (b) aldehyde, secondary alcohol, ketone

 (c) tertiary alcohol, ether, ester

 (d) secondary alcohol, ketone, aldehyde

 (e) carboxylic acid, ether, tertiary alcohol

70. Which of the following is paramagnetic?

 (a) $Zn(H_2O)_6^{2+}$ (b) $Mn(CN)_6^{2-}$ (strong field)

 (c) $Cu(CN)_3^{2-}$ (d) $Co(NH_3)_6^{3+}$ (strong field) (e) none of these

71. A solid dissolved in a gas describes a(n)

 (a) foam (b) sol (c) emulsion (d) aerosol (e) none of these

72. The fact that O_2 is paramagnetic can be explained by

 (a) resonance (b) the Lewis structure of O_2 (c) a violation of the octet rule

 (d) hybridization of atomic orbitals in O_2 (e) the molecular orbital diagram for O_2

73. What is the rate law for the following reaction, given the data below?

 $2NO + H_2 \rightarrow N_2O + H_2O$
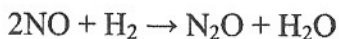
Experiment	Initial [NO] (mol/L)	Initial [H₂] (mol/L)	Initial Rate of Disappearance of NO (mol/L · s)
1	6.4×10^{-3}	2.2×10^{-3}	2.6×10^{-5}
2	12.8×10^{-3}	2.2×10^{-3}	1.0×10^{-4}
3	6.4×10^{-3}	4.5×10^{-3}	5.1×10^{-5}

 (a) Rate = $k[NO]$ (b) Rate = $k[NO]^2$ (c) Rate = $k[NO]^2[H_2]$

 (d) Rate = $k[NO][H_2]$ (e) Rate = $k[N_2O][H_2O]$

74. Which one of the following statements about solid Cu (face-centered cubic unit cell) is incorrect?

 (a) There are two atoms per unit cell.

 (b) It will conduct electricity.

 (c) The number of atoms surrounding each Cu atom is 12.

 (d) The solid has a cubic closest-packed structure.

 (e) The length of a face diagonal is four times the Cu radius.

75. What are the oxidation numbers of the central metal atom in the following coordination compounds?
$K_3[Fe(CN)_6]$, $[Cr(NH_3)_4Br_2]Br$, $[Ni(H_2O)_6]Cl_2$, $Na_2[TaF_7]$ are

(a) 3, 3, 3, 5   (b) 3, 3, 2, 5   (c) 3, 3, 2, 7   (d) –3, 2, 2, 5   (e) 3, 2, 3, 5

76. The volume of a balloon is 1.20 liters at 24.0 °C. The balloon is heated to 48.0 °C. Calculate the new volume of the balloon.   (a) 1.20 L   (b) 2.40 L   (c) 1.70 L   (d) 1.30 L   (e) 2.10 L

77. Which of the following are oxidation-reduction reactions?   I. $PCl_3 + Cl_2 \rightarrow PCl_5$ II. $Cu + 2AgNO_3 \rightarrow Cu(NO_3)_2 + 2Ag$ III. $CO_2 + 2LiOH \rightarrow Li_2CO_3 + H_2O$ IV. $FeCl_2 + 2NaOH \rightarrow Fe(OH)_2 + 2NaCl$

(a) III   (b) IV   (c) I and II   (d) I, II, and III   (e) I, II, III, and IV

78. The acids $HC_2H_3O_2$ and HF are both weak but HF is a stronger acid than $HC_2H_3O_2$. HCl is a strong acid. Order the following according to base strength.

(a) $C_2H_3O_2^- > F^- > H_2O > Cl^-$

(b) $C_2H_3O_2^- > F^- > Cl^- > H_2O$

(c) $Cl^- > F^- > C_2H_3O_2^- > H_2O$

(d) $F^- > C_2H_3O_2^- > H_2O > Cl^-$

(e) none of these

79. A protein is

(a) a polysaccharide.

(b) a saturated ester of glycerol.

(c) one of the units composing a nucleic acid.

(d) an aromatic hydrocarbon with a fused ring structure.

(e) a polymer of amino acid units.

80. Which form of electromagnetic radiation has the longest wavelengths?

(a) gamma rays   (b) radio waves   (c) X-rays   (d) microwaves   (e) infrared radiation