

高雄醫學大學 106 學年度學士後醫學系招生考試試題

科目:物理及化學

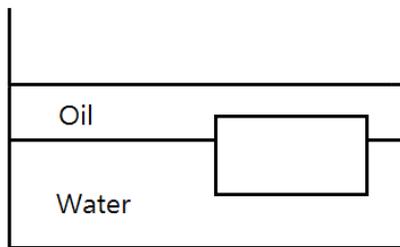
考試時間: 100 分鐘

說明:一、選擇題用 2B 鉛筆在「答案卡」上作答,修正時應以橡皮擦擦拭,不得使用修正液(帶),未遵照正確作答方法而致電腦無法判讀者,考生自行負責。
二、試題及答案卡必須繳回,不得攜出試場。

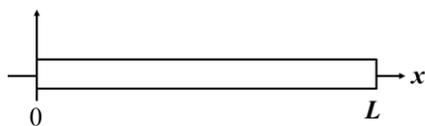
Choose one best answer for the following questions

【單選題】每題 1 分,共計 30 分,答錯 1 題倒扣 0.25 分,倒扣至本大題零分為止,未作答,不給分亦不扣分。
1~15 題為物理,16~30 題為化學。

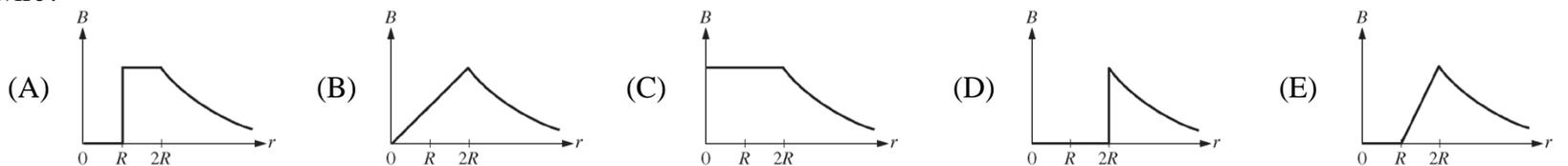
- The capacitance of a cylindrical capacitor can be increased by:
 - decreasing both the radius of the inner cylinder and the length.
 - increasing both the radius inner cylinder and the length.
 - increasing the radius outer cylindrical shell and decreasing the length.
 - decreasing the radius inner cylinder and increasing the radius of the outer cylindrical shell.
 - only by decreasing the length.
- A layer of oil with density 800 kg/m^3 floats on top of a volume of water with density $1,000 \text{ kg/m}^3$. A block floats at the oil-water interface with $1/4$ of its volume in oil and $3/4$ of its volume in water, as shown in the figure below. What is the density of the block ?



- 200 kg/m^3
 - 850 kg/m^3
 - 950 kg/m^3
 - $1,050 \text{ kg/m}^3$
 - $1,800 \text{ kg/m}^3$
- X rays of wavelength $\lambda = 0.250 \text{ nm}$ are incident on the face of a crystal at angle θ , measured from the crystal surface. The smallest angle that yields an intense reflected beam is $\theta = 14.5^\circ$. Which of the following gives the value of the interplanar spacing d ? ($\sin 14.5^\circ \cong 1/4$)
 - 0.125 nm
 - 0.250 nm
 - 0.500 nm
 - 0.625 nm
 - 0.750 nm
 - A rod of length L and mass M is placed along the x -axis with one end at the origin, as shown in the figure below. The rod has linear mass density $\lambda = \frac{2M}{L^2}x$, where x is the distance from the origin. Which of the following gives the x -coordinate of the rod's center of mass?

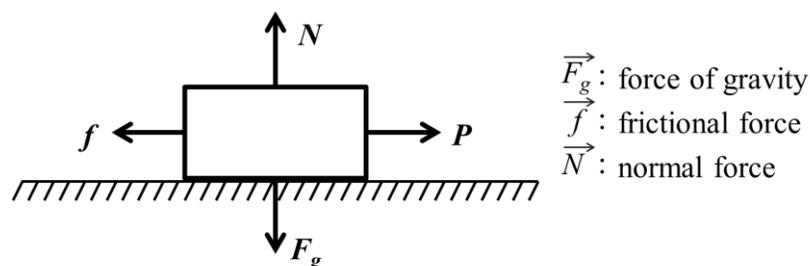


- $\frac{1}{12}L$
 - $\frac{1}{4}L$
 - $\frac{1}{3}L$
 - $\frac{1}{2}L$
 - $\frac{2}{3}L$
- A long, straight, hollow cylindrical wire with an inner radius R and an outer radius $2R$ carries a uniform current density. Which of the following graphs best represents the magnitude of the magnetic field as a function of the distance from the center of the wire?



- The density of ice is 0.920 g/cm^3 while that of sea water is 1.025 g/cm^3 . What fraction of an iceberg is submerged?
 - 0.898
 - 0.927
 - 0.976
 - 1.087
 - 1.114
- A series RLC circuit, driven with a sinusoidal external emf with rms voltage 120 V , contains a resistance $R = 200 \Omega$, an inductance $L = 1.0 \text{ H}$, and a capacitance $C = 16 \mu\text{F}$. What is the resonance frequency of this circuit?
 - 960 Hz
 - $1,600 \text{ Hz}$
 - 40 Hz
 - $6,400 \text{ Hz}$
 - 250 Hz

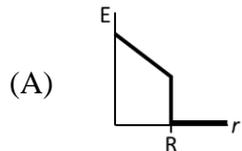
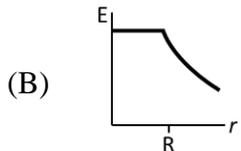
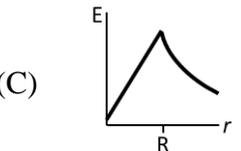
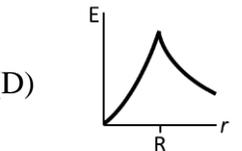
8. A star radiates uniformly in all directions. At a distance of $5.0 \times 10^{12} \text{ m}$ from the star, the intensity of the radiation from the star is 15 W/m^2 . What is the total power output of the star?
 (A) $3.2 \times 10^{38} \text{ W}$ (B) $4.7 \times 10^{27} \text{ W}$ (C) $3.8 \times 10^{26} \text{ W}$ (D) $7.5 \times 10^{13} \text{ W}$ (E) $1.1 \times 10^{15} \text{ W}$
9. The focal length of a camera lens is 20.0 cm . How far from the lens should the subject for the photo be if the lens is 20.5 cm from the film?
 (A) 8.20 m (B) 4.10 m (C) 2.10 m (D) 6.30 m (E) 10.0 m
10. Two different samples have the same mass and temperature. Equal quantities of energy are absorbed as heat by each. Their final temperatures may be different because the samples have different:
 (A) thermal conductivities (B) coefficients of expansion (C) densities (D) volumes (E) heat capacities
11. A block whose mass m is 650 g is fastened to a spring whose spring constant k is 65 N/m . The block is pulled a distance $x = 11 \text{ cm}$ from its equilibrium position at $x = 0$ on a frictionless surface and released from rest at $t = 0$. What is the angular frequency of the resulting oscillation motion?
 (A) 8 rad/s (B) 9 rad/s (C) 10 rad/s (D) 11 rad/s (E) 12 rad/s
12. The angular velocity vector of a spinning body points out of the page. If the angular acceleration vector points into the page then:
 (A) the body is slowing down (B) the body is speeding up
 (C) the body is starting to turn in the opposite direction (D) the axis of rotation is changing orientation
 (E) none of the above
13. A boy pulls a wooden box along a rough horizontal floor at constant speed by means of a force \vec{P} as shown. In the diagram f is the magnitude of the force of friction, N is the magnitude of the normal force, and F_g is the magnitude of the force of gravity. Which of the following must be true?



- (A) $P = f$ and $N = F_g$ (B) $P = f$ and $N > F_g$ (C) $P > f$ and $N < F_g$
 (D) $P > f$ and $N = F_g$ (E) None of the above.
14. The inertia of a body tends to cause the body to:
 (A) speed up (B) slow down (C) resist any change in its motion
 (D) fall toward the Earth (E) decelerate due to friction
15. A thin-walled hollow tube rolls without sliding along the floor. The ratio of its translational kinetic energy to its rotational kinetic energy (about an axis through its center of mass) is:
 (A) 1 (B) 2 (C) 3 (D) 1/2 (E) 1/3
16. Select the answer with the correct number of decimal places for the following sum:
 $13.914 \text{ cm} + 243.1 \text{ cm} + 12.00460 \text{ cm} =$
 (A) 269.01860 cm (B) 269.0186 cm (C) 269.019 cm (D) 269.02 cm (E) 269.0 cm
17. The difference between a student's experimental measurement of the density of sodium chloride and the known density of this compound reflects the _____ of the student's result.
 (A) accuracy (B) precision (C) random error
 (D) systematic error (E) indeterminate error
18. The average mass of a carbon atom is 12.011 . Assuming you were able to pick up only one carbon unit, the chances that you would randomly get one with a mass of 12.011 is _____.
 (A) 0% (B) 0.011% (C) about 12%
 (D) 12.011% (E) greater than 50%
19. A catalyst _____.
 (A) changes the enthalpy of the reaction (B) does not change the activation energy
 (C) provides an alternate pathway to the reaction (D) does not change the effective collisions
 (E) is consumed when more reacting molecules are added
20. For a gas sample, which conditions of P (pressure), T (temperature), and n (molar number), respectively, are most ideal?
 (A) high P , high T , high n (B) low P , low T , low n (C) high P , low T , high n
 (D) low P , high T , high n (E) low P , high T , low n

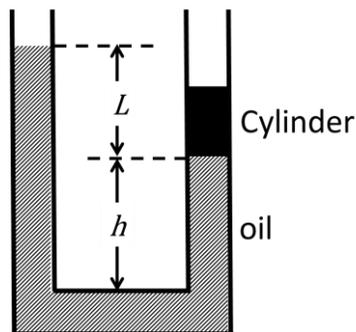
21. One mole of an ideal gas at 20 °C is expanded isothermally and reversibly from 100 L to 200 L. Which statement is correct?
 (A) $\Delta S_{\text{gas}} = 0$ (B) $\Delta S_{\text{surr}} = 0$ (C) $\Delta S_{\text{univ}} = 0$ (D) $\Delta S_{\text{gas}} = R \ln 2$ (E) $\Delta S_{\text{gas}} = \Delta S_{\text{surr}}$
22. Which of the following ionic compounds has the largest lattice energy?
 (A) LiF (B) NaCl (C) MgO (D) KBr (E) BaCl₂
23. Which of the following species has a trigonal bipyramid structure?
 (A) IF₅ (B) I₃⁻ (C) NH₃ (D) PCl₅ (E) All of the above.
24. Naturally occurring copper exists in two isotopic forms: ⁶³Cu and ⁶⁵Cu. The atomic mass of copper is 63.55 amu. What is the approximate natural abundance of ⁶³Cu?
 (A) 70% (B) 63% (C) 90% (D) 50% (E) 30%
25. Mixing 20 mL of a 4.0 M sodium chloride solution with 40 mL of a 2.0 M calcium chloride solution results in a solution with a chloride ion concentration of _____ M.
 (A) 2.67 (B) 3.33 (C) 4.00 (D) 4.33 (E) 5.00
26. How many electrons in an atom can have the quantum numbers $n = 4, l = 1$?
 (A) 2 (B) 6 (C) 10 (D) 18 (E) 32
27. The following reaction takes place at 120 °C: $\text{H}_2\text{O}_{(l)} \rightarrow \text{H}_2\text{O}_{(g)}$, $\Delta H = 44.0 \text{ kJ/mol}$, $\Delta S = 0.119 \text{ kJ/mol}\cdot\text{K}$. Which of the following must be true?
 (A) The reaction is not spontaneous. (B) The reaction is spontaneous. (C) $\Delta G < 0$
 (D) Two of these. (E) None of the above.
28. How many σ bonds and π bonds are there in $\text{H}_3\text{C}-\text{CH}_2-\text{CH}=\text{CH}-\text{CH}_2-\text{C}\equiv\text{CH}$?
 (A) 16, 3 (B) 13, 2 (C) 10, 2 (D) 10, 3 (E) 14, 3
29. _____ is a method of separation that employs a system with two phases of matter, including a mobile phase and a stationary phase.
 (A) Chromatography (B) Distillation (C) Homogenization
 (D) Vaporization (E) Filtration
30. Which of the following is an example of nitrogen fixation?
 (A) Absorption of NH₃ and its transformation into to N₂.
 (B) Absorption of NH₃ and its transformation into to NO₂.
 (C) Absorption of N₂ and its transformation into elemental nitrogen.
 (D) Absorption of N₂ and its transformation into NH₃.
 (E) Absorption of nitric acid and its transformation into N₂.

【單選題】 每題 2 分，共計 120 分，答錯 1 題倒扣 0.5 分，倒扣至本大題零分為止，未作答，不給分亦不扣分。
 31~60 題為物理，61~90 題為化學。

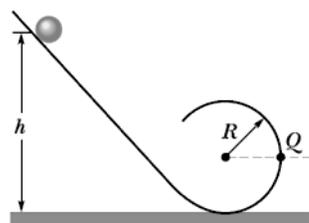
31. Two stationary tuning forks (350 and 352 Hz) are struck simultaneously. The resulting sound is observed to:
 (A) beat with a frequency of 2 beats/s (B) beat with a frequency of 351 beats/s
 (C) be loud but not beat (D) be Doppler shifted by 2 Hz
 (E) have a frequency of 702 Hz
32. Which of the following graphs represents the magnitude of the electric field as a function of the distance from the center of a solid charged conducting sphere of radius R?
 (A)  (B)  (C)  (D)  (E) 
33. A resistor in a circuit dissipates energy at a rate of 1 W. If the voltage across the resistor is doubled, what will be the new rate of energy dissipation?
 (A) 0.25 W (B) 0.5 W (C) 1 W (D) 2 W (E) 4 W
34. Unpolarized light is incident on a pair of ideal linear polarizers whose transmission axes make an angle of 45° with each other. The transmitted light intensity through both polarizers is what percentage of the incident intensity?
 (A) 100% (B) 75% (C) 50% (D) 25% (E) 0%
35. The mass of α particle is $6.601 \times 10^{-27} \text{ kg}$. If the α particle falls through the 100 kV potential difference, then the velocity of the α particle is: ($e = 1.602 \times 10^{-19} \text{ C}$)
 (A) $3.1 \times 10^6 \text{ m/s}$ (B) $3.1 \times 10^5 \text{ m/s}$ (C) $3.1 \times 10^4 \text{ m/s}$ (D) $3.1 \times 10^3 \text{ m/s}$ (E) $3.1 \times 10^2 \text{ m/s}$

36. What is the pressure on a swimmer 2 m below the surface of a swimming pool? (normal atmospheric pressure $P_{\text{atm}} = 1.013 \times 10^5\text{ Pa}$)
 (A) $1.313 \times 10^5\text{ Pa}$ (B) $1.278 \times 10^5\text{ Pa}$ (C) $1.234 \times 10^5\text{ Pa}$ (D) $1.209 \times 10^5\text{ Pa}$ (E) $1.156 \times 10^5\text{ Pa}$
37. A wheel has a radius of 0.4 m and rotates at an angular velocity of 4 rad/s . A peg at the edge of the wheel is at the heighted point at $t = 0$. What is the period of the motion of the shadow?
 (A) 1.51 s (B) 1.57 s (C) 2.05 s (D) 2.36 s (E) 3.14 s
38. A solenoid has an inductance 75 mH and a winding resistance $0.50\ \Omega$. If a battery is connected to the solenoid, how long will the current reach half its final equilibrium value? ($\log 2 = 0.301$, $\ln 2 = 0.693$)
 (A) 0.10 s (B) 45 ms (C) 4.6 s (D) 2.0 s (E) 26 ms
39. The electric potential in an xy plane is given by $V = (1.0\text{ V/m}^2)x^2 - (2.0\text{ V/m}^2)y^2$. What is the magnitude of the electric field at the point $(3.0\text{ m}, 2.0\text{ m})$?
 (A) 5.0 N/C (B) 6.0 N/C (C) 8.0 N/C (D) 10 N/C (E) 14 N/C
40. A cyclotron has a dee radius R and is operated at an oscillator frequency f in Hz . What is the magnitude of the magnetic field B needed for deuterons to be accelerated in the cyclotron? The mass of the deuteron is m in kilograms, f is in Hz , and B is in Tesla.
 (A) $2\pi m f R / q$ (B) $2\pi m f / (Rq)$ (C) $2\pi m f / q$ (D) $2\pi m f / (R^2 q)$ (E) $2\pi m f R^2 / q$
41. A 2.0 kg particle moves along an x axis, being pushed by a variable force directed along that axis. Its position is given by $x = 2.0\text{ m} - 3.0\text{ (m/s)}t + 4.0\text{ (m/s}^2)t^2 - 1.0\text{ (m/s}^3)t^3$. What is the force on the particle at $t = 2.0\text{ s}$?
 (A) $4.0\text{ N}\hat{i}$ (B) $-4.0\text{ N}\hat{i}$ (C) $8.0\text{ N}\hat{i}$ (D) $-8.0\text{ N}\hat{i}$ (E) $2.0\text{ N}\hat{i}$
42. A 5.0 kg block of steel slides down a ramp with acceleration 0.40 m/s^2 directed down the ramp. The ramp makes an angle of 37° with the horizontal. What is the coefficient of kinetic friction between the block and the ramp?
 (A) 0.50 (B) 0.70 (C) 0.25 (D) 0.75 (E) 5.0
43. A particle with position vector $\vec{r} = (4.0\text{ m})\hat{i} + (3.0\text{ m})\hat{j}$ is acted on by a force $\vec{F} = (3.0\text{ N})\hat{i} + (4.0\text{ N})\hat{j}$. What is the torque on the particle about the origin?
 (A) $7.0\text{ (N}\cdot\text{m})\hat{k}$ (B) $-7.0\text{ (N}\cdot\text{m})\hat{k}$
 (C) $7.0\text{ (N}\cdot\text{m})\hat{i} + 7.0\text{ (N}\cdot\text{m})\hat{j}$ (D) $-7.0\text{ (N}\cdot\text{m})\hat{i} - 7.0\text{ (N}\cdot\text{m})\hat{j}$
 (E) $12\text{ (N}\cdot\text{m})\hat{i} + 12\text{ (N}\cdot\text{m})\hat{j}$
44. A disk with a rotational inertia of $5.0\text{ kg}\cdot\text{m}^2$ rotates around its central axis while undergoing a torque given by $\tau = (3.0 + 4.0t)\text{ N}\cdot\text{m}$. The disk's angular momentum is $2.5\text{ kg}\cdot\text{m}^2/\text{s}$ at time $t = 1.0\text{ s}$. What is the disk's angular momentum at $t = 2.0\text{ s}$?
 (A) $14\text{ kg}\cdot\text{m}^2/\text{s}$ (B) $12\text{ kg}\cdot\text{m}^2/\text{s}$ (C) $60\text{ kg}\cdot\text{m}^2/\text{s}$ (D) $5.0\text{ kg}\cdot\text{m}^2/\text{s}$ (E) $2.5\text{ kg}\cdot\text{m}^2/\text{s}$
45. A tank containing water to a height of 16.0 m also contains air above the water at a gauge pressure of 1.00 atm . Water flows out from the bottom through a small hole. What is the water's speed?
 (A) 13 m/s (B) 19 m/s (C) 4.2 m/s (D) 23 m/s (E) 6.5 m/s
46. A sound wave from a sound generator radiates uniformly in all directions in 22.0°C air. The sound intensity level is 50 dB at a distance of 4.00 m from the sound generator. The frequency of the sound wave is 500 Hz . At what distance from the sound generator is the sound intensity level 30 dB ?
 (A) 12.6 m (B) 40.0 m (C) 80.0 m (D) 6.67 m (E) 16.0 m
47. Coherent light with wavelength $0.40\ \mu\text{m}$ passes through two very narrow slits. The distance between these two slits is 0.20 mm . The interference pattern is shown on a screen 5.0 m from the slits. What is the width of the central interference maximum?
 (A) 7.5 mm (B) 5.0 mm (C) 20 mm (D) 10 mm (E) 2.5 mm
48. A cup of tea is made with 0.250 kg of 85.0°C water. Then, the cup of tea cools down to room temperature 20.0°C . What is the entropy change of the water while it cools? (For water, $c = 4200\frac{\text{J}}{\text{kg}\cdot\text{K}}$)
 (A) 200 J/K (B) 230 J/K
 (C) $1050\ln(1.22)\text{ J/K}$ (D) $1050\ln(0.818)\text{ J/K}$
 (E) 190 J/K
49. A Carnot engine operates between two temperatures T_H and T_C . It takes in 600 J of heat from high-temperature reservoir at $T_H = 327^\circ\text{C}$ in each cycle and gives up 200 J to the low-temperature (T_C) reservoir. What is the thermal efficiency of the cycle?
 (A) 67% (B) 33% (C) 75% (D) 50% (E) 25%
50. When a certain rubber band is stretched a distance x , it exerts a restoring force $F = ax + bx^2$, where a and b are constants. The work done in stretching this rubber band from $x = 0$ to $x = L$ is:
 (A) $aL^2 + bLx^3$ (B) $aL + 2bL^2$ (C) $a + 2bL$ (D) bL (E) $aL^2/2 + bL^3/3$

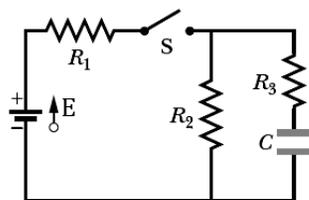
51. The diagram shows a U-tube having cross-sectional area A and partially filled with oil of density ρ . A solid cylinder, which fits the tube tightly but can slide without friction, is placed in the right arm. The system reaches equilibrium. The weight of the cylinder is:



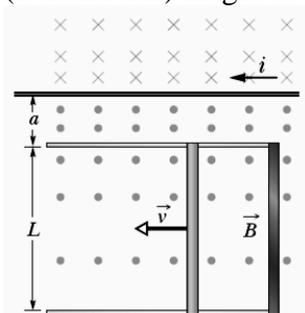
- (A) $AL\rho g$ (B) $L^3\rho g$ (C) $A\rho(L+h)g$ (D) $A\rho(L-h)g$ (E) None of the above.
52. A solid brass ball of mass 0.280 g will *roll smoothly* along a loop-the-loop track when released from rest along the straight section. The circular loop has radius $R = 14.0\text{ cm}$, and the ball has radius $r \ll R$. What is h if the ball is on the verge of leaving the track when it reaches the top of the loop?



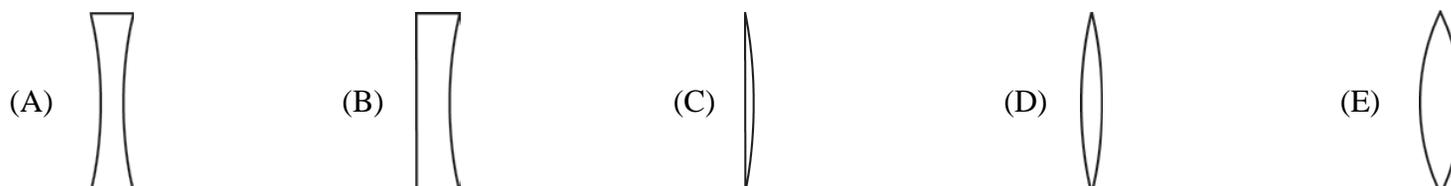
- (A) 47.8 cm (B) 27.8 cm (C) 57.8 cm (D) 37.8 cm (E) 78.3 cm
53. The emf $E = 1.2\text{ kV}$, $C = 6.5\text{ }\mu\text{F}$, $R_1 = R_2 = R_3 = 0.73\text{ M}\Omega$. With C completely uncharged, switch S is suddenly closed (at $t = 0$). At $t = 0$, what is current i_1 in resistor R_1 ?



- (A) $3.3 \times 10^{-3}\text{ A}$ (B) $3.3 \times 10^{-4}\text{ A}$ (C) $1.1 \times 10^{-4}\text{ A}$ (D) $1.1 \times 10^{-3}\text{ A}$ (E) $2.2 \times 10^{-3}\text{ A}$
54. The following shows a rod of length $L = 10.0\text{ cm}$ that is forced to move at constant speed $v = 5.00\text{ m/s}$ along horizontal rails. The rod, rails, and connecting strip at the right form a conducting loop. The rod has resistance $0.400\text{ }\Omega$; the rest of the loop has negligible resistance. A current $i = 100\text{ A}$ through the long straight wire at distance $a = 10.0\text{ mm}$ from the loop sets up a (nonuniform) magnetic field through the loop. Find the emf. ($\mu_0 = 4\pi \times 10^{-7}\text{ T}\cdot\text{m/A}$, $\ln 2 = 0.693$, $\ln 10 = 2.303$, $\ln 11 = 2.398$)

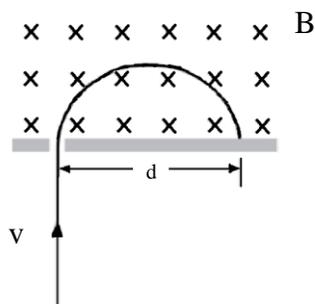


- (A) $2.4 \times 10^{-4}\text{ V}$ (B) $5.8 \times 10^{-3}\text{ V}$ (C) $4.8 \times 10^{-5}\text{ V}$ (D) $3.9 \times 10^{-4}\text{ V}$ (E) $8.8 \times 10^{-4}\text{ V}$
55. If the five lenses shown below are made of the same material, which lens has the shortest positive focal length?



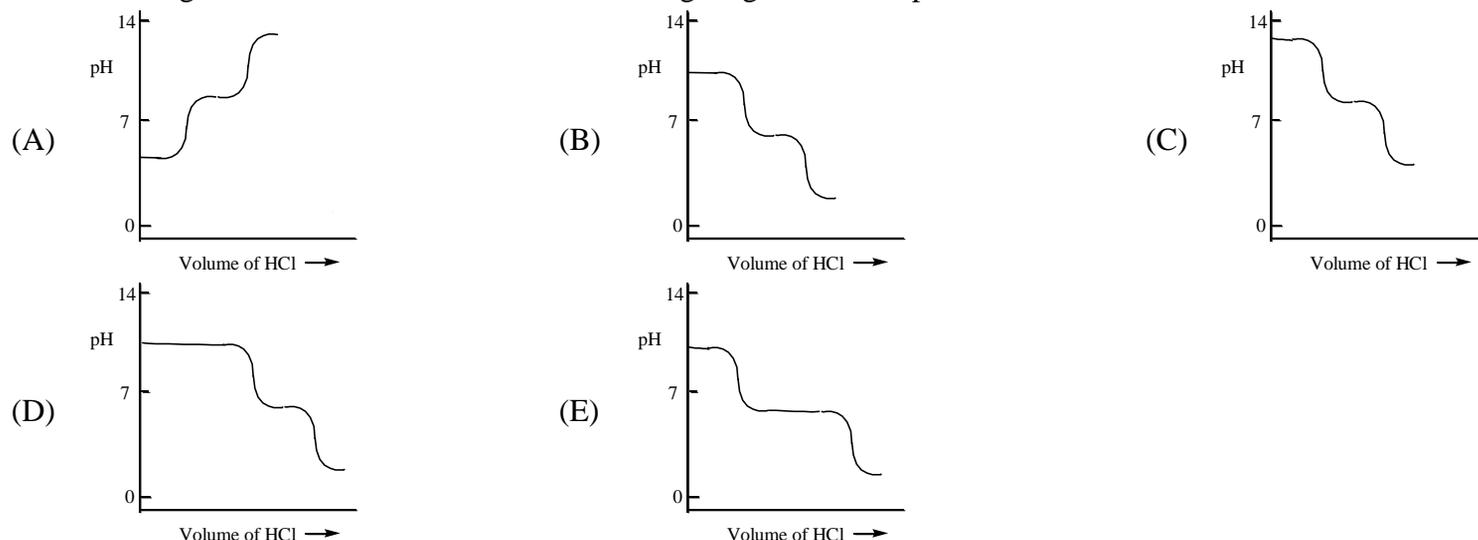
56. For quantum model, $E = h\nu = hc / \lambda$, where E is photon energy in unit of eV, h is the Planck's constant ($6.626 \times 10^{-34}\text{ J s}$), ν is the frequency (s^{-1}), λ is the wavelength in meters (m), then $E \times \lambda$ (eV m) is:
- (A) 1.24×10^{-3} (B) 1.24×10^{-4} (C) 1.24×10^{-5} (D) 1.24×10^{-6} (E) 1.24×10^{-7}

57. A particle with mass m and charge q , moving with a velocity v , enters a region of uniform magnetic field B , as shown in the figure below. The particle strikes the wall at a distance d from the entrance slit. If the particle's velocity stays the same but its charge-to-mass ratio is doubled, at what distance from the entrance slit will the particle strike the wall?



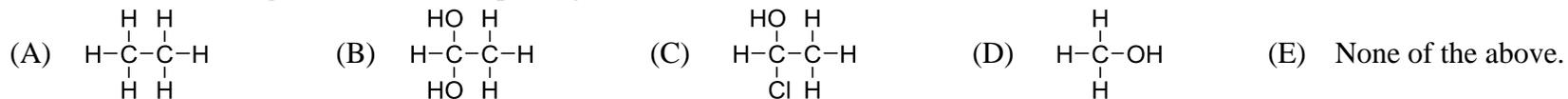
- (A) $2d$ (B) $\sqrt{2}d$ (C) d (D) $\frac{1}{\sqrt{2}}d$ (E) $\frac{1}{2}d$
58. The position of a particle moving on x -axis is given by $x = 3.0 + 2.5t - 1.0t^3$, with x in meters and t in seconds. Which statement in the following is correct?
- (A) The particle is moving in the positive direction of x with a speed of 1.5 m/s at $t = 1.0\text{ s}$.
 (B) The acceleration of the particle at $t = 1.0\text{ s}$ is -0.50 m/s^2 .
 (C) The acceleration of the particle is constant.
 (D) The particle is moving in the negative direction of x with a speed of 0.50 m/s at $t = 1.0\text{ s}$.
 (E) The velocity of the particle is constant.
59. A wire loop of area 1000 cm^2 has a resistance of 10 ohms . A magnetic field B normal to the loop initially has a magnitude of 0.1 T and is reduce to zero at a uniform rate in 10^{-4} s . Thus, the resulting current is:
- (A) 10000 A (B) 1000 A (C) 100 A (D) 10 A (E) 1 A
60. A rod of semiconducting material with length L and cross-sectional area A lies along the x -axis between $x = 0$ and $x = L$. Its resistivity varies with x according to $\rho(x) = \rho_0 \exp(-x/L)$. The material obeys Ohm's Law. What is the total resistance of the rod?
- (A) $\rho_0(1 - e^{-L})$ (B) $\rho_0(1 - e^{-L})/A$ (C) $\rho_0(1 - e^{-1})/A$ (D) $\rho_0L(1 - e^{-1})/A$ (E) $\rho_0L(1 - e^{-L})/A$
61. A solution contains the ions Ag^+ , Ba^{2+} , and Ni^{2+} . Dilute solutions of NaCl , Na_2SO_4 , and Na_2S are available to separate the positive ions from each other. In order to effect separation, the solutions should be added in which order?
- (A) Na_2S , NaCl , Na_2SO_4 (B) Na_2SO_4 , NaCl , Na_2S (C) Na_2SO_4 , Na_2S , NaCl
 (D) NaCl , Na_2S , Na_2SO_4 (E) NaCl , Na_2SO_4 , Na_2S
62. Which of the statements below correctly describes the combustion of glucose, shown below?
- $$\text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2 \rightleftharpoons 6\text{CO}_2 + 6\text{H}_2\text{O}$$
- (A) Hydrogen in $\text{C}_6\text{H}_{12}\text{O}_6$ is being reduced. (B) Oxygen in O_2 is being oxidized.
 (C) Hydrogen in $\text{C}_6\text{H}_{12}\text{O}_6$ is the reducing agent. (D) Oxygen in $\text{C}_6\text{H}_{12}\text{O}_6$ is the oxidizing agent.
 (E) Carbon in $\text{C}_6\text{H}_{12}\text{O}_6$ is being oxidized.
63. Reaction intermediates differ from activated complexes in that _____.
- (A) they are stable molecules with normal bonds and are frequently isolated
 (B) they are molecules with normal bonds rather than partial bonds and can occasionally be isolated
 (C) they are intermediate structures which have characteristics of both reactants and products
 (D) they are unstable and can never be isolated
 (E) all reactions involve reaction intermediates, but not all have activated complexes
64. Select the Lewis structure for XeO_2F_2 which correctly minimizes formal charges.
- (A) $\text{F}-\overset{\text{O}}{\parallel}{\text{Xe}}=\text{O}$ (B) $\begin{array}{c} \text{:O:} \\ \text{:F-Xe=O} \\ \text{:F:} \end{array}$ (C) $\begin{array}{c} \text{:O:} \\ \text{F=Xe=O} \\ \text{:F:} \end{array}$ (D) $\begin{array}{c} \text{:O:} \\ \text{:F-Xe-O:} \\ \text{:F:} \end{array}$ (E) $\begin{array}{c} \text{:O:} \\ \text{:F-Xe=O:} \\ \text{:F:} \end{array}$
65. Which species has the **highest** bond order?
- (A) NO^+ (B) O_2 (C) O_2^- (D) O_2^{2-} (E) NO^-
66. What hybridization is present in the phosphorus atom in PCl_3 and PCl_5 , respectively?
- (A) sp^2 , d^2sp^3 (B) sp^2 , dsp^3 (C) dsp , dsp^3 (D) sp^3 , d^2sp^3 (E) sp^3 , dsp^3
67. The spectrochemical series is $\text{I}^- < \text{Br}^- < \text{Cl}^- < \text{F}^- < \text{OH}^- < \text{H}_2\text{O} < \text{NH}_3 < \text{en} < \text{NO}_2^- < \text{CN}^-$. Which of the following complexes will absorb visible radiation of the **highest** energy?
- (A) $[\text{Co}(\text{H}_2\text{O})_6]^{3+}$ (B) $[\text{CoI}_6]^{3-}$ (C) $[\text{Co}(\text{OH})_6]^{3-}$ (D) $[\text{Co}(\text{en})_3]^{3+}$ (E) $[\text{CoCl}_6]^{3-}$

68. A diprotic acid H_2A has $K_{a1} = 1 \times 10^{-4}$ and $K_{a2} = 1 \times 10^{-8}$. The corresponding base A^{2-} is titrated with aqueous HCl, both solutions being 0.1 mol/L. Which one of the following diagrams best represents the titration curve which will be seen?

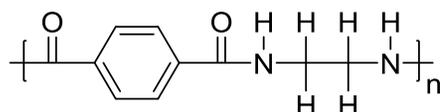


69. Which of the following coordination compounds will form a precipitate ($AgCl$) when treated with an aqueous solution of $AgNO_3$?
 (A) $[Cr(NH_3)_3Cl_3]$ (B) $[Cr(NH_3)Cl]SO_4$ (C) $Na_3[Cr(CN)_6]$ (D) $[Cr(NH_3)_6]Cl_3$ (E) None of the above.
70. If a complex ion is square planar, which d-orbital is **highest** in energy?
 (A) $d_{x^2-y^2}$ (B) d_{x^2} (C) d_{xy} (D) d_{yz} (E) d_{xz}
71. Which of the following statement is incorrect about hydrocarbons?
 (A) Breaking the C—H bonds separately of CH_4 requires different energies.
 (B) The average C—H bond energy of CH_4 is higher than that of H—H.
 (C) Hydrocarbons are hydrophobic.
 (D) Longer alkanes are with higher viscosities than shorter ones.
 (E) Branched alkanes are with lower boiling points than their corresponding straight isomers.

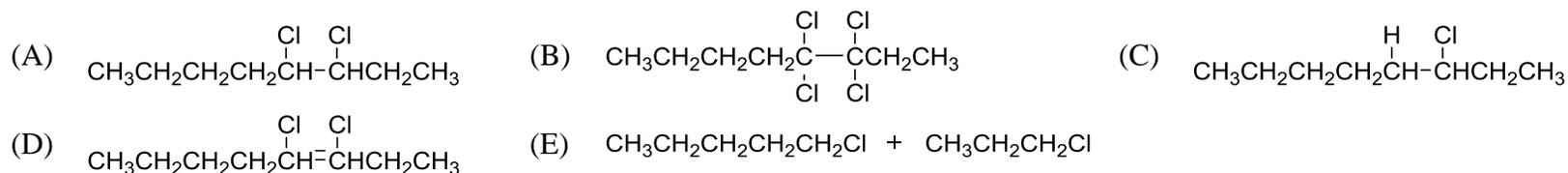
72. Which of the following molecules is an optically active molecule?



73. The structure below is the repeating unit of a



- (A) homopolymer formed by an addition reaction. (B) homopolymer formed by a condensation reaction.
 (C) copolymer formed by an addition reaction. (D) copolymer formed by a condensation reaction.
 (E) polyester formed by an addition reaction.
74. Identify the products of the reaction of 3-octene with chlorine.
 $CH_3CH_2CH_2CH_2CH=CHCH_2CH_2 + Cl_2 \longrightarrow ?$



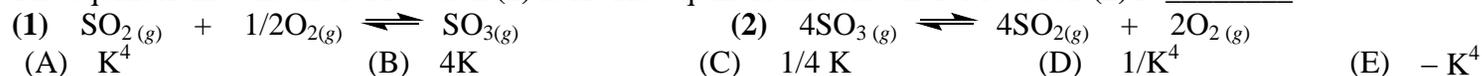
75. Which of the following statements about molecular spectroscopies is **incorrect**?

- (A) Ultraviolet-visible (UV-vis) spectra provides information about HOMO-LUMO gap.
 (B) Infrared (IR) spectra gives information on bond vibrational transitions.
 (C) Rotation transitions occur in the microwave region.
 (D) Nuclear magnetic resonance (NMR) spectra provides information about the electronic transitions.
 (E) UV-vis spectra involves both the molecular ground state and the excited state.

76. Consider the following reaction: $2NOCl_{2(g)} \rightleftharpoons 2NO_{(g)} + Cl_{2(g)}$. The equilibrium constant K is about 0.0196 at 115 °C. Calculate K_p at this temperature?

- (A) 0.196 (B) 0.624 (C) 0.285 (D) 22.9 (E) 2.9

77. The equilibrium constant for reaction (1) is K . The equilibrium constant for reaction (2) is _____.



78. The pH of a 0.005 M K_2O aqueous solution should be _____.
 (A) 11.7 (B) 7.0 (C) 2.3 (D) 12.0 (E) 5.0
79. How long will it take to produce 18.2 g of Ag (atomic mass = 107.87 amu) from a solution of $AgNO_3$ using a current of 10.00 amp? ($F = 96500 \text{ C/mol}$)
 (A) $3.26 \times 10^3 \text{ s}$ (B) $8.14 \times 10^2 \text{ s}$ (C) $4.88 \times 10^3 \text{ s}$ (D) $1.63 \times 10^3 \text{ s}$ (E) $5.43 \times 10^3 \text{ s}$
80. Given $Cu_2O_{(s)} + 1/2O_{2(g)} \rightarrow 2CuO_{(s)}$, $\Delta H^\circ = -144 \text{ kJ}$ and $Cu_2O_{(s)} \rightarrow Cu_{(s)} + CuO_{(s)}$, $\Delta H^\circ = +11 \text{ kJ}$
 Calculate the standard enthalpy of formation of $CuO_{(s)}$.
 (A) -155 kJ (B) $+299 \text{ kJ}$ (C) $+155 \text{ kJ}$ (D) -299 kJ (E) -166 kJ
81. Calculate E°_{cell} and indicate whether the overall reaction shown is spontaneous or nonspontaneous.
 $Co^{3+}_{(aq)} + e^- \rightleftharpoons Co^{2+}_{(aq)} \quad E^\circ = 1.82 \text{ V}$
 $MnO_4^-_{(aq)} + 2H_2O_{(l)} + 3e^- \rightleftharpoons MnO_{2(s)} + 4OH^-_{(aq)} \quad E^\circ = 0.59 \text{ V}$
 Overall reaction: $MnO_4^-_{(aq)} + 2H_2O_{(l)} + 3Co^{2+}_{(aq)} \rightleftharpoons MnO_{2(s)} + 3Co^{3+}_{(aq)} + 4OH^-_{(aq)}$
 (A) $E^\circ_{\text{cell}} = -1.23 \text{ V}$, spontaneous (B) $E^\circ_{\text{cell}} = -1.23 \text{ V}$, nonspontaneous (C) $E^\circ_{\text{cell}} = 1.23 \text{ V}$, spontaneous
 (D) $E^\circ_{\text{cell}} = 1.23 \text{ V}$, nonspontaneous (E) $E^\circ_{\text{cell}} = -0.05 \text{ V}$, nonspontaneous
82. The successive packing pattern for a hexagonal closest packed structures is which of the following?
 (A) ABCABC (B) ABCCBA (C) ABABAB (D) ABAABA (E) AABBA
83. Identify the missing particle in the following equation: $^{238}_{92}\text{U} \rightarrow ^4_2\text{He} + ?$
 (A) $^{242}_{94}\text{Pu}$ (B) $^{234}_{90}\text{Th}$ (C) $^{242}_{90}\text{Th}$ (D) $^{234}_{92}\text{U}$ (E) None of the above.
84. How many valence electrons are there in an atom with the electron configuration [noble gas] $ns^2(n-1)d^{10}np^3$?
 (A) 2 (B) 3 (C) 5 (D) 10 (E) 15
85. For the process $CHCl_{3(s)} \rightarrow CHCl_{3(l)}$, $\Delta H^\circ = 9.19 \text{ kJ/mol}$ and the melting point of chloroform is -64°C . Calculate ΔS° ?
 (A) 43.9 J/mol/K (B) 53.9 J/mol/K (C) 26.3 J/mol/K (D) 75.2 J/mol/K (E) None of the above.
86. Atomic orbitals developed using quantum mechanics _____.
 (A) describe regions of space in which one is most likely to find an electron
 (B) describe exact paths for electron motion
 (C) give a description of the atomic structure which is essentially the same as the Bohr model
 (D) allow scientists to calculate an exact volume for the hydrogen atom
 (E) are in conflict with the Heisenberg Uncertainty Principle
87. Which of the following species requires the **highest** energy to remove an electron from its valence shell?
 (A) Na^+ (B) F^- (C) K (D) Cl^- (E) Mg^{2+}
88. A reaction was found to be zero order in X. Increasing the concentration of X by a factor of 5 will cause the reaction rate to _____.
 (A) remain constant (B) increase by a factor of 25 (C) increase by a factor of 5
 (D) increase by a factor of 10 (E) decrease by a factor of the cube root of 5
89. Which of the following is not a factor determining the energy of activation according to the Arrhenius equation?
 (A) temperature (B) frequency of collision of reacting molecules
 (C) fraction of collisions with effective orientations (D) frequency factor
 (E) None of the above.
90. A student needs a solution buffered at pH 4.30 ($[H^+] = 5.0 \times 10^{-5} \text{ M}$). This student can choose from the following weak acids and their salts to prepare the buffer. Which system will own the best buffering capacity?
 (A) Benzoic acid ($K_a = 6.4 \times 10^{-5}$) (B) Chloroacetic acid ($K_a = 1.35 \times 10^{-3}$)
 (C) Propanoic acid ($K_a = 1.3 \times 10^{-5}$) (D) Hypochlorous acid ($K_a = 3.5 \times 10^{-8}$)
 (E) All of the above.