

110學年度 學士後醫學系招生考試

物理及化學試題封面

考試開始鈴響前，請勿翻閱本試題！

★考試開始鈴響前，請注意：

- 一、除准考證、應考文具及一般手錶外；行動電話、穿戴式裝置及其他物品均須放在臨時置物區。
- 二、請務必確認行動電話已取出電池或關機，行動電話及手錶的鬧鈴功能必須關閉。
- 三、就座後，不可擅自離開座位或與其他考生交談。
- 四、坐定後，雙手離開桌面，確認座位號碼、答案卡號碼與准考證號碼相同，以及抽屜中、桌椅下或座位旁均無非考試必需用品。如有任何問題，請立即舉手反應。
- 五、考試開始鈴響前，不得翻閱試題本或作答。
- 六、考試全程不得吃東西、喝水及嚼食口香糖。
- 七、違反上述規定，依「筆試規則及違規處理辦法」議處。

★作答說明：

- 一、考試時間：100 分鐘。
- 二、本試題（含封面）共 17 頁，如有缺頁或毀損，應立即舉手請監試人員補發。
- 三、本試題共 90 題，皆為單選題，共計 150 分；每題答錯倒扣，不作答不計分。
- 四、答題依題號順序劃記在答案卡上，寫在試題本上無效；答案卡限用 2B 鉛筆劃記，若未按規定劃記，致電腦無法讀取者，考生自行負責。
- 五、試題本必須與答案卡一併繳回，不得攜出試場。

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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。

1. If the diameter of the hydrogen atom is scaling up to the 400 m track playground, what would the size of its nucleus be?

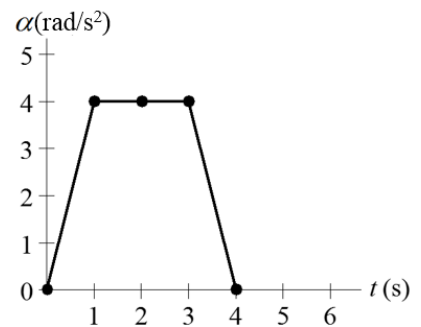
Hint: Radius of hydrogen is 0.053 nano meter. Radius of its nucleus is 0.85 femto meter.

- (A) a few-mm sand grain (B) a ping-pong ball (C) a base ball
(D) a bowling ball (E) a basketball

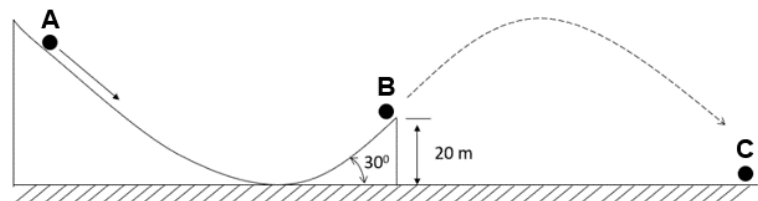
2. Since 2019, the magnitudes of all SI units have been defined by declaring exact numerical values for *defining constants* when expressed in terms of their SI units. Which one of the following constants is not included?

- (A) the speed of light in vacuum, c (B) the Planck constant, h
(C) the Coulomb constant, k_e (or $1/4\pi\epsilon_0$) (D) the Boltzmann constant, k (or k_B)
(E) the Avogadro constant, N_A

3. The graph below shows the angular acceleration α of a bicycle tire. During the four-second time interval for which this graph is drawn, we can conclude that _____.



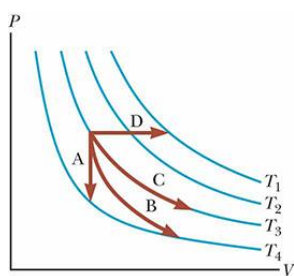
- (A) the angular velocity of the wheel did not change
(B) the angular momentum of the wheel about an axis through its center did not change
(C) the angular velocity of the wheel increased by 8 rad/s
(D) the angular velocity of the wheel increased by 12 rad/s
(E) the angular velocity of the wheel increased by 16 rad/s
4. A ball rolls down and leaves a slope at an angle of 30° above the horizontal direction. The ball hits the ground 10 seconds later at a point 20 meters below the leaving point, as shown below. How far does the ball travel horizontally when it hits the ground (from point B to point C)? (Gravitational acceleration $g = 10 \text{ m/s}^2$)



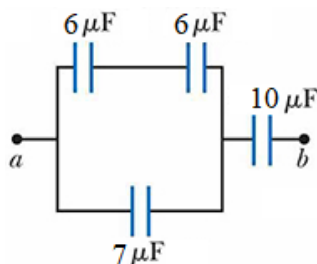
- (A) 623 (B) 835 (C) 936 (D) 1019 (E) 2021

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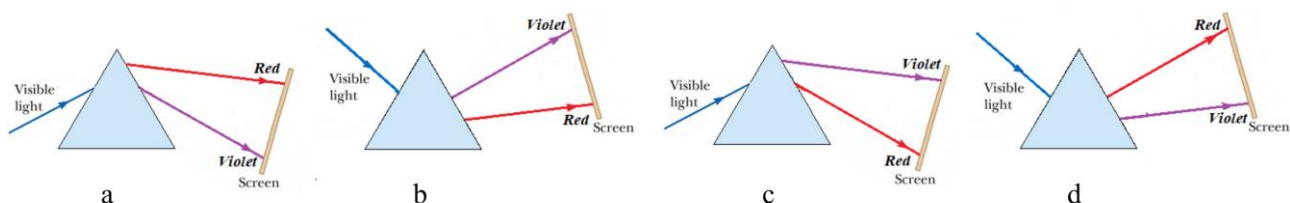
9. Which of the following answers is a correct description of the corresponding process as indicated in the figure?



- (A) Isobaric (B) Adiabatic (C) Isovolumetric
(D) Isothermal (E) None of the above is correct.
10. Two waves traveling in opposite directions interfere to produce a standing wave described by $y = 3 \sin(2x) \cos(5t)$ where x is in m and t is in s. What is the wavelength of the interfering waves?
- (A) 3.14 m (B) 1.00 m (C) 2.00 m (D) 6.28 m (E) 12.00 m
11. When the same temperature increase in a system, the change in entropy, ΔS , is the largest in a reversible _____.
- (A) constant-volume process (B) constant-pressure process
(C) adiabatic process (D) process in which no heat is transferred
(E) process in which no work is performed
12. Four capacitors are connected as shown in the figure. How much is the total charges stored in capacitors if $\Delta V_{ab} = 15 \text{ V}$.

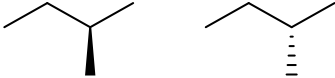


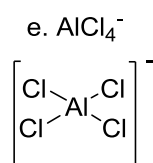
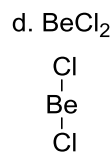
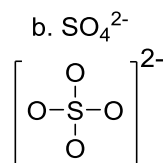
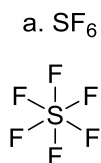
- (A) $30 \mu\text{C}$ (B) $45 \mu\text{C}$ (C) $60 \mu\text{C}$ (D) $75 \mu\text{C}$ (E) $90 \mu\text{C}$
13. Which of the following is correct for visible light through a prism?



- (A) a and d (B) c and b (C) c and d
(D) a and b (E) None of these

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14. In an atom, how many electrons can be contained at most at the 4th orbit?
(A) 9 (B) 18 (C) 32 (D) 162 (E) 324
15. An energy of 13.6 eV is needed to ionize an electron from the ground state of a hydrogen atom. What is the longest photon wavelength needed to accomplish this task? (Planck constant = $6.62 \times 10^{-34} \text{ m}^2 \cdot \text{kg/s}$, speed of light = $3 \times 10^8 \text{ m/s}$, $1 \text{ eV} = 1.6 \times 10^{-19} \text{ J}$)
(A) 60 nm (B) 70 nm (C) 80 nm (D) 90 nm (E) 100 nm
16. For the process $\text{Co}(\text{NH}_3)_5\text{Cl}^{2+} + \text{Cl}^- \rightarrow \text{Co}(\text{NH}_3)_4\text{Cl}_2^+ + \text{NH}_3$, what would be the ratio of *cis* to *trans* isomers in the product?
(A) 1:1 (B) 4:1 (C) 2:1 (D) 1:4 (E) 1:2
17. Which of the solvents shown below could best dissolve KBr?
(A) C_6H_{14} (hexane) (B) $\text{CH}_3\text{CH}_2\text{OH}$ (ethanol)
(C) C_6H_6 (benzene) (D) CCl_4 (carbon tetrachloride)
(E) C_6H_{12} (cyclohexane)
18. Which of the following options best describes the relationship between the following two compounds?
- 
- (A) Constitutional isomers
(B) Stereoisomers
(C) Identical
(D) Not isomers, different compounds entirely.
(E) Conformers
19. Please calculate the specific heat capacity of a metal if 15.0 g of it requires 169.6 J to change the temperature from 25.00°C to 32.00°C?
(A) 0.619 J/g°C (B) 11.3 J/g°C
(C) 24.2 J/g°C (D) 1.62 J/g°C
(E) 275 J/g°C
20. Which of the following structures contains the central atom which has a formal charge of +2?



(A) a

(B) b

(C) c

(D) d

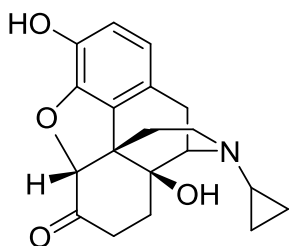
(E) e

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21. What is the molecular shape of IF_3 using the VSEPR theory?

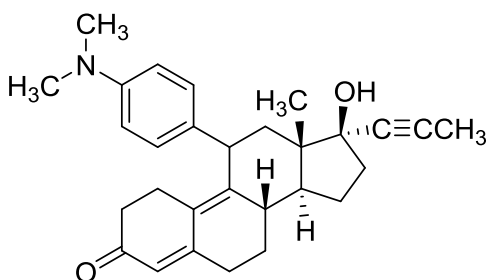
- (A) Trigonal bipyramidal (B) See-saw (C) T-shaped
(D) Linear (E) Square pyramidal

22. What are the hybridization state and geometry of the nitrogen atom in the following chemical structure?



- (A) sp hybridized and linear geometry (B) sp^2 hybridized and trigonal pyramidal
(C) sp^3 hybridized and trigonal pyramidal (D) sp^3 hybridized and trigonal planar
(E) sp^3 hybridized and bent

23. How many asymmetric carbons are presented in the compound below?



- (A) 2 (B) 3 (C) 4 (D) 5 (E) 6

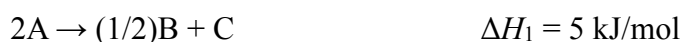
24. The chemical compound “ethylenediaminetetraacetic acid, EDTA” is a chelating agent to coordinate several metallic ions, such as ferric, copper, and calcium ions. In the living organism, which amino acid is usually used as a chelating agent?

- (A) Cysteine (B) Glycine (C) Leucine
(D) Tryptophan (E) Proline

25. Which one of the following molecules has a dipole moment but without polarity?

- (A) O_3 (B) PH_3 (C) NH_3 (D) PCl_5 (E) H_2O_2

26. Consider the following processes:



Calculate ΔH for: $\text{C} \rightarrow \text{E} + 3\text{D}$

- (A) 0 kJ/mol (B) 10 kJ/mol (C) -10 kJ/mol (D) -20 kJ/mol (E) 20 kJ/mol

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27. CdS can be described as cubic closest packed anions with the cations in tetrahedral holes. What fraction of the tetrahedral holes is occupied by the cations?

- (A) 0.125 (B) 0.25 (C) 0.50 (D) 0.75 (E) 1.0

28. For the reaction $3A(g) + 2B(g) \rightarrow 2C(g) + 2D(g)$, the following data was collected at constant temperature. Determine the correct rate law for this reaction.

Trial	Initial [A] (mol/L)	Initial [B] (mol/L)	Initial Rate (mol/(L·min))
1	0.200	0.100	6.00×10^{-2}
2	0.100	0.100	1.50×10^{-2}
3	0.200	0.200	1.20×10^{-1}
4	0.300	0.200	2.70×10^{-1}

- (A) Rate = $k[A][B]$ (B) Rate = $k[A][B]^2$ (C) Rate = $k[A]^3[B]^2$
 (D) Rate = $k[A]^{1.5}[B]$ (E) Rate = $k[A]^2[B]$

29. What is the number of the half-lives required for a radioactive element to decay to about 6% of its original activity? (please choose the nearest number)

- (A) 2 (B) 3 (C) 4 (D) 5 (E) 6

30. Identify the element of Period 2 which has the following successive ionization energies, in kJ/mol.

IE ₁ , 1314	IE ₂ , 3389	IE ₃ , 5298	IE ₄ , 7471
IE ₅ , 10992	IE ₆ , 13329	IE ₇ , 71345	IE ₈ , 84087

- (A) Li (B) B (C) O
 (D) Ne (E) None of these

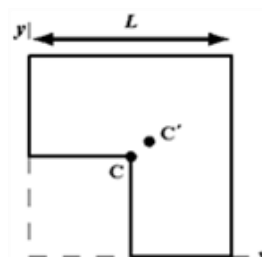
【單選題】 每題 2 分，共計 120 分，答錯 1 題倒扣 0.5 分，倒扣至本大題零分為止，未作答，不給分亦不扣分。31~60 題為物理，61~90 題為化學。

31. Based on an order-of-magnitude estimate, what is the radius of the Earth in the unit of kilometer (km)?

Hint: The meter was originally defined in 1793 as one ten-millionth of the distance from the equator to the North Pole along a great circle.

- (A) 2 (B) 4 (C) 6 (D) 8 (E) 10

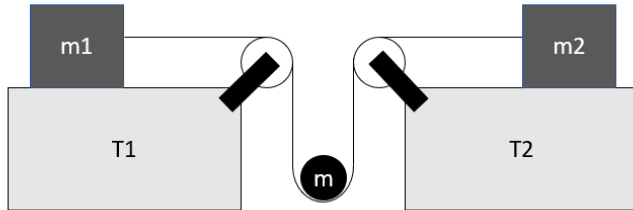
32. A part of the square that has sides of length L is removed from one corner. The center of mass of the remainder moves from C to C' . The displacement of the x coordinate of the center of mass (from C to C') is _____.



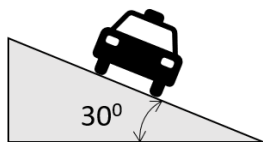
- (A) $(2/3)L$ (B) $(1/6)L$ (C) $(1/8)L$ (D) $(1/10)L$ (E) $(1/12)L$

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33. The string and the pulley are massless, and the coefficient of static and kinetic frictions are 0.2 and 0.1, respectively, for both table 1 (T1) and 2 (T2). If $m_1 = 2 \text{ kg}$, $m_2 = 3 \text{ kg}$, and $m = 1.5 \text{ kg}$, find the acceleration of m . (Gravitational acceleration $g = 10 \text{ m/s}^2$)



- (A) $7.7 \text{ m}^2/\text{s}$ (B) $8.7 \text{ m}^2/\text{s}$ (C) $9.7 \text{ m}^2/\text{s}$ (D) $10.7 \text{ m}^2/\text{s}$ (E) $11.7 \text{ m}^2/\text{s}$
34. Aluminum Rod #1 has a length L and a diameter d . Aluminum Rod #2 has a length $2L$ and a diameter $2d$. If Rod #1 is under tension T and Rod #2 is under tension $2T$, how do the changes in length of the two rods compare?
- (A) They are the same.
 (B) Rod #1 has double the change in length that Rod #2 has.
 (C) Rod #2 has double the change in length that Rod #1 has.
 (D) Rod #1 has quadruple the change in length that Rod #2 has.
 (E) Rod #2 has quadruple the change in length that Rod #1 has.
35. A toy car is running on a banked circular track of radius 10 m , as shown below. If the car weighs 5 kg and on wet ice, find the maximum velocity for the car to keep on the track without skid. (Gravitational acceleration $g = 10 \text{ m/s}^2$, $\cos 30^\circ = 0.87$, $\cos 60^\circ = 0.5$)



- (A) 5.4 m/s (B) 7.6 m/s (C) 9.4 m/s (D) 12.6 m/s (E) 15.7 m/s
36. A small block of mass m rests on the sloping side of a triangular block of mass M which itself rests on a horizontal table as shown in the figure below. Assuming all surfaces are frictionless, determine the magnitude of the force F that must be applied to M so that m remains in a fixed position relative to M .



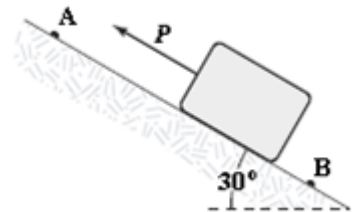
- (A) $mg \sin\theta$ (B) $mg \tan\theta$ (C) $(m+M)g \tan\theta$
 (D) $(m+M)g \sin\theta$ (E) None of these

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37. The four tires of an automobile are inflated to a gauge pressure of $2.0 \times 10^5 \text{ N/m}^2$ (29 psi). Each of the four tires has an area of 0.024 m^2 that is in contact with the ground. Determine the weight of the auto.

- (A) $4.80 \times 10^3 \text{ N}$ (B) $1.92 \times 10^4 \text{ N}$ (C) $7.68 \times 10^4 \text{ N}$
(D) $8.33 \times 10^6 \text{ N}$ (E) $2.08 \times 10^7 \text{ N}$

38. A 2-kg block slides down a frictionless incline from point A to point B. A force (magnitude $P = 3 \text{ N}$) acts on the block between A and B, as shown in the figure. Points A and B are 2 m apart. If the kinetic energy of the block at A is 10 J, what is the kinetic energy of the block at B? (Gravitational acceleration $g = 10 \text{ m/s}^2$)



- (A) 17 J (B) 20 J (C) 24 J (D) 27 J (E) 37 J

39. On a bridge, a man (weight = 70 kg) plays bungee jumping by tying himself to one end of an elastic rope. The rope has a length of 100 m, and the height of the bridge is 500 m. After jumping, the man begins to bounce back 10 seconds later. What is the effective weight of the man at the bouncing point? (Gravitational acceleration $g = 10 \text{ m/s}^2$)

- (A) 83 kg (B) 95 kg (C) 102 kg (D) 117 kg (E) 127 kg

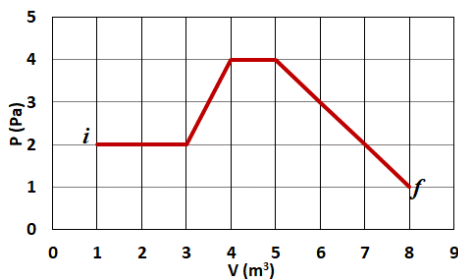
40. How much energy is required to move a mass m object from the Earth's surface to an altitude twice the Earth's radius R_E ?

- (A) $(-1/2)mgR_E$ (B) $(1/2)mgR_E$ (C) $(-2/3)mgR_E$ (D) $(2/3)mgR_E$ (E) $(1/4)mgR_E$

41. A styrofoam container used as a picnic cooler contains a block of ice at 0°C . If 225 g of ice melts in 1 hour, how much heat energy (Joule) per second is passing through the walls of the container? (The heat of fusion of ice is $3.33 \times 10^5 \text{ J/kg}$).

- (A) 20.8 (B) 124.8 (C) 1800.0 (D) 7492.5 (E) 749250.0

42. How much is the internal energy change of a gas that expands from i to f as indicated in the figure if there is also a frictional heat loss of 10 J?

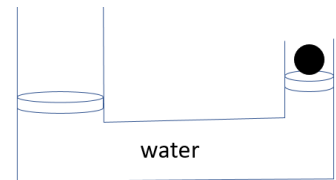


- (A) -34.5 J (B) 22.5 J (C) -18.5 J (D) -28.5 J (E) 36.5 J

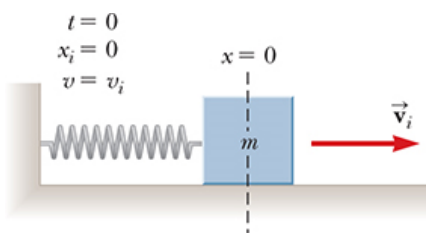
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43. A solid melt at 100°C by absorbing 2450 kJ heat. How much is the entropy change in this melting process?
 (A) 8.23 kJ/K (B) 4.32 kJ/K (C) 7.43 kJ/K (D) 6.57 kJ/K (E) 5.69 kJ/K
44. What is the efficiency if a Carnot engine transfers 9.5×10^3 J of energy from a hot reservoir during a cycle and dumps 2×10^3 J heat to a cold reservoir?
 (A) 0.69 (B) 0.84 (C) 0.79 (D) 0.65 (E) 0.72
45. Water pressurized to 3.5×10^5 Pa is flowing at 5.0 m/s in a horizontal pipe which contracts to $1/3$ its former area. What are the pressure and flow speed of the water after the contraction?
 (A) 2.5×10^5 Pa, 15 m/s (B) 3.0×10^5 Pa, 10 m/s (C) 3.0×10^5 Pa, 15 m/s
 (D) 4.5×10^5 Pa, 1.5 m/s (E) 5.5×10^5 Pa, 1.5 m/s

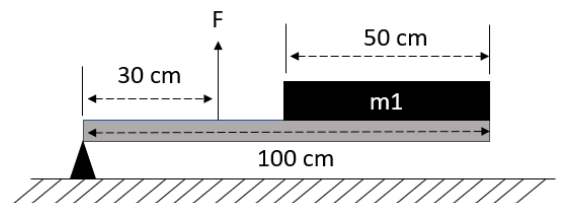
46. A hydraulic jack with two pistons is shown in the figure. The radii are 10 cm and 5 cm, and the weights are 40 kg and 1 kg for the left and right piston, respectively. A ball weighs 9 kg is placed on the right piston. Find the height difference between two pistons in equilibrium status. (Gravitational acceleration $g = 10 \text{ m/s}^2$)



- (A) 0 cm (B) 10 cm (C) 1 m (D) 10 m (E) 20 m
47. A car approaches a stationary police car at 36 m/s. The frequency of the siren (relative to the police car) is 500 Hz. What is the frequency (in Hz) heard by an observer in the moving car as he approaches the police car? (Assume the velocity of sound in air is 343 m/s.)
 (A) 220 (B) 383 (C) 448 (D) 526 (E) 552
48. A mass-spring system is shown in the figure where the spring constant $k = 100 \text{ N/m}$ and the mass is 4 kg. Assuming the initial velocity is 3.5 m/s, what is the amplitude of the motion?



- (A) 0.5 m (B) 0.7 m (C) 0.8 m (D) 0.9 m (E) 1.2 m
49. A block (m_1) with a weight of 10 kg was placed on a wooden bar with a weight of 2 kg. The left end of the bar was attached firmly to a triangle. How much force (F) does it take to keep the system in horizontal equilibrium? (Gravitational acceleration $g = 10 \text{ m/s}^2$)



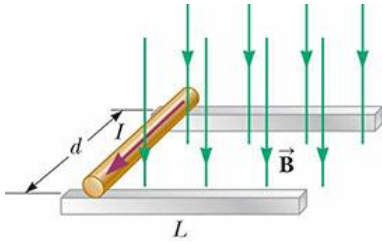
- (A) 165 N (B) 224 N (C) 283 N (D) 318 N (E) 361 N

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50. Halley's comet moves about the Sun in an elliptical orbit with its closest approach to the Sun being 0.59 A.U. and its farthest distance being 35 A.U. If the comet's speed at closest approach is 54 km/s, what is its speed when it is farthest from the Sun? [1 Astronomical Unit (A.U.) is the Earth-Sun distance.]

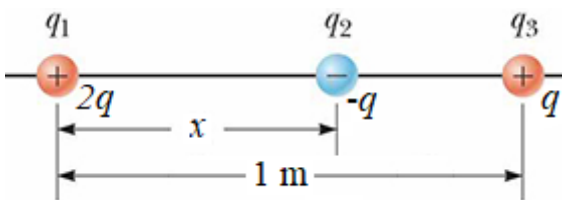
- (A) 3203 m/s (B) 910 m/s (C) 15 m/s (D) 13 m/s (E) 7011 m/s

51. A rod of 0.3 m carries a current of $I = 48.0$ A in the direction shown in the figure and rolls along the rails with a constant speed. A uniform magnetic field of magnitude 0.25 T is directed perpendicular to the rod and the rails. What is the force acting on the rod?



- (A) 3.6 N (→) (B) 2.4 N (←) (C) 1.2 N (←) (D) 3.6 N (←) (E) 1.2 N (→)

52. Three point charges align along the x -axis as shown in the figure. What is the equilibrium position x of the charge q_2 . (The electrical constant is k_e).



- (A) 0.45 m (B) 0.62 m (C) 0.36 m (D) 0.78 m (E) 0.59 m

53. Two parallel thin planes of charge electrical charge density 2.5×10^8 C/m². What is the electric field in the region between the two planes? Assume that the vacuum electric permittivity is $\epsilon_0 = 8.9 \times 10^{-12}$ C²/N·m².

- (A) 2.8×10^{18} N/C (B) 5.6×10^{19} N/C (C) 1.4×10^{18} N/C
(D) 2.8×10^{19} N/C (E) 4.2×10^{19} N/C

54. The voltage across a parallel-plate capacitor is measured to be 92.5 V. When a dielectric is inserted between the plates, the voltage drops to 23.4 V. What is the dielectric constant of the inserted material? Assume that the vacuum electric permittivity is $\epsilon_0 = 8.9 \times 10^{-12}$ C²/N·m².

- (A) 0.26 (B) 2.64 (C) 0.62 (D) 3.95 (E) 1.82

55. An AC generator consists of 6 turns of a wire. Each turn has an area of 0.040 m². The loop rotates in a uniform field ($B = 0.20$ T) at a constant frequency of 50 Hz. What is the maximum induced emf?

- (A) 2.4 V (B) 3.0 V (C) 4.8 V (D) 13 V (E) 15 V

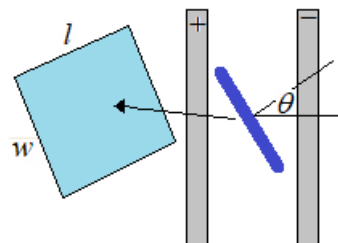
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56. It is known that the magnetic field of 0.17 T can cause an O_2^+ ion to move in a circular orbit of radius 2 m. Find the radius of circular orbit of a Na^{2+} ion with identical velocity in the same magnetic field. (Ion moves in direction perpendicular to the magnetic field.)

- (A) 0.12 m (B) 0.25 m (C) 0.34 m (D) 0.52 m (E) 0.72 m

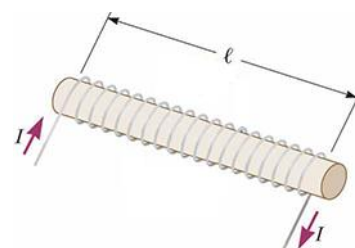
57. What is the electric flux through a surface in between two parallel planes shown in the figure if

$w = 2$ cm, $l = 5$ cm, $E = 500$ N/C and $\theta = 30^\circ$?



- (A) $0.52 \text{ N}\cdot\text{m}^2/\text{C}$ (B) $0.26 \text{ N}\cdot\text{m}^2/\text{C}$ (C) $0.81 \text{ N}\cdot\text{m}^2/\text{C}$
(D) $0.43 \text{ N}\cdot\text{m}^2/\text{C}$ (E) $0.36 \text{ N}\cdot\text{m}^2/\text{C}$

58. A solenoid with 200 turns of copper wires is operated by a 1000 V power supply and must be 25 cm long. What is the magnitude of magnetic field that is created in the solenoid? (The resistance of Cu wire is 0.2Ω and the permeability $\mu_0 = 4\pi \times 10^{-7} \text{ T}\cdot\text{m}/\text{A}$)



- (A) 5.03 T (B) 3.21 T (C) 7.84 T (D) 4.58 T (E) 4.36 T

59. For a convex mirror with radius of curvature $R = 10$ cm, if an object is placed 15 cm in front the mirror, what is the magnification of the image and is it a real or virtual? Upright or inverted? (mirror's equation: $1/p + 1/q = 2/R$)

- (A) 3.75 cm (virtual behind mirror) and $M = 0.25$, inverted
(B) 7.50 cm (virtual behind mirror) and $M = 0.5$, upright
(C) 3.75 cm (real in front mirror) and $M = 0.5$, inverted
(D) 7.50 cm (real in front mirror) and $M = 0.25$, inverted
(E) 3.75 cm (virtual behind mirror) and $M = 0.25$, upright

60. For a bi-concave thin lens, the radii of curvature are 10 and 20 cm. If an object is placed 15 cm in front of the mirror, what is the magnification of the image and is it a real or virtual? Upright or inverted? (thin lens' equation: $1/p + 1/q = (n-1)(1/R_1 - 1/R_2)$, the refractive index of glass is 1.5).

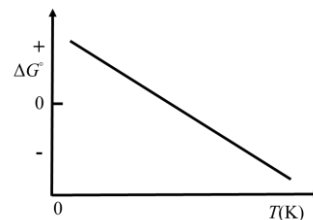
- (A) 9.72 cm (virtual behind mirror) and $M = 0.64$, inverted
(B) 11.64 cm (virtual behind mirror) and $M = 0.58$, inverted
(C) 10.91 cm (virtual in front mirror) and $M = 0.73$, upright
(D) 8.69 cm (real in front mirror) and $M = 0.25$, inverted
(E) 12.45 cm (virtual behind mirror) and $M = 0.53$, upright

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61. 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
62. Detection of radiation by a Geiger-Müller counter depends on _____.
(A) the emission of a photon from an excited atom
(B) the ability of an ionized gas to carry an electrical current
(C) the emission of a photon of light by the radioactive particle
(D) the ability of a photomultiplier tube to amplify the electrical signal from a phosphor
(E) the detection of the sound made by decay particles
63. Please calculate the ΔS if ΔH_{vap} is 66.8 kJ/mol, and the boiling point is 83.4°C at 1 atm, when the substance is vaporized at 1 atm.
(A) -187 J/K mol (B) 187 J/K mol (C) 801 J/K mol
(D) -801 J/K mol (E) 0
64. Which of the following values is based on the Third Law of Thermodynamics?
(A) $\Delta H^{\circ}_{\text{f}} = 0$ for Al(s) at 298 K
(B) $\Delta G^{\circ}_{\text{f}} = 0$ for H₂(g) at 298 K
(C) $S^{\circ} = 51.446 \text{ J}/(\text{mol}\cdot\text{K})$ for Na(s) at 298 K
(D) $q_{\text{sys}} < 0$ for H₂O(l) → H₂O(s) at 0°C
(E) None of these
65. What are the values of bond order belonging to O₂⁻ and O₂⁺, respectively?
(A) 1.5, 2.5 (B) 2.5, 1.5 (C) 2, 3 (D) 3, 2 (E) 2, 2
66. The lattice energy of NaI(s) is -686 kJ/mol, and its heat of solution is -7.6 kJ/mol. Calculate the hydration of energy of NaI(s) in kJ/mol.
(A) -678 (B) -694 (C) +678 (D) +694 (E) +15.2
67. According to molecular orbital, which of the following molecules is diamagnetic?
(A) HF (B) O₂ (C) NO (D) N₂⁺ (E) N₂⁻

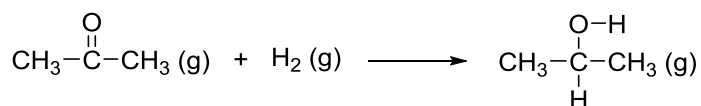
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68. Consider the figure, which shows ΔG° for a chemical process plotted against absolute temperature. Which of the following is an incorrect conclusion, based on the information in the diagram?



- (A) $\Delta H^\circ > 0$
- (B) $\Delta S^\circ > 0$
- (C) The reaction is spontaneous at high temperatures.
- (D) ΔS° increases with temperature while ΔH° remains constant.
- (E) There exists a certain temperature at which $\Delta H^\circ = T\Delta S^\circ$.

69. Acetone can be easily converted to isopropyl alcohol by addition of hydrogen to the carbon-oxygen double bond. Calculate the enthalpy of reaction using the bond energies given.



Bond:	C=O	H-H	C-H	O-H	C-C	C-O
Bond energy (kJ/mol):	745	436	414	464	347	351
(A) -484 kJ	(B) -366 kJ	(C) -48 kJ	(D) +48 kJ	(E) +366 kJ		

70. How many of the following molecules exhibit resonance: NO_2^- , O_3 , OCl_2 , NF_3 , N_2O , CCl_4 , CNO^- , O_2F_2 ?

- (A) 1
- (B) 2
- (C) 3
- (D) 4
- (E) 5

71. One mole of $\text{X}(\text{g})$ and one mole of $\text{Y}(\text{g})$ are mixed in a closed reactor in the presence of catalysts, and $\text{Z}(\text{g})$ is generated. The reaction is $a\text{X} + b\text{Y} \rightarrow c\text{Z}$, where a , b , and c are the coefficients in the balanced equation. At a certain time, the mixture contains 1.8 moles of gases while the ratio of their partial pressures is $P_X:P_Y:P_Z = 7:9:2$. What are the values of a , b , and c ?

- (A) $a = 1, b = 2, c = 3$
- (B) $a = 3, b = 1, c = 2$
- (C) $a = 7, b = 9, c = 2$
- (D) $a = 3, b = 1, c = 8$
- (E) $a = 2, b = 9, c = 7$

72. Consider an adiabatic and reversible expansion process from state I to state II. Which of the following statements is true?

- (A) $P_1V_1 = P_2V_2$
- (B) $T_1V_1^\gamma = T_2V_2^\gamma, \gamma = C_p/C_v$
- (C) The final temperature will be higher than the initial temperature.
- (D) The final volume of the gas is much greater than the expansion were carried out isothermally.
- (E) The work delivered to the surrounding is much smaller than the expansion were carried out isothermally.

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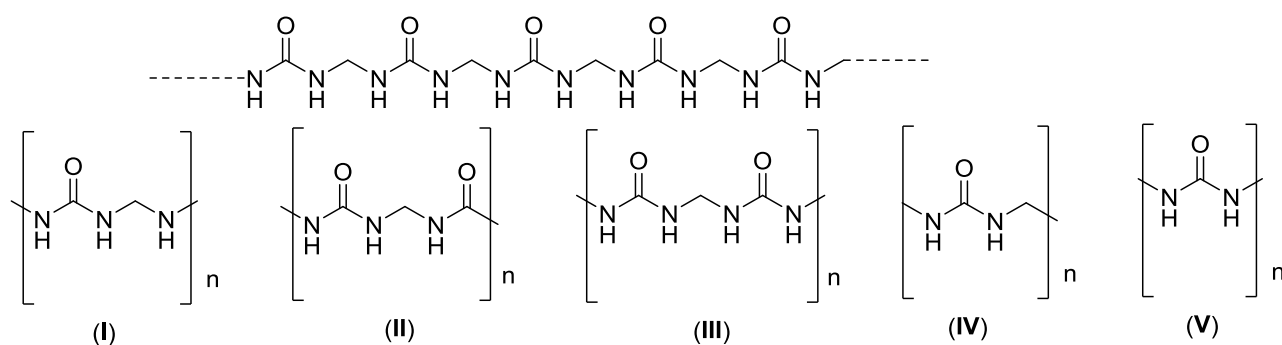
73. When a 1.00 mL of the 3.55×10^{-4} M solution of organic acid is diluted with 9.00 mL of ether, forming solution A and then 2.00 mL of the solution A is diluted with 8.00 mL of ether, forming solution B. What is the concentration of solution B?

- (A) 3.55×10^{-6} M (B) 9.86×10^{-6} M (C) 7.10×10^{-5} M
(D) 7.89×10^{-5} M (E) 7.10×10^{-6} M

74. What is the volume of $O_2(g)$ generated when 22.4 g of $KClO_3$ is decomposed at $153^\circ C$ under 0.820 atm? ($KClO_3$: 122.55 g/mol)

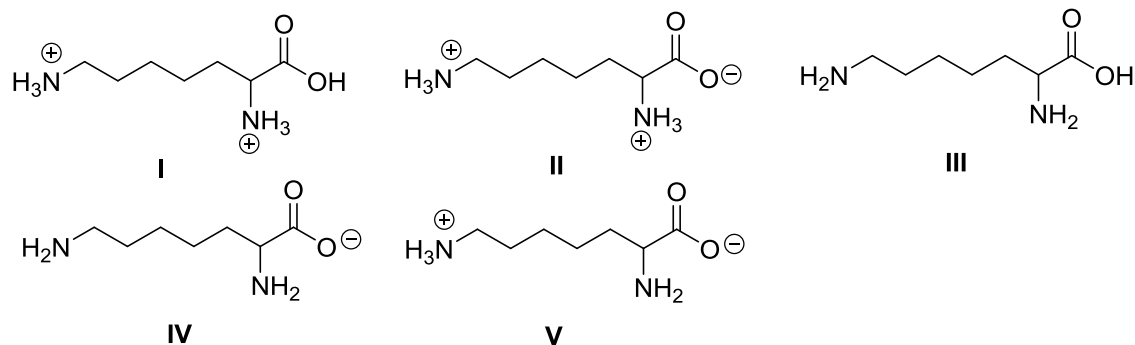
- (A) 0.09 L (B) 3.00 L (C) 4.20 L (D) 7.79 L (E) 11.7 L

75. What is the appropriate representation of the repeating unit of the following polymer?



- (A) I (B) II (C) III (D) IV (E) V

76. Which of the following structures is the major form of the lysine at the pH = 14?



- (A) I (B) II (C) III (D) IV (E) V

77. Which of the followings is a correct set of quantum numbers for an electron in a $3d$ orbital?

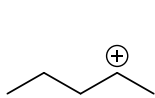
- (A) $n = 3, l = 0, m_l = -1$ (B) $n = 3, l = 1, m_l = 3$ (C) $n = 3, l = 2, m_l = 3$
(D) $n = 3, l = 3, m_l = 2$ (E) $n = 3, l = 2, m_l = -2$

78. Which of the following complexes will absorb visible radiation of the shortest wavelength?

- (A) $[Co(H_2O)_6]^{3+}$ (B) $[Co(I)_6]^{3-}$ (C) $[Co(OH)_6]^{3-}$
(D) $[Co(en)_3]^{3+}$ (E) $[Co(NH_3)_6]^{3+}$

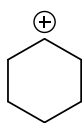
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79. Please choose the most stable cation?



I

(A) I



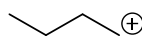
II

(B) II



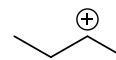
III

(C) III



IV

(D) IV



V

(E) V

80. Which of the following statements about “The Bohr Model” and “Particle in a Box” is TRUE?

- (A) For an electron trapped in a one-dimensional box, as the length of the box increases, the spacing between energy levels will increase.
- (B) The total probability of finding a particle in a one-dimensional box (length is L) in energy level $n = 4$ between $x = L/4$ and $x = L/2$ is 50%.
- (C) If the wavelength of light necessary to promote an electron from the ground state to the first excited state is λ in a one-dimensional box, then the wavelength of light necessary to promote an electron from the first excited state to the third excited state will be 3λ .
- (D) A function of the type $A \cos(Lx)$ can be an appropriate solution for the particle in a one-dimensional box.
- (E) Assume that a hydrogen atom's electron has been excited to the $n = 5$ level. When this excited atom loses energy, 10 different wavelengths of light can be emitted.

81. Which of the following statements concerning a face-centered cubic unit cell and the corresponding lattice, made up of identical atoms, is incorrect?

- (A) The coordination number of the atoms in the lattice is 8.
- (B) The packing in this lattice is more efficient than for a body-centered cubic system.
- (C) If the atoms have radius r , then the length of the cube edge is $\sqrt{8} \times r$.
- (D) There are four atoms per unit cell in this type of packing.
- (E) The packing efficiency in this lattice and hexagonal close packing are the same.

82. Which of the followings will give a solution with a $\text{pH} > 7$, but is not an Arrhenius base in the strict sense?

- (A) CH_3NH_2 (B) NaOH (C) CO_2 (D) $\text{Ca}(\text{OH})_2$ (E) CH_4

83. Pentane, C_5H_{12} , boils at 35°C . Which of the followings is true about kinetic energy, E_k , and potential energy, E_p , when liquid pentane at 35°C is compared with pentane vapor at 35°C ?

- (A) $E_k(g) < E_k(l)$; $E_p(g) \approx E_p(l)$ (B) $E_k(g) > E_k(l)$; $E_p(g) \approx E_p(l)$
(C) $E_p(g) < E_p(l)$; $E_k(g) \approx E_k(l)$ (D) $E_p(g) > E_p(l)$; $E_k(g) \approx E_k(l)$
(E) $E_p(g) \approx E_p(l)$; $E_k(g) \approx E_k(l)$

84. Five molecules are shown as below. Which one has the highest ionic strength?

- (A) $\text{B}(\text{OH})_3$ (B) HNO_3 (C) Na_2HPO_4 (D) CaCO_3 (E) BaSO_4

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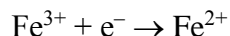
85. Hydroxylamine nitrate contains 29.17 mass % N, 4.20 mass % H, and 66.63 mass % O. Determine its empirical formula.

- (A) HNO (B) H₂NO₂ (C) HN₆O₁₆ (D) HN₁₆O₇ (E) H₂NO₃

86. Given the following two standard reduction potentials,



determine for the standard reduction potential of the half-reaction



- (A) 0.40 V (B) 0.77 V (C) -0.40 V (D) -0.11 V (E) 0.11 V

87. The rate law for a reaction is found to be $\text{Rate} = k[\text{A}]^2[\text{B}]$. Which of the following mechanisms gives this rate law?

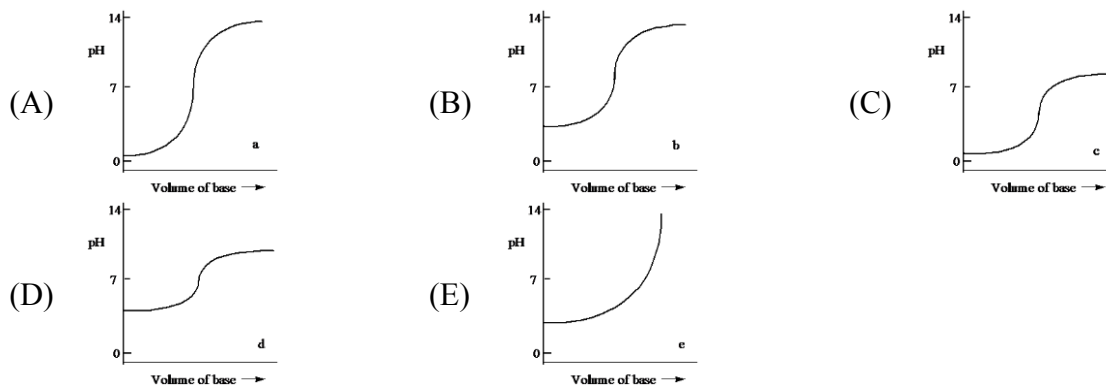
- I. $\text{A} + \text{B} \rightleftharpoons \text{E}$ (fast) II. $\text{A} + \text{B} \rightleftharpoons \text{E}$ (fast) III. $\text{A} + \text{A} \rightarrow \text{E}$ (slow)
 $\text{E} + \text{B} \rightarrow \text{C} + \text{D}$ (slow) $\text{E} + \text{A} \rightarrow \text{C} + \text{D}$ (slow) $\text{E} + \text{B} \rightarrow \text{C} + \text{D}$ (fast)

- (A) I (B) II (C) III (D) I & II (E) II & III

88. When the redox reaction in basic solution: $\text{NO}_2^{-}(\text{aq}) + \text{Al}(\text{s}) \rightarrow \text{NH}_3(\text{aq}) + \text{AlO}_2^{-}(\text{aq})$ is balanced using the smallest whole-number coefficients, the coefficient of H₂O is x and the sum of all coefficients is y . What is the sum of x and y , $(x + y)$?

- (A) 9 (B) 10 (C) 11 (D) 12 (E) 13

89. Which of the followings is the best representation of the titration curve which will be obtained in the titration of a weak acid (0.10 mol L⁻¹) with a strong base of the same concentration?



90. The students used salicylic acid and acetic anhydride to synthesize aspirin in the experiment of “The Preparation of Aspirin”. The chemical reaction is shown as below:

Which compound will react with FeCl₃ to become a purple complex?

- (A) Salicylic acid (B) Acetic anhydride (C) Aspirin
 (D) Acetic acid (E) 18 M sulfuric acid