國立中山大學113學年度
學士後醫學系招生考試試題

科目名稱：物理與化學

－作答注意事項－

考試時間：100分鐘

- 考試開始鈴響前不得翻閱試題，並不得書寫、劃記、作答。請先檢查答案卡之應考證號碼、桌角號碼、應試科目是否正確，如有不同立即請監試人員處理。
- 答案卡請以2B鉛筆劃記，不可使用修正液（帶）塗改，未使用2B鉛筆、劃記太輕或污損致光學閱讀機無法辨識答案者，後果由考生自負。
- 答案卡應保持清潔完整，不得折疊、破壞或塗改應考證號碼及條碼，亦不得書寫考生姓名、應考證號碼或與答案無關之任何文字或符號。
- 不可使用計算機，並不得攜帶書籍、紙張(應考證不得做計算紙書寫)、具有通訊、記憶、傳輸或收發等功能之相關電子產品或其他有礙試場安寧、考試公平之各類器材入場。
- 試題及答案卡請務必繳回，未繳回者該科成績以零分計算。
- 試題採雙面列印，考生應注意試題頁數確實作答。
- 違規者依本校招生考試試場規則及違規處理辦法處理。

國立中山大學113學年度學士後醫學系招生考試試題

科目名稱：物理與化學

※本科目依簡章規定「不可以」使用計算機(選擇題)

選擇題(單一選擇題，共90題，總分150分)

壹、第1~30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。

Unit	Abbreviation
newton	*N*
meter	*m*
second	*s*
kilogram	*kg*
radian	*rad*
joule	*J*
coulomb	*Coul*
volt	*V*
mole	*mol*
tesla	*T*
kelvin	*K*

1. Newton's law of gravitational force is represented by $F = GMm/r^2$. What is the dimension of the gravitational constant G?
(A) $kg{\cdot}m^3{\cdot}s^{-2}$ (B) $kg^{-1}{\cdot}m{\cdot}s^{-2}$ (C) $kg{\cdot}m^2{\cdot}s^{-2}$ (D) $kg{\cdot}m{\cdot}s^{-2}$ (E) $kg^{-1}{\cdot}m^3{\cdot}s^{-2}$
Ans: (E)

2. The numerical value of the Boltzmann constant is $k_B = 1.38 \times 10^{-23}$. Which of the following units is a correct unit of the Boltzmann constant k_B ?
(A) K^{-2} (B) JK^{-1} (C) $JK^{-1}\,mol^{-1}$ (D) JK^{-2} (E) K^{-1}
Ans: (B)

3. Bernoulli's equation results from which conservation law?
(A) conservation of electric charge (B) linear momentum conservation
(C) angular momentum conservation (D) energy conservation
(E) no relation to the above conservation
Ans: (D)

4. Which of the following statements of gravitational force is wrong?
(A) It is a conservative force.
(B) Objects with masses always attract each other.
(C) It obeys Newton's third law.
(D) The value of gravitational constant G is different on the moon.
(E) All of the above are correct.
Ans: (D)

5. Which of the following statements of lenses is true?
(A) Nearsighted glasses use concave lenses.
(B) Farsighted glasses use concave lenses.
(C) Simple magnifying glass uses concave lenses.
(D) All of the above.
(E) None of the above.
Ans: (A)

6. An object is placed *2f* away from a thin and double convex lens of focal length *f*. Which of the following descriptions on its image is true?
(A) erect, real, and magnified
(B) inverted, virtual, and reduced
(C) inverted, real, and the same size
(D) erect, virtual, and magnified
(E) inverted, real, and reduced
Ans: (C)

7. Order the following electromagnetic waves by wavelengths from the shortest to the longest: (i) visible light, (ii) radio waves, (iii) infrared light, (iv) ultraviolet light, (v) x-ray.
(A) (v) < (ii) < (i) < (iv) < (iii)
(B) (v) < (iv) < (i) < (iii) < (ii)
(C) (iii) < (i) < (iv) < (ii) < (v)
(D) (v) < (iv) < (iii) < (i) < (ii)
(E) (iii) < (i) < (iv) < (v) < (ii)
Ans: (B)

8. According to the laws of thermodynamics, which of the following statements is correct?
(A) Thermodynamic perpetual machine is possible.
(B) Heat always flows from a colder to a hotter object.
(C) The entropy of an isolated system never decreases.
(D) All thermodynamic processes are reversible.
(E) Work done on a system is always greater than the heat added.
Ans: (C)

9. Which of the following statements about absolute pressure P, gauge pressure P_G and atmospheric pressure P_0 is true?
(A) P is the same as P_G at 273 K.
(B) $P_0 + P_G$ is the absolute pressure P.
(C) Gauge pressure P_G is always positive.
(D) Absolute pressure P is the atmospheric pressure P_0 at 15°C.
(E) None of the above.
Ans: (B)

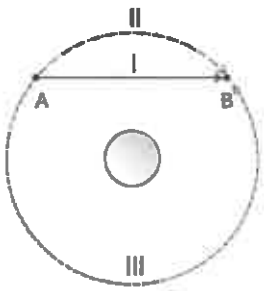
10. Which of the following gases would exhibit a more narrow Maxwell-Boltzmann speed distribution at a given temperature?
(A) Hydrogen (H_2)　(B) Oxygen (O_2)　(C) Nitrogen (N_2)
(D) Helium (He)　(E) Argon (Ar)
Ans: (E)

11. Which of the following descriptions of electrons is correct?
(A) Electrons are massless.
(B) Electrons are positively charged.
(C) Electrons can travel at the speed of light.
(D) Electrons obey the Pauli exclusion principle.
(E) None of the above.
Ans: (D)

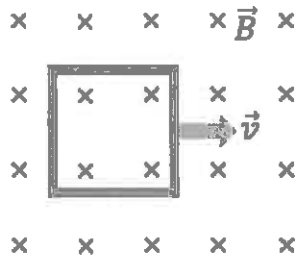
12. Under what condition does the magnetic force on a charged particle perform work?
(A) When the particle moves parallel to the magnetic field.
(B) When the particle moves perpendicular to the magnetic field.
(C) When the particle moves at an angle to the magnetic field.
(D) When the magnetic field is non-uniform.
(E) None of the above.
Ans: (E)

13. According to Lenz's law, when changing the magnetic flux through a coil, the direction of the induced current in a coil is such that it…
(A) opposes the change in magnetic flux.　(B) supports the change in magnetic flux.
(C) depends on the resistance of the coil.　(D) is unrelated to the magnetic flux.
(E) aligns with the magnetic flux.
Ans: (A)

14. See the right figure, there is a metallic sphere, on which a constant electric potential is applied. A charged particle moves from point A to point B through three different kinds of paths denoted as I, II, and III. Through which path does the particle gain the most electric energy?
(A) I　(B) II　(C) III　(D) All the same
(E) It depends on the sign of the charge.
Ans: (D)



15. Refer to the figure. A conducting loop (square coil of wire) is pulled at constant velocity through a uniform magnetic field entering the plane. Which of the following statements is correct?
(A) Current is induced in the loop in the clockwise direction.
(B) Current is induced in the loop in the counterclockwise direction.
(C) Alternating current is induced in the loop.
(D) Charge separation occurs; negative charges are accumulated at the bottom edge.
(E) Charge separation occurs; negative charges are accumulated at the top edge.
Ans: (D)



16. The coordination geometry of $Cr(NO)_4$ is _____.
(A) tetrahedral　(B) trigonal pyramidal　(C) see-saw
(D) square planar　(E) none of the above
Ans: (A)

17. What type of high energy bonds are found in ATP and ADP?
(A) carboxylic anhydride　(B) phosphodiester　(C) thioester
(D) phosphoanhydride　(E) amine
Ans: (D)

18. Consider the second-order reaction A → products, which has a first half-life of 25 s. If the concentration of A after 15.6 s is 0.36 M, determine the initial concentration of A.
(A) 0.58 M　(B) 0.26 M　(C) 0.53 M　(D) 0.14 M　(E) 0.16 M
Ans: (A)

19. Which of the following is the reason for minimum chemical interferences in inductively-coupled plasma?
(A) Zeeman effect correction　(B) high ionization efficiency
(C) high temperature　(D) large number of emission lines
(E) none of the above
Ans: (C)

20. The point group of H_2O_2 is _____.
(A) C_2　(B) C_{2v}　(C) C_3　(D) C_{3v}　(E) none of the above
Ans: (A)

21. The C-O bond order of CO^- is _____.
(A) 1　(B) 1.5　(C) 2　(D) 2.5　(E) 3
Ans: (D)

22. The reaction A → B + C is known to be zero order in A with a rate constant of 4.8×10^{-2} mol/L · s at 25°C. An experiment was run at 25°C where $[A]_0 = 4.0$ M. What is the concentration of B after 5.0s?
(A) 1.7 M　(B) 4.5×10^{-1} M　(C) 3.0 M　(D) 1.1×10^{-1} M　(E) 2.4×10^{-1} M
Ans: (E)

23. Which of the following statements is/are true?
I. An excited atom can return to its ground state by absorbing electromagnetic radiation.
II. The energy of an atom is increased when electromagnetic radiation is emitted from it.
III. The energy of electromagnetic radiation increases as its frequency increases.
IV. An electron in the n = 4 state in the hydrogen atom can go to the n = 2 state by emitting electromagnetic radiation at the appropriate frequency.
V. The frequency and wavelength of electromagnetic radiation are inversely proportional to each other.
(A) III, V　(B) II, III, IV　(C) I, II, IV　(D) I, II, III　(E) III, IV, V
Ans: (E)

24. How many electrons can be described by the quantum numbers $n = 4$, $l = 4$, $m_l = 1$?
(A) 14　(B) 6　(C) 10　(D) 0　(E) 2
Ans: (D)

25. The concentration of OH^- ions in a solution is 5.62 mM. Determine the pH of the solution.
(A) 11.7　(B) 2.2　(C) 14.7　(D) 13.3　(E) 5.6
Ans: (A)

26. In which of the following techniques are we measuring the amount of light absorbed as a function of wavelength?
(A) atomic absorption spectroscopy
(B) X-ray diffraction
(C) inductively coupled plasma-optical emission spectrometry (ICP-OES)
(D) gas chromatography
(E) none of the above
Ans: (A)

27. A gas releases 2.0 J of heat and then performs 11.8 J of work. What is the change in the internal energy of the gas?
(A) –13.8 J (B) 9.8 J (C) –9.8 J (D) 2.0 J (E) 13.8 J
Ans: (A)

28. The pK_b of the base cyclohexamine, $C_6H_{11}NH_2$, is 3.36. What is the pK_a of the conjugate acid, $C_6H_{11}NH_3^+$? (K_w=1.0 × 10^{-14} at 25°C)
(A) 3.36 (B) 14.00 (C) 10.64 (D) 7.64 (E) –10.64
Ans: (C)

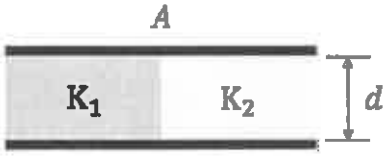
29. Ellipsometry is commonly used to measure the thickness of films. Which of the following signal is detected in ellipsometry?
(A) resonance angle (B) reflected laser spot (C) second-harmonic generation
(D) polarized light (E) none of the above
Ans: (D)

30. Which of the following is not a feature of carrier gas used in gases chromatography?
(A) The carrier gas should be chemically inert.
(B) The carrier gas should be inexpensive.
(C) The purity of carrier gas should not be very high.
(D) The carrier gas should be suitable for the detector employed.
(E) None of the above.
Ans: (C)

貳、第31～90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. Determine the correct unit and magnitude of the electric field at distance x from the midpoint of a very long line of uniformly distributed positive charge. Assume x is much smaller then the length of the wire, and let λ be the charge per unit length.
(A) $\frac{1}{2\pi\epsilon_0}\frac{\lambda}{x}$, unit (V/m) (B) $\frac{1}{2\pi\epsilon_0}\frac{\lambda}{x^2}$, unit (V/m) (C) $\frac{1}{2\pi\epsilon_0}\frac{\lambda}{x^2}$, unit (V/m^2)
(D) $\frac{1}{2\pi\epsilon_0}\frac{\lambda}{x}$, unit (V/m^2) (E) $\frac{1}{2\pi\epsilon_0}\frac{\lambda}{x^{1/2}}$, unit (V/m)
Ans: (A)

32. The plates of a parallel-plate capacitor have area A and separation d. Two different dielectrics each fill half the space between the plates of a parallel-plate capacitor (as shown in figure). Determine the correct unit and the capacitance in terms of K_1, K_2, the area A of the plates, and the separation d, where K_1 and K_2 are the dielectric constants of two dielectrics. ϵ_0 is the vacuum permittivity.
(A) $\frac{\epsilon_0 A}{2d}(K_1+K_2)$, unit (Coul/V)
(B) $\frac{2\epsilon_0 A}{d}(K_1+K_2)$, unit (Coul/V)
(C) $\frac{2\epsilon_0 A}{d}(K_1+K_2)$, unit (V/Coul)
(D) $\frac{\epsilon_0 A}{2d}(K_1+K_2)$, unit (V/Coul)
(E) $\frac{\epsilon_0 A}{d}(K_1+K_2)$, unit (Coul/V)
Ans: (A)



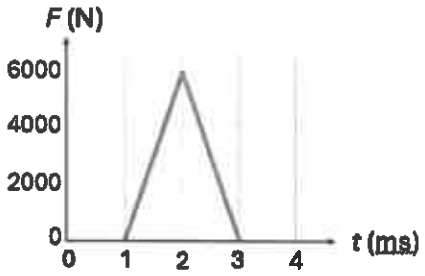
33. A system comprises three particles with masses of 2.0 kg, 3.0 kg, and 5.0 kg, respectively. A force $\mathbf{F} = 3.0\boldsymbol{i} + 4.0\boldsymbol{j}$ (N) acts on the 2.0-kg particle, where $\boldsymbol{i}$ and $\boldsymbol{j}$ are unit vectors that point along x and y coordinate axes, respectively. What is the acceleration of the center of mass $\boldsymbol{a}_c$ caused by the force?
(A) $\boldsymbol{a}_c = 0.30\boldsymbol{i} + 0.40\boldsymbol{j}\ (m/s^2)$
(B) $\boldsymbol{a}_c = 0.60\boldsymbol{i} + 0.80\boldsymbol{j}\ (m/s^2)$
(C) $\boldsymbol{a}_c = 3.0\boldsymbol{i} + 1.0\boldsymbol{j}\ (m/s^2)$
(D) $\boldsymbol{a}_c = 3.0\boldsymbol{i} + 4.0\boldsymbol{j}\ (m/s^2)$
(E) $\boldsymbol{a}_c = 15\boldsymbol{i} + 20\boldsymbol{j}\ (m/s^2)$
Ans: (A)

34. Assume that a satellite of mass M orbits Earth in a perfect circle of radius R. If the satellite is replaced with another one with mass $2M$ but with the same circling radius, what is the ratio of the period of the first satellite to the period of the second one (i.e., T_1/T_2)?
(A) 1/2　(B) $1/\sqrt{2}$　(C) 1　(D) $\sqrt{2}$　(E) 2
Ans: (C)

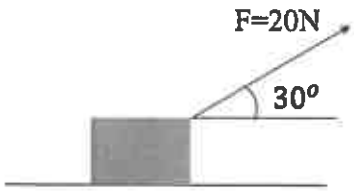
35. A 5.0-kg block moves with velocity $\boldsymbol{v} = 3.0\boldsymbol{i} + 5.0\boldsymbol{j}$ (m/s) on a horizontal surface of coefficient of kinetic friction $\mu = 0.30$, where $\boldsymbol{i}$ and $\boldsymbol{j}$ are unit vectors that point along the x and y coordinate axes, respectively. When the block comes to rest, what is the total thermal energy increased?
(A) 1.2×10^2 J　(B) 63 J　(C) 38 J　(D) 26 J　(E) 85 J
Ans: (E)

36. A wheel rotates initially at a rate of 10 rad/s and begins to accelerate at a rate of 2 rad/s^2. After 3 seconds the rate of the rotation will be
(A) 6 rad/s　(B) 9 rad/s　(C) 10 rad/s　(D) 16 rad/s　(E) 19 rad/s
Ans: (D)

37. A force-time curve for a ball struck by a bat is shown in the figure. What is the impulse on the ball?
(A) 12000 (N·s)　(B) 6000 (N·s)　(C) 3000 (N·s)
(D) 6 (N·s)　(E) 3 (N·s)
Ans: (D)

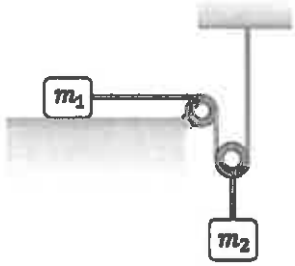


38. A force of 20 N acts on a wagon at an angle of 30° to the ground. Calculate the work done by the force when the wagon is dragged 100 m along the ground.
(A) 600 J　(B) 800 J　(C) 100 J
(D) 1300 J　(E) 1700 J
Ans: (E)



39. Calculate the recoil velocity of a 5-kg rifle that shoots a 0.02-kg bullet at a speed of 620 (m/s).
(A) −10 m/s　(B) −5 m/s　(C) −2.5 m/s　(D) −1.25 m/s　(E) −1 m/s
Ans: (C)

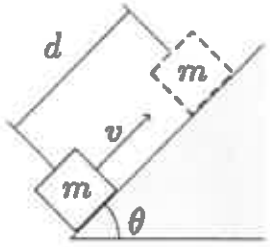
40. Neglect the friction and weights of pulleys and cord in the figure. The body of mass m_2 is falling down with aceeleration $a_2 = g/2$. What is the mass ratio m_2/m_1?



(A) 1　(B) 3/2　(C) 2　(D) 5/2　(E) 4

Ans: (E)

41. A block of mass m was placed on a surface (coefficient of kinetic friction μ) with an inclined angle θ. The block is initially moving uphill with speed v. What is the total distance d the block moves before the block goes downhill or stops?

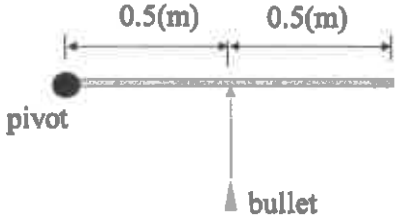


(A) $\frac{v^2}{2g}$　(B) $\frac{v^2}{2g(sin^2\theta+\mu cos^2\theta)}$　(C) $\frac{v^2}{g}$

(D) $\frac{v^2}{2g(sin\theta+\mu cos\theta)}$　(E) $\frac{v^2 sin^2\theta}{g}$

Ans: (D)

42. A uniform stick 1.0 m long with total mass 15 kg rests on a frictionless table and is pivoted at its end. The uniform stick rotates freely about this pivot. A bullet with a mass of 10 g and a speed of 400 m/s strikes the center of the stick, in a direction perpendicular to the stick and embeds itself there. Find the stick's angular speed.



(A) 0.1 rad/s　(B) 0.4 rad/s　(C) 0.6 rad/s

(D) 0.2 rad/s　(E) 0.8 rad/s

Ans: (B)

43. One quarter of a circular loop of wire carries a current I. The current I enters and leaves on straight segments of wire. The straight wires are along the radial direction from the center of the circular portion. Find the magnetic field at the center of the circular.

(A) $\frac{\mu_0 I}{2R}$　(B) $\frac{\mu_0 I}{4R}$　(C) $\frac{\mu_0 I}{8R}$　(D) $\frac{\mu_0 I}{16R}$　(E) $\frac{\mu_0 I}{32R}$

Ans: (C)

44. A capacitor C is fully charged by a dc power supply so that one plate has charge Q_0. It is disconnected from the power supply and is connected to a inductor L, which results in an electrical oscillation. What is the angular frequency ω of the oscillation and its maximum current I_0?

(A) $\omega = \frac{L}{C}$, $I_0 = \frac{L}{C}Q_0^2$　(B) $\omega = \frac{C}{L}$, $I_0 = \frac{Q_0}{LC}$　(C) $\omega = \frac{1}{\sqrt{LC}}$, $I_0 = \frac{Q_0}{\sqrt{LC}}$

(D) $\omega = \frac{\sqrt{LC}}{2\pi}$, $I_0 = Q_0\sqrt{LC}$　(E) $\omega = \frac{1}{2\pi}\sqrt{\frac{C}{L}}$, $I_0 = \frac{1}{2\pi}\sqrt{\frac{C}{L}}Q_0^2$

Ans: (C)

45. What is the average translational kinetic energy of molecules in an ideal gas at 37°C?

(A) 1.3×10^{-21} J　(B) 2.6×10^{-21} J　(C) 4.2×10^{-21} J　(D) 5.2×10^{-21} J　(E) 6.4×10^{-21} J

Ans: (E)

46. In human, blood flows from the heart into the aorta, from which it passes into the major arteries. These branch into the small arteries (arterioles), which in turn branch into myriads of tiny capillaries. The radius of the aorta is about 1.2 cm, and the blood passing through it has a speed of about 40 cm/s. A typical capillary has a radius of about 4×10^{-4} cm, and blood flows through it at a speed of about 5×10^{-4} m/s. Estimate the number of capillaries that are in the body.
(A) 1×10^{9} (B) 3×10^{9} (C) 5×10^{9} (D) 7×10^{9} (E) 9×10^{9}
Ans: (D)

47. An electron travels at 2×10^{7} m/s in a plane perpendicular to a uniform 0.01 T magnetic field. What is the radius of the travel path? (electron mass = 9.1×10^{-31} kg, charge on electron = 1.6×10^{-19} *Coul*)
(A) 5.2 cm (B) 3.8 cm (C) 2.1 cm (D) 1.1 cm (E) 0.5 cm
Ans: (D)

48. A soap bubble appears green (wavelength:540 nm) at the point on its front surface nearest the viewer. What is the smallest thickness the soap bubble film could have? Assume that the index of refraction of the soap film is n=1.35.
(A) 100 nm (B) 150 nm (C) 200 nm (D) 250 nm (E) 300 nm
Ans: (A)

49. An engine's heat input per second is 8.0 kJ at 500 K reservoir and output per second is 4.0kJ at 300 K reservoir. What is the Carnot efficiency of this engine?
(A) 20% (B) 40% (C) 50% (D) 80% (E) none of the above
Ans: (B)

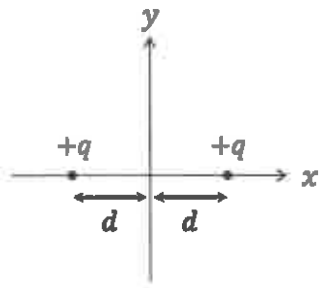
50. For a car traveling with speed v around a curve of radius r, determine a formula for the angle θ, at which a road should be banked so that no friction is required.
(A) $sin\theta = \frac{v^2}{rg}$ (B) $cos\theta = \frac{v^2}{rg}$ (C) $tan\theta = \frac{v^2}{rg}$ (D) $cot\theta = \frac{v^2}{rg}$ (E) 0
Ans: (C)

51. Calcualte the moment of inertia of a hollow cylinder when the rotational axis is through the center. The inner radius is R_1 and outer radius is R_2? The total mass of the hollow cylinder is M.
(A) $\frac{1}{3}M(R_1^2+R_2^2)$ (B) $\frac{1}{4}M(R_2^2-R_1^2)$ (C) $\frac{1}{2}M(R_2-R_1)^2$
(D) $\frac{1}{2}M(R_1^2+R_2^2)$ (E) $M(R_1+R_2)^2$
Ans: (D)

52. Consider a parallel-plate capacitor. Each plate has area A. One plate carries a uniform surface charge density σ and the other carries a uniform surface charge density –σ. Each plate of a parallel-plate capacitor exerts a force F on the other. Calculate the force.
(A) $\frac{\sigma^2}{2\epsilon_0}$ (B) $\frac{\sigma^2}{2\epsilon_0 A}$ (C) $\frac{\sigma A}{\pi\epsilon_0}$ (D) $\frac{\sigma^2 A}{2\epsilon_0}$ (E) $\frac{2\sigma}{\epsilon_0 A}$
Ans: (D)

53. An observer is moving with speed u toward a stationary source which emits sound waves of frequency f. What is the frequency f' heard by the observer? Assume the speed of sound to be v.
(A) $f'=f$ (B) $f'=\left(\frac{v+u}{v}\right)f$ (C) $f'=\left(\frac{v}{v+u}\right)f$
(D) $f'=\left(\frac{v+u}{v-u}\right)f$ (E) $f'=\left(\frac{v-u}{v+u}\right)f$
Ans: (B)

54. Two charges ($+q$) are located on the x axis as the figure shows. What is the resulting electric field at points on the y axis?



(A) $\frac{-1}{4\pi\epsilon_0}\frac{2qd}{\sqrt{d^2+y^2}}i$　(B) $\frac{-1}{4\pi\epsilon_0}\frac{2qd}{(d^2+y^2)^{3/2}}i$

(C) $\frac{1}{4\pi\epsilon_0}\frac{2qy}{(d^2+y^2)^{3/2}}j$　(D) $\frac{1}{4\pi\epsilon_0}\frac{2qy}{\sqrt{d^2+y^2}}j$　(E) 0

Ans: (C)

55. An ice skater with rotational inertia I and angular speed ω pulls his arms in and increases his angular speed to 3ω. Calculate the change in kinetic energy.

(A) $\frac{9}{2}I\omega^2$　(B) $\frac{3}{2}I\omega^2$　(C) $\frac{1}{2}I\omega^2$　(D) $I\omega^2$　(E) $\frac{1}{4}I\omega^2$

Ans: (D)

56. A cylindrical container with a radius of $2R$ and a height of $2R$ contains liquid with a density of ρ, filling 17/18 of its volume. When a plastic ball of radius R is placed in the liquid, the liquid perfectly fills the container without any liquid spilled out. What is the density of the plastic ball in terms of ρ?

(A) $\rho/4$　(B) $\rho/3$　(C) $\rho/2$　(D) $3\rho/4$　(E) $2\rho/3$

Ans: (B)

57. An object travelling at constant speed v in a circle of radius R has an acceleration a. If both R and v are doubled, the acceleration will change to

(A) a　(B) 2a　(C) 4a　(D) 8a　(E) a/2

Ans: (B)

58. Two samples of the same ideal gas have the same volume and density. Sample B has twice the presure of sample A. What is the root-mean-square speed of the molecules in sample B?

(A) same as that in sample A　(B) twice that in sample A　(C) half that in sample A

(D) $\sqrt{2}$ times that in sample A　(E) insufficient information to determine

Ans: (D)

59. Given a traveling sinusoidal wave, $y(x,t) = A\,sin(kx - \omega t + \varphi)$. What are the wavelength and frequency of the wave?

(A) wavelength:1/k, frequency:1/ω　(B) wavelength: k/(2π), frequency: 2π/ω

(C) wavelength: 2π/k, frequency: 2π/ω　(D) wavelength: 2πk, frequency: 2πω

(E) wavelength: 2π/k, frequency: ω/(2π)

Ans: (E)

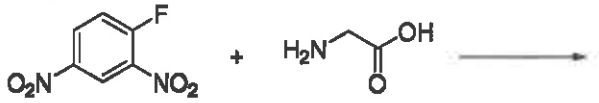
60. If the wavelength of light is increased in a single-slit diffraction experiment, what happens to the angular width of the central maximum?

(A) It increases.　(B) It decreases.　(C) It remains constant.

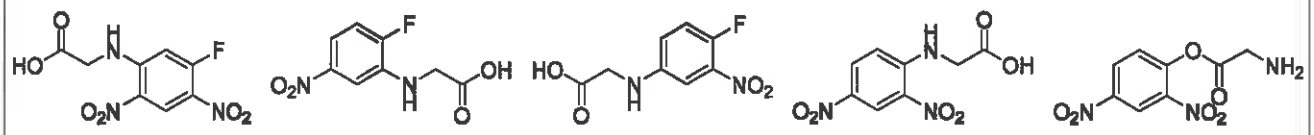
(D) It becomes zero.　(E) It depends on the slit width.

Ans: (A)

61. Sanger's reagent (shown below) is a chemical used for protein sequencing. This reagent works by reacting with the N-terminal amino acid of polypeptides. Which is the product formed when Sanger's reagent is reacted with Glycine?



Sanger's reagent　　Glycine



(A)　(B)　(C)　(D)　(E)

Ans: (D)

62. The highest occupied molecular orbital of ferrocene is _____.
(A) d_{x2-y2}　(B) d_{z2}　(C) d_{x2-y2}, d_{z2}　(D) d_{xy}, d_{xz}, d_{yz}　(E) none of the above
Ans: (B)

63. The number of unpaired electrons in nickelocene is _____.
(A) 0　(B) 1　(C) 2　(D) 3　(E) none of the above
Ans: (C)

64. Which of the following are isolobal fragments?
(A) CH^- and $Ni(CO)_3$　(B) CH_2^+ and $Fe(CO)_3$　(C) CH_3^- and $[Cu(CO)_2]^+$
(D) CH_4 and $[Co(CO)_4]^+$　(E) none of the above
Ans: (A)

65. What is the valence electron configuration of S?
(A) $3s^23p^4$　(B) $4s^24p^4$　(C) $1s^22s^22p^63s^23p^4$　(D) $1s^22s^22p^4$　(E) none of the above
Ans: (A)

66. Which of the following statements about adiabatic processes is/are true?
I. In an adiabatic process, no energy such as heat flows into or out of the system.
II. An adiabatic process occurs when there is thermal conductivity between a system and its surrounding.
III. For an adiabatic process, q = 0 and ΔE = w.
(A) I only　(B) II only　(C) III only　(D) I and II　(E) I and III
Ans: (E)

67. $\Delta H°$ and $\Delta S°$ for the vaporization of $Br_2(l)$ at 25°C and 1 atm are 30.8 kJ/mol and 92.8 J/K·mol, respectively. Assuming $\Delta H°$ and $\Delta S°$ are temperature independent, calculate the normal boiling point of bromine.
(A) 25°C　(B) 332°C　(C) 0°C　(D) 332 K　(E) none of the above
Ans: (D)

68. Which technique used for the separation of compounds is based on the different electrostatic interactions between the stationary phase and solutes.
(A) ion exchange chromatography (B) solvent extraction (C) paper chromatography
(D) distillation (E) none of the above
Ans: (A)

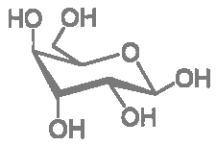
69. Compound A on ozonolysis yields acetophenone and propanal. What is the structure of compound A?

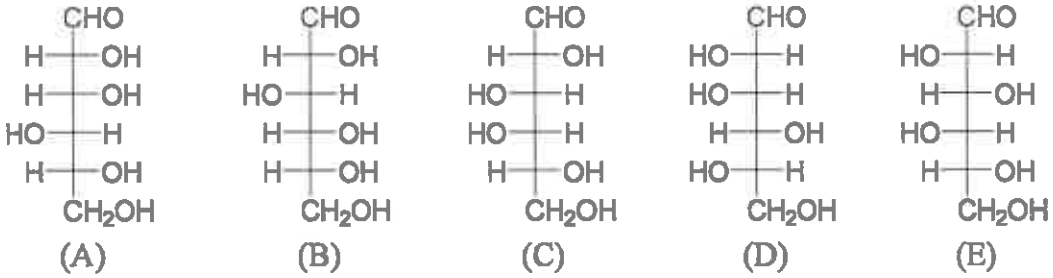
$$\text{Compound A} \xrightarrow[2.\ (CH_3)_2S]{1.\ O_3} \text{Acetophenone} + \text{propanal}$$

(A) 2-phenyl-2-pentene (B) 1-phenyl-1-hexene (C) 1-phenyl-2-pentene
(D) 2-phenyl-2-hexene (E) none of the above
Ans: (A)

70. What compound is formed when 2,2-dimethyloxirane is treated with ethanol containing a trace of HCl?
(A) 2-ethoxy-2-methyl-1-propanol (B) 1-ethoxy-2-methyl-2-propanol
(C) 2-ethoxy-2-methyl-2-propanol (D) 2-ethoxy-1-butanol
(E) 1-ethoxy-2-butanol
Ans: (A)

71. Identify the C3 epimer of the sugar on the right drawn in its open chain (acyclic) Fischer projection.





Ans: (C)

72. A first-row transition metal complex $[M(H_2O)_6]^{2+}$ has the ligand field stabilization energy of $-0.6\Delta_o$, M = _____.
(A) Ti (B) V (C) Cr (D) Mn (E) none of the above
Ans: (C)

73. The ground term of a free carbon atom is _____.
(A) ^1S (B) ^2S (C) ^1P (D) ^3P (E) none of the above
Ans: (D)

74. Among the following compounds, which has the highest C–O stretching frequency?
(A) $[Ti(CO)_6]^{2-}$ (B) $[V(CO)_6]^{-}$ (C) $[Cr(CO)_6]$ (D) $[Mn(CO)_6]^{+}$ (E) $[Fe(CO)_6]^{2+}$
Ans: (E)

75. How many C–O stretching bands does *fac*-$Mo(CO)_3(PF_3)_3$ give in its IR spectrum?
(A) 0 (B) 1 (C) 2 (D) 3 (E) none of the above
Ans: (C)

76. Which of the following elements plays an important role in Suzuki coupling reactions?
(A) Ag (B) B (C) Cu (D) Sn (E) Zn
Ans: (B)

77. Which of the following is the most representative element in Wilkinson's hydrogenation catalyst?
(A) Fe (B) Co (C) Ni (D) Pd (E) Rh
Ans: (E)

78. The activation energy for the reaction $H_2(g) + I_2(g) \rightarrow 2\ HI(g)$ is changed from 184 kJ/mol to 59 kJ/mol at 600 K by the introduction of a Pt catalyst. Calculate the value of the ratio rate(catalyzed)/rate(uncatalyzed).
(A) 1.00 (B) 0.32 (C) 2.58 (D) 7.6×10^{10} (E) none of the above
Ans: (D)

79. At a particular temperature, the half-life of a zero-order reaction is 29.0 min. How long will it take for the reactant concentration to deplete to 1/8 of the initial concentration?
(A) 87.0 min (B) 58.0 min (C) 50.8 min (D) 232 min (E) 203 min
Ans: (C)

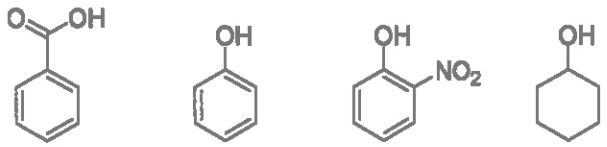
80. The reaction, $2H_2O(g) \rightarrow 2H_2(g) + O_2(g)$, has a positive value for $\Delta G°$. Which of the following statements must be true?
(A) The reaction is slow.
(B) The reaction will not occur. That is, when $H_2O(g)$ is introduced into a flask, no O_2 or H_2 will form even over a long period of time.
(C) The equilibrium lies far to the right.
(D) The reaction is exothermic.
(E) None of these are true.
Ans: (E)

81. Why does the pH value affect the separation of amino acids by electrophoresis? Please choose the wrong reason.
(A) Amino acids exist as zwitterions.
(B) At low pH values, the amino acid molecules will be strongly attracted to the negative electrode.
(C) At high pH values, the amino acid molecules will be strongly attracted to the negative electrode.
(D) In basic solution, the net charge is negative due to the dissociation of the carboxylic acid groups.
(E) None of the above.
Ans: (C)

82. What is a virtual state in Raman spectroscopy? Please choose the correct description.
(A) It helps us to visualize both elastic and inelastic scattering processes.
(B) It lies between the ground state and a vibrational state of the molecule.
(C) It is also a first vibrational state.
(D) It is a real electronic energy state.
(E) None of the above.
Ans: (A)

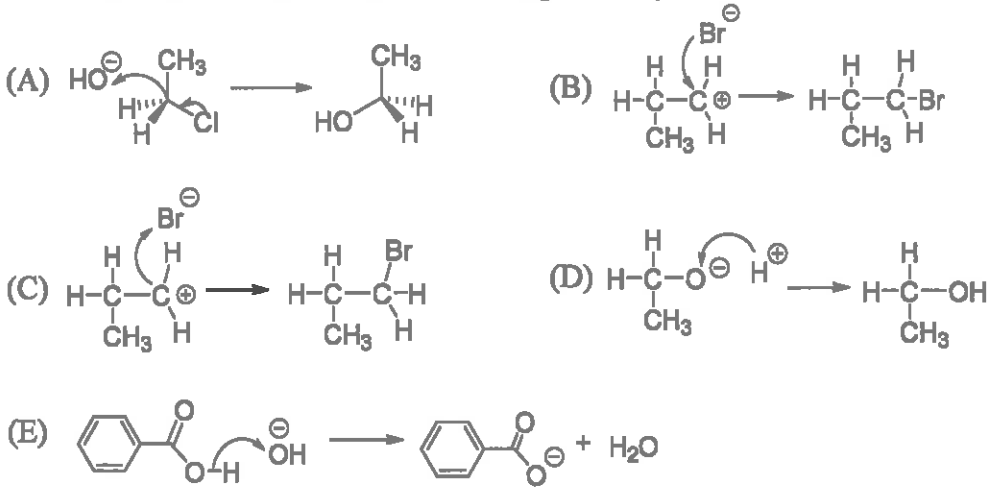
83. Sort the following compounds in decreasing order by their pK_a values(from highest to lowest).

(A) I > II > III > IV
(B) IV > III > II > I
(C) IV > II > III > I
(D) III > I > II > IV
(E) I > III > II > I
Ans: (C)



I　　II　　III　　IV

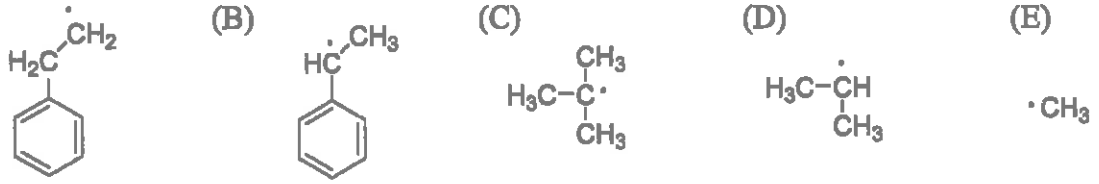
84. Which of the reactions below shows the correct usage of curly arrows?



Ans: (B)

85. Which of the following radicals is the most stable?

(A)　(B)　(C)　(D)　(E)



Ans: (B)

86. Disulfide linkages can form between _____.

(A) two cysteine residues　　(B) two methionine residues
(C) a cysteine residue and a methionine residue　　(D) two threonine residues
(E) a methionine residue and a threonine residue
Ans: (A)

87. What is the electron configuration for the barium atom?

(A) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$　　(B) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1$　　(C) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2$
(D) [Xe] $6s^2$　　(E) $1s^2 2s^2 2p^6 3s^2$
Ans: (D)

88. Choose the correct statement.
(A) A reaction that exhibits a negative value of ΔS cannot be spontaneous.
(B) Exothermic reactions are always spontaneous.
(C) Free energy is independent of temperature.
(D) At constant pressure and temperature, a decrease in free energy ensures an increase in the entropy of the system.
(E) None of the above.
Ans: (E)

89. Which of the following statements is true about the ionization energy of Mg^+?
(A) It will be equal to the negative value of the electron affinity of Mg.
(B) It will be equal to the negative value of the electron affinity of Mg^+.
(C) It will be equal to the ionization energy of Li.
(D) It will be equal to the negative value of the electron affinity of Mg^{2+}.
(E) None of the above.
Ans: (D)

90. Please choose the correct description for confidence level.
(A) Confidence level is the probability that the sample mean lies within a certain interval.
(B) Confidence level is the probability that the true mean lies within a certain interval.
(C) Confidence level is the range of values within which the population mean is expected to lie with a certain probability.
(D) Confidence level is the range of values within which the true value is expected to lie with a certain probability.
(E) None of the above.
Ans: (B)