

國立中山大學 112 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)

共 14 頁第 1 頁

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。

1. Which equation may describe a damped harmonic oscillator? x is for the displacement of the body and m, b, k are all positive real.

- (A) $m \frac{d^2x}{dt^2} - kx = 0$
 (B) $m \frac{d^2x}{dt^2} - kx - b \frac{dx}{dt} = 0$
 (C) $m \frac{d^2x}{dt^2} + kx - b \frac{dx}{dt} = 0$
 (D) $m \frac{d^2x}{dt^2} - kx + b \frac{dx}{dt} = 0$
 (E) $m \frac{d^2x}{dt^2} + kx + b \frac{dx}{dt} = 0$

Ans: (E)

2. In the process of free expansion of an isolated ideal gas, which statement is incorrect?

- (A) The gas gets cooler.
 (B) The gas does not do work.
 (C) The gas does not absorb heat.
 (D) The process is irreversible.
 (E) The entropy of the system changes.

Ans: (A)

3. An electron travels in a uniform magnetic field directed perpendicular to its path. Which of the following quantity of the electron will change?

- (A) Its speed.
 (B) Its potential energy.
 (C) Its kinetic energy.
 (D) Its acceleration.
 (E) All of the above.

Ans: (D)

4. Which statement of the energy carried by a photon is WRONG?

- (A) It is proportional to the photon frequency.
 (B) It is inversely proportional to the photon wavelength.
 (C) It is proportional to the photon mass.
 (D) All of the above are correct.
 (E) All of the above are wrong.

Ans: (C)

5. A 1000 kg car traveling north at 15 m/s collides with a 2000 kg truck traveling east at 10 m/s. The two vehicles move away from the impact point as one. What is the velocity of the wreckage just after impact?

- (A) 0 m/s (B) 8.3 m/s (C) 5.0 m/s (D) 6.6 m/s (E) 1.7 m/s

Ans: (B)

6. When a mass attached to a spring is stretched by an amount x away from its equilibrium position, it oscillates with frequency f . What is the oscillation frequency if the mass is instead released $2x$ from its

國立中山大學 112 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)

共 14 頁第 2 頁

equilibrium position?

- (A)
- $f/2$
- (B)
- f
- (C)
- $\sqrt{2}f$
- (D)
- $2f$
- (E)
- $4f$

Ans: (B)

7. Two waves

$$y_1 = (3.0 \text{ cm}) \cos \frac{\pi}{2} [(2.0 \text{ m}^{-1})x + (5.0 \text{ s}^{-1})t],$$

$$y_2 = (3.0 \text{ cm}) \cos \frac{\pi}{2} [(2.0 \text{ m}^{-1})x - (5.0 \text{ s}^{-1})t],$$

are sent to a long string to create a standing wave. Let x be positive ($x \geq 0$). Where is the first node (the smallest value of x)?

- (A) 5 cm (B) 10 cm (C) 50 cm (D) 100 cm (E) 200 cm

Ans: (C)

8. A spherical ball contains a charge $+q$ uniformly distributed over its surface. When its diameter is D , the electric field at its surface has magnitude E . What will the electric field be if its diameter changes to $2D$ without changing the charge?

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

Ans: (E)

9. What is the total energy supplied while the current increases from zero to a final value I ? Assume L is the inductance.

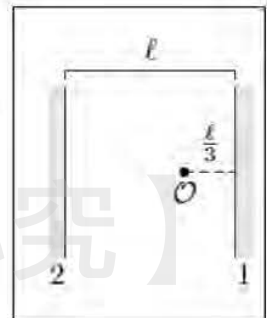
- (A)
- $\frac{1}{2}LI^2$
- (B)
- LI^2
- (C)
- $2LI^2$
- (D)
- $\frac{1}{4}LI^2$
- (E)
- $4LI^2$

Ans: (A)

10. An object O is placed between two mirrors of distance ℓ apart. If object O is distance $\ell/3$ away from mirror 1 (see the right figure), what is the distance of the second closest image of object O that appears in mirror 1? (Hint: The closest one is $\ell/3$.)

- (A)
- $\ell/3$
- (B)
- $2\ell/3$
- (C)
- ℓ
- (D)
- $4\ell/3$
- (E)
- $5\ell/3$

Ans. (E)



11. Which of the following statements on radioactive decays is true?

- (A) The rate of decay ($\frac{dN}{dt}$) is proportional to the number of undecayed substance.
- (B) The rate of decay ($\frac{dN}{dt}$) is proportional to the half-life of the undecayed substance.
- (C) The decay constant is proportional to the half-life of the undecayed substance.
- (D) The half-life of a substance decreases with time.
- (E) None of the above.

Ans. (A)

國立中山大學 112 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)

共 14 頁第 3 頁

12. A force produces potential $U(x) = ax^4$, where $a = 1.43 \text{ J/m}^4$. What is the force and direction when the particle is at $x = -0.78 \text{ m}$?
 (A) 0 N
 (B) -0.67 N
 (C) 0.67 N
 (D) -2.7 N
 (E) 2.7 N
 Ans: (E)
13. In vacuum, an electromagnetic wave traveling along the x axis has an electric field \vec{E} and a magnetic field \vec{B} whose magnitudes depend on x and t as

$$E(x, t) = E_0 \sin(kx - \omega t), B(x, t) = B_0 \sin(kx - \omega t + \phi),$$
 where E_0 and B_0 are the amplitudes of \vec{E} and \vec{B} . Which fact below is correct?
 (A) $B_0/E_0 = c = 1/\sqrt{\epsilon_0\mu_0}$
 (B) The directions of \vec{E} and \vec{B} are arbitrary once they are perpendicular to x .
 (C) $\phi = \pi/2$
 (D) $\omega k = c$
 (E) This is a linearly polarized wave.
 Ans: (E)
14. Which statement regarding total internal reflection is not true?
 (A) It cannot occur when the incident light is in the medium of lower index of refraction.
 (B) Total internal reflection occurs for rays with their incident angles greater a critical angle.
 (C) It explains the phenomenon that the water-to-air interface looks like a mirror when an observer is in water.
 (D) It is used in transmission through optical fibers.
 (E) The effect is used to realize polarizers.
 Ans: (E)
15. Which of the following statements on a wave function $\psi(x, t)$ in quantum mechanics is correct?
 (A) The probability of finding the particle in region $x \in (a, b)$ is $\int_a^b dx |\psi(x, t)|^2$.
 (B) The wave function can be determined via a series of measurements.
 (C) Since it is not a function of velocity, it does not carry the information of momentum.
 (D) All of the above.
 (E) None of the above.
 Ans: (A)
16. Which type of titration is used to determine the concentration of calcium ions in a sample?
 (A) Acidity Titration
 (B) Alkalinity Titration
 (C) Redox Titration
 (D) Complexometric Titration
 (E) Ionic Strength Titration
 Ans: (D)
17. Which of the following is a cyclic organic compound with four nitrogen atoms?
 (A) Tetrazine (B) Diazine (C) Triazine (D) Benenze (E) None of the above
 Ans: (A)

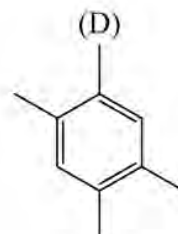
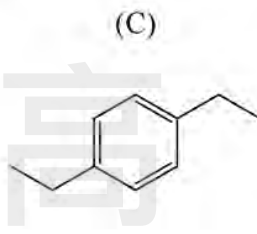
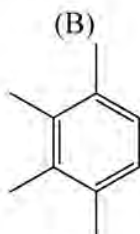
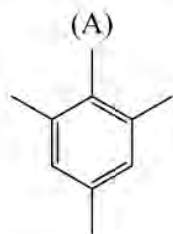
國立中山大學 112 學年度學士後醫學系招生考試試題

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)

共 14 頁第 4 頁

18. Which of the following organic compounds with the sum formula $C_{10}H_{14}$ exhibits two singlets in the 1H NMR spectrum and three signals in the ^{13}C NMR spectrum?



(E) None of the above

Ans: (D)

19. What type of bonds hold the monomers in a typical polymer like PP together?

- (A) Ionic bonds
(B) Hydrogen bonds
(C) Covalent bonds
(D) Hydrophobic interaction
(E) Van der Waals interaction

Ans: (C)

20. Which of the following amino acids has a positively charged side chain under physiological conditions?

- (A) Alanine (B) Asparagine (C) Glutamine (D) Aspartate (E) Arginine

Ans: (E)

21. Determine the ligand field stabilization energy of $[Rh(H_2O)_6]^{3+}$.

- (A) $0 \Delta_o$ (B) $-0.4 \Delta_o$ (C) $-1.9 \Delta_o$ (D) $-2.0 \Delta_o$ (E) $-2.4 \Delta_o$

Ans: (E)

22. Determine the number of isomers for the $[Co(NH_3)_2(H_2O)_2BrCl]^+$ complex.

- (A) 3 (B) 4 (C) 5 (D) 6 (E) 7

Ans: (D)

23. The reaction $P_4(g) \rightleftharpoons P_2(g)$ has a reaction enthalpy of $\Delta H = 217 \text{ kJ mol}^{-1}$. If the bond energy of a single phosphorus-phosphorus bond is 200 kJ mol^{-1} , how much is the bond energy of the $P \equiv P$ bond?

- (A) 92 kJ mol^{-1} (B) 192 kJ mol^{-1} (C) 292 kJ mol^{-1} (D) 392 kJ mol^{-1} (E) 492 kJ mol^{-1}

Ans: (E)

24. Cisplatin is a well-known anticancer drug with the chemical formula $Pt(NH_3)_2Cl_2$. Which of the following statements is true?

- (A) Both Raman and IR spectra of cisplatin show two bands in the Pt-Cl stretching region.
(B) Only the Raman spectrum of cisplatin shows two bands in the Pt-Cl stretching region; the IR spectrum does not show any bands in the Pt-Cl stretching region.
(C) Only the infrared spectrum of cisplatin shows two bands in the Pt-Cl stretching region; the Raman spectrum does not show any bands in the Pt-Cl stretching region.
(D) Both Raman and IR spectra of cisplatin do not show any bands in the Pt-Cl stretching region.
(E) None of the above.

Ans: (A)

國立中山大學 112 學年度學士後醫學系招生考試試題

科目名稱：物理與化學

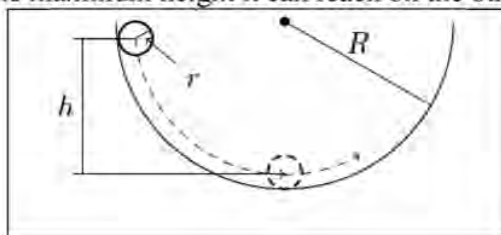
※本科目依簡章規定「不可以」使用計算機(選擇題)

共 14 頁第 5 頁

25. Which of the following is a measure of the randomness of a system in thermodynamics?
(A) Energy (B) Pressure (C) Heat transfer (D) Work done (E) Entropy
Ans: (E)
26. What is the relationship between the activation energy and rate constant of a chemical reaction?
(A) The rate constant is proportional to the negative activation energy.
(B) The rate constant is inversely proportional to the negative activation energy.
(C) As the activation energy decreases, the rate constant remains constant.
(D) As the activation energy increases, the rate constant increases exponentially.
(E) As the activation energy increases, the rate constant decreases exponentially.
Ans: (E)
27. Organic compounds can be classified based on their functional groups. Which of the following is not a functional group?
(A) Isocyano (B) Carbonyl (C) Isocyanide (D) Carboxyl (E) None of the above
Ans: (C)
28. Which of the following binary compounds has two different solid-state structures?
(A) NaCl (B) CsCl (C) CaF₂ (D) NiAs (E) ZnS
Ans: (E)
29. Which of the following compounds is typically not needed for the conversion of trialkyl borane to an alcohol?
(A) Sodium hydroxide (B) Water (C) Diborane (D) Hydrogen peroxide (E) None of the above
Ans: (C)
30. Arrangement of nucleotides in DNA can be seen using which of the following methods?
(A) Electron microscopy
(B) Electrospray ionization mass spectrometry
(C) X-Ray crystallography
(D) Cyclic voltammetry
(E) Fourier-transform infrared spectroscopy
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. A ball at rest with mass m and radius r (i.e., rotational inertia $I = \frac{2}{5}mr^2$) rolls without sliding from a bowl of radius R from height h (see figure below). The coefficient of static friction between the ball and the bowl is μ . What is the maximum height it can reach on the other side of the bowl?



國立中山大學 112 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)

共 14 頁第 6 頁

- (A) $\frac{R}{R+r}h$ (B) $\frac{(1-\mu)R}{R+r}h$ (C) h (D) $\frac{\mu r}{R}h$ (E) μh

Ans: (C)

32. A cannonball of mass 10.0 kg is fired upward. The cannonball explodes into 3 pieces when it reaches the maximum height. At the moment of explosion, a 5-kg piece carries velocity $\vec{v}_1 = 2\hat{i} - 3\hat{j}$ while another 4-kg piece carries velocity $\vec{v}_2 = 3\hat{j} - 2\hat{k}$. What is the velocity \vec{v}_3 of the third piece?

(A) Cannot be determined without knowing the energy provided by the explosion

(B) $\vec{v}_3 = 10\hat{i} - 27\hat{j} - 8\hat{k}$ (C) $\vec{v}_3 = 10\hat{i} - 8\hat{k}$ (D) $\vec{v}_3 = -2\hat{i} + 2\hat{k}$ (E) $\vec{v}_3 = -10\hat{i} + 3\hat{j} + 8\hat{k}$

Ans: (E)

33. Two bodies of mass m are connected individually to strings of length R , which are both pinned at P , as shown in the right figure. One body is raised with an angle θ and then released to swing. When the bodies collide, they stick to each other. Find the frequency of the motion after the collision.



- (A) $\frac{1}{2\pi}\sqrt{\frac{g \sin \theta}{R}}$ (B) $\frac{1}{2\pi}\sqrt{\frac{2g \sin \theta}{R}}$ (C) $\frac{1}{2\pi}\sqrt{\frac{g}{R}}$ (D) $\frac{1}{2\pi}\sqrt{\frac{2g}{R}}$ (E) $\frac{1}{\pi}\sqrt{\frac{g}{R}}$

Ans: (C)

34. A block of density 800 kg/m³ floats face down in a fluid of density 1200 kg/m³. The block has height $H = 6$ cm. If the block is held fully submerged and then released, what is the magnitude of its initial acceleration?

(A) 2.45 m/s² (B) 19.6 m/s² (C) 0 m/s² (D) 9.8 m/s² (E) 4.9 m/s²

Ans: (E)

35. What is the pressure difference between the heart and the brain of a man if the brain is 40 cm above the heart? (The density of blood is 1.05 g/cm³.)

(A) 411.6 Pa (B) 4116 Pa (C) 41160 Pa (D) 411600 Pa (E) 41.16 Pa

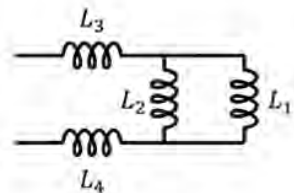
Ans: (B)

36. A flashlight uses two 1.5-V batteries. If the current passing through the lightbulb is 0.5 A, how much energy is consumed by the lightbulb in half an hour?

(A) 45 J (B) 90 J (C) 900 J (D) 2700 J (E) 10800 J

Ans: (D)

37. A circuit, as shown in the right figure, contains four inductors of $L_1=20.0$ mH, $L_2=30.0$ mH, $L_3=40.0$ mH, and $L_4=50.0$ mH. What is the equivalent inductance of the circuit?



(A) 102 mH (B) 15.38 mH (C) 140 mH (D) 7.81 mH (E) 60 mH

Ans: (A)

38. It takes time T for M gram(s) of a radioactive substance to decay to $M/4$ gram(s). How long does it take for $M/4$ gram(s) of the substance to decay to $M/8$ gram(s)?

(A) $2T$ (B) T (C) $T/2$ (D) T^2 (E) \sqrt{T}

Ans: (C)

國立中山大學 112 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)

共 14 頁第 7 頁

39. A 5.0-kg ball is dropped from a cliff. Given the resistive force is $R = (0.49 \text{ kg/m})v^2$, where v is the speed of the ball, and the gravitational acceleration is $g = 9.8 \text{ m/s}^2$, what is the terminal speed the ball?

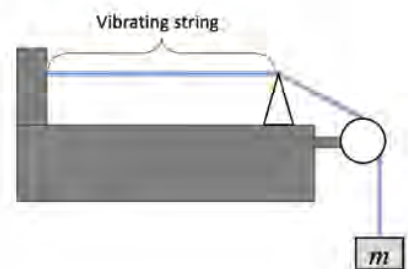
(A) 4.9 m/s (B) 10 m/s (C) 40 m/s (D) 2.0 m/s (E) 20 m/s

Ans: (B)

40. In the figure, the string is tensioned by a hanging block of mass m and can vibrate with a fundamental frequency f . If one wants to create a fundamental frequency of $2f$, what should the block's mass be?

(A) m (B) $\sqrt{2}m$ (C) $2m$ (D) $m/2$ (E) $4m$

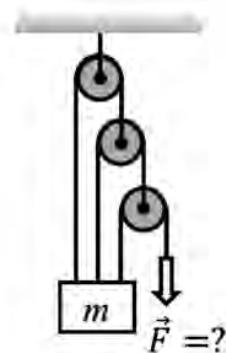
Ans: (E)



41. The force \vec{F} in the figure will keep the block and the pulleys in equilibrium. The block has mass m . Neglect the mass of pulleys and strings and friction in the system. What is the strength of \vec{F} ?

(A) mg (B) $mg/3$ (C) $mg/5$ (D) $mg/7$ (E) $mg/9$

Ans: (D)



42. At one instant, a force $\vec{F} = (4\text{N})\hat{j}$ acts on a 0.25 kg object that has position vector $\vec{r} = (2\text{m})\hat{i} - (2\text{m})\hat{k}$ and velocity $\vec{v} = (-5 \text{ m/s})\hat{i} + (8 \text{ m/s})\hat{k}$. What is the object's angular momentum about the origin?

(A) $-1.5 \text{ kg m}^2/\text{s}$ (B) $1.5 \text{ kg m}^2/\text{s}$ (C) $-0.75 \text{ kg m}^2/\text{s}$ (D) $-0.375 \text{ kg m}^2/\text{s}$ (E) $0 \text{ kg m}^2/\text{s}$

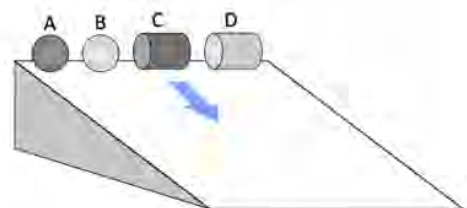
Ans: (A)

43. A jet aircraft of speed 200 m/s is making a vertical circular loop of radius 2 km. What is the force exerted by the seat on the 60-kg pilot at the top of the loop? (Gravitational acceleration $g = 9.8 \text{ m/s}^2$)

(A) 12 N (B) 24 N (C) 306 N (D) 612 N (E) 48 N

Ans: (D)

44. Four objects are released from rest at the top of an inclined plane and roll down the plane (see the figure). A is a solid sphere, B is a hollow sphere, C is a solid cylinder, and D is a hollow cylinder. All of the four objects have identical radii and masses. Assume that the objects roll without slipping. Which one would win the race?



(A) A (B) B (C) C (D) D (E) All arrive at the end of the inclined plane at the same time.

Ans: (A)

國立中山大學 112 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)

共 14 頁第 8 頁

45. Knowing that a particle of mass m in a potential will do a simple harmonic motion as $x(t) = X \cos(\omega t + \phi)$, where $x(t)$ is the position of the particle with time. What will be the angular frequency for a particle of mass $2m$ when it moves in this potential?

(A) ω (B) 2ω (C) $\omega/2$ (D) $\sqrt{2}\omega$ (E) $\omega/\sqrt{2}$

Ans: (E)

46. Assuming a satellite orbits a planet in a perfect circle with radius r . If the mass of the satellite is M_S and the mass of the planet is M_P , what is the speed of the satellite orbiting the planet? (G is the gravitational constant.)

(A) $\sqrt{\frac{GM_P}{2r}}$ (B) $\sqrt{\frac{GM_P}{r}}$ (C) $\sqrt{\frac{GM_S}{2r}}$ (D) $\sqrt{\frac{GM_S M_P}{2r^2}}$ (E) $\sqrt{\frac{GM_S^2}{2M_P r}}$

Ans: (B)

47. If an amount of heat Q can increase the temperature of a solid metal sphere of diameter D from 10°C to 12°C . What is the amount of heat needed to increase the temperature of a solid sphere of diameter $2D$ of the same metal from 10°C to 16°C ?

(A) Q (B) $3Q$ (C) $6Q$ (D) $24Q$ (E) $48Q$

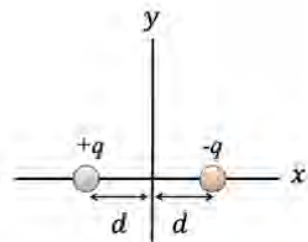
Ans: (D)

48. Two opposite charges $+q$ and $-q$ are located as the right figure shows. What is the resulting electric field at points on the y axis?

(A) $kq(2d)(d^2 + y^2)^{-\frac{3}{2}} \hat{i}$ (B) $-kq(2d)(d^2 + y^2)^{-\frac{3}{2}} \hat{i}$ (C) $kq(2y)(d^2 + y^2)^{-\frac{3}{2}} \hat{j}$ (D) $-kq(2y)(d^2 + y^2)^{-\frac{3}{2}} \hat{j}$

(E) 0

Ans: (A)



49. What is the capacitance of a parallel plate capacitor? Assume A is the area of each plate, ϵ is electric constant and d is the distance between plates.

(A) $\frac{4\epsilon A}{d}$ (B) $\frac{2\epsilon A}{d}$ (C) $\frac{\epsilon A}{d}$ (D) $\frac{\epsilon A}{2d}$ (E) $\frac{\epsilon A}{4d}$

Ans: (C)

50. A magnetic flux is through the conducting loop according to the relation $\Phi_B(t) = 6t^2 + 7t$, where Φ_B is in milliwebers and t is in seconds. What is the magnitude of the emf induced in the loop when $t = 2.0$ s?

(A) 38 mV (B) 30 mV (C) 31 mV (D) 15 mV (E) 15.5 mV

Ans: (C)

51. The intensity of electromagnetic energy 3 m from the point source is 100 W/m^2 . What is the intensity 30 m away?

(A) 1000 W/m^2 (B) 100 W/m^2 (C) 10 W/m^2 (D) 1 W/m^2 (E) 0.1 W/m^2

Ans: (D)

52. If the distance between the first and the tenth minima of the double-slit pattern is 18.0 mm and the slits are separated by 0.150 mm with the screen 50.0 cm from the slits, what is the wavelength of the

國立中山大學 112 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)

共 14 頁第 9 頁

light used?

(A) 400 nm (B) 500 nm (C) 600 nm (D) 700 nm (E) 800 nm

Ans: (C)

53. A 29.5-kg boy standing still on a frictionless surface catches a 500-g dodgeball with velocity $\vec{v} = (20.0 \text{ m/s})\hat{i}$. What is the total energy loss of the system (the boy and the dodgeball)?

(A) 16.7 J (B) 48.0 J (C) 98.3 J (D) 67.6 J (E) Not enough information

Ans: (C)

54. A block with mass 0.5 kg is forced against a horizontal spring of negligible mass, compressing the spring with a distance of 0.2 m. When the block is released, the block moves on a horizontal tabletop for 1.0 m before coming to rest. The force constant of the spring is 100 N/m. What is the coefficient of kinetic friction between the block and the tabletop?

(A) 0.16 (B) 0.25 (C) 0.32 (D) 0.41 (E) 0.53

Ans: (D)

55. The gravitational acceleration at the surface of Earth is g . Another planet has the density of Earth but twice the radius. What is the gravitational acceleration at the surface of the planet?

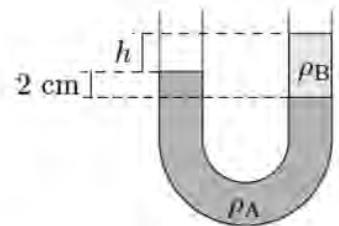
(A) 8g (B) 4g (C) 2g (D) g (E) g/4

Ans: (C)

56. The left column of a U-tube is filled with liquid A of density ρ_A , and the right column is filled with another liquid B of density $\rho_B = \rho_A/3$. How much higher is the liquid in the right column than in the left one (see figure right)?

(A) $h = 6 \text{ cm}$ (B) $h = 4 \text{ cm}$ (C) $h = 3 \text{ cm}$ (D) $h = 2 \text{ cm}$ (E) $h = 1 \text{ cm}$

Ans: (B)



57. An ideal gas undergoes a reversible isothermal expansion. The change in entropy ΔS of the gas versus the volume of the gas is shown on the right. When V is expanded from 0.5 m^3 to 2 m^3 , $\Delta S = 3 \text{ J/K}$. How many moles are in the sample? (The gas constant is $R = 8.3 \text{ J}\cdot\text{K}^{-1}\cdot\text{mol}^{-1}$.)

(A) 10 mol

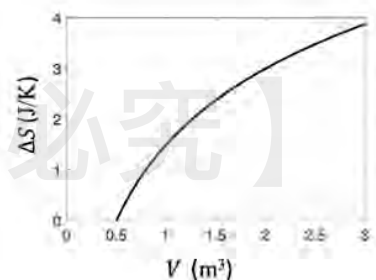
(B) 49.8 mol

(C) 0.26 mol

(D) 3.74 mol

(E) 104.3 mol

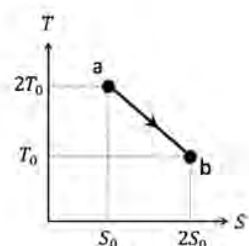
Ans: (C)



58. An ideal monatomic gas undergoes the following reversible process ($a \rightarrow b$). How much energy of heat is absorbed by the gas?

(A) $T_0 S_0$ (B) $T_0 S_0/2$ (C) $4T_0 S_0$ (D) $3T_0 S_0/2$ (E) 0

Ans: (D)



國立中山大學 112 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)

共 14 頁第 10 頁

59. Two conducting spheres with radius r and $3r$ are separated far-apart. The larger sphere carries charge Q , while the smaller one is neutral. After the two spheres are connected by a conducting wire, what are the charges Q_S and Q_L carried by the smaller sphere and larger sphere, respectively?
 (A) $Q_S = 15Q/16$ and $Q_L = Q/16$
 (B) $Q_S = 9Q/10$ and $Q_L = Q/10$
 (C) $Q_S = Q/10$ and $Q_L = 9Q/10$
 (D) $Q_S = Q/16$ and $Q_L = 15Q/16$
 (E) $Q_S = Q/4$ and $Q_L = 3Q/4$
 Ans: (E)
60. What is the electrical oscillations angular frequency in an inductance-capacitor circuit? Assume L is the inductance and C is capacitance.
 (A) $\sqrt{\frac{1}{4LC}}$ (B) $\sqrt{\frac{1}{2LC}}$ (C) $\sqrt{\frac{4}{LC}}$ (D) $\sqrt{\frac{2}{LC}}$ (E) $\sqrt{\frac{1}{LC}}$
 Ans: (E)
61. Which symbol is used to denote the coupling between non-equivalent hydrogen atoms on adjacent carbon atoms in NMR spectroscopy?
 (A) J (B) Hz (C) δ (D) eV (E) ppm
 Ans: (A)
62. What is the role of $AlCl_3$ in the reaction of benzene and Cl_2 ?
 (A) To act as a nucleophile
 (B) To act as an electrophile
 (C) To strengthen the Cl-Cl bond
 (D) To increase the reactivity of the electrophile
 (E) To act as a neutral species
 Ans: (D)
63. Which of the following methods can be used to determine the molecular weight of a protein?
 I: Sodium dodecyl sulfate-polyacrylamide gel electrophoresis; II: Size-exclusion chromatography;
 III: Electrospray ionization mass spectrometry; IV: Infrared spectroscopy;
 V: Ultraviolet-visible spectroscopy
 (A) I, II, III, IV, V (B) I, II, III, IV (C) I, II, III (D) I, II (E) I
 Ans: (C)
64. Boron consists of two isotopes, ^{10}B and ^{11}B . Chlorine also has two isotopes, ^{35}Cl and ^{37}Cl . Consider the mass spectrum of BCl_3 . How many peaks would be present?
 (A) 7 (B) 8 (C) 9 (D) 10 (E) 11
 Ans: (B)
65. Which of the following statements about 1D NMR and 2D NMR spectroscopy is **INCORRECT**?
 (A) 1D NMR is faster than 2D NMR.
 (B) 1D NMR gives less information than 2D NMR.
 (C) 2D NMR spectrum provides information about the spatial relationships between different nuclei in the sample, such as the distances and angles between atoms.
 (D) 2D NMR distinguishes between the overlapping signals that exist in larger molecules.
 (E) The advantage of 2D NMR spectroscopy is that it requires only one frequency axis.
 Ans: (E)

國立中山大學 112 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)

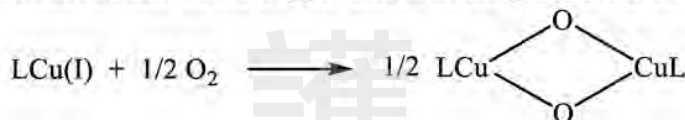
共 14 頁第 11 頁

66. The half-life of ^{14}C is 5730 years. A sample taken for radiocarbon dating has been found to contain 56 % of its original ^{14}C . Which of the following options is the best estimate for the age of the sample? (Radioactive decay of ^{14}C follows first-order kinetics.)
 (A) 4.8×10^2 (B) 4.8×10^3 (C) 4.8×10^4 (D) 4.8×10^5 (E) 4.8×10^6
 Ans: (B)

67. Sort the molecules in the order from the largest bond angle to the smallest bond angle: H_2O , NH_3 , BF_3 , CH_4 , CO_2
 (A) CH_4 , CO_2 , H_2O , BF_3 , NH_3
 (B) CO_2 , BF_3 , CH_4 , NH_3 , H_2O
 (C) NH_3 , H_2O , BF_3 , CO_2 , CH_4
 (D) H_2O , NH_3 , BF_3 , CH_4 , CO_2
 (E) BF_3 , NH_3 , H_2O , CH_4 , CO_2
 Ans: (B)

68. If the ionization energy of a hydrogen atom is 13.6 eV, the energy required to excite it from ground state to the next higher state is approximately:
 (A) 3.4 eV (B) 10.2 eV (C) 17.2 eV (D) 13.6 eV (E) 6.8 eV
 Ans: (B)

69. Hemocyanins (Hc) are proteins that transport oxygen throughout the bodies of some invertebrate animals. These metalloproteins contain two copper atoms that reversibly bind a single oxygen molecule (O_2). The scheme below shows a proposed structure of how the copper atoms bind to oxygen. What is the oxidation state of the copper atoms in the product? L is a neutral ligand.



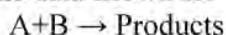
- (A) +1, +1 (B) +2, +2 (C) +3, +3 (D) +0.5, 0.5 (E) +1.5, +1.5
 Ans: (C)

70. The value of the Bohr radius for hydrogen is:

- (A) $0.529 \times 10^{-6} \text{ cm}$
 (B) $0.529 \times 10^{-8} \text{ cm}$
 (C) $0.529 \times 10^{-10} \text{ cm}$
 (D) $0.529 \times 10^{-12} \text{ cm}$
 (E) $0.529 \times 10^{-14} \text{ cm}$

Ans: (B)

71. Select the rate law that corresponds to the data shown for the following reaction:



$[\text{X}]_0$ represents the initial concentration for a species X.

Experiment entry	$[\text{A}]_0 / \text{M}$	$[\text{B}]_0 / \text{M}$	Initial rate / M/s
1	0.012	0.035	0.1
2	0.024	0.070	0.8
3	0.024	0.035	0.1
4	0.012	0.070	0.8

- (A) Rate = $k[\text{A}]^3$
 (B) Rate = $k[\text{A}]^2[\text{B}]^1$
 (C) Rate = $k[\text{A}]^1[\text{B}]^2$

國立中山大學 112 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)

共 14 頁第 12 頁

(D) $\text{Rate} = k[\text{B}]^3$

(E) None of the above

Ans: (D)

72. Which one of the following tetrahedral MX_4^{2-} complexes has the strongest crystal field stabilization?(A) FeCl_4^{2-} (B) MnCl_4^{2-} (C) CoCl_4^{2-} (D) NiCl_4^{2-} (E) CuCl_4^{2-}

Ans: (C)

73. Although the peroxide ion, O_2^{2-} , and the acetylide ion, C_2^{2-} , have long been known, the diazenide ion N_2^{2-} has only been prepared in 2001. By comparison with the other diatomic species, N_2 and O_2 , what is the bond order and number of unpaired electrons for N_2^{2-} , respectively?

(A) 1, 1 (B) 3, 1 (C) 2, 1 (D) 2, 0 (E) 2, 2

Ans: (E)

74. Calculate the reduced mass of HF molecule given that the mass of H atom is 1 amu and the mass of F atom is 19 amu. Note: assume 1 amu = 20 mg.

(A) 18 mg (B) 19 mg (C) 20 mg (D) 21 mg (E) 22 mg

Ans: (B)

75. What factors affect the ionization energy of an atom?

- (A) Electron shielding
- (B) Electron configuration
- (C) Nuclear charge
- (D) All of the above
- (E) None of the above

Ans: (D)

76. How can we explain the fact that CCl_4 is a liquid and Cl_4 is a solid at 25°C ? Which of the following options is the best explanation?

- (A) CCl_4 has a larger dipole moment than Cl_4 due to the higher electronegativity of Cl compared to I.
- (B) Cl_4 has a larger dipole moment than CCl_4 because there is stronger electron repulsion in the C-I bonds than in the C-Cl bonds.
- (C) London dispersion forces are stronger in CCl_4 than in Cl_4 because Cl is more electronegative than I.
- (D) London dispersion forces are stronger in Cl_4 than in CCl_4 because Cl_4 has a more easily polarizable electron cloud.
- (E) None of the above.

Ans: (D)

77. How many microstates does a s^1d^1 electron configuration have?

(A) 5 (B) 10 (C) 15 (D) 20 (E) 25

Ans: (D)

78. The most probable distribution function for a system of molecules is given by

- (A) Maxwell-Boltzmann distribution
- (B) Fermi-Dirac distribution
- (C) Bose-Einstein distribution
- (D) All of the above
- (E) None of the above

Ans: (A)

國立中山大學 112 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)

共 14 頁第 13 頁

79. What is the oxidation state of the terminal nitrogen atom in azide ions?
(A) -3 (B) -1 (C) +1 (D) +4 (E) +5
Ans: (B)
80. What is the highest occupied molecular orbital of a C_2^{4+} ion?
(A) σ_{2s}^* (B) π_{2p} (C) σ_{2p} (D) π_{2p}^* (E) σ_{2p}^*
Ans: (D)
81. On the basis of VSEPR, what is the predicted point group for XeO_2F_2 ?
(A) C_i (B) C_s (C) C_{2v} (D) C_{4v} (E) D_{3h}
Ans: (C)
82. Sort the ions in the order from the largest radius to the smallest radius:
(1) Se^{2-} (2) Br^- (3) Rb^+ (4) Sr^{2+}
(A) 1, 2, 3, 4 (B) 4, 3, 2, 1 (C) 3, 1, 2, 4 (D) 3, 2, 1, 4 (E) 3, 1, 4, 2
Ans: (A)
83. What is the highest molecular orbital degeneracy of cyclic H_3^+ ?
(A) 0 (B) 1 (C) 2 (D) 3 (E) 4
Ans: (C)
84. Which of the following $[M(H_2O)_6]^{n+}$ complexes reacts the slowest in a water exchange reaction?
(A) Cu^{2+} (B) High-spin Fe^{3+} (C) V^{3+} (D) Ti^{3+} (E) Cr^{3+}
Ans: (E)
85. How many carbonyl stretching bands could be observed in the IR spectrum of the $[Co(CO)_3(PPh_3)_2]^+$ complex exhibiting a trigonal bipyramidal molecular geometry, where all three CO ligands are in the equatorial plane?
(A) 1 (B) 2 (C) 3 (D) 4 (E) 5
Ans: (A)
86. The infrared spectrum of synthesized $[Co(CO)_2(CN)_2Br_2]^-$ exhibits two bands attributable to C-O stretching but only one band attributable to C-N stretching. What is the most likely arrangement of the coordinated CO and CN ligands around the Co center, respectively?
(A) *cis* C-O, *trans* C-N
(B) *cis* C-O, *cis* C-N
(C) *trans* C-O, *cis* C-N
(D) *trans* C-O, *trans* C-N
(E) None of the above
Ans: (A)
87. In Valence Bond theory, bonds between atoms are formed by _____.
(A) overlap of proton wave functions
(B) overlap of neutron wave functions
(C) overlap of electron wave functions
(D) overlap of proton and neutron wave functions
(E) overlap of positron wave functions
Ans: (C)

國立中山大學 112 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)

共 14 頁第 14 頁

88. What is the formal charge of the oxygen atom in a molecule of CO_2 ?

(A) 0 (B) +1 (C) -1 (D) +2 (E) -2

Ans: (A)

89. What does a low relative standard deviation indicate?

(A) High accuracy (B) High precision (C) Low accuracy (D) Low precision (E) None of the above

Ans: (B)

90. What is the number of σ -bonds in ethylene (C_2H_4)?

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

Ans: (E)

【版權所有，翻印必究】

國立中山大學 112 學年度學士後醫學系招生考試試題答案疑義釋疑公告

科目	題號	釋疑答覆	釋疑結果
物理與化學	7	<p>Two waves</p> $y_1 = (3.0 \text{ cm}) \cos \frac{\pi}{2} [(2.0 \text{ m}^{-1})x + (5.0 \text{ s}^{-1})t]$ $y_2 = (3.0 \text{ cm}) \cos \frac{\pi}{2} [(2.0 \text{ m}^{-1})x - (5.0 \text{ s}^{-1})t]$ <p>Are sent to a long string to create a standing wave. Let x be positive ($x \geq 0$). Where is the first node (the smallest value of x)?</p> <p>ANS:</p> <p>The total wave function, y_{total}, is the superposition of the two waves:</p> $y_{total} = y_1 + y_2$ $= (3.0 \text{ cm}) \cos \frac{\pi}{2} [(2.0 \text{ m}^{-1})x + (5.0 \text{ s}^{-1})t]$ $+ (3.0 \text{ cm}) \cos \frac{\pi}{2} [(2.0 \text{ m}^{-1})x - (5.0 \text{ s}^{-1})t]$ $= (6.0 \text{ cm}) \cdot \cos \left[\frac{\pi}{2} (2.0 \text{ m}^{-1})x \right] \cos \left[\frac{\pi}{2} (5.0 \text{ s}^{-1})t \right]$ $= (6.0 \text{ cm}) \cdot \cos(\pi x) \cos \left[\frac{\pi}{2} (5.0 \text{ s}^{-1})t \right]$ <p>The node is where $y_{total} = 0$ at any time.</p> <p>Therefore, $\cos(\pi x) = 0$, then $\pi x = \frac{\pi}{2} \cdot n$, where $n = 1, 3, 5 \dots$</p> <p>The first node is when $n = 1$, then $x = \frac{1}{2} \text{ m} = 50 \text{ cm}$</p>	維持原公布答案 (C)
	16	<p>Ca^{2+} 一般會使用 EDTA 進行 complexometric titration。使用的指示劑為 murexide 或 Eriochrome Black T。考生所提出來的方法 (i) 先用草酸根沉澱 Ca^{2+} (ii) 將沉澱物分離 (iii) 透過與酸性試劑的反應形成草酸 (iv) 對草酸進行 redox titration) 雖然可以測量 Ca^{2+} 的濃度，惟該方法的本質不是單純的滴定實驗。該方法的關鍵原理是透過一個配位反應形成 CaC_2O_4，並測量產物的量。但是測量產物量的方法並不一定需要使用滴定法。因此，該題的答案不應該包含 redox titration。</p>	維持原公布答案 (D)
	22	<p>該結構有六個 structural isomer。由於題目中未註明 “structural isomer” 或 “geometrical isomer”，在計算異構物數量也應該也將 optical isomer 列入考量。因此正確答案應該是：該結構有八個異構物。</p>	更正原公布答案—本題無正確答案，所有到考生均給分

27

“Isocyanide” 在化學文獻中不會用於形容一個官能基，而是形容含化合物。請參考以下 IUPAC 的解釋：

維持原公布答案
(C)

Gold Book Resources ▾

isocyanides Online use... ▾

<https://doi.org/10.1351/goldbook.I03270>

The isomer $\text{HN}^+\equiv\text{C}^-$ of hydrocyanic acid, $\text{HC}\equiv\text{N}$, and its hydrocarbyl derivatives RNC ($\text{RN}^+\equiv\text{C}^-$).

Source:
PAC, 1995, 67, 1307. (*Glossary of class names of organic compounds and reactivity intermediates based on structure (IUPAC Recommendations 1995)*) on page 1344 [Terms] [Paper]

Cite as: IUPAC. *Compendium of Chemical Terminology*, 2nd ed. (the "Gold Book"). Compiled by A. D. McNaught and A. Wilkinson. Blackwell Scientific Publications, Oxford (1997). Online version (2019-) created by S. J. Chalk. ISBN 0-9678550-9-8. <https://doi.org/10.1351/goldbook>.

Div. III PDF Text JSON History Last revised: February 24, 2014

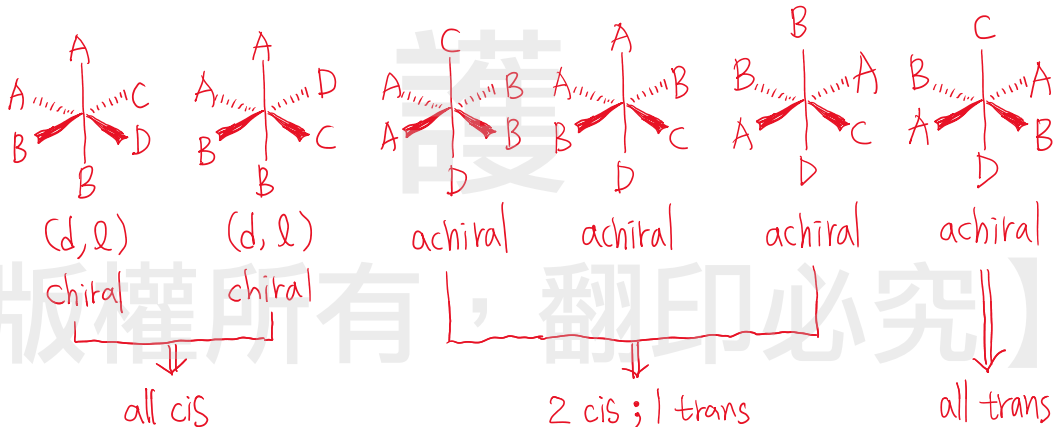
【版權所有，翻印必究】

D

(A) Acidity Titration
(B) Alkalinity Titration
(C) Redox Titration
(D) Complexometric Titration
(E) Ionic Strength Titration

$$\text{Ca-EBT (紅色)} + \text{EDTA} \longrightarrow \text{Ca-EDTA} + \text{EBT (藍色)}$$

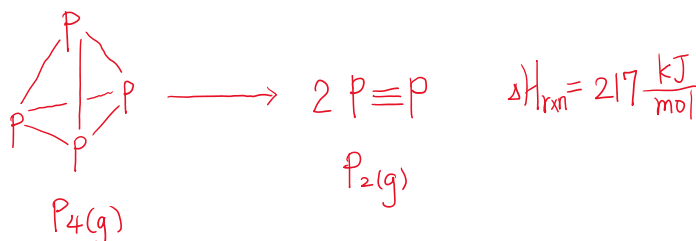

(A) 3 (B) 4 (C) 5 (D) 6 (E) 7



-17-

23. The reaction $P_4(g) \rightleftharpoons P_2(g)$ has a reaction enthalpy of $\Delta H = 217 \text{ kJ mol}^{-1}$. If the bond energy of a single phosphorus-phosphorus bond is 200 kJ mol^{-1} , how much is the bond energy of the $P \equiv P$ bond?
 (A) 92 kJ mol^{-1} (B) 192 kJ mol^{-1} (C) 292 kJ mol^{-1} (D) 392 kJ mol^{-1} (E) 492 kJ mol^{-1}

E



$$\Delta H_{rxn} = (+200) \times 6 + (-BDE) \times 2 = +217 \Rightarrow BDE = 491.5 \frac{\text{kJ}}{\text{mol}}$$

打斷 6 組 $P-P$ single bond 生成 2 組 $P \equiv P$ triple bond

25. Which of the following is a measure of the randomness of a system in thermodynamics?
 (A) Energy (B) Pressure (C) Heat transfer (D) Work done (E) Entropy

E

熵(entropy)是評定系統之混亂程度的物理量

26. What is the relationship between the activation energy and rate constant of a chemical reaction?
 (A) The rate constant is proportional to the negative activation energy.
 (B) The rate constant is inversely proportional to the negative activation energy.
 (C) As the activation energy decreases, the rate constant remains constant.
 (D) As the activation energy increases, the rate constant increases exponentially.
 (E) As the activation energy increases, the rate constant decreases exponentially.

E

Arrhenius equation : $k = e^{-\frac{E_a}{RT}}$

【版權所有，翻印必究】

66. The half-life of ^{14}C is 5730 years. A sample taken for radiocarbon dating has been found to contain 56 % of its original ^{14}C . Which of the following options is the best estimate for the age of the sample? (Radioactive decay of ^{14}C follows first-order kinetics.)
 (A) 4.8×10^2 (B) 4.8×10^3 (C) 4.8×10^4 (D) 4.8×10^5 (E) 4.8×10^6

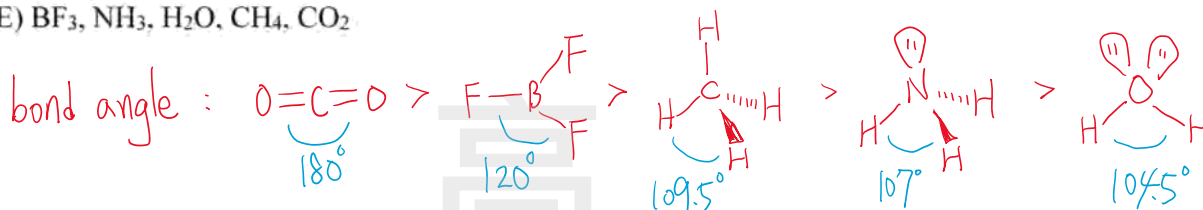
B

$$\ln\left(\frac{100}{56}\right) = \left(\frac{\ln 2}{5730}\right) \times t \Rightarrow t = 4.8 \times 10^3 \text{ yr}$$

67. Sort the molecules in the order from the largest bond angle to the smallest bond angle: H_2O , NH_3 , BF_3 , CH_4 , CO_2

B

- (A) CH_4 , CO_2 , H_2O , BF_3 , NH_3
 (B) CO_2 , BF_3 , CH_4 , NH_3 , H_2O
 (C) NH_3 , H_2O , BF_3 , CO_2 , CH_4
 (D) H_2O , NH_3 , BF_3 , CH_4 , CO_2
 (E) BF_3 , NH_3 , H_2O , CH_4 , CO_2



68. If the ionization energy of a hydrogen atom is 13.6 eV, the energy required to excite it from ground state to the next higher state is approximately:

B

- (A) 3.4 eV (B) 10.2 eV (C) 17.2 eV (D) 13.6 eV (E) 6.8 eV

$$\Delta E = 13.6 \times 1^2 \times \left(\frac{1}{1^2} - \frac{1}{2^2} \right) = 10.2 \text{ eV}$$

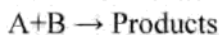
70. The value of the Bohr radius for hydrogen is:

B

- (A) $0.529 \times 10^{-6} \text{ cm}$
 (B) $0.529 \times 10^{-8} \text{ cm}$
 (C) $0.529 \times 10^{-10} \text{ cm}$
 (D) $0.529 \times 10^{-12} \text{ cm}$
 (E) $0.529 \times 10^{-14} \text{ cm}$

氫原子的 Bohr radius 約為 52.9 pm，即 $0.529 \times 10^{-8} \text{ cm}$

71. Select the rate law that corresponds to the data shown for the following reaction:



$[\text{X}]_0$ represents the initial concentration for a species X.

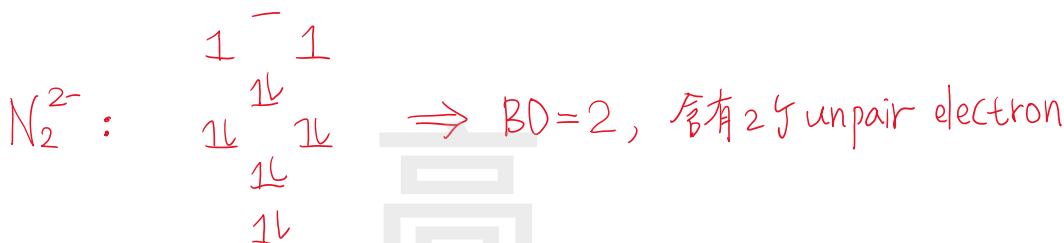
Experiment entry	$[\text{A}]_0 / \text{M}$	$[\text{B}]_0 / \text{M}$	Initial rate / M/s
1	0.012	0.035	0.1
2	0.024	0.070	0.8
3	0.024	0.035	0.1
4	0.012	0.070	0.8

D

- (A) Rate = $k[\text{A}]^3$
 (B) Rate = $k[\text{A}]^2[\text{B}]^1$
 (C) Rate = $k[\text{A}]^1[\text{B}]^2$
 (D) Rate = $k[\text{B}]^3$
 (E) None of the above

太簡單了，詳解略

73. Although the peroxide ion, O_2^{2-} , and the acetylide ion, C_2^{2-} , have long been known, the diazenide ion N_2^{2-} has only been prepared in 2001. By comparison with the other diatomic species, N_2 and O_2 , what is the bond order and number of unpaired electrons for N_2^{2-} , respectively?
 (A) 1, 1 (B) 3, 1 (C) 2, 1 (D) 2, 0 (E) 2, 2



75. What factors affect the ionization energy of an atom?

(A) Electron shielding
 (B) Electron configuration
 (C) Nuclear charge
 (D) All of the above
 (E) None of the above

太簡單了，詳解略

76. How can we explain the fact that CCl_4 is a liquid and CI_4 is a solid at 25°C ? Which of the following options is the best explanation?

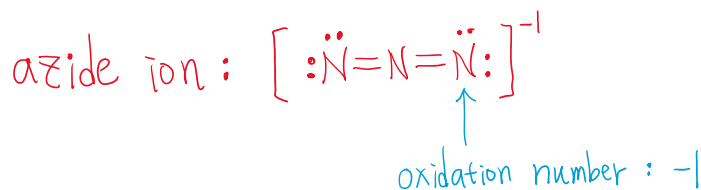
(A) CCl_4 has a larger dipole moment than CI_4 due to the higher electronegativity of Cl compared to I.
 (B) CI_4 has a larger dipole moment than CCl_4 because there is stronger electron repulsion in the C-I bonds than in the C-Cl bonds.
 (C) London dispersion forces are stronger in CCl_4 than in CI_4 because Cl is more electronegative than I.
 (D) London dispersion forces are stronger in CI_4 than in CCl_4 because CI_4 has a more easily polarizable electron cloud.
 (E) None of the above.

決定鹵烷分子間作用力大小的主要因素為分散力
 分子量愈大者，通常分散力愈大

CI_4 的分子間作用力大於 CCl_4 ，因此室溫下 CI_4 呈現 solid state 而 CCl_4 呈現 liquid state

79. What is the oxidation state of the terminal nitrogen atom in azide ions?

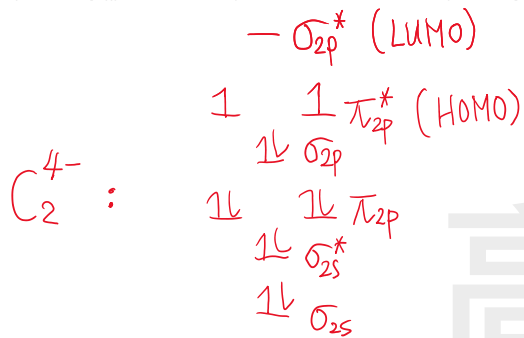
(A) -3 (B) -1 (C) +1 (D) +4 (E) +5



D

80. What is the highest occupied molecular orbital of a C_2^{4-} ion?

- (A)
- σ_{2s}^*
- (B)
- π_{2p}
- (C)
- σ_{2p}
- (D)
- π_{2p}^*
- (E)
- σ_{2p}^*

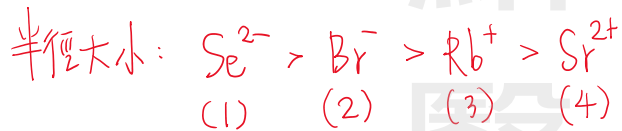


A

82. Sort the ions in the order from the largest radius to the smallest radius:

- (1)
- Se^{2-}
- (2)
- Br^-
- (3)
- Rb^+
- (4)
- Sr^{2+}

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



C

87. In Valence Bond theory, bonds between atoms are formed by ____.

- (A) overlap of proton wave functions
 (B) overlap of neutron wave functions
 (C) overlap of electron wave functions
 (D) overlap of proton and neutron wave functions
 (E) overlap of positron wave functions

太簡單了，詳解略

A

88. What is the formal charge of the oxygen atom in a molecule of CO_2 ?

- (A) 0 (B) +1 (C) -1 (D) +2 (E) -2

太簡單了，詳解略

B

89. What does a low relative standard deviation indicate?

- (A) High accuracy (B) High precision (C) Low accuracy (D) Low precision (E) None of the above

標準差是衡量數據離散程度的指標

標準差小，表示數據的離散程度小，屬於高精密度(high precision)的量測結果

E

90. What is the number of σ -bonds in ethylene (C_2H_4)?

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

太簡單了，詳解略

物理

程量子(陳宗德)老師提供

1. Which equation may describe a damped harmonic oscillator? x is for the displacement of the body and m , b , k are all positive real.

- (A) $m \frac{d^2x}{dt^2} - kx = 0$
 (B) $m \frac{d^2x}{dt^2} - kx - b \frac{dx}{dt} = 0$
 (C) $m \frac{d^2x}{dt^2} + kx - b \frac{dx}{dt} = 0$
 (D) $m \frac{d^2x}{dt^2} - kx + b \frac{dx}{dt} = 0$
 (E) $m \frac{d^2x}{dt^2} + kx + b \frac{dx}{dt} = 0$

1. 解：(E)

由 $\vec{F} = m\vec{a}$

$$-kx - bv = +m \frac{d^2x}{dt^2} \Rightarrow m \frac{d^2x}{dt^2} + b \frac{dx}{dt} + kx = 0$$

2. In the process of free expansion of an isolated ideal gas, which statement is incorrect?

- (A) The gas gets cooler.
 (B) The gas does not do work.
 (C) The gas does not absorb heat.
 (D) The process is irreversible.
 (E) The entropy of the system changes.

2. 解：(A)

當氣體在作自由膨脹時，熱、內能、溫度皆沒有改變，僅有熵作改變，屬於不可逆過程。另外，因為隔板瞬間拿開，故氣體沒有對外界作功。

3. An electron travels in a uniform magnetic field directed perpendicular to its path. Which of the following quantity of the electron will change?

- (A) Its speed.
 (B) Its potential energy.
 (C) Its kinetic energy.
 (D) Its acceleration.
 (E) All of the above.

3. 解：(D)

$$\vec{F} = q\vec{v} \times \vec{B} = m\vec{a}$$

4. Which statement of the energy carried by a photon is WRONG?

- (A) It is proportional to the photon frequency.
 (B) It is inversely proportional to the photon wavelength.
 (C) It is proportional to the photon mass.
 (D) All of the above are correct.
 (E) All of the above are wrong.

4. 解：(C)

$$E = h\nu = \frac{hc}{\lambda}$$

$$E = mc^2 \text{ (能量正比於光子相對論性質量)}$$

5. A 1000 kg car traveling north at 15 m/s collides with a 2000 kg truck traveling east at 10 m/s. The two vehicles move away from the impact point as one. What is the velocity of the wreckage just after impact?

(A) 0 m/s (B) 8.3 m/s (C) 5.0 m/s (D) 6.6 m/s (E) 1.7 m/s

5. 解：(B)

由動量守恆

$$\begin{aligned} 1000 \times 15\hat{j} + 2000 \times 10\hat{i} &= 3000 \times \vec{v} \\ \Rightarrow \vec{v} &= 5\hat{j} + \frac{20}{3}\hat{i} \\ \Rightarrow v &= \sqrt{5^2 + \left(\frac{20}{3}\right)^2} = 8.3[m/s] \end{aligned}$$

6. When a mass attached to a spring is stretched by an amount x away from its equilibrium position, it oscillates with frequency f . What is the oscillation frequency if the mass is instead released $2x$ from its equilibrium position?

(A) $f/2$ (B) f (C) $\sqrt{2}f$ (D) $2f$ (E) $4f$

6. 解：(B)

$$\omega = \sqrt{\frac{k}{m}} = 2\pi f \Rightarrow f = \frac{1}{2\pi} \sqrt{\frac{k}{m}} \text{ 與位置無關}$$

7. Two waves

$$y_1 = (3.0\text{cm})\cos\frac{\pi}{2}[(2.0\text{m}^{-1})x + (5.0\text{s}^{-1})t]$$

$$y_2 = (3.0\text{cm})\cos\frac{\pi}{2}[(2.0\text{m}^{-1})x - (5.0\text{s}^{-1})t]$$

are sent to a long string to create a standing wave. Let x be positive ($x \geq 0$). Where is the first node (the smallest value of x)?

(A) 5 cm (B) 10 cm (C) 50 cm (D) 100 cm (E) 200 cm

7. 解：(C)

$$\begin{aligned} y &= y_1 + y_2 = (3.0\text{cm})\left\{\cos\frac{\pi}{2}[(2.0\text{m}^{-1})x + (5.0\text{s}^{-1})t] + \cos\frac{\pi}{2}[(2.0\text{m}^{-1})x - (5.0\text{s}^{-1})t]\right\} \\ &= \left|2(3.0\text{cm})\cos\left(\frac{\pi}{2} \times 5.0\text{s}^{-1}t\right)\right| \cos\left(\frac{\pi}{2} \times 2.0\text{m}^{-1}x\right) \end{aligned}$$

$$k = \pi = \frac{2\pi}{\lambda} \Rightarrow \lambda = 2$$

$$kx = \frac{\pi}{2} \Rightarrow \frac{2\pi}{\lambda}x = \frac{\pi}{2} \Rightarrow x = 1 \times \frac{\lambda}{4} = 1 \times \frac{2}{4} = 0.5[m] = 50[cm]$$

8. A spherical ball contains a charge $+q$ uniformly distributed over its surface. When its diameter is D , the electric field at its surface has magnitude E . What will the electric field be if its diameter changes to $2D$ without changing the charge?

(A) E (B) $2E$ (C) $4E$ (D) $E/2$ (E) $E/4$

8. 解：(E)

$$E = \frac{q}{4\pi\epsilon_0 R^2} = \frac{q}{4\pi\epsilon_0 \left(\frac{D}{2}\right)^2}$$

$$E' = \frac{q}{4\pi\epsilon_0 R'^2} = \frac{q}{4\pi\epsilon_0 \left(\frac{2D}{2}\right)^2} = \frac{E}{4}$$

9. What is the total energy supplied while the current increases from zero to a final value I ? Assume L is the inductance.

(A) $\frac{1}{2}LI^2$ (B) LI^2 (C) $2LI^2$ (D) $\frac{1}{4}LI^2$ (E) $4LI^2$

9. 解：(A)

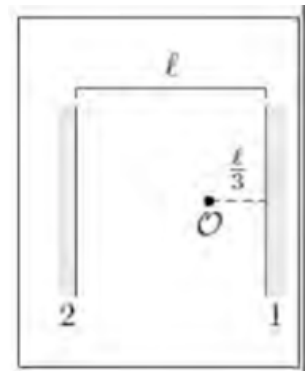
$$U_L = \frac{1}{2}LI^2$$

10. An object O is placed between two mirrors of distance l apart. If object O is distance $l/3$ away from mirror 1 (see the right figure), what is the distance of the second closest image of object O that appears in mirror 1? (Hint: The closest one is $4/3$.)

(A) $l/3$ (B) $2l/3$ (C) l (D) $4l/3$ (E) $5l/3$

10. 解：(E)

在第二面鏡子內 $2l/3$ 處會產生影像，此影像距離第一面鏡子 $5l/3$



【版權所有，翻印必究】
(其他試題詳解，歡迎參考高點出版67MU201707【物理歷屆試題解析】一書)