高雄醫學大學 107 學年度學士後醫學系招生考試試題

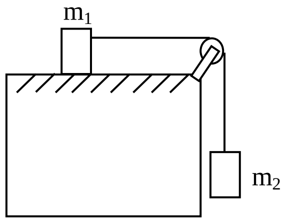
科目:物理及化學　　　　　　　　　　　　　　　　考試時間: 100 分鐘

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

Choose one best answer for the following questions

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

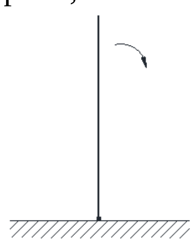
1. Two boxes are connected by a string, as shown below. The string and pulley are massless, and $m_1+m_2=16$ kg. If the system is at rest and the coefficient of static friction is 0.6, what is the **minimum** weight of m_1?



(A) 4 kg (B) 6 kg (C) 8 kg (D) 10 kg (E) 12 kg

2. A 70 kg person stands on one end of a one-meter long board. The board is uniform and weighs 100 kg. How far is the center of mass of the system “person on board” from the person?
(A) 0.1 m (B) 0.3 m (C) 0.5 m (D) 0.8 m (E) 0.9 m

3. A thin uniform rod of mass M and length L is positioned vertically above an anchored frictionless pivot point, as shown below, and then allowed to fall to the ground. At what speed does the free end of the rod strike the ground?



(A) $\sqrt{\frac{1}{3}gL}$ (B) $\sqrt{gL}$ (C) $\sqrt{3gL}$ (D) $\sqrt{12gL}$ (E) $12\sqrt{gL}$

4. A disk with a radius of 2.0 m and a rotational inertia of 0.40 kg·m^2 rotates with an angular speed of 4.0 rad/s around a frictionless vertical axle. A wade of clay (m = 25 g) drops onto and sticks to the edge of the disk. What is the new angular speed of the disk?
(A) 3.2 rad/s (B) 3.6 rad/s (C) 2.7 rad/s (D) 1.1 rad/s (E) 0.67 rad/s

5. A violin is played with an initial intensity I_i changing to a final intensity I_f. If $I_f = 5\,I_i$, what is the difference in sound intensity level (dB) between these two extremes?
(A) 10(log5) (B) 5 (C) 10 (D) 10(log2) (E) 2(log5)

6. An engine is designed to obtain energy from the temperature gradient of the ocean. What is the thermodynamic efficiency of such an engine if the temperature of the surface of the water is 15 ℃ and the temperature below the surface is 5 ℃?
(A) 96% (B) 67% (C) 31% (D) 17% (E) 3.5%

7. If 10 kg of ice at 0 ^{o}C is mixed with 100 kg of water at 80 ^{o}C and is additionally heated with 4620 kJ, what is the final temperature of the water? (The heat capacity constant of water is 4.2 kJ·kg^{-1}·K^{-1}, and the latent heat of fusion of water is 333 kJ·kg^{-1}.)
(A) 45 ^{o}C (B) 55 ^{o}C (C) 65 ^{o}C (D) 70 ^{o}C (E) 75 ^{o}C

8. Some species of whales can dive to the depth of one kilometer. What is the approximate total pressure they experience at this depth? (ρ_{sea} = 1020 kg/m^3 and 1 atm =1.01 ×10^5 N/m^2)
(A) 9.00 atm (B) 90.0 atm (C) 100 atm (D) 111 atm (E) 130 atm

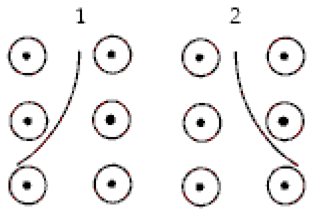
9. A proton moves around a circular path (radius = 2.0 mm) in a uniform 0.25 T magnetic field. What total distance does this proton travel during a 1.0 s time interval? (m_p = 1.67×10^{-27} kg, q = 1.6× 10^{-19} C)
(A) 82 km (B) 59 km (C) 71 km (D) 48 km (E) 7.5 km

10. A current loop freely rotates in a uniform magnetic field (B = 0.50 T). The maximum torque on the loop is 0.60 N · m. What is the magnetic dipole moment of the loop?
(A) 1.2 A·m^2 (B) 2.4 A·m^2 (C) 0.60 A·m^2 (D) 0.30 A·m^2 (E) 0.83 A·m^2

11. A 2.0 kΩ resistor and an initially uncharged 6.0 μF capacitor are connected in series to a 12 V battery. A switch is closed to complete the circuit at t = 0. What is the voltage across the resistor at t = 1.0 s?
(A) 0 V (B) 12 V (C) 6 V (D) 3 V (E) 9 V

12. A 3 μF capacitor is connected in series with a 6 μF capacitor. When a 300 V potential difference is applied across this combination, the total energy stored in the two capacitors is ______.
(A) 0.09 J (B) 0.18 J (C) 0.27 J (D) 0.41 J (E) 0.81 J

13. A magnetic field is directed out of the page. Two charged particles enter from the top and take the paths shown in the figure. Which statement is **correct**?



(A) Particle 1 has a positive charge and particle 2 has a negative charge.
(B) Particle 1 has a negative charge and particle 2 has a positive charge.
(C) Both particles are negatively charged.
(D) Both particles are positively charged.
(E) The direction of the paths depends on the magnitude of the velocity, not the sign of the charge.

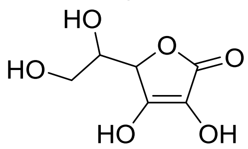
14. In radioactive decays, which of the following statements is **incorrect**?
(A) The energy, momentum, electric charge, and number of nucleons must be conserved.
(B) In gamma decay, electromagnetic photons are emitted when a nucleus undergoes a transition from a higher to lower energy.
(C) In beta decay, an electron (e^-) or a positron (e^+) can be emitted by a nucleus.
(D) In positron (e^+) decay, annihilation radiation is generated with different photon energies.
(E) The alpha decay is usually observed in the heavy unstable nuclei.

15. In X-ray spectrum, which of the following statements is **correct**?
(A) The electron beam is accelerated in the air to strike a target and generate X-rays.
(B) The minimum frequency of X-ray is proportional to the potential difference between anode and cathode.
(C) Most of the generated X-rays are bremsstrahlung radiation.
(D) Characteristic X-rays are the radiation generated by atom nucleus.
(E) Most kinetic energy of electrons is converted to X-rays.

16. Carbon monoxide is commonly used to reduce ores to produce free metals and carbon monoxide is converted to ______.
(A) carbon dioxide (B) carbon black (C) methane (D) graphite (E) carbon nanotube

17. Which of the following is the **correct** order of boiling points for KNO_3, CH_3OH, C_2H_6, and Ne?
(A) $KNO_3 < CH_3OH < C_2H_6 < Ne$ (B) $CH_3OH < Ne < C_2H_6 < KNO_3$ (C) $Ne < C_2H_6 < KNO_3 < CH_3OH$
(D) $Ne < C_2H_6 < CH_3OH < KNO_3$ (E) $C_2H_6 < Ne < CH_3OH < KNO_3$

18. How many chiral centers are in this molecule?



(A) 0 (B) 1 (C) 2 (D) 3 (E) 4

19. Which of the following statements is **incorrect**?
(A) A triple bond is composed of two π bonds and one σ bond.
(B) σ bonds result from the head-to-head overlap of atomic orbitals.
(C) Free rotation does not occur about a double bond.
(D) π bonds have electron density on the inter-nuclear axis.
(E) More than one of these statements are incorrect.

20. Which of the following statements is **incorrect**?
(A) The reaction constant might change when the reaction temperature changes.
(B) The reaction constant won't change when the concentration of reactants changes.
(C) The reaction constant might change when the catalyst is added to the reaction.
(D) The activation of energy for a reaction might change when the catalyst is added.
(E) The activation of energy for a reaction might change when the reaction temperature changes.

21. When 6 M sodium hydroxide is added to an unknown white solid, the solid is dissolved.
What is a possible identity for this solid?
(A) $Mg(OH)_2$ (B) $Al_2(SO_4)_3$ (C) $BaCO_3$ (D) AgBr (E) $Ca_3(PO_4)_2$

22. A chemist wishes to separate benzoic acid from 4-hydroxybenzaldehyde. Which is the **best** method to achieve this separation?

(A) Partitioning the mixture between diethyl ether and water.
(B) Partitioning the mixture between diethyl ether and 1 M aqueous $NaHCO_3$.
(C) Partitioning the mixture between diethyl ether and 1 M aqueous NaOH.
(D) Partitioning the mixture between diethyl ether and 1 M aqueous HCl.
(E) Recrystallizing the mixture in diethyl ether.

23. The reaction system $CO(g) + H_2O(g) \rightleftharpoons H_2(g) + CO_2(g)$ has already reached equilibrium. Which of the following statements is **correct**?
(A) Additional $H_2O(g)$ added to the system will shift to the left to obtain the equilibrium.
(B) As an exothermic reaction, the system will shift to the right to attain the equilibrium when temperature increases.
(C) When carbon dioxide is removed, the system will shift to the left to achieve the equilibrium.
(D) When volume of the reaction container is decreased, the system will shift to the right to reach the equilibrium.
(E) Addition of helium gas into the reaction system will have no effects on its equilibrium.

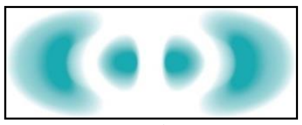
24. Which elements are **most** similar in atomic size?
(A) Li (Z = 3) and Na (Z = 11) (B) B (Z = 5) and Al (Z = 13) (C) Co (Z = 27) and Rh (Z = 45)
(D) Zr (Z = 40) and Hf (Z = 72) (E) Be (Z = 4) and F (Z = 9)

25. In the Lewis structure of I_3^-, there are _________ electrons around the central iodine atom.
(A) 4 (B) 6 (C) 8 (D) 10 (E) 12

26. Which of the following statements is **incorrect** for colloids?
(A) Colloids are suspension of very large particles (>2000 nm) in a medium.
(B) Tyndall effect is observed for colloids.
(C) Electric repulsion seems to be the main factor that stabilizes colloids.
(D) Removal of soot from smoke is an example of coagulation of colloids.
(E) None of the above.

27. Which organic base is **NOT** found in RNA?
(A) Uracil (B) Cytosine (C) Thymine (D) Adenine (E) Guanine

28. The figure below is a cross section of the electron probability distribution for an orbital. What are n and ℓ values for this orbital?



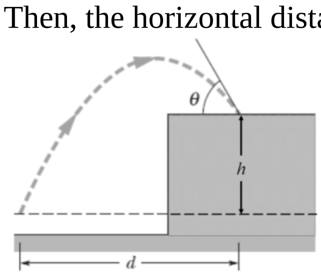
(A) $n = 3, \ell = 1$ (B) $n = 2, \ell = 0$ (C) $n = 2, \ell = 1$ (D) $n = 3, \ell = 2$ (E) $n = 2, \ell = 2$

29. A sample of a white solid is known to be $NaHCO_3$, $AgNO_3$, Na_2S, or $CaBr_2$. Which 0.1 M aqueous solution can be used to confirm the identity of the solid?
(A) $NH_3(aq)$ (B) $HCl(aq)$ (C) $NaOH(aq)$ (D) $KCl(aq)$ (E) $CH_3COOH(aq)$

30. The Haber process ____________________
(A) is used to produce nitric acid. (B) is used to produce sulfuric acid. (C) is used to produce ammonia.
(D) is used to produce urea. (E) None of the above.

【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。

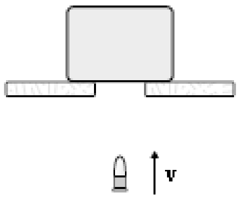
31. As the figure shows, a stone was thrown on the roof of height h=10 m from the throw. After 6 seconds, the stone fell on the roof at a horizontal distance d from the throw. The angle between the final flight path of the stone and the roof is $\theta = 60°$. Then, the horizontal distance d it travels is:



(A) 166.5 m (B) 333.0 m (C) 144.2 m (D) 288.4 m (E) 55.5 m

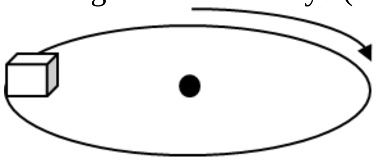
32. A force $\vec{F} = (4.0\hat{\imath} + 2.0\hat{\jmath} + 3.0\hat{k})N$ acts on a particle with a position vector $\vec{r} = (1.0\hat{\imath} + 3.0\hat{\jmath} + 2.0\hat{k})m$. Find the torque due to this force about the axis passing through the origin.
(A) $-5.0\hat{\imath} - 5.0\hat{\jmath} + 10\hat{k}\ (N \cdot m)$ (B) $10\hat{\imath} + 5.0\hat{\jmath} - 5.0\hat{k}\ (N \cdot m)$
(C) $5.0\hat{\imath} - 5.0\hat{\jmath} - 10\hat{k}\ (N \cdot m)$ (D) $5.0\hat{\imath} + 5.0\hat{\jmath} - 10\hat{k}\ (N \cdot m)$
(E) $5.0\hat{\imath} - 5.0\hat{\jmath} + 10\hat{k}\ (N \cdot m)$

33. A 10 g bullet moving 1000 m/s strikes and passes through a 2.0 kg block initially at rest, as shown. The bullet emerges from the block with a speed of 400 m/s. What is the **maximum** height at which the block will rise above its initial position?



(A) 78 cm (B) 66 cm (C) 56 cm (D) 46 cm (E) 37 cm

34. A box of mass 1 kg was placed on the edge of a rotating table with radius 10 cm, as shown below. At what rotating speed, the box begins to slide away? (The coefficient of static friction between the box and table is 0.8)

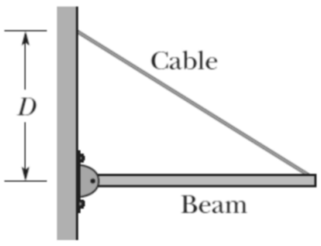


(A) 32 cm/s (B) 53 cm/s (C) 68 cm/s (D) 89 cm/s (E) 98 cm/s

35. A 10 N tangential force is applied at the edge of a 20 kg disk with a radius of 2.0 m. Then, the disk rotates from rest. What is the kinetic energy of the disk 3.0 s after the force is applied?

(A) 180 J (B) 360 J (C) 45 J (D) 90 J (E) 23 J

36. A uniform beam of weight 300 N and length 3.0 m is suspended horizontally. On the left it is hinged to a wall; on the right it is supported by a cable bolted to the wall at distance *D* above the beam. The tension on the cable is 250 N. What value of *D* corresponds to that tension?



(A) 1.25 m (B) 1.50 m (C) 1.75 m (D) 2.00 m (E) 2.25 m

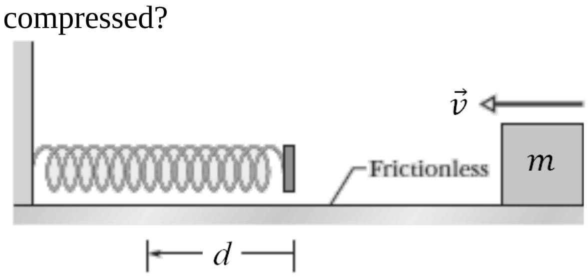
37. A force $\vec{F} = (-4.0)\text{x}(\text{N/m})\hat{\imath} + (2.0)\text{y}(\text{N/m})\hat{\jmath}$ is applied on a particle. What is the work done by the force as the particle moves in an x-y plane from (1.0 m, 0.0 m) to (-2.0 m, 3.0 m)?

(A) 15 J (B) 1.0 J (C) 3.0 J (D) 17 J (E) 11 J

38. A single conservative force $F(x)$ acts on a particle that moves along an x axis. The particle has mass of 2.0 kg. The potential energy $U(x)$ associated with $F(x)$ is described by $U(x) = -(2.0)xe^{-2x}\,J$, where x is in meters. What is the value of x where $F(x)$ is equal to zero?

(A) -1.0 m (B) 1.0 m (C) 0.5 m (D) -0.5 m (E) 0 m

39. In the figure, a block of mass m = 20.0 kg slides through a horizontal frictionless ground at a speed of *v* = 0.50 m/s. It then compresses the spring with spring constant k = 5.0 N/m. When the block decelerates to a stop, by what distance *d* is the spring compressed?



(A) 0.5 m (B) 1.0 m (C) 1.5 m (D) 2.0 m (E) 2.5 m

40. 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

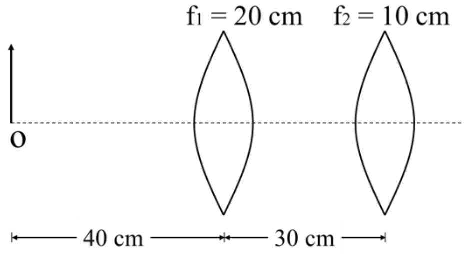
41. A pipe open at both ends has a fundamental frequency of f. A second pipe closed at one end and open at the other end has the same fundamental frequency. What is the ratio of the length of the pipe open at both ends to the length of the pipe closed at one end?

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

42. A converging glass lens with a refractive index of 1.5 is placed in water with a refractive index of 1.25. How many times of focal length of the lens will be changed in water?

(A) 0.3 (B) 0.8 (C) 1.5 (D) 2 (E) 2.5

43. An object is located at 40 cm from the first of two thin converging lenses of focal lengths 20 cm and 10 cm, respectively, as shown in the figure above. The lenses are separated by 30 cm.
The final image formed by the two-lens system is located ______.



(A) 5.0 cm to the right of the second lens
(B) 13.3 cm to the right of the second lens
(C) infinitely far to the right of the second lens
(D) 13.3 cm to the left of the second lens
(E) 100 cm to the left of the second lens

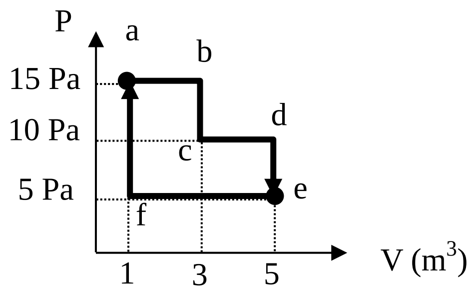
44. Two stars are separated by an angle of 3×10^{-5} radians. What is the diameter of the smallest telescope that can resolve the two stars using visible light ($\lambda \cong 600$ nm)? (Ignore any effects due to Earth's atmosphere.)

(A) 1 mm (B) 2.5 cm (C) 10 cm (D) 2.5 m (E) 10 m

45. Unpolarized light of intensity I_0 is incident on a series of three polarizing filters. The axis of the second filter is oriented at 45^o to that of the first filter, while the axis of the third filter is oriented at 90^o to that of the first filter. What is the intensity of the light transmitted through the third filter?

(A) 0 (B) $\frac{I_0}{8}$ (C) $\frac{I_0}{4}$ (D) $\frac{I_0}{2}$ (E) $\frac{I_0}{\sqrt{2}}$

46. If a gas undergoes a series of pressure (P) and volume (V) changes, as shown below, how much work is done by the gas along the path a→b→c→d→e→f→a?

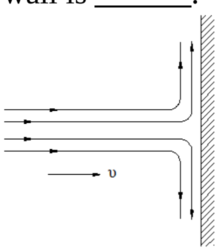


(A) 20 J (B) 30 J (C) 40 J (D) 50 J (E) 60 J

47. There is a laminar flow in a tube. When both the radius and length of the tube are doubled, how many times of flow resistance is changed?

(A) $\frac{1}{64}$ (B) $\frac{1}{32}$ (C) $\frac{1}{16}$ (D) $\frac{1}{8}$ (E) $\frac{1}{4}$

48. A steam of water of density ρ, cross-sectional area A, and speed υ strikes a wall that is perpendicular to the direction of the stream, as shown in the figure below. The water then flows sideways across the wall. The force exerted by the stream on the wall is ______.



(A) $\rho\upsilon^2$A (B) $\rho\upsilon$A/2 (C) ρghA (D) υ^2A/ρ (E) υ^2A/2ρ

49. Water is flowing at 4.0 m/s in a circular pipe. If the diameter of the pipe decreases to 1/2 its former value, what is the velocity of the water downstream?

(A) 16 m/s (B) 4.0 m/s (C) 1.0 m/s (D) 8.0 m/s (E) 2.0 m/s

50. A 5.0 nC point charge is embedded at the center of a nonconducting sphere (radius = 2.0 cm) which has a charge of -8.0 nC distributed uniformly throughout its volume. What is the magnitude of the electric field at a point that is 1.0 cm from the center of the sphere? (where electric constant k=9.0×10^9 N·m^2/C^2)

(A) 9.0×10^4 *N/C* (B) 1.8×10^5 *N/C* (C) 2.7×10^5 *N/C* (D) 3.6×10^5 *N/C* (E) 7.2×10^5 *N/C*

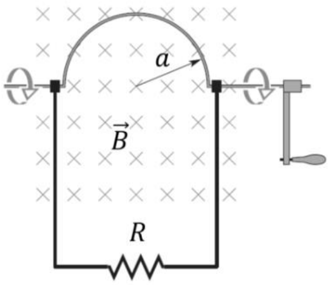
51. A 5.0 A current flows along a wire with $\vec{l} = (1.5\,\hat{\imath} - 2.0\,\hat{\jmath})$m. The wire resides in a uniform magnetic field $\vec{B} = (0.1\,\hat{\imath} - 0.3\,\hat{k})$T. The magnetic force acting on the wire is described by $\vec{F} = (C\,\hat{\imath} + D\,\hat{\jmath} + E\,\hat{k})N$. What is the value of C+D+E?

(A) 1.3 N (B) 6.3 N (C) 1.8 N (D) 4.3 N (E) 0.35 N

52. The current in an inductor (L = 40 mH) is described by $I = 3.0 - 4.0t + t^2$ with I in amperes and t in seconds. What is the magnitude of the *emf* induced in the inductor at t = 3.0 s?

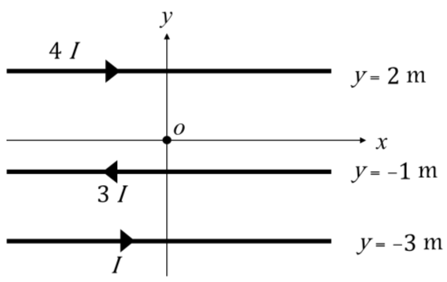
(A) 2.0 V (B) 0.080 V (C) 50 V (D) 0 V (E) 4.0 V

53. A stiff wire bent into a semicircle of radius *a* = 2.0 cm is rotated at constant angular speed 40 rev/s in a uniform 20 mT magnetic field. What is the amplitude of the *emf* induced in the loop?



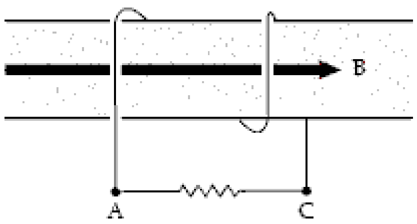
(A) 3.16×10^{-2} V (B) 3.16×10^{-3} V (C) 3.16×10^{-1} V (D) 1.98×10^{-2} V (E) 1.98×10^{-3} V

54. Three long wires parallel to the *x* axis carry currents as shown. If *I* = 20 *A*, what is the magnitude of the magnetic field at the origin point O? (magnetic constant $\mu_0 = 4\pi \times 10^{-7}$ T·m/A)



(A) 19 μT (B) 28 μT (C) 37 μT (D) 47 μT (E) 58 μT

55. The coil shown below has 2 turns, a cross-sectional area of 0.20 m^2, and a field (parallel to the axis of the coil) with a magnitude given by $B = (4.0 + 3.0t^2)$ T, where t is in *s*. What is the potential difference, $V_A - V_C$, at *t* = 3.0 *s*?



(A) -7.2 V (B) +7.2 V (C) -4.8 V (D) +4.8V (E) -12 V

56. A series RLC circuit is connected to an ac source ($\xi_{rms} = 120$ V, f = 60 Hz). The resistance, capacitive reactance and inductive reactance are 40 Ω, 80 Ω, and 50 Ω respectively. What is the current (I_{rms}) in the circuit?

(A) 3.0 A (B) 0.040 A (C) 1.7 A (D) 1.4 A (E) 2.4 A

57. The rest mass of an electron is m_0. What is the kinetic energy of an electron with the speed of 0.80c? (The constant c is the speed of light in vacuum.)

(A) $\frac{5}{4}m_0c^2$ (B) $\frac{1}{4}m_0c^2$ (C) $\frac{5}{3}m_0c^2$ (D) $\frac{2}{3}m_0c^2$ (E) $\frac{8}{3}m_0c^2$

58. In the hydrogen spectrum, the ratio of the wavelengths for Lyman-*α* radiation (*n* = 2 to *n* = 1) to Balmer-*α* radiation (*n* = 3 to *n* = 2) is ______.

(A) $\frac{5}{48}$ (B) $\frac{5}{27}$ (C) $\frac{1}{3}$ (D) 3 (E) $\frac{27}{5}$

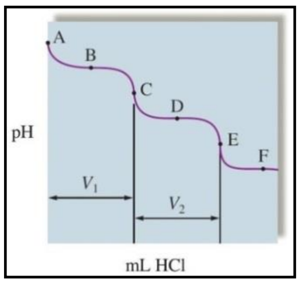
59. A sample of radioactive nuclei of a certain element can decay only by γ -emission and β -emission. If the half-life for γ -emission is 24 minutes and that for β -emission is 36 minutes, the half-life for the sample is

(A) 30 minutes (B) 24 minutes (C) 20.8 minutes (D) 14.4 minutes (E) 6 minutes

60. The radioactive isotope ^{226}Ra decays to ^{222}Rn with a half-life of 1600 years. The radioactive isotope ^{238}U decays to ^{234}Th with a half-life of 4.5×10^9 years. What is the ratio of the decay rate of 1 g ^{226}Ra to that of 10 g ^{238}U?

(A) 3.0×10^6 (B) 3.0×10^{-7} (C) 3.0×10^5 (D) 3.0×10^{-6} (E) 3.0×10^7

61. Which of the following solution has shown the **correct** titration curve?

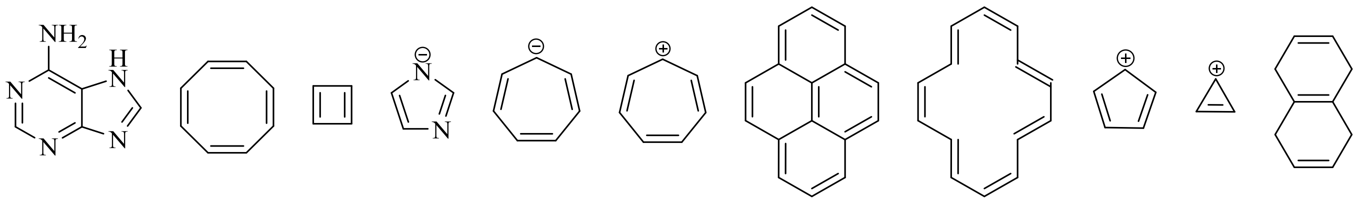


(A) NH_3 (B) CO_3^{2-} (C) HCN (D) PO_4^{3-} (E) NaOH

62. Cisplatin *cis*-$[PtCl_2(NH_3)_2]$ has been applied as an anti-tumor drug. What is its main interaction *in vivo*?
(A) Binding with DNA. (B) Binding with lipid. (C) Binding with protein.
(D) Binding with sugar. (E) Blocking ion absorption.

63. A chemist needs to prepare a buffered solution using one of the following acids (and its sodium salt): HA (Ka = 1.4 $\times$ 10^{-3}), HB (Ka = 9.8 $\times$ 10^{-6}), HC (Ka = 8.4 $\times$ 10^{-5}), HD (Ka = 3.5 $\times$ 10^{-7}), HE (Ka = 1.9 $\times$ 10^{-8}). To prepare a solution buffered at pH = 5.10, which system will work **best** (a buffer with the best capacity)?
(A) HA and its sodium salt (B) HB and its sodium salt (C) HC and its sodium salt
(D) HD and its sodium salt (E) HE and its sodium salt

64. Of the following eleven compounds, how many of them have aromatic character?



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

65. Which of the following species has the **lowest** dissociation energy?
(A) O_2 (B) O_2^{-} (C) O_2^{2-} (D) O_2^{+} (E) O_2^{2+}

66. According to the Bohr Model, please use the equation below and calculate the **minimum** energy required to remove the electron from a He^+ ion in its first excited state. $E = -2.178 \times 10^{-18}$ J (Z^2/n^2)
(A) 2.178×10^{-18} J (B) 5.445×10^{-19} J (C) 8.712×10^{-18} J (D) 4.356×10^{-18} J (E) 1.089×10^{-18} J

67. About the atomic orbitals, which of the following statements is **incorrect**?
(A) In a polyelectronic atom, the orbital relative energies are $E_{3s} < E_{3p} < E_{3d}$.
(B) In H atom, energy is absorbed and electron jumps from 1*s* to 3*s* orbital.
(C) The 2*p* orbital is spherically symmetric.
(D) The square of the wave function is indicated as a probability distribution.
(E) None of the above.

68. NF_3 has a bond angle of 102.5°, while PF_3 has a bond angle of 96.3°. What is the **best** explanation for the larger bond angle in NF_3?
(A) The nitrogen 2*s* orbital participates more in bonding than the phosphorus 3*s* orbital does.
(B) Nitrogen is more electronegative than phosphorus.
(C) NF_3 has no unpaired electrons while PF_3 has two unpaired electrons.
(D) NF_3 is an ionic compound while PF_3 forms covalent bonds.
(E) NF_3 adopts a trigonal geometry, while PF_3 displays a trigonal planar configuration.

69. When the reaction below is at equilibrium, what is the temperature?
$2\ NO(g) + O_2(g) \rightarrow 2\ NO_2(g)$ $\Delta H°_{rxn} = -113$ kJ•mol^{-1} $\Delta S°_{rxn} = -145$ J•mol^{-1}•K^{-1}
(A) –195 °C (B) 77.9 °C (C) 350.9 °C (D) 506 °C (E) 779 °C

70. Please balance the following equation (o, p, q, x, y, z are reaction coefficients).
What is the **sum** of all coefficients (o + p + q + x + y + z) ?
$\mathbf{o}\ Cr_2O_7^{2-}{}_{(aq)} + \mathbf{p}\ H_2O_{2(aq)} + \mathbf{q}\ H^+{}_{(aq)} \rightarrow \mathbf{x}\ Cr^{3+}{}_{(aq)} + \mathbf{y}\ O_{2(g)} + \mathbf{z}\ H_2O_{(aq)}$
(A) 18 (B) 20 (C) 22 (D) 24 (E) 26

71. For the reaction A + B → products, the following data were obtained:

Initial rate (mol/L•s)	0.030	0.059	0.060	0.090	0.090
$[A]_o$ (mol/L)	0.10	0.20	0.20	0.30	0.30
$[B]_o$ (mol/L)	0.20	0.20	0.30	0.30	0.50

What is the experimental rate law?
(A) Rate = k[A] (B) Rate = k[B] (C) Rate = k[A][B]
(D) Rate = $k[A]^2[B]$ (E) Rate = $k[A][B]^2$

72. In the blood of an adult human, there are approximately 2.64×10^{13} red blood cells with a total of 2.90 g of iron. On the average, how many iron atoms in each red blood cell? (Fe = 55.85 g/mol)
(A) 5.19×10^{-2} (B) 4.72×10^{11} (C) 1.09×10^{-13} (D) 9.10×10^{12} (E) 1.18×10^{9}

73. What is the rate constant for radioactive decay of $^{14}CO_2(g)$ at 0.1 atm? (The half-life of C-14 nucleus is 5730 years.)
(A) 1.38×10^{-8} h^{-1} (B) 2.76×10^{-8} h^{-1} (C) 1.38×10^{-9} h^{-1}
(D) 3.45×10^{-9} h^{-1} (E) 6.90×10^{-9} h^{-1}

74. 1 mg of a non-electrolyte protein is dissolved in enough water to make 1.00 mL of solution. The osmotic pressure of the solution is found to be 1.56 torr at 25°C. The molecular weight of this protein is approximately ________ g.
(A) 1.19×10^{7} (B) 11905 (C) 5950 (D) 999 (E) None of the above

75. When the permanganate ion, MnO_4^-, acts as an oxidizing agent which forms different products depending on the pH of the solution. Which species corresponding to the conditions listed below is **correct**?

	acidic	basic	neutral
A	Mn^{2+}	$Mn(OH)_2$	MnO_2
B	Mn^{2+}	MnO_4^{2-}	MnO_2
C	MnO_2	MnO_4^{2-}	$Mn(OH)_2$
D	Mn^{2+}	$Mn(OH)_2$	MnO_4^{2-}
E	MnO_2	$Mn(OH)_2$	MnO_4^{2-}

(A) A (B) B (C) C (D) D (E) E

76. Alanine, $H_2NCH(CH_3)CO_2H$, has $K_a = 4.5 \times 10^{-3}$ and $K_b = 7.4 \times 10^{-5}$. Which species has the **highest** concentration in water (pH=7.0)?
(A) $H_2NCH(CH_3)CO_2H$ (B) $^+H_3NCH(CH_3)CO_2H$ (C) $H_2NCH(CH_3)CO_2^-$
(D) $H_2NCH(CH_3)CO_2H_2^+$ (E) $^+H_3NCH(CH_3)CO_2^-$

77. The rate of effusion of an unknown gas is measured and found to be 24 mL/min. Under the same condition, the rate of effusion of CO gas is 38 mL/min. Which is the **best** formula of this unknown gas?
(A) CO_2 (B) H_2O (C) C_5H_{10} (D) C_6H_6 (E) C_2H_5OH

78. An unknown concentration of NH_3 solution is titrated by HCl solution. The color change for indicators at different pH values are shown in the table below. Which of the following indicators is the **best** for this titration?

Indicator	Color of acidic form	pH range for the color change	Color of basic form
crystal violet	yellow	0---2	blue
thymol blue	red	1---3	yellow
	yellow	8---9	blue
methyl red	red	4---6	yellow
phenolphthalein	colorless	8---10	red
alizarine yellow R	yellow	10---12	red

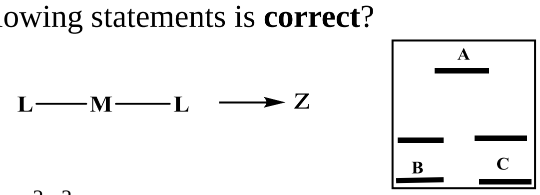
(A) phenolphthalein (B) alizarine yellow R (C) methyl red
(D) crystal violet (E) thymol blue

79. $HNO_2(l) + NaCl(s) \rightarrow HCl(g) + NaNO_2(s)$ Calculate the $\Delta H°$ value for the reaction above based on the information below.

Reaction	$\Delta H°$ kJ•mol^{-1}
$NO(g) + NO_2(g) + Na_2O(s) \rightarrow 2\ NaNO_2(s)$	–427.0
$NO(g) + NO_2(g) \rightarrow N_2O(g) + O_2(g)$	–43.0
$2\ NaCl(s) + H_2O(l) \rightarrow 2\ HCl(g) + Na_2O(s)$	507.0
$2\ HNO_2(l) \rightarrow N_2O(g) + O_2(g) + H_2O(l)$	34.0

(A) –78.5 kJ (B) –157 kJ (C) 0 kJ (D) 78.5 kJ (E) 157 kJ

80. The crystal field diagram for a linear transition metal complex ML_2 where the ligands lie along the z axis is shown below. Which of the following statements is **correct**?



(A) A orbital is $d_{x^2-y^2}$ (B) B orbital and C orbital are d_{xz} and d_{yz}
(C) A orbital is d_{xy} (D) B orbital and C orbital are $d_{x^2-y^2}$ and d_{z^2}
(E) A orbital is d_{z^2}

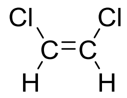
81. Consider the following complexes: (en=$H_2N–CH_2–CH_2–NH_2$ and is bidentate)
I. $Pt(NH_3)_2Cl_2$ (square planar) II. $RhCl_2(en)_2^{2+}$ (octahedral)
III. $CoCl_4^{2-}$ (tetrahedral) IV. $RhCl_4(en)^{2+}$ (octahedral)
Which can exhibit *cis-trans* isomerism?
(A) I (B) I and II (C) I, II, and III (D) I, II, III, and IV (E) I, II, and IV

82. Four solutions have violet, blue, yellow and green color, respectively. Each solution contains the following compounds: I. $[Cr(H_2O)_4Cl_2]Cl$, II. $[Cr(H_2O)_5Cl]Cl_2$, III. $[Cr(H_2O)_6]Cl_3$, IV. $[Cr(ethylenediamine)_3]Cl_3$. Please use the following table to predict the color for each solution.

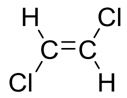
Absorbed wavelength (nm) and color	Observed color
400 violet	brownish yellow
450 blue	yellow
570 yellow-green	violet
580 yellow	dark blue
600 orange	blue
650 red	green

(A) I: green; II: blue; III: violet; IV: yellow
(B) I: yellow; II: violet; III: blue; IV: green
(C) I: green; II: yellow; III: violet; IV: blue
(D) I: green; II: violet; III: blue; IV: yellow
(E) I: violet; II: blue; III: green; IV: yellow

83. Which of the following statements is the **best** to describe the results of attempted separation by fractional distillation of the two isomers of 1,2-dichloroethene?



Isomer **1**



Isomer **2**

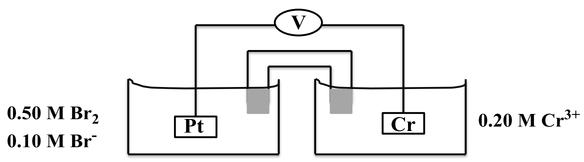
(A) They can be separated by fractional distillation, with isomer **1** boiling at the lower temperature.
(B) They can be separated by fractional distillation, with isomer **2** boiling at the lower temperature.
(C) They cannot be separated by fractional distillation because both isomers have the same boiling point.
(D) They cannot be separated by fractional distillation because they interconvert rapidly at the distillation temperature.
(E) They cannot be separated by fractional distillation because they have the same molecular weight and reactivity.

84. Which isomers of C_4H_8 has the **lowest** absolute entropy at 25℃?
(A) 1-butene (B) *cis*-2-butene (C) *trans*-2-butene (D) 2-methylpropene (E) cyclobutane

85. What are the factors influencing the infrared frequency of the CX vibration for CH_3X?
I. mass of X
II. strength of the CX bond
III. type of CX vibration (stretch or bend)
(A) I (B) II (C) I and II (D) II and III (E) I, II, and III

86. The radioactive isotope ^{247}Bk (Z = 97) decays by a series of α-particle and β-particle productions, taking ^{247}Bk through many transformations to end up as ^{207}Pb (Z = 82). In the complete decay series, how many α particles and β particles are produced, respectively?
(A) 10, 8 (B) 10, 5 (C) 10, 2 (D) 8, 8 (E) 5, 8

87. Consider the galvanic cell shown below (the contents of each half-cell are written beneath each compartment).
The standard reduction potentials are as follows:
$Cr^{3+} + 3e^- \rightarrow Cr(s)$ $E° = -0.73$ V
$Br_2(aq) + 2e^- \rightarrow 2Br^-$ $E° = +1.09$ V



Which of the following statements about this cell is **incorrect**?
(A) The value of $E°$ for this cell is 1.82 V
(B) Electrons flow from the Cr electrode to the Pt electrode.
(C) Reduction occurs at the Cr electrode.
(D) The cell is not at standard conditions.
(E) The value of E for this cell at 25℃ should larger than 1.82 V.

88. A galvanic cell consists of two half-reactions:
$Cl_2(g) + 2e^- \rightarrow 2Cl^-(aq)$ E° = 1.36 V $Fe^{3+}(aq) + e^- \rightarrow Fe^{2+}(aq)$ E° = 0.77 V
What is the **maximum** work can be obtained from this cell at standard condition? (Faraday constant = 96500 C mol^{-1})
(A) 173.7 kJ (B) 347.4 kJ (C) 569.4 kJ (D) 113.9 kJ (E) None of the above.

89. Alkali metals (Group 1) are different with alkaline earth metals (Group 2). Which of the following statements is **correct**?
(A) Alkali metals have larger ionic radii.
(B) Alkali metals have higher melting points.
(C) Alkali metals have greater first ionization energies.
(D) Alkali metals have greater densities.
(E) Alkali metals have greater electronegativity.

90. The partial pressure of $CO_2(g)$ is 0.22 atm and that of $CO(g)$ is 0.44 atm in a mixture of the two gases at 25°C. What is the mass fraction of CO_2 in the mixture? (atomic weight: C = 12 g/mol, O = 16 g/mol)
(A) 44% (B) 56% (C) 33.3% (D) 66.7% (E) 50%