國立中山大學 114 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 15 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. Atmospheric pressure decreases with altitude, but not in a linear manner. It decreases according to the following formula: $P = P_0 e^{-ky}$, where the constant k is given by $k = 1.25 \times 10^{-4} \text{ m}^{-1}$, P_0 is the atmospheric pressure at sea level, and y is the height above sea level. At what height above sea level will the atmospheric pressure be reduced to half? [ln2 = 0.69314]
   (A) 5545 m　　　(B) 3447 m　　　(C) 5034 m　　　(D) 4790 m　　　(E) 2996 m
   Ans: (A)

2. There are two tuning forks with frequencies 255 Hz and 251 Hz. When both tuning forks start vibrating, what frequency will be heard by the ear? How many times per second can a loud sound be heard?
   (A) 251 Hz, 2 times each second　　　(B) 255 Hz, 4 times each second
   (C) 254 Hz, 3 times each second　　　(D) 253 Hz, 4 times each second
   (E) 252 Hz, 2 times each second
   Ans: (D)

3. The method to correct hyperopia is to wear a convex lens with an appropriate focal length. Suppose a hyperopic person, at the maximum accommodation of the eye's lens (with the minimum curvature radius), can clearly see objects at a distance of 1.5 meters. What should be the focal length of the convex lens required for them to clearly see an object at a distance of 15 cm?
   (A) 14.0 cm　　　(B) 13.5 cm　　　(C) 22.0 cm　　　(D) 15.0 cm　　　(E) 16.6 cm
   Ans: (E)

4. In an adiabatic compression of an ideal gas, which of the following statements is **NOT** true?
   (A) The gas does work on its surroundings.
   (B) The internal energy of the gas increases.
   (C) The temperature of the gas increases.
   (D) The gas absorbs heat from its surroundings.
   (E) The process results in a change in the state of the gas.
   Ans: (D)

5. The method to correct myopia is to wear a concave lens with an appropriate focal length. Suppose a person has myopia, and the nearest object he/she can clearly see without the accommodation of the lens is at a distance of 45 cm. What should be the focal length of the concave lens required for the person to clearly see objects at infinity?
   (A) 22.5 cm　　　(B) 45.0 cm　　　(C) 90.0 cm　　　(D) 15.0 cm　　　(E) 60.0 cm
   Ans: (B)

6. The arterial blood pressure in the head and feet of a person standing differs from that when lying down. Suppose the difference (in magnitude) in arterial blood pressure in the head between the lying and standing positions is ΔP_1, and the difference in arterial blood pressure in the feet between these two positions is ΔP_2. Given that the density of blood is ρ and the local gravitational field strength is g, find the height of the person.
   (A) $\frac{\Delta P_1 - \Delta P_2}{2\rho g}$　　(B) $\frac{\Delta P_1 + \Delta P_2}{2\rho g}$　　(C) $\frac{\Delta P_1 - \Delta P_2}{\rho g}$　　(D) $\frac{\Delta P_1 + \Delta P_2}{\rho g}$　　(E) $\frac{\Delta P_1 \cdot \Delta P_2}{2\rho g}$
   Ans: (D)

試題請隨卷繳回，請留意背面是否有題。

7. If the ammeter detects a current of 10^{-8} A, how many electrons pass through the cross-section of the wire per second?
   (A) 6.60×10^{10} (B) 4.25×10^{10} (C) 6.25×10^{10}
   (D) 5.44×10^{11} (E) 4.98×10^{11}
   Ans: (C)

8. An electrocardiogram (ECG) can detect heart activity because the heart can form an electric dipole under external stimulation. Suppose the capacitance per unit area of a cardiac myocyte (心肌細胞) is C, the total surface area of the cardiac myocyte is A, and the transmembrane voltage is V. Suppose that the thickness of the cardiac myocyte is d. What is the electric dipole moment of a single cardiac myocyte?
   (A) CVAd   (B) CVd   (C) CVd/A   (D) CV/A   (E) CV
   Ans: (A)

9. Nyboer theoretically discovered in 1940 that changes in impedance can be used to determine changes in the cross-sectional area of blood vessels. Impedance is the resistance of a conductor in an alternating current circuit (frequency ω). There are various substances with different resistivities within the human body, so the human body exhibits a significant capacitance. The circuit composed of resistance R and capacitance C can be divided into series and parallel configurations. In the case of resistance and capacitance in series, what is the impedance Z?

   (A) $Z = \sqrt{R^2 + \omega^2 C^2}$ (B) $Z = \sqrt{\omega^2 + \frac{1}{(RC)^2}}$ (C) $Z = \sqrt{\omega^2 + (RC)^2}$

   (D) $Z = \sqrt{R^2 + \left(\frac{\omega}{C}\right)^2}$ (E) $Z = \sqrt{R^2 + \frac{1}{(\omega C)^2}}$

   Ans: (E)

10. When the observer and the sound source are stationary relative to each other, the observed frequency is f. Suppose the observer and the source are moving toward each other. If the observer's speed is 0.25v and the source's speed is also 0.25v, where v is the sound speed. What will be the observed frequency?
    (A) 5f/4   (B) 3f/4   (C) 4f/3   (D) 3f/5   (E) 5f/3
    Ans: (E)

11. In a scenario where a patient is sliding down a ramp during rehabilitation, and friction is present, what happens to the initial total mechanical energy?
    (A) It is completely converted to kinetic energy.
    (B) It is completely converted to potential energy.
    (C) It remains constant.
    (D) It is partially converted to thermal energy due to friction.
    (E) It disappears.
    Ans: (D)

12. Effectively, a nerve fiber can be considered as being composed of many individual circuits, where each circuit consists of a battery, a capacitor of capacitance C, and a resistor of resistance R connected in series which is the so-called RC circuit. What is the time constant of the RC circuit?
    (A) R/C   (B) 1/RC   (C) RC   (D) RC^2 (E) CR^2
    Ans: (C)

13. High-frequency electromagnetic fields are typically used in medicine to heat internal tissues or organs of the body, such as in surgical cutting. For microwaves with a frequency of 3×10^{11} Hz, what is their wavelength? Can they be seen with the naked eye? [speed of light is 3×10^8 m/s]
    (A) 10^{-3} m; invisible　　　(B) 10^{-3} m; visible　　　(C) 10^{-2} m; invisible
    (D) 10^{-2} m; visible　　　(E) 10^{-4} m; invisible
    Ans: (A)

14. X-rays are a commonly used electromagnetic wave in medical imaging technology. Using an X-ray tube to generate X-rays, the shortest wavelength λ_{min} that can be produced is inversely proportional to the voltage V of the tube. This relationship can be expressed by the following equation. λ_{min} = Q/V. What is the value of the constant Q in the equation? Planck constant, an electric charge, and the speed of light are denoted as h, e, and c, respectively.
    (A) hc　　　(B) e/h　　　(C) e/(hc)　　　(D) hc/e　　　(E) e^2/h
    Ans: (D)

15. The dimensions of stress are _____.
    (A) $[M/TL]$　　　(B) $[M/T^2L]$　　　(C) $[MT/L]$　　　(D) $[M/L]$　　　(E) $[MTL]$
    Ans: (B)

16. For the Arrhenius equation, k = exp ($-E_a/RT$), which of the following statement is **CORRECT**?
    (A) The effect of an enzyme is to increase the magnitude of A.
    (B) The exp ($-E_a/RT$) term represents the fraction of molecules with a kinetic energy larger than E_a.
    (C) The reaction rate k is linearly proportional to temperature T.
    (D) The activation energy E_a is associated with the collision frequency of the reactants.
    (E) The steric factor of reaction affects the magnitude of E_a.
    Ans: (B)

17. Which of the following are state functions?
    (A) work, heat, enthalpy　　　(B) heat, enthalpy, energy　　　(C) enthalpy, energy
    (D) work, heat, enthalpy, energy　　　(E) work, heat
    Ans: (C)

18. The mass of a sample of calcium carbonate powder is measured using weight by difference. If a vial containing calcium carbonate powder has an initial mass of 87.36 ± 0.03 g and a final mass of 76.99 ± 0.03 g, what mass of calcium carbonate was taken?
    (A) 10.37 ± 0.04 g　　　(B) 10.37 ± 0.03 g　　　(C) 10.370 ± 0.042 g
    (D) 10.370 ± 0.004 g　　　(E) 10.370 ± 0.005 g
    Ans: (A)

19. Which of the following ionic compounds has (in absolute values) the largest lattice energy; that is, which has the lattice energy most favorable to a stable lattice?
    (A) LiF　　　(B) LiI　　　(C) CsF　　　(D) MgO　　　(E) CsI
    Ans: (D)

20. What is the key step in the Heck reaction?
    (A) radical generation　　　(B) carbocation formation
    (C) palladium-catalyzed oxidative addition and reductive elimination
    (D) nucleophilic substitution　　　(E) decarboxylation
    Ans: (C)

21. _____ is the upward force exerted on an object in a gaseous or liquid fluid. The mass measured by an analytical balance in air is _____ its actual mass.
    (A) Buoyancy; heavier than
    (B) Buoyancy; lighter than
    (C) Electromagnetic force; heavier than
    (D) Electromagnetic force; lighter than
    (E) Tare; equal to
    Ans: (B)

22. How many electrons in an atom can have the quantum numbers $n = 4$, $l = 2$?
    (A) 18   (B) 32   (C) 2   (D) 6   (E) 10
    Ans: (E)

23. Which of the following options shows the molecules in the order from most polar to least polar? ("=" indicates that two molecules are similarly polar)
    (A) $CF_2Cl_2 > CF_2H_2 > CCl_2H_2 > CH_4 = CCl_4$
    (B) $CF_2H_2 > CCl_2H_2 > CF_2Cl_2 > CH_4 = CCl_4$
    (C) $CH_4 > CF_2Cl_2 > CF_2H_2 > CCl_4 > CCl_2H_2$
    (D) $CF_2Cl_2 > CF_2H_2 > CCl_4 > CCl_2H_2 > CH_4$
    (E) $CH_4 > CF_2H_2 > CF_2Cl_2 > CCl_4 > CCl_2H_2$
    Ans: (B)

24. Lead(II) nitrate reacts with sodium chloride in aqueous solution to form a precipitate. What is the net ionic equation for the precipitation process?
    (A) $Na^+(aq) + Cl^{2-}(aq) \rightarrow Na_2Cl(s)$
    (B) $Na^+(aq) + NO_3^-(aq) \rightarrow NaNO_3(s)$
    (C) $Pb^{2+}(aq) + 2NO_3^-(aq) \rightarrow Pb(NO_3)_2(s)$
    (D) $Na^+(aq) + Cl^-(aq) \rightarrow NaCl(s)$
    (E) $Pb^{2+}(aq) + 2Cl^-(aq) \rightarrow PbCl_2(s)$
    Ans: (E)

25. Which of the following anions is the strongest base?
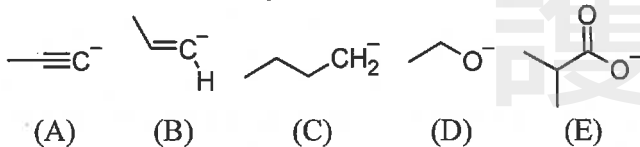
    (A)   (B)   (C)   (D)   (E)
    Ans: (C)

26. Polystyrene is an addition polymer of styrene. What would be the effect, if some divinylbenzene were added to styrene and then polymerized?
    (A) The polymer would be more flexible. Divinylbenzene acts as a plasticizer.
    (B) The polymer would be less flammable than pure polystyrene.
    (C) There would be an effect, but it cannot be predicted.
    (D) There would be no effect on the properties of the polymer.
    (E) Divinylbenzene would act as a cross-linking agent, making the polymer stronger.
    Ans: (E)

    styrene
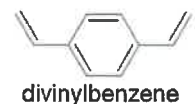
    divinylbenzene

27. Which of the following quantum model is most adequate as an approximation to describe an π-electron moving in β-carotene?
    (A) a particle in a one-dimensional box
    (B) harmonic oscillator
    (C) a freely moving particle
    (D) rotation in two dimensions
    (E) a rigid rotor
    Ans: (A)

28. Consider the reaction $2NO_2(g) \rightarrow 2NO(g) + O_2(g)$. The concentration of NO_2 was measured to be 0.0038 mol/L after 200 s and 0.0033 mol/L after 250 s. Calculate the reaction rate for NO_2.
    (A) 2.0×10^{-3} mol L^{-1} s^{-1}　　　(B) 1.0×10^{-4} mol L^{-1} s^{-1}　　　(C) 2.0×10^{-5} mol L^{-1} s^{-1}
    (D) 2.0×10^{-4} mol L^{-1} s^{-1}　　　(E) 1.0×10^{-5} mol L^{-1} s^{-1}
    Ans: (E)

29. A liquid above the packed solid following a centrifugation is called the _____.
    (A) solvonatant　　(B) analyte　　(C) serum　　(D) decanted　　(E) supernatant
    Ans: (E)

30. Which of the options below shows an **INCORRECT** chemical formula for the named compound?
    (A) iron(II) oxide　　　　FeO　　　　　　(B) potassium sulfate　　K_2SO_4
    (C) sodium sulfide　　　　NaS　　　　　　(D) zinc nitrate　　　　　　$Zn(NO_3)_2$
    (E) calcium carbonate　　$CaCO_3$
    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. During the heart's beating process, the activity of cardiomyocytes generates a magnetic field in space. In 1963, Baule and others first recorded the magnetic field generated by the electrical currents in the human heart, leading to the development of magnetocardiography (MCG). Using the Biot-Savart law to estimate the magnetic field. Suppose that $I = 10^{-5}$ A is the total current generated by myocardial activity and $r = 0.1$ m is the distance to the measurement point, what is the order of magnitude of the magnetic field generated by the heart in T? The permeability of free space is $\mu_0 = 1.26 \times 10^{-6}$ (T·m/A).
    (A) 10^{-9} T　　　　(B) 10^{-1} T　　　　(C) 10^{-12} T
    (D) 10^{-5} T　　　　(E) 10^{-7} T
    Ans: (C)

32. A particle moving in circular motion on a plane with a radius r has an angular momentum L and mass m. Which of the following expressions represents the centripetal force F of this circular motion?
    (A) $F = mr^2L$　　　　(B) $F = \frac{1}{2}mL^2$　　　　(C) $F = rmL$
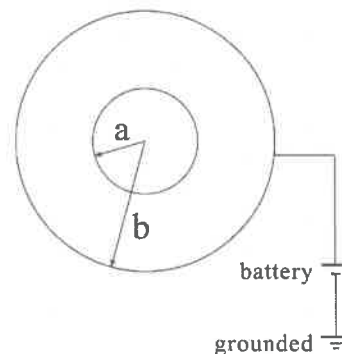   (D) $F = \frac{L}{mr^2}$　　　　(E) $F = \frac{L^2}{mr^3}$
    Ans: (E)

33. Two concentric conducting spheres have an inner sphere of radius a and an outer sphere of radius b. One terminal of a battery is connected to the outer sphere, while the other terminal is grounded (see **Figure**). What is the capacitance of this system?
    (A) $C = 4\pi\epsilon_0(\frac{1}{a} - \frac{1}{b})$　　　　(B) $C = 4\pi\epsilon_0(a+b)$
    (C) $C = 4\pi\epsilon_0\frac{ab}{b-a}$　　　　(D) $C = 4\pi\epsilon_0 b$　　　　(E) $C = 4\pi\epsilon_0 a$
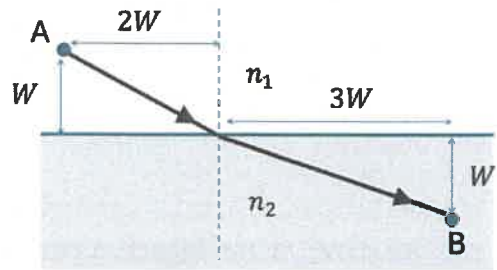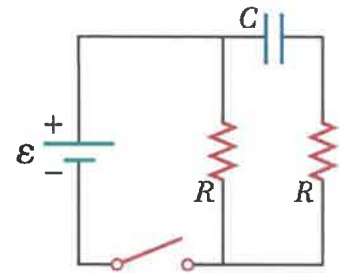   Ans: (D)

34. A beam of light traveling from point A to point B (see **Figure**) undergoes refraction as the figure shows. If the refractive indices of the top and bottom media are n_1 and n_2, respectivly, what is the ratio $\frac{n_2}{n_1}$?
    (A) 2/3　　　(B) 3/2　　　(C) $\sqrt{8}/3$
    (D) 3/$\sqrt{8}$　　(E) $\sqrt{2}/1$
    Ans: (C)

35. Consider the circuit in the **Figure** and assume the battery has no internal resistance. Just after the switch is closed, what is the current in the battery?

    (A) 0　　　　(B) $\varepsilon/2R$　　(C) $2\varepsilon/R$
    (D) ε/R　　(E) $\varepsilon/3R$
    Ans: (C)

36. For any given scattering angle θ, this equation
    $$\lambda' - \lambda_0 = \frac{h}{m_e c}(1 - \cos\theta)$$
    gives the same value for the Compton shift for any wavelength. Keeping that in mind, for which of the following types of radiation is the fractional shift in wavelength at a given scattering angle the largest?
    (A) radio waves　　　(B) microwaves　　　(C) visible light
    (D) x-rays　　　　　(E) infrared
    Ans: (D)

37. A fancy sports car passes Big Ben at a speed of 0.600c. What time interval will the driver measure for a one-second interval on the large clock?
    (A) 1.67 s　　　(B) 0.600 s　　　(C) 0.800 s　　　(D) 1.00 s　　　(E) 1.25 s
    Ans: (E)

38. The correct form of the Ampère-Maxwell law is
    (A) $\oint \boldsymbol{B} \cdot d\boldsymbol{s} = 0$
    (B) $\oint \boldsymbol{B} \cdot d\boldsymbol{s} = I_{enclosed}$
    (C) $\oint \boldsymbol{B} \cdot d\boldsymbol{s} = \mu_0 I_{enclosed}$
    (D) $\oint \boldsymbol{B} \cdot d\boldsymbol{s} = \mu_0 I_{enclosed} + \mu_0 \varepsilon_0 \frac{d\Phi_E}{dt}$
    (E) $\oint \boldsymbol{B} \cdot d\boldsymbol{s} = \mu_0 I_{enclosed} + \mu_0 \varepsilon_0 \frac{d\Phi_E}{dt} - \frac{\varepsilon_0}{\mu_0^2} \frac{d\Phi_B}{dt}$
    Ans: (D)

39. When a driver is traveling at a speed of v_1, they hear the frequency of a distant whistle as f_1. When they reduce their speed to v_2, the frequency of the whistle is heard as f_2. The car is moving toward the sound source. Assuming the sound source is stationary relative to the ground, what is the speed of sound?
    (A) $\frac{f_2 v_1 - f_1 v_2}{f_1 - f_2}$　　(B) $\frac{f_1 v_1 + f_2 v_2}{f_1 + f_2}$　　(C) $\frac{f_2 v_1 - f_1 v_2}{f_1 + f_2}$　　(D) $\frac{f_1 v_1 + f_2 v_2}{f_1 - f_2}$　　(E) $\frac{v_1}{v_2}(f_1 + f_2)$
    Ans: (A)
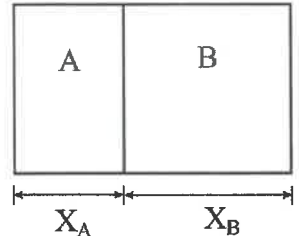
40. A moving hydrogen atom absorbs a photon and then comes to rest. Assume that the kinetic energy of the hydrogen atom can be neglected. Find the maximum possible wavelength of this photon. The ground state energy of the hydrogen atom is -13.6 eV. [hc=1240 eV·nm]
    (A) 121.6 nm　　　(B) 243.2 nm　　　(C) 178.6 nm　　　(D) 289.1 nm　　　(E) 342.5 nm
    Ans: (A)

41. As shown in the **Figure,** a partition divides the space into two sections, A and B. The molar mass of the gas in section A is 14 g, while the molar mass of the gas in section B is 32 g. Assuming the total mass of the gases in A and B is the same, what is the ratio X_A/X_B of their lengths when equilibrium is reached?
    (A) 13/5　　　(B) 13/2　　　(C) 17/4　　　(D) 14/3　　　(E) 16/7
    Ans: (E)

42. A parallel-plate capacitor has plates of area A = 8 m^2 and separation d = 1.5 mm. A dielectric sheet of the same area and thickness is placed between the plates. The dielectric constant is ε = 4.2. Determine the capacitance filled with the dielectric.
    [vacuum permittivity is $\varepsilon_0 = 8.85 \times 10^{-12}$ C/N·m^2]
    (A) 3.22×10^{-7} F　　　(B) 1.72×10^{-7} F　　　(C) 1.98×10^{-7} F
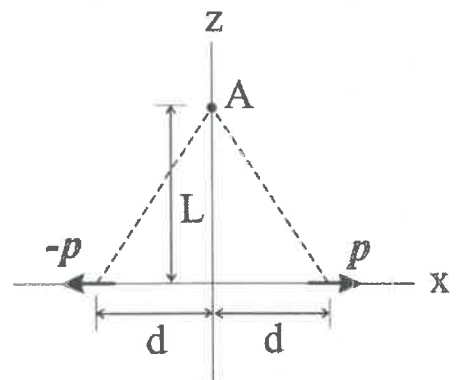   (D) 2.77×10^{-7} F　　　(E) 4.20×10^{-7} F
    Ans: (C)

43. Suppose a coil has a magnetic dipole moment $\vec{M} = IA(\hat{i}+\hat{j})/\sqrt{2}$ and is placed in a uniform magnetic field $\vec{B} = B_0(\hat{j}-\hat{k})/\sqrt{2}$, where I and A are the current and area of the coil, respectively. What is the torque experienced by the coil? The vectors $\hat{i}, \hat{j}, \hat{k}$ are unit vectors corresponding to the x, y, and z axes, respectively.
    (A) $IAB_0 (2\hat{j}-\hat{k})/7$　　　(B) $IAB_0 (\hat{i}+2\hat{j}-\hat{k})/2$　　　(C) $IAB_0 \hat{k}$
    (D) $IAB_0 (-\hat{i}+\hat{j}+\hat{k})/2$　　　(E) $IAB_0 (\hat{i}-\hat{k})/5$
    Ans: (D)

44. Two electric dipoles are placed horizontally along the x-axis, but one of them is oriented in the opposite direction, as shown in the **Figure**. Both electric dipoles have the same magnitude p. What is the electric potential V at point A on the z-axis at a distance L?
    (A) $V = \frac{1}{4\pi\epsilon_0} \frac{-2pd}{\left(d^2+L^2\right)^{3/2}}$　　　(B) $V = \frac{1}{4\pi\epsilon_0} \frac{-2pd}{\left(d^2+L^2\right)^{1/2}}$
    (C) $V = \frac{1}{4\pi\epsilon_0} \frac{-pd}{\left(d^2+L^2\right)^{1/2}}$　　　(D) $V = \frac{1}{4\pi\epsilon_0} \frac{-pd}{\left(d^2+L^2\right)^{3/2}}$
    (E) $V = \frac{1}{4\pi\epsilon_0} \frac{-4pd}{\left(d^2+L^2\right)^{3/2}}$
    Ans: (A)

45. During human respiration, oxygen passes through the alveoli (肺泡) into the bloodstream. Suppose an alveolus is approximated as a sphere with a volumn $V = 4.46 \times 10^{-11} \, m^3$ and an internal pressure $P = 1.2 \times 10^5$ Pa. The oxygen content inside the alveolus is 25 %. If air is treated as an ideal gas and the human body temperature is 37 °C (310 K), what is the number N oxygen molecules in a single alveolus? [Boltzmann constant $k = 1.38 \times 10^{-23}$ J/K]
    (A) $N = 1.89 \times 10^{15}$ (B) $N = 2.15 \times 10^{14}$ (C) $N = 1.24 \times 10^{15}$
    (D) $N = 3.13 \times 10^{14}$ (E) $N = 4.71 \times 10^{15}$
    Ans: (D)

46. The sound intensity level is defined as $L = 10 \cdot \log_{10}(I/I_0)$ with the unit dB, where I is the sound intensity in units of W/m^2 and $I_0 = 10^{-12}$ W/m^2. If a machine generates a noise level of 84 dB, what will be the noise level if an additional identical machine is turned on? [$\log_{10} 2 = 0.301$]
    (A) 84 dB   (B) 168 dB   (C) 90 dB   (D) 190 dB   (E) 87 dB
    Ans: (E)

47. Two stars of masses M and $2M$ are in a binary star system, orbiting a common center of mass. Which of the following statements is true about their orbital periods?
    (A) The star with mass M has a longer orbital period.
    (B) The star with mass $2M$ has a longer orbital period.
    (C) Both stars have the same orbital period.
    (D) The orbital periods depend on the distance between the stars.
    (E) The orbital periods are independent of the masses of the stars.
    Ans: (C)

48. A sample of gas is held in a container at a constant pressure. If the volume is halved, how will the rms (root-mean-square)-speed of the molecules change compared with the original rms-speed?
    (A) $\sqrt{2}$ times smaller   (B) $\sqrt{2}$ times greater   (C) the same
    (D) 2 times greater   (E) 2 times smaller
    Ans: (A)

49. A person with a volume of 0.08 m³ floats in fresh water (density = 1000 kg/m³). What is the buoyant force acting on the person? (Assume the acceleration due to gravity g is 10 m/s²)
    (A) 8000 N   (B) 800 N   (C) 80 N   (D) 8 N   (E) 0 N
    Ans: (B)

50. A steam of water with a constant flow at 1 kg/s cools a machine. The water enters the machine at 10 °C and leaves at 80 °C. How much thermal energy is removed every minute? The specific heat capacity of water is 4.186 kJ/kg·K.
    (A) 17.6 MJ   (B) 15.1 MJ   (C) 251.2 kJ   (D) 25.1 kJ   (E) 2.5 MJ
    Ans: (A)

51. A hot object at temperature 500 K is moved to contact with a cool object at 300 K, and a heat of 50 kJ flows irreversibly from one to the other. Assume that neighter object changes its temperature. How much is the entropy of the universe changed?
    (A) 1000 J/K   (B) 40 MJ/K   (C) 66.7 J/K
    (D) 62.5 J/K   (E) none of the above
    Ans: (C)

52. The **Figure** shows a planet moving about the sun in an elliptical orbit. Its speeds at the following four points shown in the **Figure** are v_A, v_B, v_C, and v_D, repsectively.
Which of the following statement is correct?
(A) $v_A > v_B > v_C > v_D$
(B) $v_A < v_B < v_C < v_D$
(C) $v_A > v_B = v_D > v_C$
(D) $v_A < v_B = v_D < v_C$
(E) none of the above
Ans: (C)
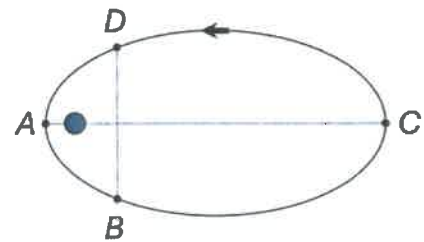
53. A patient is undergoing radiation therapy. A radioactive isotope decays and emits an α particle with an initial velocity of 2×10^7 m/s. The α particle is slowed down by the Coulomb force from a nearby nucleus, experiencing a deceleration of 5×10^{14} m/s². How far will the α particle travel before coming to a stop?
(A) 0.1 meters　　(B) 0.2 meters　　(C) 0.3 meters
(D) 0.4 meters　　(E) 0.5 meters
Ans: (D)

54. A patient's prosthetic leg, weighing 5 kg, is sliding across the floor with a coefficient of kinetic friction of 0.2. What is the force of friction acting against the leg? (g = 9.8m/s²)
(A) 9.8 N　　(B) 1 N　　(C) 49 N　　(D) 1.96 N　　(E) 245 N
Ans: (A)

55. How long will it take for an oscillator at a frequncy of 2.5 Hz to make 100 vibrations?
(A) 250 s　　(B) 40 s　　(C) 25 s　　(D) 4 s　　(E) 0.025 s
Ans: (B)

56. Cobalt $_{27}^{60}$Co has a half-life of 5 years. If there was sample of that isotope with an initial mass of 240 g, how much of the sample remains after 30 years?
(A) 30 g　　(B) 15 g　　(C) 7.5 g　　(D) 3.75 g　　(E) 0.89 g
Ans: (D)

57. Unpolarized light of the intensity I_0 passes through two polaroids. The axis of the first polaroid is vertical. The second polariod is at 30° to the vertical. Find the intensity of the transmitted light.
(A) $(3/4)I_0$　　(B) $(3/8)I_0$　　(C) $(1/4)I_0$　　(D) $(1/8)I_0$　　(E) $(1/2)I_0$
Ans: (B)

58. The following equation shows the decay process of uranium-238 through the emission of an α-particle: $_{92}^{238}U \rightarrow _{Z}^{A}X + _{2}^{4}He$. Which of the following is the element X?
(A) $_{90}^{234}Th$　　(B) $_{80}^{206}Pb$　　(C) $_{82}^{210}Po$　　(D) $_{51}^{104}Sb$　　(E) $_{35}^{81}Br$
Ans: (A)

59. Suppose a healthy bone can withstand compressive stress of 181 N/mm² before breaking. If the cross-sectional area of the bone is 3.2 cm², how much weight (in kg) can it support? (gravitational acceleration g = 9.8m/s²)
(A) 2790 kg　　(B) 3240 kg　　(C) 5910 kg　　(D) 2072 kg　　(E) 4790 kg
Ans: (C)

60. The light intensity incident on a metallic surface produces photoelectrons with a maximum kinetic energy of 2 eV. The light intensity is doubled. Determine the maximum kinetic energy of the photoelectrons (in eV).
   (A) 4 eV　　　(B) 2 eV　　　(C) $\sqrt{2}$ eV　　　(D) 1 eV　　　(E) 8 eV
    Ans: (B)

61. Arrange the steps below in the order required to perform a Kjeldahl Nitrogen Analysis.
    I　　Distillation of ammonia into standard hydrochloric acid.
    II　　Neutralize ammonium to release ammonia.
    III　　Digest the organic sample with boiling sulfuric acid to convert nitrogen to ammonium.
    IV　　Titrate unreacted standard hydrochloric acid with sodium hydroxide.
    (A) III, II, I, IV　　(B) II, I, IV, III　　(C) I, IV, III, II　　(D) IV, III, II, I　　(E) III, I, IV, II
    Ans: (A)

62. What is the product of the following reaction?
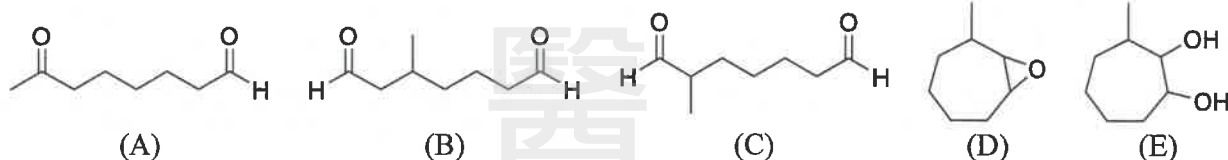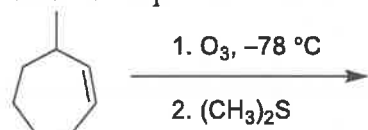
    Ans: (C)

63. Stray light is a problem for spectrophotometers that are not tightly sealed. What is the main impact of stray light on the recorded absorbance?
    (A) The apparent absorbance is greater than the true absorbance and increases as the amount of stray light increases.
    (B) The apparent absorbance is greater than the true absorbance and decreases as the amount of stray light increases.
    (C) The apparent absorbance is less than the true absorbance and increases as the amount of stray light decreases.
    (D) The apparent absorbance is less than the true absorbance and decreases as the amount of stray light decreases.
    (E) It is impossible to determine effect of stray light on measured absorbance.
    Ans: (C)

64. How many unpaired electrons are there in an atom of oxygen in its ground state?
    (A) 1　　　(B) 2　　　(C) 4　　　(D) 0　　　(E) 3
    Ans: (B)

65. A crystal of NaCl is _____ .
    (A) hard, high-melting, and a poor electrical conductor
    (B) hard, high-melting, and a good electrical conductor
    (C) soft, low-melting, and a good electrical conductor
    (D) soft, high-melting, and a poor electrical conductor
    (E) soft, low-melting, and a poor electrical conductor
    Ans: (A)

66. Which of the following chemical or physical changes is an endothermic process?
(A) the evaporation of water　　(B) the mixing of sulfuric acid and water
(C) the freezing of water　　　(D) the combustion of gasoline
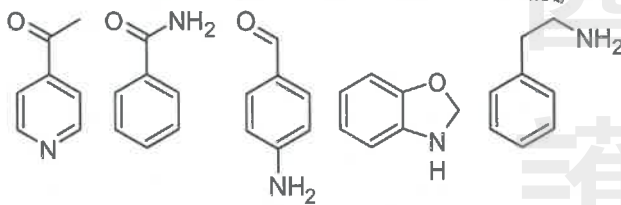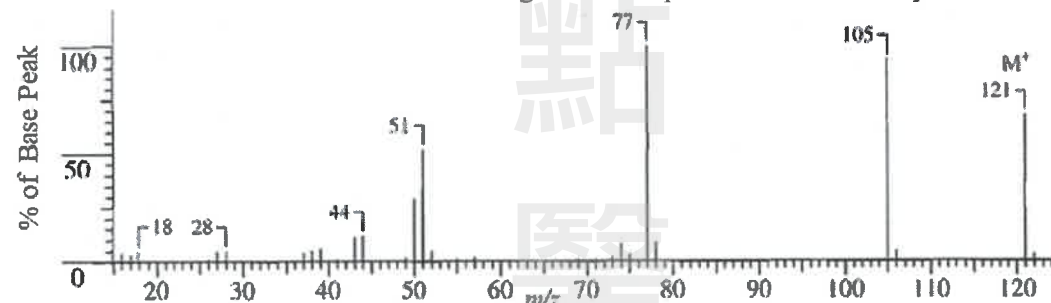(E) none of the above
Ans: (A)

67. The _____ is the electrode at which the reaction of interest occurs.
(A) auxillary electrode　　(B) counter electrode　　(C) anode
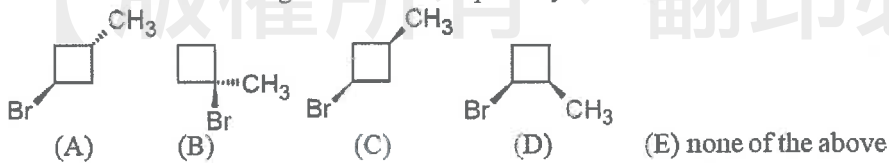(D) cathode　　　　　　　(E) working electrode
Ans: (E)

68. Which of the shown molecules fits the fragmentation pattern of the mass spectrum below the best?

(A)　　(B)　　(C)　　(D)　　(E)

Ans: (B)

69. Which of the following molecules is optically active?

(A)　　(B)　　(C)　　(D)　　(E) none of the above

Ans: (D)

70. Rank the following compounds according to increasing solubility in water.
I　　$CH_3–CH_2–CH_2–CH_3$　　　　II　　$CH_3–CH_2–O–CH_2–CH_3$
III　　$CH_3–CH_2–OH$　　　　　　IV　　$CH_3–OH$
(A) I < II < IV < III　　　　(B) I < III < IV < II
(C) I < II < III < IV　　　　(D) III < IV < II < I
(E) None of the above is correct.
Ans: (C)

71. Nitrogen gas (N_2) reacts with hydrogen gas (H_2) to form ammonia (NH_3). At 200°C in a closed container, 1.2 atm of nitrogen gas is mixed with 2.3 atm of hydrogen gas. At equilibrium, the total pressure is 2.1 atm. Calculate the partial pressure of hydrogen gas at equilibrium.
    (A) 2.3 atm　　　(B) 0.0 atm　　　(C) 1.8 atm　　　(D) 0.20 atm　　　(E) 0.92 atm
    Ans: (D)

72. The corrosion of which transition metal results in a characteristic green patina?
    (A) lead　　　(B) copper　　　(C) chromium　　　(D) silver　　　(E) iron
    Ans: (B)

73. EDTA is an example of a(n) _____ ligand.
    (A) hexadentate　　(B) bidentate　　(C) octadentate　　(D) tetradentate　　(E) tridentate
    Ans: (A)

74. When a molecule absorbs a photon, the molecule is promoted to an excited state M*. The rate at which M* is created is proportional to the concentration of M. There are three pathways that M* may take to return to the ground state. Which statement about these three pathways below is wrong?
    (A) The rate at which the excited state returns to the ground state is independent of the pathway to the ground state and the concentration of excited state molecules.
    (B) The three possible pathways to return to the ground state are emission, deactivation, and quenching.
    (C) Quenching occurs when a second molecule, the quencher Q, collides with M* and energy is transferred from M* to Q: $M^* + Q \rightarrow M + Q^*$.
    (D) Deactivation returns M* to the ground state by colliding with other molecules and releasing energy in the form of heat: $M^* \rightarrow M + heat$.
    (E) Emission returns M* to the ground state by emitting a photon: $M^* \rightarrow M + h\nu$.
    Ans: (A)

75. A novel analytical method named _____ may enhance the fluorescence of immunoassays by a factor of 100 by measuring the fluorescence of Eu^{3+} 200 μs after excitation with a laser pulse.
    (A) time-resolved fluorescence immunoassay
    (B) time-dependent fluorescence immunoassay
    (C) immunoassay fluorescence over time immunoassay
    (D) weakly bound time fluorescence immunoassay
    (E) europium-bound fluorescence immunoassay
    Ans: (A)

76. Given that $S = 131$ J/K · mol for $H_2(g)$, estimate the value of $\Delta S°$ for the reaction: $Ti(s) + H_2(g) \rightarrow TiH_2(s)$
    (A) 0 J/K　　　(B) 131 J/K　　　(C) –131 J/K　　　(D) 262 J/K　　　(E) –262 J/K
    Ans: (C)

77. Which of the following exhibits the correct (increasing) orders for the atomic radius r and the ionization energy (IE), respectively?
    (A) r: F < S < O, IE: O < S < F　　　(B) r: F < O < S, IE: S < O < F
    (C) r: S < O < F, IE: F < O < S　　　(D) r: S < F < O, IE: S < F < O
    (E) none of the above
    Ans: (B)

78. The entropy change of a system (ΔS) is_____ for exothermic reactions and _____ for endothermic reactions.
    (A) unfavorable, unfavorable　　　(B) favorable, unfavorable　　　(C) favorable, favorable
    (D) unfavorable, favorable　　　(E) none of the above
    Ans: (E)

79. Using a 400 MHz ^{1}H NMR instrument, if a hydrogen atom shows a quartet at δ = 4.06, 4.03, 4.00, 3.97 ppm, please calculate it's coupling constant. And where will this triplet peak shows up at a 600 MHz ^{1}H NMR instrument?
    (A) 12 Hz; δ: 4.035, 4.015, 3.995, 3.975 ppm　　(B) 12 Hz; δ: 4.045, 4.025, 4.005, 3.985 ppm
    (C) 12 Hz; δ: 4.025, 4.005, 3.985, 3.965 ppm　　(D) 6 Hz; δ: 4.045, 4.025, 4.005, 3.985 ppm
    (E) 6 Hz; δ: 4.035, 4.015, 3.995, 3.975 ppm
    Ans: (B)

80. What is the product of the following reaction?

(A)　　　(B)　　　(C)　　　(D)　　　(E)
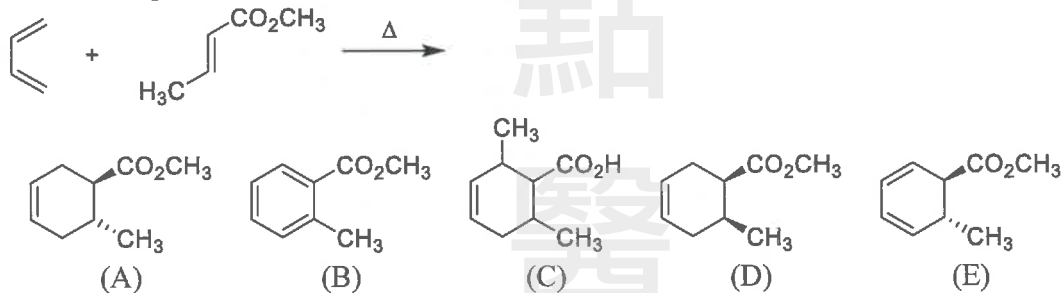
Ans: (A)

81. There are many types of noise in instrumental analysis. Which of the following descriptions about the different noise types is **INCORRECT**?
    (A) line noise – noise that occurs at discrete frequencies
    (B) drift noise – low frequency noise caused by flickering or drifting of light intensity
    (C) Gaussian noise – noise amplitude is dependent on frequency
    (D) Johnson noise – random fluctuations of electrons in electronic devices
    (E) shot noise – noise that arises from random variation in the number of photons reaching the detector or small number of electrons and holes generated in a semiconductor
    Ans: (C)

82. One of the optical components of a spectrophotometer that selects the wavelength to irradiate the sample can be called the _____.
    (A) polychromator　　　(B) monochromator　　　(C) beam splitter
    (D) light source　　　(E) optode
    Ans: (B)

83. What is the key functional group present in penicillins that is essential for their antibacterial activity?
    (A) amide　　　(B) carboxyl group　　　(C) β-lactam ring
    (D) ether　　　(E) thiophene group
    Ans: (C)

84. Indium has atomic number 49 and atomic mass 114.8 g. Naturally occurring indium contains a mixture of indium-112 and indium-115 in an atomic ratio of approximately_____.
    (A) 25/75　　　(B) 75/25　　　(C) 50/50　　　(D) 94/6　　　(E) 6/94
    Ans: (E)

85. The OH radical disproportionates according to the elementary chemical reaction OH + OH → H_2O + O. This reaction is second order in OH. The rate constant for the reaction is 2.1×10^{-12} cm^3/molecule·s at room temperature. If the initial OH concentration is 1.6×10^{13} molecules/cm^3, what is the first half-life for the reaction?
    (A) 3.3×10^{11} s　　　(B) 0.030 s　　　(C) 3.8×10^{24} s　　　(D) 3.9 s　　　(E) 6.0 s
    Ans: (B)

86. The equilibrium process $CaCO_3 \leftrightharpoons Ca^{2+} + CO_3^{2-}$ can be split into several equilibrium processes to give a more complete picture of calcium carbonate's solubility. Which of the following equilibrium equations does not play a role for calcium carbonate's solubility?
    (A) $CO_3^{2-} + H_2O \leftrightharpoons HCO_3^- + OH^-$　　　$K_1 = [HCO_3^-][OH^-]/[CO_3^{2-}]$
    (B) $HCO_3^- + H_2O \leftrightharpoons H_2CO_3 + OH^-$　　　$K_2 = [H_2CO_3][OH^-]/[HCO_3^-]$
    (C) $Ca^{2+} + H_2O \leftrightharpoons CaOH^+ + H^+$　　　$K_3 = [CaOH^+][H^+]/[Ca^{2+}]$
    (D) $Ca^{2+} + CO_3^{2-} \leftrightharpoons CaCO_3$　　　$K_4 = [CaCO_3]/\{[Ca^{2+}][CO_3^{2-}]\}$
    (E) $Ca^{2+} + H^+ \leftrightharpoons CaH^{3+}$　　　$K_5 = [CaH^{3+}]/\{[Ca^{2+}][H^+]\}$
    Ans: (E)

87. For the reaction, $CO_2(g) + 2H_2O(g) \rightarrow CH_4(g) + 2O_2(g)$, $\Delta H° = 803$ kJ, which of the following will increase K?
   (A) increasing the temperature of system　　　(B) decreasing the number of moles of methane
    (C) increasing the volume of system　　　(D) increasing the number of moles of CO_2
    (E) none of the above
    Ans: (A)

88. The **Figure** on the right shows the phase diagram for a compound X. You wish to purify a sample of X that was collected at $P = 1.0$ atm and $T = 100$ by subliming it. In order to sublime the sample, you should _____.
    (A) increase T to 300 K and then lower P to 0.5 atm
    (B) abandon the attempt to sublime X
    (C) lower P to 0.5 atm and then increase T to 200 K
    (D) increase P to 1.5 atm and then increase T to 300 K
    (E) increase T to 300 K, keeping $P = 1.0$ atm
    Ans: (C)
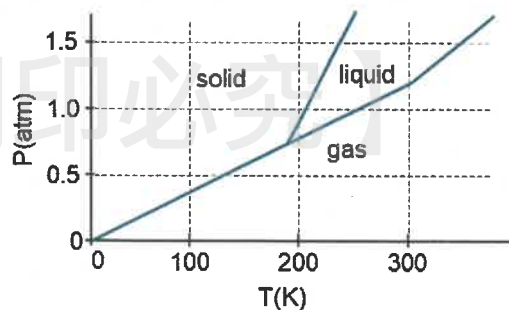
89. How many of the following electron configurations for the species in their ground state are correct?
    Ca　$1s^2 2s^2 2p^6 3s^2 3p^6 4s^1$　　　　V　[Ar] $3s^2 3d^3$　　　　P　$1s^2 2s^2 2p^6 3p^5$
    Br　$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^4$　　　As　[Ar] $4s^2 3d^{10} 4p^2$
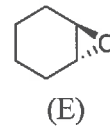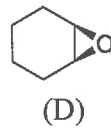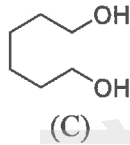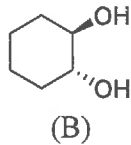   (A) 1　　　(B) 2　　　(C) 3　　　(D) 4　　　(E) none
    Ans: (E)

90. What is the product of the following reaction?

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

Ans: (A)

國立中山大學 114 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	4	The statement in item (A) that 'The gas does work on its surroundings,' is correct in the context of an adiabatic compression process. Gas compression results from positive work done on the gas by the environment, which is equivalent to *negative* work done by the gas on the environment. Item (A) does not specify the sign of the work.	維持原公布答案(D)
	6	床上的人在平躺時測量的血壓與床的高低無關. 因此頭與腳部壓力是由頭與心臟以及腳底與心臟高度差引起. 以平躺的位置即為站立時的心臟位置為符合題意的壓力差ΔP_1與ΔP_2定義 (因題目敘述已說明 "…(in magnitude)…", 所以 ΔP_1 與 ΔP_2 為正值). 因此由題意 $\rho g h_1 = \Delta P_1$, 且$\rho g h_2 = \Delta P_2$, 因此 $h_1 + h_2 = (\Delta P_1 + \Delta P_2)/\rho g$. 所以正確答案為 (D). 題目敘述已說明 "(in magnitude)", 所以 ΔP_1 與 ΔP_2 應取正值以符合題意.	維持原公布答案(D)
	31	以題意所提供的資訊, 適當物理模型應為一小段有限長電流所造之磁場來估計(心臟為有限大小), 若以圓弧估計, 則其值為 $\frac{\mu_0 I}{2R}\frac{1}{n}$, 其中 n 為正實數且 n≥1. 這物理模型考慮一小段有限長的圓弧 (弧角為 $2\pi/n$), 載流 I, 則在其圓心(半徑 R)造的磁場, 大小為 $B = \frac{\mu_0 I}{4\pi R^2}\left(\frac{2\pi R}{n}\right) = \frac{\mu_0 I}{2R}\frac{1}{n} \approx \frac{6.3\times10^{-11}}{n}$ (Tesla), 其中最後一個等式已經將題意的 R=0.1(m) 以及 $I=10^{-5}$(A) 代入. 由於 n≥1, 因此磁場 B 可小於或等於數量級 10^{-11} (Tesla). 至此已可決定正確答案為 (C). 其餘選項 (A)(B)(D)(E) 的數量級均遠大過 10^{-11}. 若用無窮長直載流導線所建立的磁場去估計, 則估計值的確為 10^{-11} (Tesla): $B \approx \frac{\mu_0 I}{2\pi r} = \frac{1.26\times10^{-6}\times10^{-5}}{2\pi(0.1)} = 2.0\times10^{-11}$(Tesla). 此值給出數量級上限. 但題目並無規定必須使用此作法(無窮長直導線)做為唯一正確答案的依據. 如上所述, 估計值可小於或等於此數量級, 因沒有10^{-11}之選項, 因此答案為(C).	維持原公布答案 (C)

國立中山大學 114 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	33	此題的敘述已說明為導體球殼(…conducting spheres…)，因此必須考慮導體球的靜電性質. 外殼充正電時，因為導體的靜電屏蔽效應，故內球殼不會有任何感應電荷，所以內球(半徑 a)與外球(半徑 b)之間沒有電場(因此沒有電位差)，所有的電力線均由外球殼向外發出. 故此題電容僅由外球殼決定，所以整個裝置的電容為 $C=4\pi\epsilon_0 b$. 因此正確答案為 (D)。	維持原公布答案 (D)
	86	選項 D 中的 $CaCO_3$ 是固態[$(CaCO_3(s)$]還是溶解於水中的狀態[$(CaCO_3(aq)$]不會影響作答，因為選項中未進一步定義 K_4 具體的物理意義。 若將 $CaCO_3$ 理解為 $CaCO_3(aq)$，將可以寫下 $K_A = [CaCO_3(aq)]/[Ca^{2+}][CO_3^{2-}]$　　　　　(式 A) 此公式與選項 D 的公式相符，而 K_A 相當於選項 D 中的 K_4。 若將 $CaCO_3$ 理解為 $CaCO_3(s)$，便可寫下 $K_B = [CaCO_3(aq)]/[CaCO_3(s)]$　　　　　(式 B) 或 $[CaCO_3(s)]K_B = [CaCO_3(aq)]$　　　　　(式 C) 並將其帶入式 A 並得到 $K_A = [CaCO_3(s)]K_B/[Ca^{2+}][CO_3^{2-}]$　　　(式 D) 此公式可改寫成 $K_A/K_B = [CaCO_3(s)]/[Ca^{2+}][CO_3^{2-}]$　　　(式 E) 由於 K_A 與 K_B 皆為常數，因此能將 K_A/K_B 表示成一個新的常數 K_C 以得到 $K_C = [CaCO_3(s)]/[Ca^{2+}][CO_3^{2-}]$　　　　(式 F) 此公式也與選項 D 的公式相符，這邊 K_C 相當於選項 D 中的 K_4。如此可見，選項 D 中的公式，無論 $CaCO_3$ 是固態還是溶解於水中的狀態，都無誤。因此選項 D 確實是一個需要考慮的平衡態。 另，由於式 F 中的[$CaCO_3(s)$]可以當作一個常數(一般狀況下等於 1)，也可以將式 F 表示成 $K'_C = K_C/[CaCO_3(s)] = 1/[Ca^{2+}][CO_3^{2-}]$　　(式 G) 此公式確實正確，但是從上面推導可見，這並不代表式 F(以及選項 D 中的公式)是錯誤的公式。因此選項 D 不是本題的正確選項。	維持原公布答案(E)

物 理

程量子(陳宗德)老師提供

1. Atmospheric pressure decreases with altitude, but not in a linear manner. It decreases according to the following formula: $P = P_o e^{-ky}$, where the constant k is given by $k = 1.25 \times 10^{-4}$ m^{-1}, P_o is the atmospheric pressure at sea level, and y is the height above sea level. At what height above sea level will the atmospheric pressure be reduced to half? [ln2 = 0.69314]

   (A) 5545 m   (B) 3447 m   (C) 5034 m   (D) 4790 m   (E) 2996 m

   1. 解：(A)
   $$\frac{1}{2}P_0 = P_0 e^{-ky} \Rightarrow y = \frac{1}{k}\ln 2 = \frac{1}{1.25 \times 10^{-4}}\ln 2 = 5544[m]$$

2. There are two tuning forks with frequencies 255 Hz and 251 Hz. When both tuning forks start vibrating, what frequency will be heard by the ear? How many times per second can a loud sound be heard?

   (A) 251 Hz, 2 times each second   (B) 255 Hz, 4 times each second

   (C) 254 Hz, 3 times each second   (D) 253 Hz, 4 times each second

   (E) 252 Hz, 2 times each second

   2. 解：(D)
   $$\frac{f_1 + f_2}{2} = \frac{255 + 251}{2} = 253[Hz]$$
   $$\Delta f = |f_1 - f_2| = |255 - 251| = 4[Hz]$$

3. The method to correct hyperopia is to wear a convex lens with an appropriate focal length. Suppose a hyperopic person, at the maximum accommodation of the eye's lens (with the minimum curvature radius), can clearly see objects at a distance of 1.5 meters. What should be the focal length of the convex lens required for them to clearly see an object at a distance of 15 cm?

   (A) 14.0 cm   (B) 13.5 cm   (C) 22.0 cm   (D) 15.0 cm   (E) 16.6 cm

   3. 解：(E)
   $$\frac{1}{p} + \frac{1}{q} = \frac{1}{f} \Rightarrow \frac{1}{+0.15} + \frac{1}{-1.5} = \frac{1}{f} \Rightarrow f = 0.1667[m] = 16.67[cm]$$

4. In an adiabatic compression of an ideal gas, which of the following statements is **NOT** true?

   (A) The gas does work on its surroundings.

   (B) The internal energy of the gas increases.

   (C) The temperature of the gas increases.

   (D) The gas absorbs heat from its surroundings.

   (E) The process results in a change in the state of the gas.

   4. 解：(D)

   　　絕熱壓縮，系統有作功，沒有熱量進出

9. Nyboer theoretically discovered in 1940 that changes in impedance can be used to determine changes in the cross-sectional area of blood vessels. Impedance is the resistance of a conductor in an alternating current circuit (frequency ω). There are various substances with different resistivities within the human body, so the human body exhibits a significant capacitance. The circuit composed of resistance R and capacitance C can be divided into series and parallel configurations. In the case of resistance and capacitance in series, what is the impedance Z?

(A) $Z = \sqrt{R^2 + \omega^2 C^2}$ 　　(B) $Z = \sqrt{\omega^2 + \dfrac{1}{(RC)^2}}$ 　　(C) $Z = \sqrt{\omega^2 + (RC)^2}$

(D) $Z = \sqrt{R^2 + \left(\dfrac{\omega}{C}\right)^2}$ 　　(E) $Z = \sqrt{R^2 + \dfrac{1}{(\omega C)^2}}$

9. 解: (E)

$$Z = \sqrt{R^2 + (X_L - X_C)^2} = \sqrt{R^2 + \frac{1}{(\omega C)^2}}$$

10. When the observer and the sound source are stationary relative to each other, the observed frequency is f. Suppose the observer and the source are moving toward each other. If the observer's speed is 0.25v and the source's speed is also 0.25v, where v is the sound speed. What will be the observed frequency?

(A) 5f/4　　(B) 3f/4　　(C) 4f/3　　(D) 3f/5　　(E) 5f/3

10. 解: (E)

$$f' = \frac{u+v}{u-v} f = \frac{v + 0.25v}{v - 0.25v} f = \frac{1.25}{0.75} f = \frac{5}{3} f$$

11. In a scenario where a patient is sliding down a ramp during rehabilitation, and friction is present, what happens to the initial total mechanical energy?
    (A) It is completely converted to kinetic energy.
    (B) It is completely converted to potential energy.
    (C) It remains constant.
    (D) It is partially converted to thermal energy due to friction.
    (E) It disappears.

11. 解: (D)

　　有摩擦力情況下，力學能不守恆。有部分能量轉換成熱能

12. Effectively, a nerve fiber can be considered as being composed of many individual circuits, where each circuit consists of a battery, a capacitor of capacitance C, and a resistor of resistance R connected in series which is the so-called RC circuit. What is the time constant of the RC circuit?

(A) RIC 　　**(B)** 1/RC 　　(C) RC 　　(D) RC^2 　　(E) CR^2

12. 解: (C)

　　時間常數 T=RC

31. During the heart's beating process, the activity of cardiomyocytes generates a magnetic field in space. In 1963, Baule and others first recorded the magnetic field generated by the electrical currents in the human heart, leading to the development of magnetocardiography (MCG). Using the Biot-Savart law to estimate the magnetic field. Suppose that I= 10^{-5} A is the total current generated by myocardial activity and r = 0.1 m is the distance to the measurement point, what is the order of magnitude of the magnetic field generated by the heart in T? The permeability of free space is μ_0=1.26x10^{-6}(T·m/A).

(A) 10^{-9} T (B) 10^{-1} T (C) 10^{-12} T (D) 10^{-5} T (E) 10^{-7} T

31. 解: (C)
$$B = \frac{\mu_0 i}{2\pi r} = \frac{1.26 \times 10^{-6} \times 10^{-5}}{2 \times 3.14 \times 10^{-1}} \approx 10^{-12}[T]$$

32. A particle moving in circular motion on a plane with a radius r has an angular momentum L and mass m. Which of the following expressions represents the centripetal force F of this circular motion?
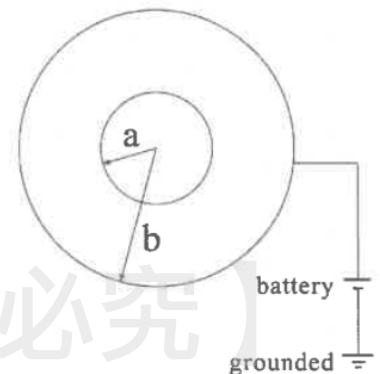
(A) $F = mr^2 L$ (B) $F = \frac{1}{2}mL^2$ (C) $F = rmL$

(D) $F = \frac{L}{mr^2}$ (E) $F = \frac{L^2}{mr^3}$

32. 解: (E)
$$F = \frac{mv^2}{r} = \frac{rmv \cdot v}{r^2} = \frac{L \cdot (r\omega)}{r^2} = \frac{L \cdot (mr^2\omega)}{mr^3} = \frac{L^2}{mr^3}$$

33. Two concentric conducting spheres have an inner sphere of radius a and an outer sphere of radius b. One terminal of a battery is connected to the outer sphere, while the other terminal is grounded (see **Figure)**. What is the capacitance of this system?

(A) $C = 4\pi\varepsilon_0(\frac{1}{a} - \frac{1}{b})$ (B) $C = 4\pi\varepsilon_0(a + b)$

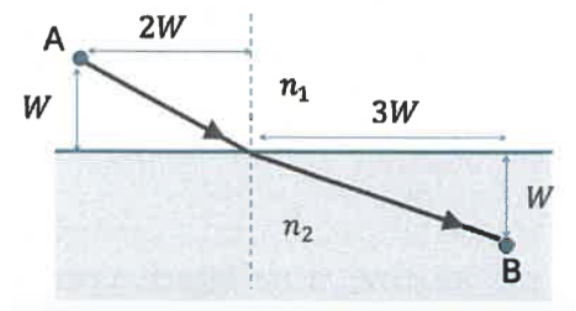(C) $C = 4\pi\varepsilon_0 \frac{ab}{b-a}$ (D) $C = 4\pi\varepsilon_0 b$ (E) $C = 4\pi\varepsilon_0 a$

33. 解: (D)
可由電池方向得知，在半徑 b處之帶電量為Q，可看成單一半徑為b之單一導體球之電容，則有 $C = 4\pi\varepsilon_0 b$

34. A beam of light traveling from point A to point B (see **Figure)** undergoes refraction as the figure shows. If the refractive indices of the top and bottom media are n_1 and n_2, respectively, what is the ratio $\frac{n_2}{n_1}$?

(A) 2/3 (B) 3/2 (C) $\sqrt{8}/3$

(D) 3/$\sqrt{8}$ (E) $\sqrt{2}/1$

34. 解: (C)

由 Snell's Law $n_1 \sin\theta_1 = n_2 \sin\theta_2$

$$n_1 \frac{2}{\sqrt{5}} = n_2 \frac{3}{\sqrt{10}} \Rightarrow \frac{n_2}{n_1} = \frac{\sqrt{10}}{\sqrt{5}} \times \frac{2}{3} = \frac{\sqrt{8}}{3}$$
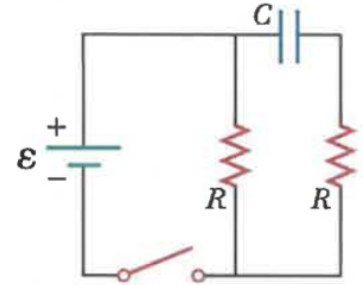
35. Consider the circuit in the **Figure** and assume the battery has no internal resistance. Just after the switch is closed, what is the current in the battery?

(A) 0　　(B) $\varepsilon/2R$　　(C) $2\varepsilon/R$　　(D) ε/R　　(E) $\varepsilon/3R$

35. 解: (C)

開關剛按下，電容 C 為短路。電阻為並聯，等效電阻為 $R/2$

$$i = \frac{\varepsilon}{R/2} = \frac{2\varepsilon}{R}$$

36. For any given scattering angle θ, this equation

$$\lambda' - \lambda_0 = \frac{h}{m_e c}(1 - \cos\theta)$$

gives the same value for the Compton shift for any wavelength. Keeping that in mind, for which of the following types of radiation is the fractional shift in wavelength at a given scattering angle the largest?

(A) radio waves　　　(B) microwaves　　　(C) visible light

(D) x-rays　　　　　(E) infrared

36. 解: (D)

固定散射角情況下，$\Delta\lambda = \lambda' - \lambda_0$ 要最大，則入射波長 λ_0 要最短，故選 x-rays

37. A fancy sports car passes Big Ben at a speed of 0.600c. What time interval will the driver measure for a one-second interval on the large clock?

(A) 1.67 s　　　(B) 0.600 s　　　(C) 0.800 s　　　(D) 1.00 s　　　(E) 1.25 s

37. 解: (E)

$$\Delta t' = \frac{\Delta t}{\sqrt{1 - \frac{v^2}{c^2}}} = \frac{1}{\sqrt{1 - \frac{(0.6c)^2}{c^2}}} = 1.25[s]$$

59. Suppose a healthy bone can withstand compressive stress of 181 N/mm^2 before breaking. If the cross- sectional area of the bone is 3.2 cm^2, how much weight (in kg) can it support? (gravitational acceleration g = 9.8m/s^2)

(A) 2790 kg   (B) 3240 kg   (C) 5910 kg   (D) 2072 kg   (E) 4790 kg

59. 解：(C)

compressive stress of 181 N/mm^2 = $\dfrac{181[N]}{(10^{-3})^2 m^2} = \dfrac{m \times 9.8}{3.2 \times (10^{-2})^2} \Rightarrow m = 5910[kg]$

60. The light intensity incident on a metallic surface produces photoelectrons with a maximum kinetic energy of 2 eV. The light intensity is doubled. Determine the maximum kinetic energy of the photoelectrons (in eV).

(A) 4 eV   (B) 2 eV   (C) -J2 eV   (D) 1 eV   (E) 8 eV

60. 解：(B)

光電方程式中的最大動能與強度無關

更多試題詳解，歡迎參考高點出版67MU2017【物理歷屆試題解析】一書，
學士後相關書籍出版詳情，請上高點網路書店查詢。

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化 學

梁 傑（梁家榮）老師提供

16. For the Arrhenius equation, $k = \exp(-E_a/RT)$, which of the following statement is **CORRECT**?
    (A) The effect of an enzyme is to increase the magnitude of A.
    (B) The $\exp(-E_a/RT)$ term represents the fraction of molecules with a kinetic energy larger than E_a.
    (C) The reaction rate k is linearly proportional to temperature T.
    (D) The activation energy E_a is associated with the collision frequency of the reactants.
    (E) The steric factor of reaction affects the magnitude of E_a.
    Ans: (B)

    (A)錯誤，enzyme會降低Ea

    (C)錯誤，k

    (D)(E)錯誤，Ea與collision frequency或steric factor皆無關

18. The mass of a sample of calcium carbonate powder is measured using weight by difference. If a vial containing calcium carbonate powder has an initial mass of 87.36 ± 0.03 g and a final mass of 76.99 ± 0.03 g, what mass of calcium carbonate was taken?
    (A) 10.37 ± 0.04 g   (B) 10.37 ± 0.03 g   (C) 10.370 ± 0.042 g
    (D) 10.370 ± 0.004 g   (E) 10.370 ± 0.005 g
    Ans: (A)

    (1)先計算central value： $87.36 - 76.99 = 10.37$

    (2)合併不確定度： $\sqrt{(0.03)^2 + (0.03)^2} = \sqrt{0.0018} \approx 0.04$

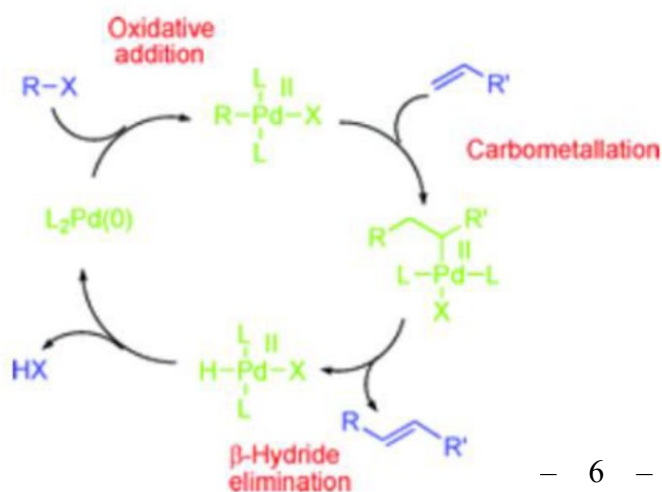   (3)結論：calcium carbonate的質量表達為 10.37 ± 0.04

20. What is the key step in the Heck reaction?
    (A) radical generation   (B) carbocation formation
    (C) palladium-catalyzed oxidative addition and reductive elimination
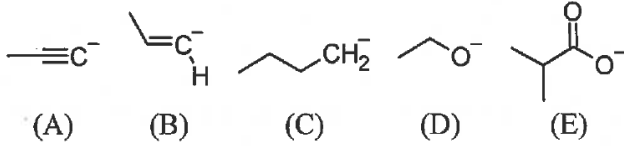   (D) nucleophilic substitution   (E) decarboxylation
    Ans: (C)
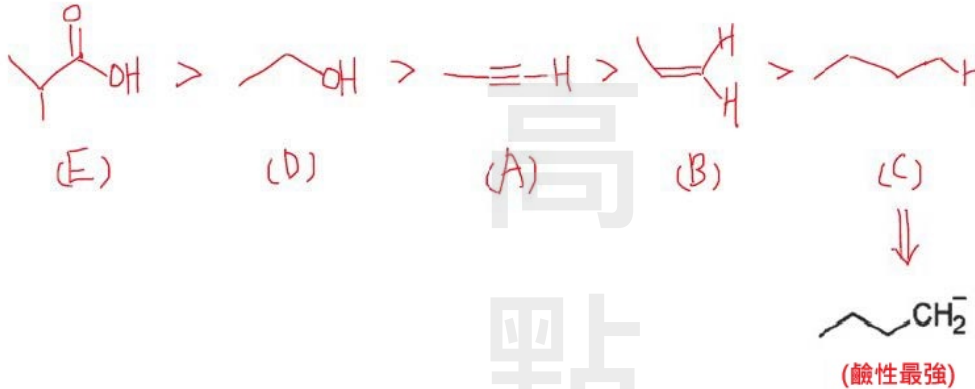
全反應：

$$R-X + \diagup\!\!\!\diagup R' \xrightarrow{Pd\ catalyst} R\diagup\!\!\!\diagup R' + HX$$

反應機構:

25. Which of the following anions is the strongest base?
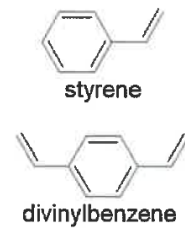

(A)　　(B)　　(C)　　(D)　　(E)

Ans: (C)

共軛酸的酸性次序：

(鹼性最強)

26. Polystyrene is an addition polymer of styrene. What would be the effect, if some divinylbenzene were added to styrene and then polymerized?

styrene

divinylbenzene

(A) The polymer would be more flexible. Divinylbenzene acts as a plasticizer.
(B) The polymer would be less flammable than pure polystyrene.
(C) There would be an effect, but it cannot be predicted.
(D) There would be no effect on the properties of the polymer.
(E) Divinylbenzene would act as a cross-linking agent, making the polymer stronger.

Ans: (E)

styrene加成聚合過程中，divinyl benzene結構上的C=C也會參與聚合

將兩條polystyrene鏈結在一起，產生強度更高的聚合物，稱為交聯(cross-link)

29. A liquid above the packed solid following a centrifugation is called the _____.
(A) solvonatant　　(B) analyte　　(C) serum　　(D) decanted　　(E) supernatant

Ans: (E)

(A) solvonatant = 沒有這種字(出題老師亂寫的)

(B) Analyte = 分析物= 實驗中要被偵測、測量或分析的目標物質

(C)serum = 血清= 血液中去除血細胞與凝固因子剩下的液體部分

(D) decanted = 把液體倒出並讓沉澱物留在容器底部的動作

(E) supernatant = 上清液= 離心或沉澱過程後，位於固體物質(如沉澱物, pellet)上方的清澈液體

30. Which of the options below shows an **INCORRECT** chemical formula for the named compound?
(A) iron(II) oxide　　　　FeO　　　　　(B) potassium sulfate　　K_2SO_4
(C) sodium sulfide　　　　NaS　　　　　(D) zinc nitrate　　　　$Zn(NO_3)_2$
(E) calcium carbonate　　$CaCO_3$

Ans: (C)

(C)選項錯誤，sodium sulfide = Na_2S

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61. Arrange the steps below in the order required to perform a Kjeldahl Nitrogen Analysis.
    I   Distillation of ammonia into standard hydrochloric acid.
    II Neutralize ammonium to release ammonia.
    III Digest the organic sample with boiling sulfuric acid to convert nitrogen to ammonium.
    IV Titrate unreacted standard hydrochloric acid with sodium hydroxide.
    (A) III, II, I, IV　　(B) II, I, IV, III　　(C) I, IV, III, II　　(D) IV, III, II, I　　(E) III, I, IV, II
    Ans: (A)

    Kjeldahl Nitrogen Analysis是一種常用來分析食品、土壤、化學品中氮元素含量的分析方法
    主要有以下步驟：

    (1) 消化分解：將樣品與硫酸共熱，將樣品中的氮轉成NH_4^+ (step III)

    (2) 蒸餾：在蒸餾裝置中加入鹼，並加熱「蒸出氮」，此時NH_4^+ 碰到鹼會被中和產生NH_3 (step II)
        再把NH_3 收集到酸性溶液當中(step I)
    (3) 滴定：利用NaOH滴定酸性溶液，用以計算含氮量(step IV)

62. What is the product of the following reaction?
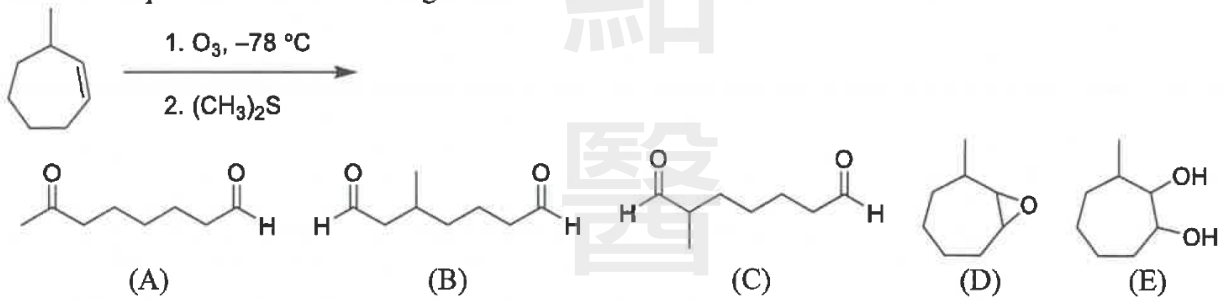
    Ans: (C)

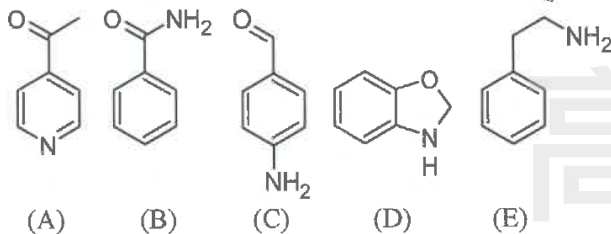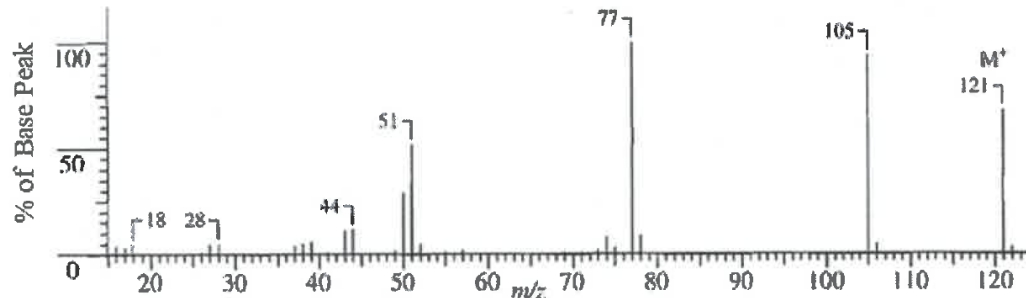   此反應屬於臭氧切斷搭配還原性後處理，切斷後會得到aldehyde stray
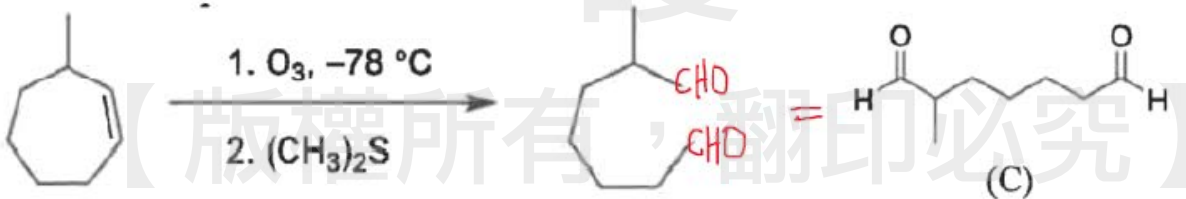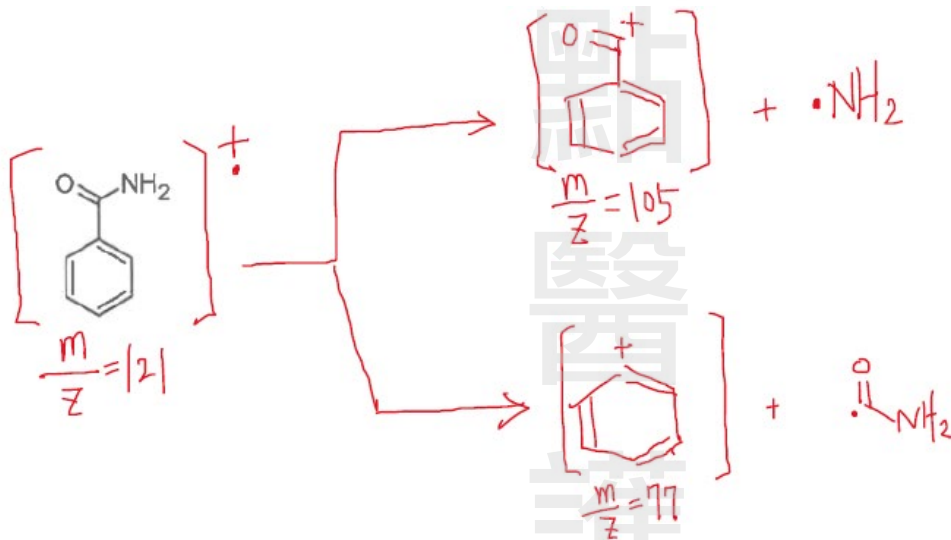

65. A crystal of NaCl is _____ .
    (A) hard, high-melting, and a poor electrical conductor
    (B) hard, high-melting, and a good electrical conductor
    (C) soft, low-melting, and a good electrical conductor
    (D) soft, high-melting, and a poor electrical conductor
    (E) soft, low-melting, and a poor electrical conductor
    Ans: (A)

    NaCl = 離子化合物= 硬且脆、高熔點、固態不導電但融熔狀態或水溶液可導電

68. Which of the shown molecules fits the fragmentation pattern of the mass spectrum below the best?

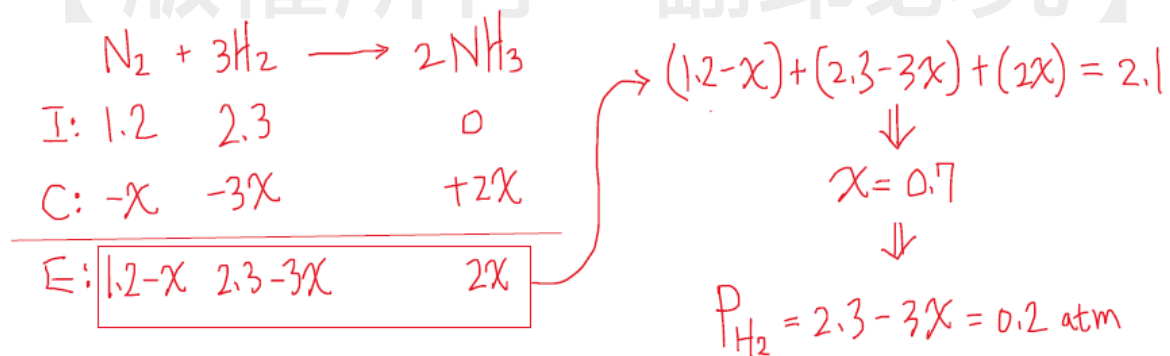(A)　　　(B)　　　(C)　　　(D)　　　(E)

Ans: (B)

71. Nitrogen gas (N_2) reacts with hydrogen gas (H_2) to form ammonia (NH_3). At 200°C in a closed container, 1.2 atm of nitrogen gas is mixed with 2.3 atm of hydrogen gas. At equilibrium, the total pressure is 2.1 atm. Calculate the partial pressure of hydrogen gas at equilibrium.
(A) 2.3 atm　　　(B) 0.0 atm　　　(C) 1.8 atm　　　(D) 0.20 atm　　　(E) 0.92 atm
Ans: (D)

$$N_2 + 3H_2 \longrightarrow 2NH_3$$

I: 1.2　　2.3　　　　0

C: $-x$　$-3x$　　$+2x$

E: $1.2-x$　$2.3-3x$　　$2x$

$$(1.2-x) + (2.3-3x) + (2x) = 2.1$$
$$\Downarrow$$
$$x = 0.7$$
$$\Downarrow$$
$$P_{H_2} = 2.3 - 3x = 0.2 \text{ atm}$$

— 9 —

74. When a molecule absorbs a photon, the molecule is promoted to an excited state M^*. The rate at which M^* is created is proportional to the concentration of M. There are three pathways that M^* may take to return to the ground state. Which statement about these three pathways below is wrong?
    (A) The rate at which the excited state returns to the ground state is independent of the pathway to the ground state and the concentration of excited state molecules.
    (B) The three possible pathways to return to the ground state are emission, deactivation, and quenching.
    (C) Quenching occurs when a second molecule, the quencher Q, collides with M^* and energy is transferred from M* to Q: $M^* + Q \rightarrow M + Q^*$.
    (D) Deactivation returns M^* to the ground state by colliding with other molecules and releasing energy in the form of heat: $M^* \rightarrow M + heat$.
    (E) Emission returns M^* to the ground state by emitting a photon: $M^* \rightarrow M + hv$.
    Ans: (A)

(A)錯誤

激發態回到基態的路徑不同，速率也會不同

例如：螢光路徑放光回到基態速率很快，但磷光路徑放光回到基態速率就很慢

而高濃度激發態的分子間如果發生分子間能量轉移，也會影響回到基態的速率

76. Given that $S = 131$ J/K · mol for $H_2(g)$, estimate the value of ΔS° for the reaction: $Ti(s) + H_2(g) \rightarrow TiH_2(s)$
    (A) 0 J/K (B) 131 J/K (C) −131 J/K (D) 262 J/K (E) −262 J/K
    Ans: (C)

由於Ti 和TiH₂ 都是固態物質，其標準熵都不大

因此全反應的反應熵變化約為：

$$\Delta S = S_{TiH_2} - (S_{Ti} + S_{H_2}) \approx -131 \frac{J}{K}$$

很小　很小　131

79. Using a 400 MHz ^{1}H NMR instrument, if a hydrogen atom shows a quartet at $\delta = 4.06, 4.03, 4.00, 3.97$ ppm, please calculate it's coupling constant. And where will this triplet peak shows up at a 600 MHz ^{1}H NMR instrument?
    (A) 12 Hz; δ: 4.035, 4.015, 3.995, 3.975 ppm   (B) 12 Hz; δ: 4.045, 4.025, 4.005, 3.985 ppm
    (C) 12 Hz; δ: 4.025, 4.005, 3.985, 3.965 ppm   (D) 6 Hz; δ: 4.045, 4.025, 4.005, 3.985 ppm
   (E) 6 Hz; δ: 4.035, 4.015, 3.995, 3.975 ppm
    Ans: (B)

出題老師題目有誤：此吸收為quartet，並非triplet (但出題老師認為不影響作答而不送分)

$$400 MHz: 0.03 = \frac{12\ Hz}{400\ MHz}$$

$$600 MHz: 0.02 = \frac{12\ Hz}{600\ MHz}$$
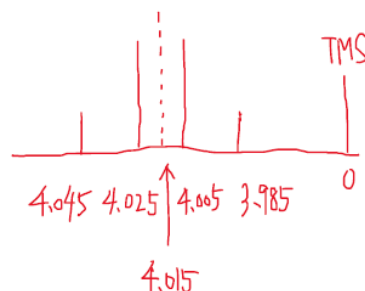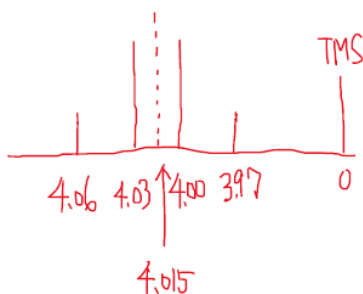
88. The **Figure** on the right shows the phase diagram for a compound X. You wish to purify a sample of X that was collected at $P = 1.0$ atm and $T = 100$ by subliming it. In order to sublime the sample, you should _____.
 (A) increase T to 300 K and then lower P to 0.5 atm
 (B) abandon the attempt to sublime X
 (C) lower P to 0.5 atm and then increase T to 200 K
 (D) increase P to 1.5 atm and then increase T to 300 K
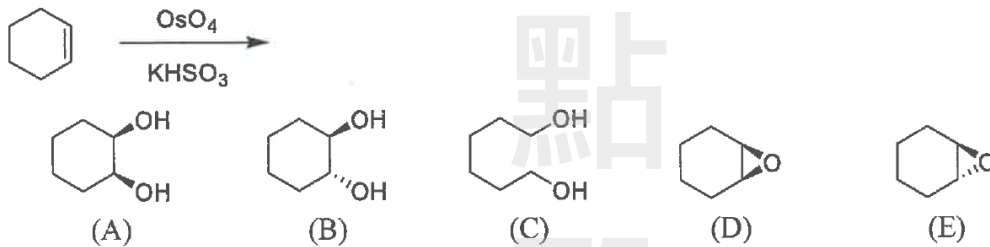 (E) increase T to 300 K, keeping $P = 1.0$ atm
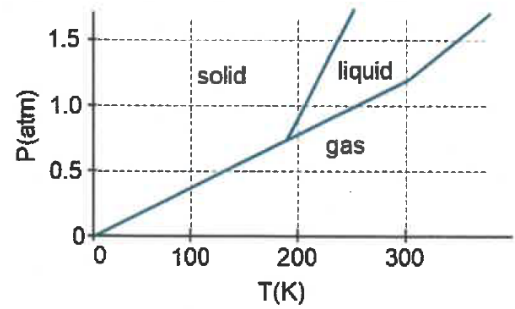
Ans: (C)

1 atm, 100 K時，cpd X的穩定狀態是solid state

若要將cpd X昇華，壓力必須低於三相點壓力且溫度要超過昇華溫度

(約為0.75 atm)

90. What is the product of the following reaction?

Ans: (A)

OsO4能針對C=C進行syn-hydroxylation，答案只能選(A)

更多試題詳解，歡迎參考高點出版67MU2001【後西醫化學歷屆試題精解】一書，學士後相關書籍出版詳情，請上高點網路書店查詢。

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