注意：考試開始鈴響前，不得翻閱試題，

並不得書寫、畫記、作答。

國立清華大學 111 學年度學士後醫學系單招試題

系所班組別：學士後醫學系
自然科學組

科目代碼：0103

考試科目：化學與物理

—作答注意事項—

1. 請核對答案卷（卡）上之准考證號、科目名稱是否正確。
2. 作答中如有發現試題印刷不清，得舉手請監試人員處理，但不得要求解釋題意。
3. 考生限在答案卷上標記「由此開始作答」區內作答，且不可書寫姓名、准考證號或與作答無關之其他文字或符號。
4. 答案卷用盡不得要求加頁。
5. 答案卷可用任何書寫工具作答，惟為方便閱卷辨識，請儘量使用藍色或黑色書寫；答案卡限用 2B 鉛筆畫記；如畫記不清（含未依範例畫記）致光學閱讀機無法辨識答案者，其後果一律由考生自行負責。
6. 其他應考規則、違規處理及扣分方式，請自行詳閱准考證明上「**國立清華大學試場規則及違規處理辦法**」，無法因本試題封面作答注意事項中未列明而稱未知悉。

國立清華大學 111 學年度學士後醫學系單獨招生試題

考試科目：化學與物理

Choose one best answer for the following questions

【單選題】每題 2.5 分，共計 150 分。答錯一題倒扣 0.625 分，未作答，不給分亦不扣分。1~30 題為化學，31~60 題為物理。

1. One mole of an ideal gas undergoes an isothermal reversible expansion at 300 K. During this process, the system absorbs 450 J of heat from the surroundings. When this gas is compressed to the initial state in one step isothermally, twice as much work is done on the system as was performed on the surroundings during the expansion. Which of the following statements about these processes are correct?
   I. ΔS_{sys} for the one-step isothermal compression is 1.5 J/K.
   II. ΔS_{surr} for the one-step isothermal compression is 3.0 J/K.
   III. ΔS_{univ} for the reversible isothermal expansion is zero.
   IV. ΔS_{univ} for the overall process (expansion and compression) is zero.
   V. ΔS_{surr} for the overall process (expansion and compression) is −1.5 J/K.
   (A) I, II　(B) II, III　(C) II, III, IV　(D) II, III, V　(E) I, IV, V

2. Which of the following statements about ligands, *d*-block metals, and coordination complexes is correct?
   (A) The cyanate ion (OCN^-) can have three different Lewis structures, in which all the N atoms have the same formal charge.
   (B) Zinc is a component of vitamin B_{12}, which is essential for the metabolism of carbohydrates, fats, and proteins.
   (C) $[Co(NH_3)_4Cl_2]^+$ has *cis-trans* isomers, and the *cis* isomer is optically active.
   (D) $[Cr(en)(NH_3)_2I_2]^+$ (en = ethylenediamine) has three geometrical isomers.
   (E) The octahedral Cu^{2+} complexes are more appropriate than the octahedral Cr^{2+} complexes to be used to determine the field strength of a ligand.

3. Consider 1.0 mole of an ideal gas contained in a 2.0 L bulb at 27 °C. This bulb is connected to a 10.0 L sealed, initially evacuated bulb via a valve. When the valve is opened, the temperature is assumed to remain constant. Which of the following statements is <u>*incorrect*</u>? (gas constant R = 0.082 atm·L·K^{-1}·mol^{-1})
   (A) The final pressure at equilibrium will be 2.1 atm.
   (B) The enthalpy change (ΔH) for this process is zero.
   (C) This is a spontaneous process.
   (D) Work does not occur during the expansion of this gas.
   (E) The driving force for this process to occur is an increase in the internal energy.

4. Compound **X**, like most substances, exhibits only three phases: solid, liquid, and vapor. The triple point of **X** is at 90 torr and 115 °C. Which of the following statements concerning the liquid and gaseous **X** is correct?

(A) **X**(l) cannot exist at 1 atmosphere pressure.

(B) **X**(l) cannot exist above 115 °C.

(C) **X**(g) cannot exist below 115 °C.

(D) **X**(l) cannot have a vapor pressure greater than 90 torr.

(E) **X**(l) cannot exist at a pressure of 15 torr.

5. Given the following half-reactions and associated standard reduction potentials:

$$Cr^{3+} + e^- \rightarrow Cr^{2+} \qquad E° = -0.50\ V$$

$$Cr^{3+} + 3\ e^- \rightarrow Cr \qquad E° = -0.73\ V$$

Calculate the standard reduction potential for the following half-reaction:

$$2\ Cr^{2+} + 4\ e^- \rightarrow 2\ Cr$$

(A) −0.23 V　(B) −0.46 V　(C) −0.85 V　(D) −1.23 V　(E) −1.70 V

6. How many of the following statements are correct?

I. All the group 13 elements are metals.

II. Alkaline earth metals react less vigorously with water than do alkali metals.

III. Salts can consist of hydrogen.

IV. Because Li has a more negative standard reduction potential than Na and K, it reacts most quickly with water among these three alkali metals.

V. BeO is amphoteric.

(A) 1　(B) 2　(C) 3　(D) 4　(E) 5

7. Given the following eleven gaseous molecules:

$H_2C{=}C{=}CH_2$　$H_2C{=}CH_2$　H_2CO　CO_2　$BeCl_2$　H_2O_2　TeF_4

NF_3　NO_2　KrF_4　SF_4

Which of the following statements about these molecules is correct?

(A) There are six molecules with all their atoms lying in the same plane.

(B) Same hybridized orbitals are used by the N atoms in NF_3 and NO_2.

(C) Both TeF_4 and KrF_4 are nonpolar molecules.

(D) All the C-atoms in the four carbon-containing molecules use sp^2 hybridized orbital.

(E) Both H_2O_2 and NO_2 exhibit resonance.

8. Ammonium benzoate is a salt formed from ammonia (NH_3) and benzoic acid (C_6H_5COOH). Calculate the pH of a 0.10 M solution of ammonium benzoate at 25 °C. ($K_a = 6.4 \times 10^{-5}$ for C_6H_5COOH, $K_b = 1.8 \times 10^{-5}$ for NH_3; log2 = 0.301; log3 = 0.477; log7 = 0.845)

(A) 4.74　(B) 5.96　(C) 6.73　(D) 7.28　(E) 8.04

9. Yellow phosphorus (P_4) undergoes disproportionation in NaOH(aq) to produce PH_3 and NaH_2PO_2. If 16.0 g of P_4 was used in the reaction, how many grams of P_4 would behave as the oxidizing agent? (atomic weight of P = 31 u)

(A) 12.0 g　(B) 10.0 g　(C) 8.0 g　(D) 6.4 g　(E) 4.0 g

10. Consider the titration of 50.0 mL of 0.100 M NaH_2PO_4(aq) with 0.100 M NaOH(aq). For H_3PO_4, $K_{a1} = 7.5 \times 10^{-3}$, $K_{a2} = 6.0 \times 10^{-8}$, and $K_{a3} = 4.8 \times 10^{-13}$. Three pH values during the titration are listed as follows.

(1) Before the addition of NaOH(aq), the pH is x.

(2) After the addition of 25.0 mL NaOH(aq), the pH is y.

(3) After the addition of 50.0 mL NaOH(aq), the pH is z.

Which of the following statements about x, y, and z is correct?

(log2 = 0.301, log3 = 0.477, log5 = 0.699)

(A) $x < 4, y > 7$　(B) $x > 4, z > 10$　(C) $y > 7, z < 10$

(D) $y > 8, z > 9$　(E) $x < 5, y < 7$

11. Element X has only two isotopes, **1** and **2**, and its atomic weight is y.33 u. Of the following combinations of isotope abundance and corresponding neutron number, which is the most reasonable? (note: y, z, p, q and r are integers)

	isotope **1**		isotope **2**	
	abundance	number of neutron	abundance	number of neutron
(A)	50%	p	50%	p + 0.66
(B)	67%	y	33%	y + 1
(C)	75%	q	25%	q + 2
(D)	45%	r	55%	r – 1
(E)	83%	z	17%	z + 2

12. Which of the following molecular formulae has the most structural isomers, all containing a hydroxyl group?

(A) C_3H_6O　(B) C_3H_8O　(C) C_4H_8O　(D) $C_4H_{10}O$　(E) $C_5H_{12}O$

13. Which of the following statements about the dominant Lewis structures of ClO_x^{n-} is correct?

(A) ClO obeys the octet rule.
(B) ClO^- has 1 π bond.
(C) ClO_2^- has 8 lone pair electrons.
(D) ClO_3^- has 2 π bonds.
(E) ClO_4^- has 10 lone pair electrons

14. Which of the following statements about the van der Waals equation is *incorrect*?

$$(P + \blacksquare)(V - \square) = nRT$$

(A) The van der Waals equation describes the behavior of real gases.
(B) ■ $= n^2a/V^2$ and is used to compensate for the attraction force between gas molecules.
(C) □ = nb and is used to correct the volume of real gases.
(D) ■ is negative for most gases.
(E) □ is positive for most gases.

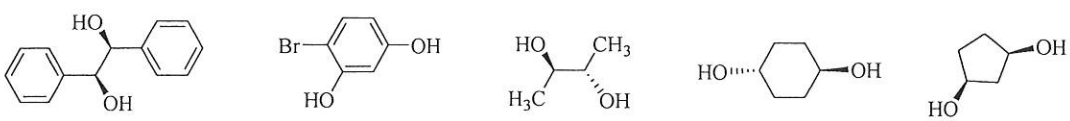
15. If the reaction A(g) + 3 B(s) ⇌ 2 C(g) + D(g) starts with only 1 mole of A and 1 mole of B in a 1.0 L sealed reaction vessel, the equilibrium constant of this reaction is *K*. Which of the following statements is correct?

(A) The expression for *K* of this reaction is $([C]^2[D])/([A][B]^3)$.
(B) If $K = 1$, [A] is 0.5 M at equilibrium.
(C) If $K = 1$, [C] is 0.3 M at equilibrium.
(D) If [C] = 0.5 M at equilibrium, $K = 0.08$.
(E) If [D] = 0.25 M at equilibrium, $K = 0.17$.

16. Which of the following comparisons for the acidity of the following species in an aprotic solvent is correct?

(A) Acidity: $CH_3COO^- > HPO_4^{2-}$
(B) Acidity: $NaNH_2 > NH_3$
(C) Acidity: $HCO_3^- > HSO_4^-$
(D) Acidity: $CH_3OH > NH_4Cl$
(E) Acidity: $C_6H_5OH > (CH_3)_3COH$

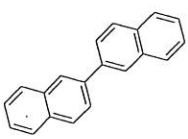
17. Which of the following compounds (**1**-**5**) is optically active?



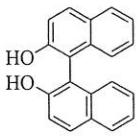
1 **2** **3** **4** **5**

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

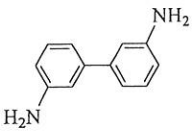
18. Which of the following compounds (**6-10**) is chiral?



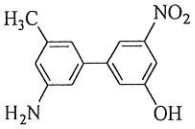
6



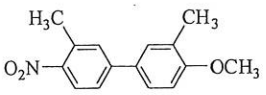
7



8



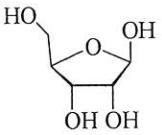
9



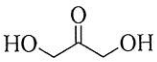
10

(A) **6**　(B) **7**　(C) **8**　(D) **9**　(E) **10**

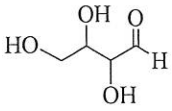
19. Which of the following compounds (**11-15**) is *not* monosaccharide?



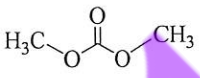
11



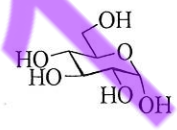
12



13



14



15

(A) **11**　(B) **12**　(C) **13**　(D) **14**　(E) **15**

20. Each of the longest wavelength of the spectral lines recorded for two electron transitions from n = 2 and n = 4 of hydrogen atoms is X and Y, respectively. What is the relationship between X and Y?

(A) X:Y = 11:34　(B) X:Y = 5:4　(C) X:Y = 1:4

(D) X:Y = 5:144　(E) X:Y = 7:108

21. As shown in Fig. 1, a container with a fixed volume at constant temperature is divided into three compartments (**A**, **B**, and **C**) by two partitions, which are movable without friction. Compartments **A** and **C** are filled with an equal amount of mass of gas X and Y. When two partitions stop sliding, the density of X is equal to that of Y. Which of the following statements is correct?

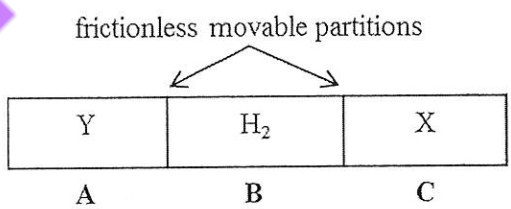


Fig. 1.

(A) Volume of gas: $V(X) > V(H_2) > V(Y)$

(B) Number of moles of gas: $n(X) < n(H_2) < n(Y)$

(C) Number of moles of gas: $n(X) = n(H_2) = n(Y)$

(D) The molecular mass of X is equal to the molecular mass of Y.

(E) The molecular mass of X is smaller than the molecular mass of Y.

22. Which of the following groups of species can coexist in significant amounts in a given solution at room temperature?
(A) A solution that turns methyl orange red contains Mg^{2+}, K^+, SO_4^{2-}, and NO_3^-.
(B) A solution that turns phenolphthalein red contains Na^+, Cu^{2+}, HCO_3^-, and NO_3^-.
(C) 0.1 M $AgNO_3$ solution contains H^+, K^+, SO_4^{2-}, and I^-.
(D) 0.1 M $Na[Al(OH)_4]$ solution contains H^+, Na^+, Cl^-, and SO_4^{2-}.
(E) An acidic potassium permanganate solution contains H^+, Na^+, SO_4^{2-}, and glucose.

23. Under the same conditions, Na, Mg, and Al of equal molar amounts are respectively added to three test tubes X, Y, and Z containing the same concentration and volume of dilute hydrochloric acid to fully react at room temperature. Which of the following three test tubes X, Y and Z must be *incorrect* in relation to the volume of gas produced?
(A) X(Na) > Y(Mg) > Z(Al)　(B) X(Na) > Y(Mg) = Z(Al)
(C) X(Na) < Y(Mg) < Z(Al)　(D) X(Na) = Y(Mg) = Z(Al)
(E) X(Na) < Y(Mg) = Z(Al)

24. A certain amount of Cl_2 is introduced into a certain concentration of potassium hydroxide solution, where both reagents are completely consumed and heat is released. Three ionic species containing chlorine are produced from this reaction, among which the amount (n/mole) of ClO^- and ClO_3^- ions and the reaction time (t/s) are shown in Fig. 2. Which of the following statements is *incorrect*?

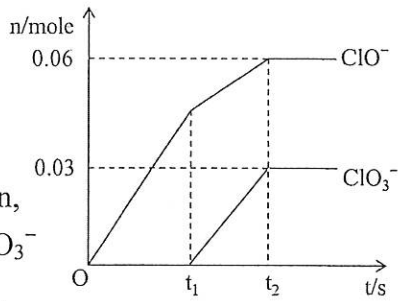


Fig. 2.

(A) Different reactions of Cl_2 and potassium hydroxide solutions may occur at different temperatures.
(B) The number of electrons transferred in the reaction is 1.26×10^{23}.
(C) The amount of KOH in the original potassium hydroxide solution cannot be determined.
(D) The amount of Cl^- in the product is 0.21 mol.
(E) The amount of K^+in the solution is 0.30 mol.

25. Based on the following experiments, which substance can prove to be bleaching?
(A) When chlorine is introduced into a NaOH solution with phenolphthalein, the solution immediately discolors.
(B) When a small amount of Na_2O_2 powder is added to the water with phenolphthalein, the solution first turns red and then discolors.
(C) The red color of phenolphthalein solution fades after the addition of SO_2.
(D) When SO_2 is added to an acidic solution of $KMnO_4$, the purple color of the solution fades.
(E) Addition of nitric acidified $AgNO_3$ solution to chlorine water results in white precipitate.

26. Two bottles of gas are $NO_2(g)$ and $Br_2(g)$ with the same appearance. A chemist designed a variety of identification methods:
I. wet test paper with starch/KI, II. addition of a small amount of NaCl solution,
III. addition of a small amount of $AgNO_3$ solution,
IV. addition of a small amount of water and then an appropriate amount of benzene,
V. change the temperature
Which methods can be used to distinguish $NO_2(g)$ from $Br_2(g)$?
(A)I, III, IV (B)II, III, IV (C)I, II, III, IV (D)I, II, III, V (E)II, III, IV, V

27. At 298 K and 101 kPa, $2\ SO_2\ (g) + O_2\ (g) \rightleftharpoons 2\ SO_3\ (g)\ \Delta H = -197\ kJ \cdot mol^{-1}$. At the same temperature and pressure, 2 moles of SO_2 and 1 mole of O_2 are introduced into a closed container, and when equilibrium is reached, the amount of heat given off is Q_1. If 1 mole of SO_2, 0.5 mole of O_2 and 1 mole of SO_3 are introduced into a container of the same volume, and the amount of heat given off at equilibrium is Q_2, which of the following relationships is correct?
(A) $Q_2 < Q_1 < 197$ kJ (B) $Q_2 > Q_1 > 197$ kJ (C) $Q_2 = Q_1 = 197$ kJ
(D) $Q_1 < Q_2 < 197$ kJ (E) $Q_2 = Q_1 < 197$ kJ

28. After electrolyzing a certain concentration of copper sulfate solution with an inert electrode at a certain temperature for a certain period of time, 0.1 mole of basic copper carbonate [$Cu_2(OH)_2CO_3$] is added to the resulting solution, and the concentration and pH are restored to exactly the same level as before electrolysis (without considering the dissolution of carbon dioxide). What is the total number of electrons transferred during the electrolysis?
(A) 0.4 mole (B) 0.5 mole (C) 0.6 mole (D) 0.7 mole (E) 0.8 mole

29. Acetic acid is an electrolyte. Which of the following facts indicate that acetic acid is a weak electrolyte?

①Acetic acid and water are miscible in any ratio.
②Acetic acid solution conducts electricity.
③Acetic acid molecules are present in acetic acid solution.
④The pH of 0.1 M acetic acid solution is greater than that of 0.1 M hydrochloric acid.
⑤Acetic acid reacts with calcium carbonate to give off CO_2.
⑥The pH of 0.1 M sodium acetate solution = 8.9.
⑦When zinc grains of the same size react with the same concentration of hydrochloric acid and acetic acid solution, the acetic acid starts to produce H_2 at a slower rate.

(A)②⑥⑦　(B)③④⑤⑥　(C)③④⑥⑦　(D)②④⑥⑦　(E)①②

30. Five different types of chemical bonds in the molecular structure of ethanol are shown in Fig. 3. Which of the following statements about reactions in which ethanol breaks bonds is *incorrect*?

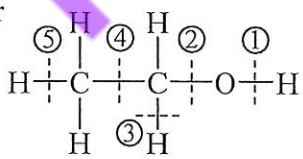


Fig. 3.

(A) Bond ① breaks upon reaction with sodium metal.
(B) Bond ② and bond ⑤ break, when heating with concentrated sulfuric acid to 170 °C.
(C) Only bond ② breaks, when heating with concentrated sulfuric acid to 140 °C.
(D) Bond ① and bond ③ break upon reaction with O_2 catalyzed by copper.
(E) Only bond ① breaks, when reacting with carboxylic acids in the presence of concentrated sulfuric acid.

31. Which of the following values is closest to the average translational kinetic energy of one mole of N_2 gas at a temperature of 27 °C? The Boltzmann constant is 1.38×10^{-23} $m^2 \cdot kg \cdot s^{-2} \cdot K^{-1}$.

(A) 500 J　(B) 1000 J　(C) 2000 J　(D) 4000 J
(E) information is not sufficient to answer

32. A 50-kg boy runs up the stairs to the top of the 200-m tall 18 Peaks Mountain in 8 minutes and 20 seconds. Which of the following values is closest to his average power output in horse power? ($g = 10\ m/s^2$, 1 hp = 750 W)

(A) 0.4　(B) 0.3　(C) 2.0　(D) 10.0　(E) 50.0

33. A magnetron in a microwave oven emits electromagnetic waves with frequency f = 2450 MHz. Which of the following values in Gauss is closest to the magnetic field strength required for electrons to move in circular paths with this frequency?

(A) 5　(B) 50　(C) 200　(D) 600　(E) 900

34. Suppose two parallel plates in Fig. 4, each has an area of 100 cm^2 and are 0.1 cm apart. The capacitor is connected to a power supply and charged to a potential difference $V_0 = 3000$ V. It is then disconnected from the power supply. Which of the following values is closest to the total energy (U) stored in the capacitor in J?

(A) 8.0×10^{-2}　(B) 3.0×10^{-3}　(C) 6.0×10^{-3}

(D) 1.0×10^{-4}　(E) 4.0×10^{-4}

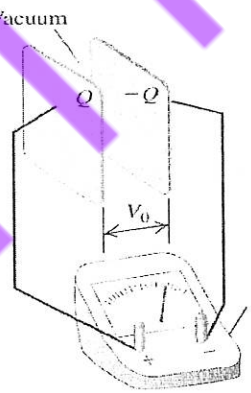


Fig. 4.

35. A heat pump does work W to bring heat Q_L from the cold outside (at constant temperature T_L) and deliver heat Q_H to warm the interior at constant temperature T_H. Which of the following is wrong?

(A) The coefficient of performance COP = $\frac{Q_H}{W}$　(B) $W = Q_H - Q_L$

(C) COP < 1.0　(D) Ideally COP = $\frac{T_H}{T_{H-T_L}}$　(E) $Q_H > Q_L$

36. Which of the following values is closest to the minimum power in hp required for a 1000-kg car that is climbing a 5.7° hill at a steady 72 km/h? Assume that the average drag force on the car at that speed is 500 N throughout.
($g = 10\ m/s^2$, 1 hp = 750 W)

(A) 5　(B) 20　(C) 40　(D) 100　(E) 300

37. Which of the following values is closest to the total electric potential energy of 1 mole of H_2O? For simplicity in calculation, here we assume a pure ionic bonding (H carries a charge +e; O, −2e), the O–H bond length ≅ 100 picometers, and the H–O–H bond angle is 180°.
(A) 4.8 kJ/mol (B) 24 kJ/mol (C) 48 kJ/mol
(D) 240 kJ/mol (E) 480 kJ/mol

38. Suppose an electron is trapped in a one-dimensional infinite well of width L = 2 nm: U = 0 from 0 to L, U = ∞ everywhere else. Obviously the particle can never climb out of well. Which of the following values is closest to the energy of the photon (in eV) that emits when the electron make the transition from level n = 4 to n = 3. ($h = 6.6\times10^{-34}$ m^{2}kg/s; $m_e = 9.1\times10^{-31}$ kg)
(A) 0.02 (B) 0.06 (C) 0.2 (D) 0.6 (E) 2.0

39. A simple DC motor run by a 9.0 V battery has a 20 turn square coil with sides of length 5.0 cm and total resistance of 24 Ω (Fig. 5). When the motor spins, the magnetic field felt by the wire in the coil is 2.0×10^{-2} T. Which of the following values is closest to the the maximum torque on the motor in m·N?

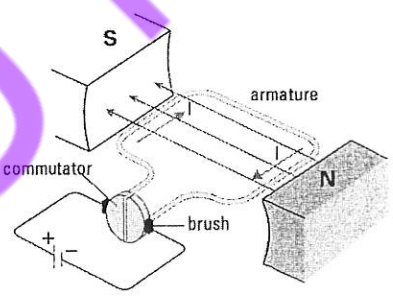


Fig. 5.

(A) 4×10^{-4} (B) 1×10^{-4} (C) 7×10^{-3} (D) 2×10^{-3} (E) 1×10^{-2}

40. A helicopter rotor blade can be considered as a long thin rod, as shown in Fig. 6. If each of the three-rotor helicopter blades is 3.75 m long and has a mass of m = 1.60×10^2 kg, which of the following value is closest to the moment of inertia of the three rotor blades about the axis of rotation in kg·m^2?

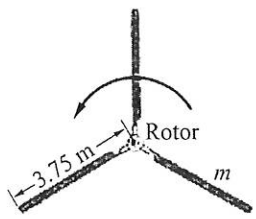


Fig. 6.

(A) 5000 (B) 2000 (C) 1000 (D) 100 (E) 20

41. Car A leaves point O at $t = 0$ and travels counterclockwisely along a quarter circle of radius 100 m at constant speed 30.0 m/s to reach point P. Car B is supposed to leave point O and travels to point P at the same speed but along a straight line. At what time should car B leave point O in order to arrive at point P at the same time as car A?
(A) $t = -4.71$ s (B) $t = -0.53$ s (C) $t = 0$ (D) $t = 0.53$ s (E) $t = 4.71$ s

42. In a one dimensional problem, an object of mass m = 2.0 kg is under effect of a resultant force F_x as shown in Fig. 7. If the object passes through the origin (x = 0.0 m) with initial velocity v_0 = −2.0 m/s at t = 0, what is the velocity at t = 4.0 s?

(A) −2.0 m/s
(B) −3.0 m/s
(C) −5.0 m/s
(D) −8.0 m/s
(E) −16.0 m/s

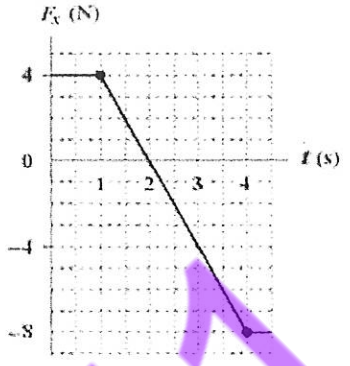


Fig. 7.

43. A spaceship of mass m circles a planet (mass = M) in an orbit of radius R. How much energy is required to transfer the spaceship to a circular orbit of radius $3R$?

(A) $\frac{GmM}{3R}$　(B) $\frac{GmM}{2R}$　(C) $\frac{2GmM}{3R}$　(D) $\frac{GmM}{9R}$　(E) $\frac{4GmM}{9R}$

44. Two blocks, m_1 = 1.0 kg and m_2 = 2.0 kg, are connected by a light string as shown in Fig. 8. The radius of the pulley is 0.2 m and its moment of inertia is 0.2 kg·m^2. If there is no slipping between the pulley and the string, what is the acceleration of block m_1?

(A) g　(B) g/2　(C) g/3　(D) g/4　(E) g/8

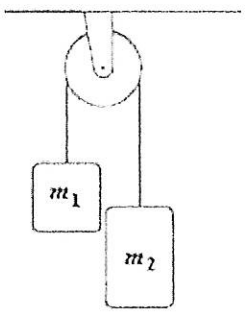


Fig. 8.

45. A wave is transmitted along a string.
Which of the following actions can quadruple the energy transmitted per unit time?

I. double the frequency
II. double the tension of the string
III. double the amplitude
IV. double the wave velocity
V. quadruple the frequency
VI. quadruple the amplitude

(A) III, V　(B) II, III, V　(C) I, VI　(D) I, III　(E) I, II, III

46. An empty can and a full can of the same shape are rolled side-by-side down an incline without slipping. If they start together at the same height, which of the following statements is correct?
(A) The empty can arrives at the bottom first.
(B) The full can arrives at the bottom first.
(C) They both will arrive at the bottom together because the gravity acceleration is the same.
(D) It depends on the materials of the cans.
(E) It depends on the incline angle.

47. An ideal gas is allowed to undergo a free expansion from volume V_1 to volume V_2, what is the change in entropy?
(A) 0　(B) nRV_2/V_1　(C) $nR(V_2 - V_1)$　(D) $nRln\frac{V_2}{V_1}$　(E) $nRTln\frac{V_2}{V_1}$

48. There is a parallel-plate capacitor of capacitance C_0. A slab of dielectric material with $\kappa = 2$ is placed into the gap between the plates, filling the bottom half of the gap. What is the resulting capacitance ?
(A) $\frac{1}{2}C_0$　(B) $\frac{3}{4}C_0$　(C) $\frac{4}{3}C_0$　(D) $2C_0$　(E) $3C_0$

49. Electromagnetic wave is travelling in the free space with the amplitudes of the electric and magnetic fields as E_{max} and B_{max}, respectively. What is the average energy density in the space?
(A) $\frac{B_{max}^2}{\mu_0}$　(B) $\frac{B_{max}^2}{4\mu_0}$　(C) $\varepsilon_0 E_{max}^2$　(D) $\frac{\varepsilon_0 E_{max}^2}{2} + \frac{B_{max}^2}{2\mu_0}$　(E) $\frac{\varepsilon_0 E_{max}^2}{4} + \frac{B_{max}^2}{4\mu_0}$

50. Which of the following observations in the photoelectric effect experiment can be explained by the wave behavior of light?
(A) There is a cutoff frequency below which no photoelectric current can be observed.
(B) Photoelectric current increases with increasing the intensity of the light.
(C) There is a stopping potential for photoelectric current regardless the intensity of the light.
(D) Dependence of ejection of electrons on light frequency.
(E) Dependence of photoelectron kinetic energy on light frequency.

51. Two blocks of equal mass m placed on a frictionless flat surface are connected by a massless spring of a spring constant k, see Fig. 9. In the beginning, the spring is at its natural length, while the mass on the left is at rest and the mass on the right is moving towards right with a speed of v. The two-mass system would go on moving and oscillating relatively. During the oscillation, the maximum extension of the spring is L. What is the minimum value of the kinetic energy of the two-mass system during the oscillation?

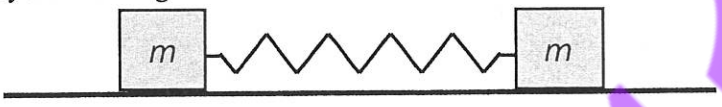


Fig. 9.

(A) $\frac{mv^2}{4}+\frac{kL^2}{2}$　(B) $\frac{mv^2}{2}+\frac{kL^2}{2}$　(C) $\frac{mv^2}{2}-\frac{kL^2}{4}$　(D) $\frac{mv^2}{4}-\frac{kL^2}{2}$　(E) $\frac{mv^2}{4}$

52. The simple harmonic motion is a general phenomenon that occurs as one perturbs a system at stable equilibrium slightly away from its potential minimum. Estimate the period of the simple harmonic motion for a particle of mass m experienced a potential energy of the form $U(x)=a(1/x+b^2x)$ (Joule) as the particle is slightly pushed away from $x_0=\frac{1}{b}$ (m), where x is the spatial coordinate of the particle.

(A) $2\pi\sqrt{\frac{4m}{ab^3}}$　(B) $2\pi\sqrt{\frac{2m}{ab^3}}$　(C) $2\pi\sqrt{\frac{m}{ab^3}}$　(D) $2\pi\sqrt{\frac{m}{2ab^3}}$　(E) 2π

53. Two strings of different linear mass density are joined at $x=0$ to form a new string. The heavier string and the lighter string are on the left and right hand side of $x=0$, respectively. Now, we keep the string stretched with a fixed weight, and send a wave from the heavier end to the lighter end. Which of the following statements is correct?

(A) As the wave travels to the lighter end, its profile is amplified.
(B) As the wave travels to the lighter end, its speed decreases.
(C) As the wave hits $x=0$, the reflected wave travels faster in the heavier string.
(D) The speed of the traveling wave remains the same regardless of which ends.
(E) As the wave hits $x=0$, there is no reflected wave.

54. Two different gases of similar mass density at room temperature react differently as the pressure is varied. Specifically, as the external pressure is raised from 1 atm to 1.01 atm, the volume of gas *A* is reduced by 0.1% while the volume of gas *B* is reduced by 0.2%. Which of the following statements is true?
(A) The sound speed of gas *A* is faster.
(B) Low frequency sound waves travel faster than the high frequency ones in gas *A*.
(C) Low frequency sound waves travel slower than the high frequency ones in gas *A*.
(D) For the same sound source of frequency *f*, the frequency changes more as it enters gas *B*.
(E) As we reduce the pressure, the volume of the gas does not always increase.

55. Two ambulances have identical sirens that would make sound waves of frequency 700 Hz. A stationary observer is in the straight line and in between these two ambulances, while one ambulance is parked and the other is moving away the observer. The observer notices that the combined sound wave exhibits a beat frequency of 20 Hz. What is the speed of the ambulance moving away from the observer? Take the speed of sound to be 340 m/s, and there is no wind blowing during the observation.
(A) 5 m/s　(B) 10 m/s　(C) 12 m/s　(D) 17 m/s　(E) 18 m/s

56. Given a non-uniform charge distribution $\rho(r) = a/r$ (C/m^3) between two concentric spheres of radius *R* and 2*R*, and it is enclosed by a thin metal spherical shell of radius 2*R* (negligible thickness) as shown in Fig. 10, what is the surface charge density on the inner surface of the metal shell?

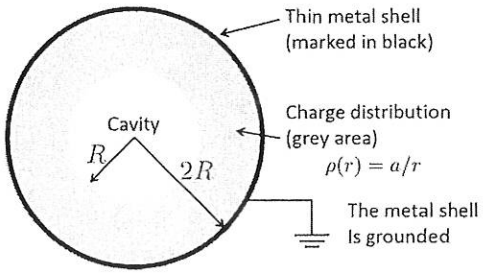


Fig. 10.

(A) $-\frac{3}{8}a$　(B) $-\frac{3}{8}\frac{a}{\epsilon_0}$　(C) $-\frac{5}{18}a$　(D) $-\frac{5}{18}\frac{a}{\epsilon_0}$　(E) $-\frac{3}{4}\frac{a^2}{R}$

57. A charging RC circuit consists of a battery with emf $\mathcal{E}$, a resistor R, and two capacitors C_1 and C_2 as shown in Fig. 11. The two capacitors are identical when there are no dielectrics inserted (that is $C_1 = C_2 =$ when placed in vacuum). In order to increase the capacitance, we place a dielectric material of the dielectric constant κ in C_2. At $t = 0$, there are no charges in capacitors, and we close the switch to charge these capacitors. Which of the following statements is correct?

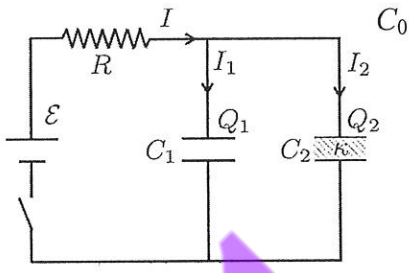


Fig. 11.

(A) The charging percentage (Q/Q_{max}) of these two capacitors would be the same at all times.

(B) The maximum charges stored in these two capacitors would be the same.

(C) The charging time would reduce if a larger resistor is used.

(D) The charging time would reduce if a battery with a larger emf is used.

(E) As more and more charges are stored in the capacitors, we expect the current flowing through the resistor is getting larger and larger.

58. A metal rod is pulled to the right in a uniform magnetic field $B_0\hat{z}$ so that it accelerates at a constant acceleration $a\hat{x}$ on rails and forms a closed circuit with a resistor R as shown in Fig. 12. For simplicity, let us say at $t = 0$, the metal rod coincides with the resistor at $x = 0$ and is at rest. The distance between rails is L. Assume that there is no friction between the rod and rails. Which of the following statements is correct?

(A) The emf induced by pulling the metal rod is proportional to t^2.

(B) The force required to pull the metal rod is proportional to t.

(C) The power dissipation in resistor is proportional to t^3.

(D) The work done by the pulling force is proportional to t.

(E) None of the above is correct.

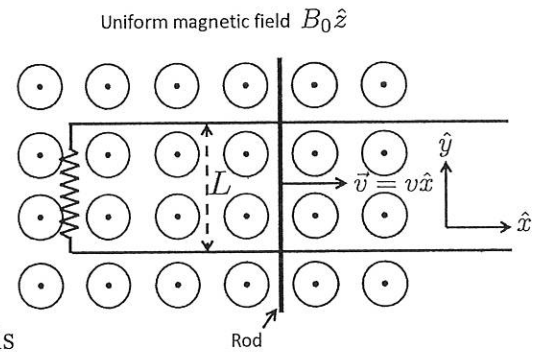


Fig. 12.

59. Which of the following statements about electromagnetic (EM) waves radiated from a point source with a fixed power is correct?

(A) The amplitude of the electric field strength of the EM wave decays with distance squared.

(B) The power received by a detector placed along the radial direction decays with distance.

(C) The energy flux density decays with distance squared.

(D) The larger the power radiated by the source is, the shorter the wavelength of the EM wave is.

(E) The amplitude of the magnetic field strength of the EM wave does not depend on distance.

60. The PV curve for the van der Waals equation at a fixed temperature is plotted in Fig. 13. In this case, the liquid phase can coexist with the gas phase at pressure P_C. The pressure P_C intercepts with the PV curve at three points: a, c, and e, respectively. And the slope of the PV curve vanishes at b and d. Which of the following statements is correct?

(A) For pressure a bit higher than P_C, it is impossible to have a stable gas phase.

(B) For pressure a bit lower than P_C, the gas phase is more stable than the liquid phase.

(C) The region $a \to b$ is the supercooled liquid region.

(D) The region $b \to c \to d$ corresponds to a fluid with a positive compressibility.

(E) None of the above.

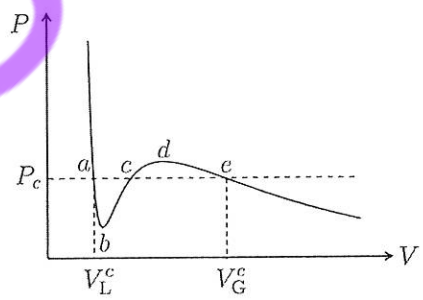


Fig. 13.

國立清華大學學士後醫學系考試 各科試題參考答案

科目名稱:英文

題號	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
答案	D	E	B	D	A	B	D	B	C	C	B	C	E	E	B
題號	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
答案	C	D	A	D	C	C	C	A	D	A	E	E	B	D	A
題號	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
答案	D	B	D	E	A	C	A	A	D	E	A	B	E	C	C
題號	46	47	48	49	50										
答案	B	A	C	E	D										

科目名稱: 生物與生化

題號	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
答案	A	D	D	C	A	A	A	B	A	B	C	A	A	D	B
題號	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
答案	E	A	B	E	E	A	B	C	E	A	B	A	A	D	E
題號	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
答案	D	D	B	A	C	D	E	D	E	D	C	A	D	B	C
題號	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
答案	B	D	C	A	C	C	B	D	A	B	B	E	E	B	B

科目名稱：化學與物理

題號	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
答案	B	D	E	E	C	C	A	C	E	C	E	C	D	D	D
題號	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
答案	E	A	B	D	E	D	A	A	C	B	E	A	C	C	C
題號	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
答案	D	B	E	E	C	C	E	D	A	B	D	B	A	E	D
題號	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
答案	B	D	C	E	B	E	D	A	A	B	A	A	B	C	B

科目名稱：資訊科學

題號	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
答案	B	A	D	B	D	D	D	D	D	A	B	B	B	C	E
題號	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
答案	C	A	D	D	E	C	B	D	B	A	B	D	C	B	A