一、單選題，每題2.5分，答錯不倒扣。選擇題答案請填於答案卡。

Important values and constants:

R (gas constant) = 8.314 J/(mol K) or 1.987 cal/(mol K)

F (Faraday constant) = 96485 C/mol
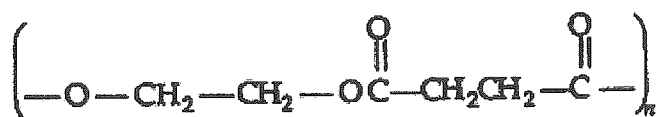
h (Planck constant) = 6.626×10^{-34} J s

mass of the electron = 9.11×10^{-31} kg

log 2 = 0.3010, log 3 = 0.4771, log 5 = 0.6990, log 7 = 0.8451

$\sqrt{2} = 1.414, \sqrt{3} = 1.732, \sqrt{5} = 2.236, \sqrt{7} = 2.646$

1. What monomer(s) is(are) needed to make the polymer shown here?

    I. $HOCH_2CH_2OH$
    II. $HOOCCH_2CH_2COOH$
    III. $HOCH_2CH_2COOH$
    IV. $HOCH = CHOH$
    V. $HOOCCH = CHCOOH$

(A) II only
(B) III only
(C) I and II
(D) IV and V
(E) II and III

2. Which one of the following statements about the structure of proteins is incorrect?
(A) Disulfide bonds provide strong intrachain interactions.
(B) Hydrogen bonding stabilizes the α-helix proteins.
(C) Heat can disrupt tertiary structure.
(D) Ionized amino acid side chains can form salt bridges within a protein.
(E) Nonpolar groups tend to face the outside of a protein in an aqueous solution.

3. Aspirin is formed via a(n) _____ reaction.
(A) combustion
(B) condensation
(C) addition
(D) hydrogenation
(E) substitution

注意:背面有試題

4. For the process $Co(NH_3)_5Cl^{2+} + Cl^- \rightarrow Co(NH_3)_4Cl_2^+ + NH_3$, what would be the ratio of *cis* to *trans* isomers in the product?
   - (A) 1:1
   - (B) 1:2
   - (C) 1:4
   - (D) 4:1
   - (E) 2:1

5. Which has the greater number of unpaired electrons?
   I. square planar $Ni(CN)_4^{2-}$
   II. tetrahedral $FeCl_4^-$
   - (A) I
   - (B) II
   - (C) Neither I nor II has any unpaired electrons.
   - (D) Both I and II have the same (nonzero) number of unpaired electrons.
   - (E) More information is needed.

6. You analyze for pyridine (K_b is approximately 10^{-9}) by dissolving 0.1000 g of the complex in 100 mL of H_2O and titrating with a 0.01 M HCl solution. Which of the following indicators should be used to detect the endpoint? (Assume that the initial concentration of pyridine is approximately 0.01 M.)
   - (A) bromophenol blue, pH range of color change = 3.0–4.6
   - (B) methyl red, pH range of color change = 4.8–6.0
   - (C) bromothymol blue, pH range of color change = 6.0–7.6
   - (D) thymol blue, pH range of color change = 8.0–9.6
   - (E) alizarin yellow, pH range of color change = 10.1–12.0

7. The deciding factor that makes HF a weak acid is that
   - (A) F_2 has a small bond energy.
   - (B) HF has a large bond energy.
   - (C) F^- has the largest ionization energy of all the halide ions.
   - (D) the enthalpy of hydration of F^- is negative.
   - (E) the entropy for hydration of F^- is a large negative value.

8. Which of the following oxides is amphoteric?
   - (A) BeO
   - (B) MgO
   - (C) CaO
   - (D) SrO
   - (E) BaO

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9. At 760 K, acetaldehyde decomposes to carbon monoxide and methane:

$$CH_3CHO \longrightarrow CH_4 + CO$$
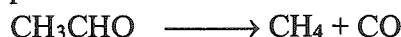
A plot of ln [CH_3CHO] versus time is linear.　After 530 s, [CH_3CHO] decreases to one half of its initial value of 0.10 M.　What is the rate law for the reaction?

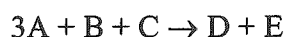(A) $-\dfrac{\Delta[CH_3CHO]}{\Delta t} = 1.9 \times 10^{-3}[CH_3CHO]^0$

(B) $-\dfrac{\Delta[CH_3CHO]}{\Delta t} = 53[CH_3CHO]^2$

(C) $-\dfrac{\Delta[CH_3CHO]}{\Delta t} = 530[CH_3CHO]^2$

(D) $-\dfrac{\Delta[CH_3CHO]}{\Delta t} = 530[CH_3CHO]$

(E) $-\dfrac{\Delta[CH_3CHO]}{\Delta t} = 1.3 \times 10^{-3}[CH_3CHO]$

10. Consider the reaction

$$3A + B + C \rightarrow D + E$$

where the rate law is defined as

$$-\frac{\Delta[A]}{\Delta t} = (1.66 \times 10^2 \text{ L}^3/\text{mol}^3 \cdot \text{s})[A]^2[B][C]$$

An experiment is carried out where [B]$_0$ = [C]$_0$ = 1.00 M and [A]$_0$ = 2.72 $\times 10^{-4}$ M. What is the half-life for this experiment?
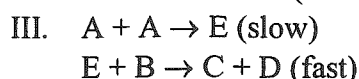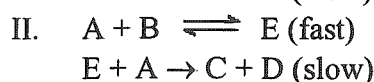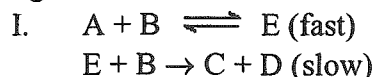
(A) 8.19×10^{-7} s

(B) 1.36×10^{-5} s

(C) 4.17×10^{-3} s

(D) 2.21×10^1 s

(E) 1.66×10^2 s

11. The rate law for a reaction is found to be Rate = $k[A]^2[B]$. Which of the following mechanisms gives this rate law?

　　I.　　$A + B \rightleftharpoons E$ (fast)
　　　　　$E + B \rightarrow C + D$ (slow)
　　II.　$A + B \rightleftharpoons E$ (fast)
　　　　　$E + A \rightarrow C + D$ (slow)
　　III.　$A + A \rightarrow E$ (slow)
　　　　　$E + B \rightarrow C + D$ (fast)

(A) I only

(B) II only

(C) III

(D) I and II

(E) II and III

注意:背面有試題

12. Which of the following statements is(are) true?

I. An excited atom can return to its ground state by absorbing electromagnetic radiation.

II. The energy of an atom is increased when electromagnetic radiation is emitted from it.

III. The energy of electromagnetic radiation increases as its frequency increases.

IV. An electron in the $n = 4$ state in the hydrogen atom can go to the $n = 2$ state by emitting electromagnetic radiation at the appropriate frequency.

V. The frequency and wavelength of electromagnetic radiation are inversely proportional to each other.

(A) II, III, IV

(B) III, V

(C) I, II, III

(D) III, IV, V

(E) I, II, IV

13. An electron in a one-dimensional box requires energy with wavelength 8080 nm to excite it from the $n = 2$ energy level to the $n = 3$ energy level.　Calculate the length of the box.

(A) 1.00 nm

(B) 1.50 nm

(C) 2.50 nm

(D) 3.00 nm

(E) 3.50 nm

14. The energy expressions for the electrons in the He^+ ion and the hydrogen atom are

$$E_n(H) = -a/n^2 \quad \text{and} \quad E_n(He^+) = -4a/n^2$$

Which of the following statements is(are) correct?

I. For the transitions $n_1 \rightarrow n_2$, the frequency is larger for H than for He^+.

II. The first ionization energy of the H atom is smaller than the second ionization energy of the He atom.

III. The 1s orbital in He^+ is larger (in the sense that the probability density is shifted outward) than the 1s orbital in H.

(A) I only

(B) II only

(C) III only

(D) I and II only

(E) I, II, and III

15. The wavelength of light associated with the $n = 2$ to $n = 1$ electron transition in the hydrogen spectrum is 1.216×10^{-7} m. By what coefficient should this wavelength be multiplied to obtain the wavelength associated with the same electron transition in the Li^{2+} ion?

(A) 1/9

(B) 1/7
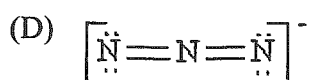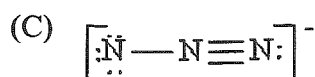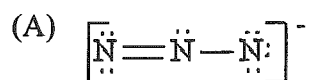
(C) 1/4

(D) 1/3

(E) 1

注意:背面有試題

16. A strip of copper is placed in a 1 M solution of copper nitrate, and a strip of silver is placed in a 1 M solution of silver nitrate. The two metal strips are connected to a voltmeter by wires, and a salt bridge connects the solutions. The following standard reduction potentials apply:

$$Ag^+(aq) + e^- \rightarrow Ag(s) \quad E° = +0.80 \text{ V}$$
$$Cu^{2+}(aq) + 2e^- \rightarrow Cu(s) \quad E° = +0.34 \text{ V}$$
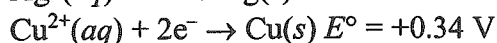
When the voltmeter is removed and the two electrodes are connected by a wire, which of the following does not take place?
   (A) Electrons flow in the external circuit from the copper electrode to the silver electrode.
   (B) The silver electrode increases in mass as the cell operates.
   (C) There is a net general movement of silver ions through the salt bridge to the copper half-cell.
   (D) Negative ions pass through the salt bridge from the silver half-cell to the copper half-cell.
   (E) Some positive copper ions pass through the salt bridge from the copper half-cell to the silver half-cell.

17. The standard potential for the reaction $A(s) + B^{3+}(aq) \rightleftharpoons A^{3+}(aq) + B(s)$ is 0.51 V. What is the equilibrium constant K for this reaction at 25°C?
   (A) 6.3×10^{25}
   (B) 1.6×10^{-26}
   (C) 17
   (D) –17
   (E) 0.015

18. Which of the following is not a valid resonance structure for N_3^-?
   (A) $\left[\ddot{N} = \dot{N} - \ddot{N} \colon \right]^-$

   (B) $\left[\colon N \equiv N - \ddot{N} \colon \right]^-$

   (C) $\left[\colon \ddot{N} - N \equiv N \colon \right]^-$

   (D) $\left[\ddot{N} = N = \ddot{N} \right]^-$

   (E) All are valid.

19. Consider the following molecules.

    I.　　　BF_3
    II.　　$CHBr_3$ (C is the central atom.)
    III.　Br_2
    IV.　$XeCl_2$
    V.　　CO
   VI.　SF_4

Select the molecule(s) that fit the given statement.

These molecules have a zero net dipole moment.
(A) III, V
(B) III, IV
(C) I, III, IV
(D) III, IV, V
(E) I, III, IV, VI

20. Which of the following is diamagnetic?
(A) H_2^+
(B) C_2^+
(C) N_2^+
(D) N_2
(E) F_2^+

21. Below is a phase diagram for 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
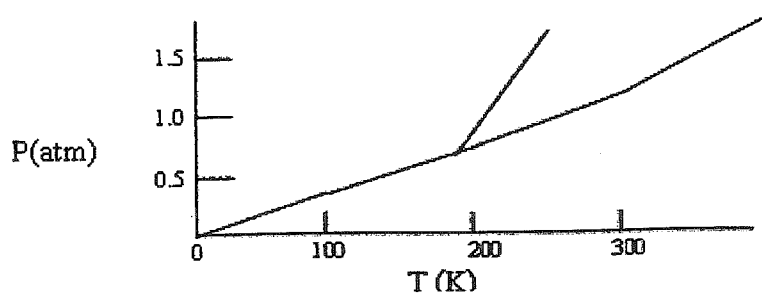

(A) increase P to 1.5 atm and then increase T to 300 K.
(B) increase T to 300 K, keeping $P = 1.0$ atm.
(C) lower P to 0.5 atm and then increase T to 200 K.
(D) increase T to 300 K and then lower P to 0.5 atm.
(E) abandon the attempt to sublime X.

注意:背面有試題

22. Alkali halides commonly have either the sodium chloride structure or the cesium chloride structure. The molar mass of CsCl is 2.88 times the molar mass of NaCl, and the edge length of the unit cell for NaCl is 1.37 times the edge length of the CsCl unit cell. Determine the ratio of the density of CsCl to the density of NaCl.
    (A) 0.541
    (B) 0.984
    (C) 1.02
    (D) 1.85
    (E) 2.10

23. Liquid A has vapor pressure x. Liquid B has vapor pressure y, and $x > y$. What is the mole fraction of A in the liquid mixture if the vapor above the solution is 30% A?
    (A) $0.3y/(0.7x + 0.3y)$
    (B) $0.7y/(0.3x + 0.7y)$
    (C) $0.3x/(0.3x + 0.7y)$
    (D) $0.7x/(0.7x + 0.3y)$
    (E) none of these

24. The oxidation states of P in KPF_6 is:
    (A) +1
    (B) +3
    (C) +5
    (D) -3
    (E) -5

25. Which of the following compounds is the strongest acid?
    (A) Acetic acid
    (B) Chloric acid
    (C) Hypochlorous acid
    (D) Boric acid
    (E) Chlorous acid

26. Which of the following ions has the lowest standard reduction potential?
    (A) Ag^+
    (B) Fe^{3+}
    (C) Cr^{3+}
    (D) Mg^{2+}
    (E) Al^{3+}

27. Which of the following names of ions is incorrect?
    (A) stannous: Sn^{2+}
    (B) plumbous: Pb^{2+}
    (C) ferric: Fe^{2+}
    (D) nitrate: NO^{3-}
    (E) dichromate: $Cr_2O_7^{2-}$

注意:背面有試題

28. The density of compound XH_n as gas is 2.393 times that of O_2. If 0.01 mol of this compound reacts with excess O_2, 0.36 g of water is generated. The atomic weight of element X is:
    (A) 69.72 g/mol
    (B) 72.55 g/mol
    (C) 74.92 g/mol
    (D) 78.97 g/mol
    (E) 83.80 g/mol

29. Which of the following compound can be dissolved in water easily?
    (A) CsCl
    (B) AgCl
    (C) $BaSO_4$
    (D) CaF_2
    (E) $MgCO_3$

30. Which of the following statements is correct?
    (A) NaF: acidic, cation acts as an acid
    (B) NH_4Cl: neutral, cation acts as an acid, and anion acts as a base
    (C) KCN: basic, cation is from strong base; anion is from strong acid
    (D) $Al(NO_3)_3$: neutral, cation is from strong base; anion is from strong acid
    (E) $FeCl_3$: acidic, hydrated cation acts as an acid

31. Which of the following statements is correct for a mercury cell to produce chlorine and sodium hydroxide?
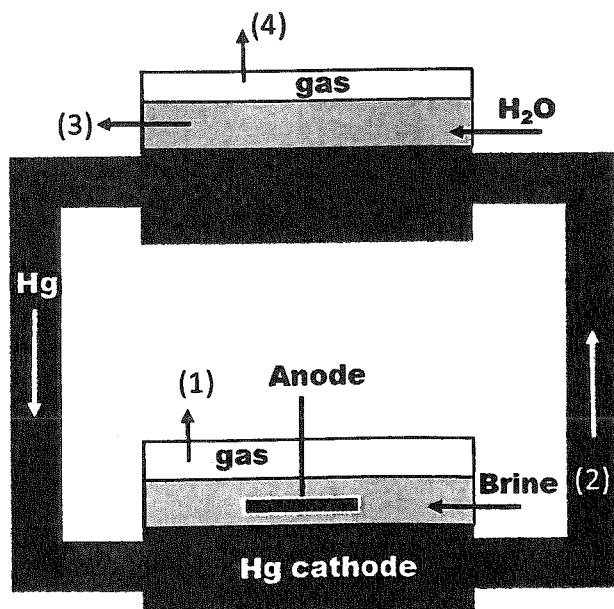
    (A) a reduction reaction occurs at anode to generate (1)
    (B) (1) is H_2
    (C) (2) is pure Hg
    (D) (3) is NaOH solution
    (E) (4) is water vapor

注意:背面有試題

32. About a chemical reaction, which of the following statements is correct?
   (A) the entropy change of ice melting is positive
   (B) the ΔS of a spontaneous reaction must be negative
   (C) the ΔS of a spontaneous reaction must be positive
   (D) the ΔG of a spontaneous reaction is larger than 0
   (E) the enthalpy change of a spontaneous reaction must be negative

33. Which of the following compounds is a paramagnetic substance?
   (A) N_2
   (B) NH_3
   (C) NO_2
   (D) hydrazine (N_2H_4)
   (E) hydrazoic acid (HN_3)

34. Which of the following electron configurations is not correct?
   (A) C: $1s^2 2s^2 2p^2$
   (B) Ne: $1s^2 2s^2 2p^6$
   (C) Ti: $[Ar]4s^2 3d^2$
   (D) Cr: $[Ar]4s^2 3d^4$
   (E) Zn: $[Ar]4s^2 3d^{10}$

35. Which of the following reactions do not produce HCl?
   (A) phosgene reacts with moisture
   (B) the anodic reaction of electrolysis of sodium chloride aqueous solution
   (C) oxalyl chloride reacts with alcohol
   (D) sodium chloride treated by sulfuric acid
   (E) dehydration of zinc chloride hydrate with thionyl chloride

36. An aqueous solution containing Ba^{2+}, Pb^{2+}, Cu^{2+}, Cr^{3+} and Hg_2^{2+} ions is treated by HCl, H_2S and NaOH solution in sequence. Which ion will not precipitate out of the solution?
   (A) Ba^{2+}
   (B) Pb^{2+}
   (C) Cu^{2+}
   (D) Cr^{3+}
   (E) Hg_2^{2+}

37. How many pars of lone pair electrons dose the Xe atom of XeF_4 possess?
   (A) 1
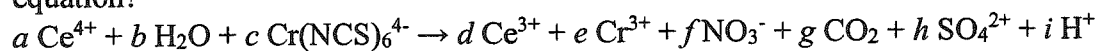   (B) 2
   (C) 3
   (D) 4
   (E) 0

注意:背面有試題

38. The coordination number of Cs in CsCl under ambient conditions is:
    (A) 1
    (B) 2
    (C) 4
    (D) 6
    (E) 8

39. Which of the following elements has the highest electron affinity (most exothermic)?
    (A) O
    (B) F
    (C) Cl
    (D) Br
    (E) I

40. Which of the following statements is not correct for balancing the following chemical equation?

    $a\ Ce^{4+} + b\ H_2O + c\ Cr(NCS)_6^{4-} \rightarrow d\ Ce^{3+} + e\ Cr^{3+} + f\ NO_3^- + g\ CO_2 + h\ SO_4^{2+} + i\ H^+$

    (A) $g = 6\ c$
    (B) $i = 108$
    (C) $a = d$ and $c = e$
    (D) $a + b + c = 152$
    (E) $d + e + f + g + h + i = 222$