單選題，每題2.5分

1. A fuel cell, which has E^0_{cell} of 1.23 V, is operated under the following conditions: (A) P_{H_2} = 1.5 atm, P_{O_2} = 1.0 atm and pH = 1.0; (B) P_{H_2} = 1.0 atm, P_{O_2} = 1.5 atm and pH = 1.0; (C) P_{H_2} = 1.25 atm, P_{O_2} = 1.25 atm and pH = 1.0; (D) P_{H_2} = 1.0 atm, P_{O_2} = 1.0 atm and pH = 7.0. The order of the magnitude of E_{cell} is:
(A) A>B>C; (B) D>C>A; (C) C>B>D; (D) B>D>A

2. The solubility product of AgCl(s) is 1.8×10^{-10} under standard condition. What is its ΔG^0 ? (log 1.8 = 0.255)
(A) 13.3 kcal/mol; (B) 1.33 kcal/mol; (C) 133 kcal/mol; (D) 0.133 kcal/mol

3. Which one of the following acidity strength orders is incorrect?
(A) HCl > HF; (B) HBr> HCl; (C) H_2S > HCl; (D) H_2S > H_2O.

4. $NiCl_4^{2-}$ and $Ni(CN)_4^{2-}$ have different geometry. Which one of the following statements is incorrect.
(A) $Ni(CN)_4^{2-}$ is diamagnetic; (B) $Ni(CN)_4^{2-}$ has a tetrahedral structure; (C) $NiCl_4^{2-}$ has two unpaired electrons; (D) $NiCl_4^{2-}$ has a d-electron configuration of $(t_{2g})^4(e_g)^4$.

5. Which one of the following statements about $Co(en)_3^{3+}$ (en: ethylenediamine) is incorrect.
(A) It has an octahedral structure; (B) Its d-electron configuration is $t_{2g}^6e_g^1$; (C) It has structural isomer; (D) It has optical isomer.

6. Which one of the following statements about transition metal species is incorrect?
(A) $TiCl_4$ is an ionic compound; (B) MnO is a basic oxide; (C) CrO_3 is an acidic oxide; (D) $ZnCl_4^{2-}$ is colorless.

7. Which one of the following processes is non-spontaneous?
(A) Burning of methane; (B) Decay of radioactive elements; (C) Transformation of diamond to graphite; (D) Decomposition of water to $H_2(g)$ and $O_2(g)$ under STP condition.

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8. Which one of the following processes leads to increasing ΔS^0_{sys}?
(A) Evaporation of alcohol; (B) Freezing of water into ice; (C) Reaction of $CO(g)$ and $O_2(g)$ to form $CO_2(g)$; (D) Reaction of $H_2(g)$ and $N_2(g)$ to form $NH_3(g)$.

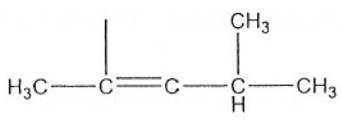
9. What is the pH of a solution when equal volumes of 0.30 M $NH_3(aq)$ ($pK_b = 4.75$) solution and 0.10 M HCl solution are mixed. ($\log 2 = 0.301$; $\log 3 = 0.477$)
(A) 8.75; (B) 9.25; (C) 8.95; (D) 9.55.

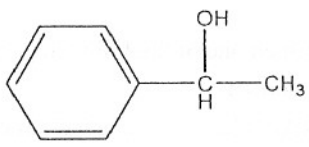
10. After 50 mL solution of 0.50 M $Fe(NO_3)_3$ is mixed with 50 mL solution of 0.50 M $Cd(NO_3)_3$, 1.00 M NaOH solution is added dropwise. Which one of the following statements is incorrect. $K_{sp}(Fe(OH)_3) = 1.6\times10^{-39}$; $K_{sp}(Cd(OH)_2) = 7.2\times10^{-15}$.
(A) $Fe(OH)_3(s)$ precipitates first; (B) After addition of 25 mL NaOH, $Cd(OH)_2$ starts to precipitate; (C) After addition of 1 drop of NaOH, no precipitate forms; (D) When $Cd(OH)_2$ starts to precipitate, the concentration of Fe^{3+} is negligible.

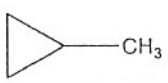
11. Which one of the following statements about reaction kinetics is incorrect.
(A) The unit of the zero order rate constant is s^{-1}; (B) When the half-life of a first order reaction is 10 sec, the time required for the reduction of concentration to 1/8 of its initial value is 30 sec; (C) The unit of the second order rate constant is $M^{-1}s^{-1}$; (D) The half-life of a second order reaction is dependent on initial concentration.

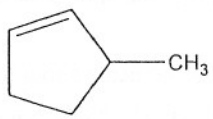
12. If the rate constant of a second order reaction at 320 K is three times that at 300 K, then the rate constant at 340 K is about how many times that at 320 K.
(A) 2.0; (B) 3.0; (C) 4.0; (D) 6.0.

13. Which one of the following compounds does not have geometrical and optical isomer.

(A) 

; (B) 

(C) 

(D) 

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14. Which one of the following statements is incorrect?
(A) IE_1: P > Al > Na: (B) EN: Cl > Se > Br; (C) Atomic size: Si > P > N; (D) number of valence electrons: S > Sb > Cs.

15. Which one of the following orders of bond lengths is correct.
(A) $SiCl_4 > CF_4 > GeBr_4$; (B) $GeBr_4 > CF_4 > SiCl_4$; (C) $CF_4 > GeBr_4 > SiCl_4$; (D) $GeBr_4 > SiCl_4 > CF_4$.

16. Which one of the following statements is correct?
(A) melting point: Si > Ar > Na; (B) ΔH_{fus}: Cs > Rb > Li; (C) boiling point: As > $Br_2 > O_2$; (D) ΔH_{vap}: $I_2 > Ar > Cl_2$.

17. Which one of the following orders of solubilities in water is incorrect?
(A) Ar > Ne; (B) AgCl > AgBr; (C) $CH_3OH > CHCl_3$; (D) $C_3H_7OH > C_2H_5OH$

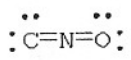
18 Which one of the statements about the strength of intermolecular interaction is correct?
(A) $CH_3OH > CCl_4 > CHCl_3$; (B) $CH_3OH > Br_2 > CCl_4$; (C) $CHCl_3 > CCl_4 > Br_2$; (D) $CHCl_3 > CH_3OH > Br_2$.

19. What is the hybridization of Br in BrF_3?
(A) dsp^3; (B) sp^3; (C) sp^2; (D) sp.

20. Which one of the following statements is incorrect?
(A) The bonding in B_2 is single bond; (B) The bond order in N_2^+ is 7/2; (C) C_2 is paramagnetic; (D) The bond order in Be_2^+ is 1/2.

21. The total number of valence electrons in C, I, Ga, and As is
(A) 18; (B) 19; (C) 20; (D) 21.

22. What is the formal charge on nitrogen in the figure below?



(A) −2 (B) −1 (C) 0 (D) +1 (E) +2

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23. The standard potential of the Cu^{2+}/Cu is +0.34 V and the standard potential of the cell

$$Sn(s)|Sn^{2+}(aq)||Cu^{2+}(aq)|Cu(s)$$

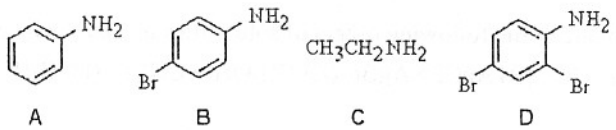
is +0.48 V. What is the standard potential of the Sn^{2+}/Sn electrode?

(A) +0.14 V (B) +0.28 V (C) +0.82V (D) -0.14 V (E) -0.82 V

24. Which of the following is not an example of a colloid?

(A) fog (B) jelly (C) mayonnaise (D) milk (E) diamond

25. Arrange the following organic bases from weakest to strongest.



A B C D

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

26. What is the answer of the following operation using the appropriate number of significant figures?

$$72.0 \times 1.320 \times (25.31 - 1.6)$$

(A) 2252 (B) 2.25×10^3 (C) 2252.4 (D) 2.2524×10^3 (E) 2252.45

27. Consider the reaction of 19.0 g of zinc with excess silver nitrite to produce silver metal and zinc nitrite. The reaction is stopped before all the zinc metal has reacted and 29.0 g of solid metal is present. How many grams of silver are in the 29.0-g mixture? (The atomic masses: Zn = 65.4, Ag = 108.0, N = 14.0, O = 16.0)

(A) 4.34 g (B) 14.7 g (C) 14.3 g (D) 10.5 g (E) 18.5 g

28. What is the difference between extensive and intensive properties?

(A) Extensive properties are state functions, while intensive properties are not.
(B) Extensive properties include color and smell, while intensive properties

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include enthalpy and mass.

(C) Extensive properties depend on the kinetic energy of a system, while intensive properties depend on the potential energy.

(D) Extensive properties occur outside a system, while intensive properties occur inside.

(E) Extensive properties depend on the quantity of matter, while intensive properties do not.

29. Assume that the energy-level diagram of N_2 molecular orbital applies to the ions CN^+ and CN^-. Which of the following statements is correct?

(A) Both CN^+ and CN^- ions are diamagnetic.
(B) The bond order of CN^- is 2.
(C) CN^- has a longer carbon –to-nitrogen bond length
(D) CN^- ion is paramagnetic.
(E) CN^+ ion has a stronger carbon –to-nitrogen bond.

30. According to VSEPR method, what is the molecular geometry for BrO_3^-?

(A) T-shape
(B) trigonal pyramidal
(C) trigonal planar
(D) tetrahedral
(E) seesaw

31. Arrange the following substances in the order of increasing melting point:
$MgCl_2$, CsCl, CCl_4, Cl_2

(A) $Cl_2 < MgCl_2 < CsCl < CCl_4$
(B) $Cl_2 < CCl_4 < MgCl_2 < CsCl$
(C) $CCl_4 < Cl_2 < MgCl_2 < CsCl$
(D) $Cl_2 < CCl_4 < CsCl < MgCl_2$
(E) $CCl_4 < Cl_2 < CsCl < MgCl_2$

32. Which of the following reactions contributes to the reason that CFC's are most damaging to the ozone layer?

(A) $NO + O_3 \rightarrow NO_2 + O_2$
(B) $Cl\cdot + O_3 \rightarrow ClO\cdot + O_2$
(C) $O_2 + O\cdot \rightarrow O_3$
(D) $2\ HgO \rightarrow 2\ Hg + O_2$
(E) $O_3 + h\nu \rightarrow O_2 + O\cdot$

33. Which of the following complex ions has the highest oxidation number for the central metal atom?

(A) $[NiBr_4]^{2-}$ (B) $[Fe(H_2O)_6]^{2+}$ (C) $[PtCl_2(NH_3)_4]^{2+}$ (D) $[Fe(CO)_5]$

(E) $[Mn(CN)_6]^{3-}$

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34. The proposed mechanism is consistent with the rate law for the following reaction having the rate law: Rate = $k[H_2][NO]^2$.

$2\ H_2(g) + 2\ NO(g) \rightarrow N_2(g) + 2\ H_2O(g)$

Proposed mechanism:

Step 1: $2\ NO \leftrightarrows N_2O_2$

Step 2: $N_2O_2 + H_2 \rightarrow N_2O + H_2O$

Step 3: $N_2O + H_2 \rightarrow N_2 + H_2O$

Which must be the rate-determining step in this mechanism?

(A) Step 1 (B) Step 2 (C) Step 3 (D) None of these

35. Which of the followings would not be more soluble in 1.0 M HCl than in pure water?

(A) CaC_2O_4 (B) $Mg(OH)_2$ (C) $BaCO_3$ (D) PbI_2 (E) FeS

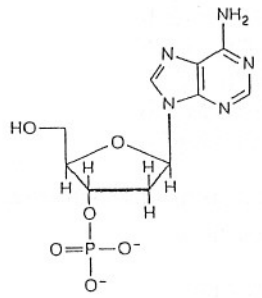
36. The voltaic cell diagrammed below register E_{cell} = 0.150 V.

$$Pt, H_2(g, 1\ atm)|H^+(x\ M)||H^+(1\ M)|H_2(g, 1\ atm), Pt$$

What is the pH of the unknown solution?

(A) 2.53 (B) 2.03 (C) 5.07 (D) 4.06 (E) 3.05

37. The following molecule is an example of what type of compound?



(A) Nucleoside (B) Nucleotide (C) Amino acid (D) Purine
(E) Pyrimidine

38. When the equation for the following reaction in basic solution is balanced, what is the sum of the coefficients?

$$CH_3OH(aq) + MnO_4^-(aq) \rightarrow HCOO^-(aq) + MnO_2(s)$$

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(A) 20 (B) 19 (C) 21 (D) 22 (E) 12

39. Predict the signs of $\Delta S°$, $\Delta H°$, and $\Delta G°$ for the following process at 25°C.

$$2\ NH_3\ (g) \rightarrow N_2\ (g) + 3\ H_2\ (g)$$

(A) $\Delta S°$ $\Delta H°$ $\Delta G°$
+ + -

(B) $\Delta S°$ $\Delta H°$ $\Delta G°$
- + -

(C) $\Delta S°$ $\Delta H°$ $\Delta G°$
+ - +

(D) $\Delta S°$ $\Delta H°$ $\Delta G°$
- - -

(E) $\Delta S°$ $\Delta H°$ $\Delta G°$
+ + +

40. Which type of spectrum would be most useful in detecting the presence of a conjugated π-electron system in a molecule?

(A) IR (B) UV-Vis (C) NMR (D) MS (E) X-ray