## I 單選題 (每題 3 分)

1. Which are the oxidation numbers of the central metal atom in the following coordination compounds: $K_3[Fe(CN)_6]$, $[Cr(NH_3)_4Br_2]Br$, $[Ni(H_2O)_6]Cl_2$, $Na_2[TaF_7]$?

a) 3, 3, 3, 5　b)3, 3, 2, 7　c) -3, 3, 2, 5　d) -3, 1, 2, 5　e) 3, 3, 2, 5

2. What is the organic base that is not found in RNA?

a) Uracil (U)　b) Cytosine　c) Thymine (T)　d) Adenine (A)　e) Guanine (G)

3. How many unpaired electrons does $[Fe(CN)_6]^{3-}$ have?

a) 0　b) 1　c) 3　d) 5　e) 2

4. Which of the following statements concerning the complex ion $[Co(en)_2Cl_2]^+$ is true? (en = ethylenediamine)

a) the complex ion contains Co(I)
b) the complex ion exhibits *cis* and *trans* geometric isomers, but no optical isomers.
c) The complex ion exhibits two geometric isomers *(cis* and *trans*) and two optical isomers.
d) Since en is a strong field ligand, the complex ion is paramagnetic.
e) The geometric isomers of the complex ion have identical chemical properties

5. Which of the following statement is not true?

a) the reaction constant might change when the reaction temperature change
b) the reaction constant won't change when the concentration of reactants change
c) the reaction constant might change when the catalyst is added to the reaction
d) the activation of energy for a reaction might change when the catalyst is added
e) the activation of energy for a reaction might change when the reaction temperature change

6. What oxidation state of metal does not exist?

a) $Fe^{2+}$　b) $Mn^{+7}$　c) $Zn^{3+}$　d) $Ni^{2+}$　e) $Cr^{3+}$

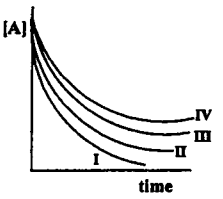
7. Please balance the following equation (o, p, q, x, y, z are reaction coefficients). What is the sum of all coefficients (o + p + q + x + y + z)

$$\mathbf{o}\ Cr_2O_7^{2-}{}_{(aq)} + \mathbf{p}\ H_2O_{2(aq)} + \mathbf{q}\ H^+{}_{(aq)} \rightarrow \mathbf{x}\ Cr^{3+}{}_{(aq)} + \mathbf{y}\ O_{2(g)} + \mathbf{z}\ H_2O$$

a) 18　b) 20　c) 22　d) 24

(背面仍有題目,請繼續作答)

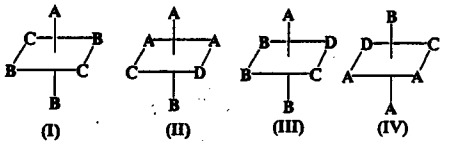
8. The graph shows the concentration of reactants versus reaction time in four different first-order reactions. Which reaction has the largest reaction rate constant?




a) I　b) II　c) III　d) IV

9. Which of the following pairs are enantiomers?

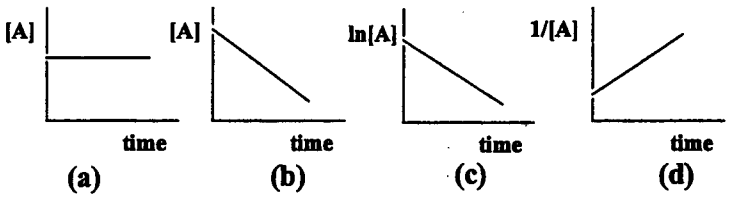
a) I, II　b) I, III　c) I, IV　d) II, III
e) II, IV




10. Which of the following elements are not in the same group?

a) Zn, Ag, Au　b) Ni, Pd, Pt　c) C, Si, Ge, Sn, Pb　d) B, Al, Ga, In

11. Which of the following plots shows that the reaction A -> B is the second order reaction? [A]: the concentration of A; t: reaction time




12. Methyl mercury is eliminated from the body by a first-order process that has a half-life of 70 days. How many days are required for the amount of methyl mercury to drop to 20% of the original value after accidental ingestion?

a) 163 days　b) 230 days　c) 40 days　d) 320 days

13 The rate of formation of dichromate ($Cr_2O_7^{2-}$) ions is 0.32 mol•$L^{-1}$•$s^{-1}$ in the reaction $2CrO_4^{2-}{}_{(aq)} + 2H^+{}_{(aq)} \rightarrow Cr_2O_7^{2-}{}_{(aq)} + H_2O_{(l)}$. What is the rate of reaction of chromate ions ($CrO_4^{2-}$) in the reaction?

a) 0.16 mol•$L^{-1}$•$s^{-1}$　b) 0.32 mol•$L^{-1}$•$s^{-1}$　c) 0.64 mol•$L^{-1}$•$s^{-1}$　d) 1.28 mol•$L^{-1}$•$s^{-1}$

14. Which of the following statements is false?

a) Nucleotides are the monomers of the nucleic acids
b) DNA is ribonucleic acids and RNA is deoxyribonucleic acid
c) Monosaccharides are the monomers of carbohydrates
d) Amino acids are the building blocks for the proteins

15. The reaction $2NO + O_2 \rightarrow 2NO_2$ exhibit the rate law $Rate = k[NO]^2[O_2]$. Which of the mechanisms on the right is consistent with this rate law?

| | |
|---|---|
| a. $NO + O_2 \longrightarrow NO_2 + O$ | Slow |
| $O + NO \longrightarrow NO_2$ | Fast |
| b. $NO + O_2 \rightleftharpoons NO_3$ | Fast equilibrium |
| $NO_3 + NO \longrightarrow 2NO_2$ | Slow |
| c. $2NO \longrightarrow N_2O_2$ | Slow |
| $N_2O_2 + O_2 \longrightarrow N_2O_4$ | Fast |
| $N_2O_4 \longrightarrow 2NO_2$ | Fast |
| d. $2NO \rightleftharpoons N_2O_2$ | Fast equilibrium |
| $N_2O_2 \longrightarrow NO_2 + O$ | Slow |
| $O + NO \longrightarrow NO_2$ | Fast |

16. Which of the following is NOT determined by the principal quantum number n of the electron in a hydrogen atom?

a) the energy of the electron

b) the minimum wavelength of the light needed to remove the electron from the atom

c) the size of the corresponding atomic orbital(s)

d) the shape of the corresponding atomic orbital(s)

e) all of these are determined by n

17. Which of the following statements is NOT true?

a) The Bohr Model can predict the energy level of electrons in oxygen atom

b) In the quantum mechanic model, the electron is described as a wave.

c) The energy and position of an electron cannot be determined at the same time.

d) The electron density at a point is proportional to $\Psi^2$ at that point.

e) An orbital can accommodate at most two electrons

18. How many unpaired electrons does an atom of oxygen have in its ground state?

a) 0　b) 1　c) 2　d) 3　e) 4

19. Which of the following statements is NOT correct?

a) 2s and 2p orbitals are degenerate in hydrogen atom

b) 2S orbital has two node which is an area of zero electron probability.

c) d orbital has 5 subshell

d) The dependence of the wave function on angular momentum quantum number determines the shapes of the atomic orbital.

20. Which of the following orbital allows more electron penetration close to the nucleus?

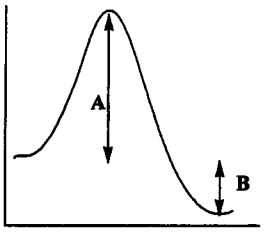
a) 4p　b) 4s　c) 4f　d) 4d

21. The figure shows the change in potential energy as a function of reaction progress

(背面仍有題目,請繼續作答)

for a reaction. Which of the following descriptions is NOT correct?

a) A represent the activation energy
b) B represent the net change in energy in going from reactant to product
c) If the catalyst is used for the reaction, A will change
d) If the catalyst is used for the reaction, B won't change
e) If the reaction of the temperature is changed, A will change




22. $^{145}Gd$ is a proton rich nuclide and unstable. Which of the process might a $^{145}Gd$ nucleus not undergo to begin to reach stability?
a) $\beta^-$ emission　b) proton emission　c) $\beta^+$ emission　d) electron capture

23. What oxidation state of metal does not exist?
a) $Fe^{2+}$　b) $Mn^{+7}$　c) $Zn^{3+}$　d) $Ni^{2+}$　e) $Cr^{3+}$

24. Which form of electromagnetic radiation has the lowest energy?
a) gamma rays　b) microwaves　c) radio waves　d) infrared radiation　e) x-rays

25. Which of the following statement for the main group elements in the periodic table is False?
a) Polarizabilities typically decrease from left to right along a period and increase down a group.
b) Electronegativities typically increase from left to right across a period and decrease down a group
c) Atomic radii typically decrease from left to right across a period and increase down a group
d) Elements with low ionization energies tend to have metallic bonds, whereas elements with high ionization energies are typically molecular and have covalent bonds
e) all the elements in period 2 and period 3 can form multiple bonds with themselves

26. For the hypothetical reaction B → C at 310 K, the standard free energy of formation for compound C is 176.4 kJ/mol. $\Delta G^\circ$ = -31.4 kJ/mol. Calculate the standard free energy of compound B.
a) 207.8 kJ/mol　b) -207.8 kJ/mol　c) 145.0 kJ/mol　d) -145.0 kJ/mol

27. Which of the following chemical is a base?

a) $BF_3$　b) $SO_2$　(c) $MgH_2$　(d) $B(OH)_{3(s)}$

28. An unknown concentration of $NH_3$ solution is titrated by HCl solution. The color change for indicators at different pH values are shown in the table below. Which of the followings is the right indicator for this titration?

(a) phenolphthalein　(b) alizarine yellow R　(c) methyl red　d) crystal violet

e) thymol blue

| 名稱(中) | 名稱(英) | 酸型顏色 | 變色範圍 | 鹼型顏色 |
|---|---|---|---|---|
| | crystal violet | 黃 | 0---2 | 藍 |
| 瑞香酚藍 | thymol blue | 紅 | 1---3 | 黃 |
| | | 黃 | 8---9 | 藍 |
| 甲基橙 | methyl orange | 紅 | 3---5 | 黃 |
| 甲基紅 | methyl red | 紅 | 4---6 | 黃 |
| 瑞百里酚藍 | bromthymol blue | 黃 | 6---8 | 藍 |
| 石蕊 | litmus | 紅 | 6---8 | 藍 |
| 酚 | phenolphthalein | (無色) | 8---10 | 紅 |
| 茜素黃 R | alizarine yellow R | 黃 | 10---12 | 紅 |

29. Which of the followings is the right trend for the strength of acids?

a) $HOClO < HOClO_2 < HOClO_3 < HOCl$

a) $HOClO_2 < HOClO_3 < HOCl < HOClO$

b) $HOClO_3 < HOCl < HOClO < HOClO_2$

c) $HOCl < HOClO < HOClO_2 < HOClO_3$

30. Which of the followings is the buffer solution

a = 1.0 L solution (0.50 M NaOH + 0.5 M HCl)

b = 1.0 L solution (0.50 M NaCl + 0.50 M NaOH)

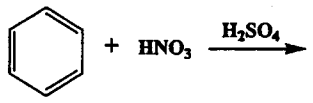
c = 1.0 L solution (0.50 M $NH_4OH$ + 0.5 M $NH_4Cl$)

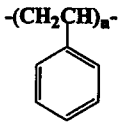
d = 1.0 L solution (0.50 M NaCl + 0.50 M HCl)

(背面仍有題目,請繼續作答)

**II 問答題 (10 分)**

1. Please write the product for the following reaction.




2. What is the monomer for the polystyrene 


3. Mixing 500 mL of 0.20 M $CH_3COOH$solution and 500 mL of 0.20 M $CH_3CO_2Na$ solution, what is the final pH value ? (Ka for $CH_3COOH = 1.8 \times 10^{-5}$)