說明： 1. 試題含(A)二十題選擇題: 1～15 為單選題，每題 3 分（共 45 分）
16～20 為複選題，每題 4 分（共 20 分）
(B)五題填空題，每題 7 分（共 35 分）。
2. 答案請依序寫在試卷上，且必須寫明題號，否則不予計分。
3. 試題共四頁，請隨試卷交回。

$R=8.31\ JK^{-1}mol^{-1}$

一、選擇題：1～15 為單選題

1. In which of the following molecules or ion can the "two-electron three-center bond" be found? (a)CO (b)N_2 (c)O_3 (d)B_2H_6 (e)I_3^-

2. Which of the following oxides is amphoteric? (a)NO_2 (b)Al_2O_3 (c)$B(OH)_3$ (d)MgO (e)none of the above.

3. Which of the following "element symbol; element name" pairs is **incorrect**?
(a)Mg; magnesium (b)Mn; manganese (c) Sn; selenium (d)Sb; antimony
(e)Cu; copper

4. The number of protons, neutrons and electrons in the isotope $^{23}_{11}Na^+$ are p, n and e, respectively. Which of the followings is true?
(a) p=12 and n=11 (b)n=11 and atomic number(Z)=11 (c)p=11 and e=11
(d)n=12 and e=10 (e)atomic number(Z)=11 and e=10.

5. Which of the following nomenclatures is correct?
(a)1,4-butadiene (b)2-ethanol (c)3,3,4-trimethylheptane
(d)1-methyl-3-ethylcyclohexane (e)1,3-fluoro-p-benzene

6. I. 2-methylpentane II. 2,3-dimethylbutane III. Hexane IV. 2-hexanol
The correct trend of the boiling points for the above compounds is:
(a)III > II > IV > I (b)IV > III > I > II (c)IV > III > II > I (d)III > II > I > IV
(e) III > I > II > IV

7. What is the major product obtained from the reaction of $CH_3CH_2CH=CH_2$ and HBr?
(a) $CH_2BrCH_2CH=CH_2$ (b) $CH_3CHBrCH=CH_2$ (c) $CH_3CH_2CBr=CH_2$
(d) $CH_3CH_2CH_2CH_2Br$ (e) $CH_3CH_2CHBrCH_3$

(背面仍有題目,請繼續作答)

8. For the hydrogen atomic spectrum, which of the following transitions emits light having the highest energy?
(a)n=3→n=1 (b) n=4→n=2 (c) n=6→n=2 (d) n=7→n=3 (e) n=9→n=2

9. In the three nuclear reactions given below

I. $^{238}_{92}U + X \rightarrow ^{239}_{92}U$ II. $^{239}_{92}U \rightarrow ^{239}_{93}Np^{+} + Y$ III. $^{9}_{4}Be + Z \rightarrow ^{12}_{6}C + X$,

X, Y and Z are respectively: (a)neutron, electron and α particle. (b)neutron, positron and electron. (c)electron, neutron and α particle. (d) proton, electron and neutron. (e)electron, neutron and α particle.

10. At 500 K, the ratio of the speeds of HF and HCl molecules is dominated by their (a)electric dipole moments (b)bond lengths (c)molar masses (d)molecular sizes (e)all of the above.

11. The number of unpaired electrons in a low-field ^{7}d octahedral ML_6 complex is:
(a) 1 (b) 2 (c) 3 (d) 4 (e) 7

12. A certain nonspontaneous process can become spontaneous if the temperature is increased. Which of the following descriptions relating to the changes of enthalpy and entropy, ΔH and ΔS, for this process is correct?
(a) $\Delta H<0$ and $\Delta S>0$ (b)$\Delta H<0$ and $\Delta S<0$ (c)$\Delta H>0$ and $\Delta S<0$
(d) $\Delta H>0$ and $\Delta S>0$ (e) $\Delta H< \Delta S<0$

13. The isotopes X and Y can be used in dating and radiation therapy, respectively. X and Y are respectively: (a)^{13}C and ^{131}I (b)^{14}C and ^{31}P (c)^{14}C and ^{238}U (d)^{14}C and ^{32}P (e)^{12}C and ^{10}B.

14. How many carbons are contained in decane and heptane, respectively?
(a) 12 and 9 (b) 20 and 9 (c) 12 and 7 (d) 20 and 7 (e) 10 and 7

15. The formula for calcium nitride and sodium azide are respectively
(a)Ca_3N_2 and NaN_3 (b) Ca_3N_2 and NaN_2 (c) Ca_3N_2 and NaCN
(d)Ca_2N_3 and NaCN (e) CaN_2 and Na_3N

以下為複選題，每題至少有兩個答案

16. Which of the following statements are true?
(a)The 3d orbitals can hold up to 10 electrons. (b)The 4g orbitals do not exist. (c)The total number of orbitals in the shell with the principal quantum number n=7 is more than 36 but less than 70. (d)One needs three quantum numbers to describe an electron. (e)The electron configuration for the valence shell are identical for elements in the same main group of the periodic table.

17. Which of the follow statements are true?
(a)The Lewis structures for $BeCl_2$ and $MgCl_2$ are the same. (b)The sp hybrid orbitals of beryllium are used for the bonding in $BeCl_2$. (c)$BeCl_2$ is a linear molecule. (d)$BeCl_2$ is a Lewis acid. (e)$BeCl_2$ is a polar molecule.

18. Which of the following ligands can form linkage isomers?
(a)CN^- (b)SCN^- (c)NO_2^- (d)CO_3^{2-} (e)ethylenediamine (en)

19. In the Lewis structure for H_3PO_3, which of the following descriptions are correct?
(a)There are two O-H bonds. (b)There is one P-H bond. (c)There are two P=O bonds. (d) No atom has formal charge. (e)There are three P-O bonds.

20. The complex ion $[FeCl_4(CO)_2]^-$ is incorrectly named as "dicarbonyltetrachloroironate(II) ion" because of : (a)numbering of ligand (b)naming the ligands (c)naming of the transition metal Fe (d)numbering the oxidation of Fe (e)ordering of the ligands

二、填充題（僅寫出答案即可）

1. In the quantum mechanical treatment of one-dimensional particle in a box, $\Delta E(2\rightarrow3)$ represents the energy required for the n=2→n=3 transition and $\Delta E(1\rightarrow2)$ is that needed for the n=1→n=2 transition.
The ratio of $\Delta E(2\rightarrow3)$ to $\Delta E(1\rightarrow2)$ is _____.

(背面仍有題目,請繼續作答)

2. For a second-order reaction, A→B + C, it takes 3 min. for the concentration of A drops to its original value, $[A]_o$=0.02 $molL^{-1}$.
   (a) The rate constant is _____.(The unit of k must be included.)
   (b)The time required for the concentration of A decreasing from $[A]_o$ to $[A]_o/4$ is _____ min.

3. The value of ΔG^o for a certain reaction is 19500 $Jmol^{-1}$ at 298.15 K. The equilibrium constant for this reaction is _____ . It is found that the equilibrium constant is $2x10^{-3}$ at 398.15 K. The value of ΔH^o is _____ $Jmol^{-1}$.

4. Given

   $Fe^{2+} + 2e^- = Fe$ $\quad E^o = -0.440$ V and
   $Fe^{3+} + e^- = Fe^{2+}$ $\quad E^o = 0.771$ V,

   the value of E^o for the half-cell $Fe^{3+} + 3e^- = Fe$ is _____ V.

5. For a 0.0100 M HF(aq) solution, the pH value is _____.
   The value of K_a for hydrofluoric acid is $7.0x10^{-4}$.