說明：一、請一律以「答案卷」作答，作答時不得使用鉛筆，違者該科答案卷不予計分；限用黑色或藍色墨水的筆書寫。
二、考生應在答案卷上規定範圍內作答，且不得書寫任何與答案無關之文字、符號，違者該科不予計分。
三、答案卷以每人一張為限，不得要求增補；試題與答案卷必須繳回，不得攜出試場。

可使用工程型計算機

第一部份 (請將答案填寫於答案卷表格內)單選題 (60%, 4 % each)

1. The most stable Lewis structure of PF_3 has _____ lone pairs and _____ bonding pairs.
(A) 9, 3　(B) 10, 3　(C) 11, 4　(D) 12, 4　(E) 11, 3

2. Which of the following substances will form **basic** solutions in an aqueous solution? NH_4Cl, $Cu(NO_3)_2$, K_2CO_3, NaF, NaCl?
(A) NaF and NaCl only　(B) NH_4Cl only　(C) K_2CO_3, NH4Cl , NaCl
(D) NH_4Cl, $Cu(NO_3)_2$　(E) NaF and K_2CO_3

3. The aqueous solubility of O_2 44.8 mL per liter. What is the molarity of O_2 in a standard water solution when the O_2 is under its normal partial pressure in air in 0.20 atm?
(A)$1x10^{-4}$M　(B)$2x10^{-4}$M　(C)$3x10^{-4}$M　(D)$4x10^{-4}$M　(E)$5x10^{-4}$M

4. A 2.5 g sample of groundwater was found to contain 5.0 ng of Cr^{6+}, what is the concentration of Cr^{6+}in parts per million? Cr: 52.0 u
(A)2.0 ppm　(B)0.2 ppm　(C)0.02 ppm　(D)0.002 ppm　(E)0.0002 ppm

5. The number of nearest neighbors in a face centered cubic cell of identical atoms is:
(A)4　(B)8　(C)12　(D)16　(E)18

6. Use the Born-Haber cycle to calculate the standard enthalpy of formation (ΔH) for LiCl(s) given the following data:
ΔH(sublimation) Li = 155.2 kJ/mol　I_1 (Li) = 520 kJ/mol
Bond energy (Cl–Cl) = 242.7 kJ/mol　EA (Cl) = 349 kJ/mol　Lattice energy (LiCl(s)) = 828 kJ/mol
(A)440 kJ/mol　(B)220 kJ/mol　(C)380 kJ/mol　(D)-380 kJ/mol　(E)-440 kJ/mol

7. Which of the following reactions is associated with the most positive change in entropy?
(A)$C_{(s,\ graphite)} + H_2O_{(g)} \rightarrow CO_{(g)} + H_{2(g)}$　(B) $2\ CH_{4(g)} + O_{2(g)} \rightarrow 2\ CH_3OH_{(l)}$
(C) $2\ H_2O_{2(l)} + N_2H_{4(l)} \rightarrow N_2(g) + 4\ H_2O_{(g)}$　(D) $2\ CO_{(g)} + O_{2(g)} \rightarrow 2\ CO_{2(g)}$　(E)$N_{2(g)} + O_{2(g)} \rightarrow 2\ NO_{(g)}$

8. A 0.1 L solution is made by dissolving 0.550g of $CaCl_2$ (Mw: 110) in water, and completely dissociated into ion, calculate the osmotic pressure at 300 K?
(A)2.69 atm　(B)3.69 atm　(C)4.69 atm　(D)5.69 atm　(E)6.69 atm

9. A mixture of 8.00g of $O_{2(g)}$ and 8.00 g of $CH_{4(g)}$ is placed in a 15.0L vessel at 27 ^oC, what is the partial pressure of each gas and what is the total pressure in the vessel? ($P_{O2(g)}$, $P_{CH4(g)}$, P_{total})
(A) (0.41, 0.82, 1.23)　(B) (0.82, 1.23, 2.05)　(C) (0.25, 0.25,0.5)　(D) (0.5, 0.5, 1.0)　(E) (0.5, 0.25, 0.75)

10. Which connection is correct (a) the first ionization energy of oxygen, (b) the second ionization energy of oxygen (c) the electron affinity of oxygen?

I: $O_{(g)} + e^- \rightarrow O^-_{(g)}$, II: $O_{(g)} + 2e^- \rightarrow O^{2-}_{(g)}$, III: $O_{(g)} \rightarrow O^+_{(g)} + e^-$, IV: $O_{(g)} \rightarrow O^{2+}_{(g)} + 2e^-$,

V: $O^+_{(g)} + e^- \rightarrow O^{2-}_{(g)}$ VI: $O_{(g)} \rightarrow O^{2+}_{(g)} + 2e^-$ VII: $O^+_{(g)} \rightarrow O^{2+}_{(g)} + e^-$

(A) (a)=III, (b)=VII and (c)= I (B) (a)=IV, (b)=VII and (c)= III (C) (a)=IV, (b)=VII and (c)= II

(D) (a)=III, (b)=II and (c)= I (E) (a)=VI, (b)=V and (c)= I

11. The energy difference between staggered and eclipsed conformations of ethane is 12.0 kJ/mol, propane is 13.6 kJ/mol, what is the C-C bond energy in the eclipsed form in propane?

(A)4.0 kJ/mol (B)8.0 kJ/mol (C)1.6 kJ/mol (D)5.6 kJ/mol (E)none of the above

12. What element contributes to the 2019 Nobel Prize in Chemistry

(A) Li (B) Na (C) Be (D) Mg (E)Al

13. For which of the following reaction does K= Kp at 100 ^oC?

(A) $N_{2(g)}+3H_{2(g)} \rightarrow 2NH_{3(g)}$ (B) $CO_{(g)}+H_2O_{(g)} \rightarrow CO_{2(g)}+H_{2(g)}$ (C) $CaCO_{3(s)} \rightarrow CaO_{(s)}+CO_{2(g)}$

(D)$3Fe_{(s)}+H_2O \rightarrow Fe_3O_{4(g)}+4H_{2(g)}$ (E) $PCl_{5(g)} \rightarrow PCl_{3(g)} + Cl_{2(g)}$

14. [^{18}F]FDG (2-deoxy-2-[^{18}F]fluoroglucose)is used for PET imaging , it decays by_____ and[^{18}F] will yield stable_____

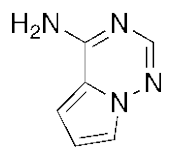
(A) alpha emission, ^{18}F (B) beta emission, ^{19}F (C) positron emission, ^{18}O

(D) photon emission, ^{19}F (E) neutron capture, ^{19}O.

15. Below structure is the precursor of the Remdesivir, an anti-viral drug. Which statements are true?

I. It is an aromatic compound, II. It has 13 σ bond. III. It shows dipole moment.

IV. It has 11 σ bond. V. It contains sp hybridization. V. It contains sp^2 hybridization



(A)Only I and IV. (B) Only II and IV. (C) I, II and III.

(D)I, II, III and V (E)I, II, IV and V

第二部份 非選擇題(請將答案填寫於答案卷表格內) (40 %)

16. Write balanced equations for each of the following processes and fill the missing element or the **missing** sub superscripts for all particles (**6pts)**
    a. **$^{238}_{92}$U decays to generate $^{234}_{90}$Th**
    b. **Electron capture of $^{201}_{80}$Hg to produce $^{201}_{79}$Au**
17. Please draw the **completely** MO energy-level diagram of **N_2**. (**6pts**) and it's molecular electron configuration (**2pts),** HOMO and LUMO of **N_2** (**2pts).** For **N_2^-**, **N_2**, **N_2^+** which has the highest bond energy(**1pts**) and which will show paramagnetism property (**1pts)**
18. Please write the electron configuration of first row transition metal of periodic table (**10 pts**)
19. For **$[Fe(H_2O)_6]^{2+}$** , draw an energy diagram showing *d* orbital splitting, predict the number of unpaired electrons (**6 pts**)
20. Lactic acid ($HC_3H_5O_3$) can be accumulated in muscle tissue during exertion. Please calculate the value of K_a for this acid in a 0.100 M aqueous solution. (lactic acid is 3.7% dissociated in 0.100 M) (**6pts**)