考試科目：綜合化學

系所名稱：生命科學暨生物科技學系碩士班乙組

＊可使用計算器

1.答案以橫式由左至右書寫。2.請依題號順序作答。

PART I：單選題，每題 3 分。(共 60 分)

1. The outside temperature is 35°C, what is the temperature in K?

A) -238 K   B) 308 K   C) 95 K   D) 31 K   E) 63 K

2. Determine the number of protons, neutrons and electrons in the following:

$^{40}_{18}X$

A) $p^+ = 18$ $n° = 18$ $e^- = 22$

B) $p^+ = 18$ $n° = 22$ $e^- = 18$

C) $p^+ = 22$ $n° = 18$ $e^- = 18$

D) $p^+ = 18$ $n° = 22$ $e^- = 40$

E) $p^+ = 40$ $n° = 22$ $e^- = 18$

3. Which one of the following compounds contains ionic bonds?

A) SrO   B) HBr   C) PBr_3 D) SiO_2

4. How many molecules of sucrose ($C_{12}H_{22}O_{11}$, molar mass = 342.30 g/mol) are contained in 14.3 mL of 0.140 M sucrose solution?

A) 8.29×10^{22} molecules $C_{12}H_{22}O_{11}$

B) 1.21×10^{21} molecules $C_{12}H_{22}O_{11}$

C) 6.15×10^{22} molecules $C_{12}H_{22}O_{11}$

D) 1.63×10^{23} molecules $C_{12}H_{22}O_{11}$

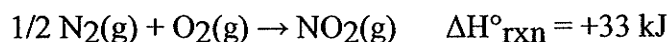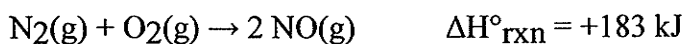E) 5.90×10^{24} molecules $C_{12}H_{22}O_{11}$

5. Determine the density of CO_2 gas at STP.

A) 1.96 g/L   B) 1.80 g/L   C) 2.24 g/L   D) 4.46 g/L   E) 5.10 g/L

6. Use the standard reaction enthalpies given below to determine $\Delta H°_{rxn}$ for the following reaction:

$2 NO(g) + O_2(g) \rightarrow 2 NO_2(g)$ $\Delta H°_{rxn} = $?

Given:

$N_2(g) + O_2(g) \rightarrow 2 NO(g)$ $\Delta H°_{rxn} = +183$ kJ

$1/2 N_2(g) + O_2(g) \rightarrow NO_2(g)$ $\Delta H°_{rxn} = +33$ kJ

A) -150. kJ   B) -117 kJ   C) -333 kJ   D) +115 kJ   E) +238 kJ

7. Which of the following transitions (in a hydrogen atom) represent absorption of the smallest frequency photon?

A) $n = 5$ to $n = 6$ B) $n = 5$ to $n = 3$ C) $n = 2$ to $n = 1$ D) $n = 1$ to $n = 3$

E) $n = 1$ to $n = 2$

8. Give the ground state electron configuration for Mg^{2+}.

A) $1s^2 2s^2 2p^6 3s^2$

B) $1s^2 2s^2 2p^6$

C) $1s^2 2s^2 2p^6 3s^2 3p^2$

D) $1s^2 2s^2 2p^6 3s^2 3p^6$

E) $1s^2 2s^2 2p^6 3s^1$

9. Identify the compound with the highest magnitude of lattice energy.

A) $MgCl_2$ B) $BaCl_2$ C) $SrCl_2$ D) $CsCl_2$

10. Using the VSEPR model, the molecular geometry of the central atom in CF_4 is _____.

A) linear   B) trigonal planar   C) tetrahedral   D) bent   E) trigonal pyramidal

11. How much energy is required to vaporize 158 g of butane (C_4H_{10}) at its boiling point, if its ΔH_{vap} is 24.3 kJ/mol?

A) 15.1 kJ   B) 66.1 kJ   C) 41.9 kJ   D) 2.60 kJ   E) 38.4 kJ

12. Calculate the boiling point of a solution of 500.0 g of ethylene glycol ($C_2H_6O_2$) dissolved in 500.0 g of water. $K_f = 1.86°C/m$ and $K_b = 0.512°C/m$. Use 100°C as the boiling point of water.

A) 108°C   B) 92°C   C) 130°C   D) 70°C   E) 8.3°C

13. What are the units of k in the following rate law?

$$Rate = k[X][Y]^2$$

A) $\dfrac{1}{M\,s^2}$ B) $\dfrac{1}{M^2\,s}$ C) $M^2\,s$ D) $\dfrac{M^2}{s}$ E) $\dfrac{1}{M^3\,s}$

14. The following reaction is exothermic.   Which change will shift the equilibrium to the left?

$$2\,SO_2(g) + O_2(g) \rightleftharpoons 2\,SO_3(g)$$
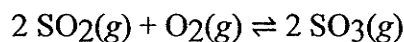
A) raising the temperature
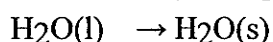
B) adding argon

C) decrease volume

D) all of the above

E) none of the above

15. Which of the following bases is the strongest? The base is followed by its K_b.

A) $(CH_3CH_2)_2NH$, 8.6×10^{-4} B) CH_3NH_2, 4.4×10^{-4}

C) $C_6H_5NH_2$, 4.0×10^{-10} D) NH_3, 1.76×10^{-5}

E) C_5H_5N, 1.7×10^{-9}

16. Determine the molar solubility of BaF_2 in pure water. K_{sp} for $BaF_2 = 2.45 \times 10^{-5}$.

A) 1.83×10^{-2} M   B) 1.23×10^{-5} M   C) 2.90×10^{-2} M

D) 4.95×10^{-3} M   E) 6.13×10^{-6} M

17. For the following example, identify the following.

$$H_2O(l) \rightarrow H_2O(s)$$

A) a negative ΔH and a negative ΔS

B) a positive ΔH and a negative ΔS

C) a negative ΔH and a positive ΔS

D) a positive ΔH and a positive ΔS

E) It is not possible to determine without more information.

18. Identify the characteristics of a spontaneous reaction.

A) $\Delta G° < 0$

B) $\Delta E°_{cell} > 0$

C) $K > 1$

D) all of the above

E) none of the above

19. Which of the following reactions would be the most spontaneous at 298 K?

A) $A + 2 B \rightarrow C$; $E°_{cell} = +0.98$ V

B) $A + B \rightarrow 2 C$; $E°_{cell} = -0.030$ V

C) $A + B \rightarrow 3 C$; $E°_{cell} = +0.15$ V

D) $A + B \rightarrow C$; $E°_{cell} = +1.22$ V

E) More information is needed to determine.

20. Which of the following describes a primary protein structure?

A) protein structure maintained by disulfide linkages

B) amino acid sequence maintained by peptide bonds

C) protein chains maintained by interactions of peptide backbones

D) arrangement of multiple protein subunits

E) protein structure maintained through multiple hydrogen bonds

PART II：簡答題及計算題，每題 10 分。(共 40 分)

1. Use the molecular orbital diagram shown to determine which of the following are paramagnetic. A) O_2^{2-}　　B) Ne_2^{2+}　　C) O_2^{2+}　　D) F_2^{2+}
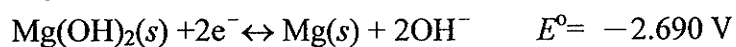
2. (A) Please detail describes the following equation for a spontaneous reaction.

$$G = H_{sys} - T\ S_{sys}$$

   (B) Determine the equilibrium constant for the following reaction at 298 K.

   $Cl(g) + O_3(g) \rightarrow ClO(g) + O_2(g)$　　$\Delta G° = -34.5$ kJ
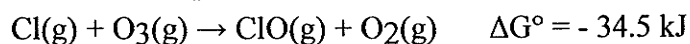
3.　From the following half-reactions, calculate the solubility product constant of $Mg(OH)_2$.

$Mg^{2+} + 2e^- \leftrightarrow Mg(s)$　　　　　　　$E° = -2.360$ V

$Mg(OH)_2(s) + 2e^- \leftrightarrow Mg(s) + 2OH^-$　　$E° = -2.690$ V

4.　Please describe the structures and functions of lipids and proteins in living cells as you know.