※ 注意：請於答案卷內之「選擇題作答區」依序作答。

1-20 為單選題(每題 5 分；總計 100 分；答錯不倒扣)

1. Which of the following pairs of compounds can be used to illustrate the law of multiple proportions?
A) NH_3 and NCl_3
B) ZnO and $ZnCl_2$
C) H_2O and HI
D) NO and NO_2
E) CH_4 and CO_2

2. *Compound X_2Y is 60% X by mass.* Calculate the percent Y by mass of the compound X_2Y_2.
A) 20%
B) 30%
C) 40%
D) 60%
E) 80%

3. Which pair of ions would *not* be expected to form a precipitate when dilute solutions of each are *mixed*?
A) Cu^{2+}, S^{2-}
B) Ag^{+}, Cl^{-}
C) Ca^{2+}, PO_4^{3-}
D) Mn^{2+}, OH^{-}
E) Mg^{2+}, SO_4^{2-}

4. For which gas do the molecules have the smallest average kinetic energy?
A) *He*
B) Cl_2
C) CH_4
D) NH_3
E) The molecules of all the gases have the same average kinetic energy.

5. Consider the reaction
$$CaCl_2(s) + 2H_2O(g) \rightleftharpoons CaCl_2 \cdot 2H_2O(s)$$
What is the equilibrium constant for the reaction as written?
A) $K = \dfrac{[CaCl_2?\ H_2O]}{[CaCl_2]\,[H_2O]^2}$
B) $K = \dfrac{1}{[H_2O]^2}$
C) $K = \dfrac{1}{[CaCl_2]\,[H_2O]^2}$
D) $K = [H_2O]^2$
E) $K = \dfrac{[CaCl_2?\ H_2O]}{[H_2O]^2}$

6. To increase the value of K for the exothermic reaction
$$2H_2(g) + O_2(g) \rightleftharpoons H_2O(g)$$
we should
A) increase the total pressure.
B) decrease the total pressure.
C) increase the temperature.
D) decrease the temperature.
E) Two of these are necessary.

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7. Which of the following is a conjugate acid-base pair?
   A) HCl/OCl_3^-
   B) H_3PO_4/PO_4^{3-}
   C) NH_4^+/NH_3
   D) H_3O^+/OH^-
   E) $Ca^{2+}/Ca(OH)_2$

8. Calculate $[H^+]$ in a solution that is 0.34 *M* in NaF and 0.58 *M* in HF. ($K_a = 7.2 \times 10^{-4}$)
   A) 0.58 *M*
   B) 4.2×10^{-4} *M*
   C) 1.2×10^{-3} *M*
   D) 2.0×10^{-2} *M*
   E) 1.1×10^{-4} *M*

9. Which of the following are state functions?
   A) work, heat
   B) work, heat, enthalpy, energy
   C) enthalpy, energy
   D) work, heat, enthalpy
   E) heat, enthalpy, energy

10. Calculate ΔG for the isothermal compression of 1 mol of an ideal monatomic gas from 1.4 atm to 5.6 atm at 23°C.
   A) 3.4×10^3 J
   B) 1.6×10^3 J
   C) -3.4×10^3 J
   D) -1.6×10^3 J
   E) 5.1×10^3 J

11. How many electrons are transferred in the following reaction?
   $2Cr_2O_7^{2-} + 14H^+ + 6Cl^- \rightarrow 2Cr^{3+} + 3Cl_2 + 7H_2O$
   A) 2
   B) 4
   C) 6
   D) 8
   E) none of these

12. What is the probability of finding a particle in a one-dimensional box in energy level $n = 4$ between $x = L/4$ and $x = L/2$? (*L* is the length of the box.)
   A) 12.5%
   B) 25%
   C) 33%
   D) 37.5%
   E) 50%

13. How many electrons in an atom can have the quantum numbers $n = 3$, $l = 1$?
   A) 10
   B) 2
   C) 6
   D) 18
   E) 32

14. Which element listed below has the highest electronegativity?
   A) K
   B) Rb
   C) Br
   D) Te
   E) I

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15. The configuration $(\sigma_{2s})^2(\sigma_{2s}^*)^2(\pi_{2py})^1(\pi_{2px})^1$ is the molecular orbital description for the ground state of which of the following species?
A) Li_2^+
B) Be_2
C) B_2
D) B_2^{2-}
E) C_2

16. Initial rate data have been determined at a certain temperature for the gaseous reaction
$2NO + 2H_2 \rightarrow N_2 + 2H_2O$

$[NO]_0$ (*M*)	$[H_2]_0$ (*M*)	Initial Rate (*M*/s)
0.16	0.32	0.0200
0.16	0.48	0.0300
0.32	0.32	0.0800

What is the numerical value of the rate constant?
A) 2.4
B) 7.6
C) 0.39
D) 1.2
E) 0.13

17. A metal crystallizes with a face-centered cubic lattice. The edge of the unit cell is 434 pm. What is the diameter of the metal atom?
A) 376 pm
B) 217 pm
C) 307 pm
D) 434 pm
E) 614 pm

18. Rank the following compounds according to increasing solubility in water.
I. $CH_3–CH_2–CH_2–CH_3$
II. $CH_3–CH_2–O–CH_2–CH_3$
III. $CH_3–CH_2–OH$
IV. $CH_3–OH$

A) I < III < IV < II
B) I < II < IV < III
C) III < IV < II < I
D) I < II < III < IV
E) None is correct.

19. Which of the metal ions in the following complex ions has a d^5 electron configuration?
A) $[V(H_2O)_6]^{2+}$
B) $[Ni(NH_3)_6]^{3+}$
C) $[Co(CN)_6]^{3-}$
D) $[Fe(CN)_6]^{3-}$
E) $[FeCl_6]^{4-}$

20. When $^{238}_{93}Np$ undergoes β emission, what are the products?
A) $^{238}_{92}U + \beta$
B) $^{238}_{94}Pu + \beta$
C) $^{238}_{92}U + \beta$
D) $^{234}_{91}Pa + He$
E) $^{238}_{94}Np + \beta$

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