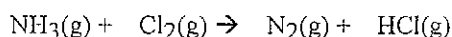


『普通化學』（化生系），單選題 25 題，每題 4 分，總分 100 分

- Which one of the following statements about atomic structure is false?
  - The electrons occupy a very large volume compared to the nucleus.
  - Almost all of the mass of the atom is concentrated in the nucleus.
  - The protons and neutrons in the nucleus are very tightly packed.
  - The number of protons and neutrons is always the same in the neutral atom.
  - All of these statements (a-d) are true.
- One commercial system removes  $\text{SO}_2$  emissions from smoke at  $95.0^\circ\text{C}$  by the following set of balanced reactions:
$$\text{SO}_2(\text{g}) + \text{Cl}_2 \rightarrow \text{SO}_2\text{Cl}_2(\text{g})$$
$$\text{SO}_2\text{Cl}_2 + 2\text{H}_2\text{O} \rightarrow \text{H}_2\text{SO}_4 + 2\text{HCl}$$
$$\text{H}_2\text{SO}_4 + \text{Ca}(\text{OH})_2 \rightarrow \text{CaSO}_4(\text{s}) + 2\text{H}_2\text{O}$$
Assuming the process is 95.0% efficient, how many grams of  $\text{CaSO}_4$  may be produced from  $1.00 \times 10^2$  grams of  $\text{SO}_2$  (molar masses:  $\text{SO}_2$ , 64.1 g/mol;  $\text{CaSO}_4$ , 136 g/mol)?
  - 44.8 g
  - 47.1 g
  - 87.2 g
  - 202 g
  - 212 g
- You heat 3.970 g of a mixture of  $\text{Fe}_3\text{O}_4$  and  $\text{FeO}$  to form 4.195 g  $\text{Fe}_2\text{O}_3$ . The mass of oxygen reacted is (molar mass: Fe, 55.847 g/mol)
  - 0.225 g.
  - 0.475 g.
  - 1.00 g.
  - cannot be determined
  - none of these
- When the following reaction is balanced in acidic solution, what is the coefficient of  $\text{I}_2$ ?
$$\text{IO}_3^- + \text{I}^- \rightarrow \text{I}_2$$
  - 1
  - 2
  - 3
  - 4
  - none of these
- Given the unbalanced reaction
$$\text{MnO}_4^- + \text{H}_2\text{O}_2 + \text{H}^+ \rightarrow \text{Mn}^{2+} + \text{H}_2\text{O} + \text{O}_2$$
determine the number of electrons involved in this reaction.
  - 10
  - 8
  - 6
  - 4
  - 2

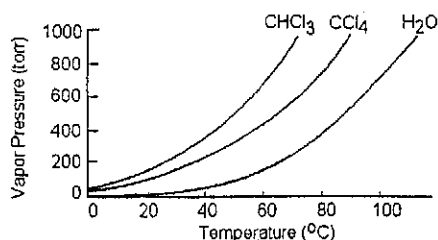
6. A mixture is prepared from 15.0 L of ammonia and 15.0 L chlorine measured at the same conditions, these compounds react according to the following unbalanced equation:



When the reaction is completed, what is the volume of each gas ( $\text{NH}_3$ ,  $\text{Cl}_2$ ,  $\text{N}_2$ , and  $\text{HCl}$ , respectively)? Assume the final volumes are measured under identical conditions.

- a) 0.00 L, 5.00 L, 7.50 L, 45.0 L  
b) 5.00 L, 0.00 L, 5.00 L, 30.0 L  
c) 0.00 L, 0.00 L, 7.50 L, 45.0 L  
d) 0.00 L, 0.00 L, 5.00 L, 30.0 L  
e) 0.00 L, 10.0 L, 15.0 L, 90.0 L
7. Calculate the ratio of the effusion rates of  $\text{N}_2$  and  $\text{N}_2\text{O}$ .  
a) 0.637      b) 1.57      c) 1.25      d) 0.798      e) 1.61
8. Using the information below, calculate  $\Delta H_f^\circ$  for  $\text{PbO}(\text{s})$   
 $\text{PbO}(\text{s}) + \text{CO}(\text{g}) \rightarrow \text{Pb}(\text{s}) + \text{CO}_2(\text{g}) \quad \Delta H = -131.4 \text{ kJ}$   
 $\Delta H_f^\circ$  for  $\text{CO}_2(\text{g}) = -393.5 \text{ kJ/mol}$   
 $\Delta H_f^\circ$  for  $\text{CO}(\text{g}) = -110.5 \text{ kJ/mol}$   
a)  $-151.6 \text{ kJ/mol}$     b)  $-283.0 \text{ kJ/mol}$       c)  $+283.0 \text{ kJ/mol}$   
d)  $-372.6 \text{ kJ/mol}$     e)  $+252.1 \text{ kJ/mol}$
9. Which statements about hydrogen are true?  
I. H has a lower ionization energy than He.  
II.  $\text{H}^-$  is smaller than H.  
III. H bonds with the halogens to form polar covalent compounds.  
IV. H is always a metal.  
V. H does not have a second ionization energy.  
a) I, V    b) II, IV    c) I, III, V    d) II, IV, V    e) I, III, IV, V
10. As indicated by Lewis structures, which of the following species could probably not exist as a stable molecule?  
a)  $\text{NH}_3$     b)  $\text{N}_2\text{H}_2$     c)  $\text{N}_2\text{H}_4$     d)  $\text{N}_2\text{H}_6$     e)  $\text{N}_2\text{O}_4$
11. What type of structure does the  $\text{XeOF}_2$  molecule have?  
a) pyramidal      b) tetrahedral      c) T-shaped  
d) trigonal planar    e) octahedral

12. Which of the following statements about the species  $\text{CN}^-$  is false?
- a) It is paramagnetic.                      b) The total number of electrons is 14.  
c) It has two  $\pi$  bonds.                      d) All of these are true.
13. Consider the molecular orbital description of the  $\text{NO}^-$  anion. Which of the following statements is false?
- a)  $\text{NO}^-$  is paramagnetic.  
b)  $\text{NO}^-$  is isoelectronic with CO.  
c) The bond energy in  $\text{NO}^+$  is greater than the bond energy in  $\text{NO}^-$ .  
d) The bond order in  $\text{NO}^-$  is 2.  
e) Statements a through d are false.



14. Given the graph above, what is the boiling point of carbon tetrachloride at standard pressure?
- a) 60° C    b) 34°C    c) 98°C    d) 77°C  
e) graph does not give that information
15. The freezing point ( $T_f$ ) for t-butanol is 25.50°C and  $K_f$  is 9.1°C/m. Usually t-butanol absorbs water on exposure to the air. If the freezing point of a 10.0-g sample t-butanol is measured as 24.59°C, how many grams of water are present in the sample?
- a) 0.10 g    b) 0.018 g    c) 10 g    d) 1.8 g    e) 18. g
16. The reaction  $2\text{NO}_2 \rightarrow 2\text{NO} + \text{O}_2$  obeys the rate law
- $$\frac{\Delta[\text{O}_2]}{\Delta t} = 1.40 \times 10^{-2} [\text{NO}_2]^2 \text{ at } 500. \text{ K.}$$
- If the initial concentration of  $\text{NO}_2$  is 1.00 M, how long will it take for the  $[\text{NO}_2]$  to decrease to 25.0% of its initial value?
- a) 49.5 s    b) 71.4 s    c) 214 s    d)  $1.40 \times 10^{-2}$  s  
e) cannot be determined from this data

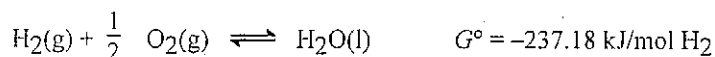
17. For a reaction in which A and B react to form C; the following initial rate data were obtained:

| [A]<br>(mol/L) | [B]<br>(mol/L) | Initial Rate of Formation of C<br>(mol/L·s) |
|----------------|----------------|---|
| 0.10           | 0.10           | 1.00  |
| 0.10           | 0.20           | 4.00  |
| 0.20           | 0.20           | 8.00  |

What is the rate law for the reaction?

- a) Rate =  $k[A][B]$       b) Rate =  $k[A]^2[B]$       c) Rate =  $k[A][B]^2$   
d) Rate =  $k[A]^2[B]^2$       e) Rate =  $k[A]^3$
18. Equilibrium is reached in chemical reactions when:
- a) the rates of the forward and reverse reactions become equal.  
b) the concentrations of reactants and products become equal.  
c) the temperature shows a sharp rise.  
d) all chemical reactions stop.  
e) the forward reaction stops.
19. For a certain reaction at 25.0°C, the value of  $K$  is  $1.2 \times 10^{-3}$ . At 50.0°C the value of  $K$  is  $3.4 \times 10^{-1}$ . This means that the reaction is
- a) exothermic.  
b) endothermic.  
c) never favorable.  
d) More information is needed.  
e) None of these (a-d)
20. Which of the following is true about the pH of a solution of sulfuric acid?
- a) If the solution is dilute the pH is not able to be calculated.  
b) If the solution is dilute the pH is completely controlled by the first dissociation.  
c) If the solution is dilute the pH is completely controlled by the second dissociation.  
d) If the solution is concentrated the pH is partially controlled by the second dissociation.  
e) If the solution is dilute the pH is partially controlled by the second dissociation.
21. In the titration of a weak acid HA with 0.100 M NaOH the stoichiometric point is known to occur at a pH value of approximately 10. Which of the following indicator acids would be best to use to mark the endpoint of this titration?
- a) indicator A,  $K_a = 10^{-14}$       b) indicator B,  $K_a = 10^{-11}$       c) indicator C,  $K_a = 10^{-8}$   
d) indicator D,  $K_a = 10^{-6}$       e) none of these

22. You have a 250.0-mL sample of 1.00 M acetic acid ( $K_a = 1.8 \times 10^{-5}$ ). Assuming no volume change, how much NaOH must be added to make the best buffer? (atomic mass: Na, 22.99)
- a) 5.0 g   b) 10.0 g   c) 15.0 g   d) 20.0 g   e) none of these
23. In which of the following changes is the work done by the system the largest at 25°C?
- a) an isothermal free expansion of an ideal gas from 1 to 10 liters  
b) an isothermal expansion of an ideal gas from 1 to 10 liters against an opposing pressure of 1 atm  
c) an isothermal expansion of an ideal gas from 1 to 10 liters against an opposing pressure of 5 atm  
d) an isothermal reversible expansion of an ideal gas from 1 to 10 liters  
e) the work is the same for processes a–d
24. Consider the hydrogen–oxygen fuel cell where



Which of the following statements is true?

- a) At standard conditions, the maximum work the fuel cell could do on the surroundings is 237.18 kJ/mol.  
b) In the real world, the actual amount of useful work the cell can do is less than 237.18 kJ.  
c) More energy is dissipated as waste heat in the fuel cell than in the reversible pathway.  
d) a, b, and c are all true.  
e) a, b, and c are all false.
25. Which of the following statements is true about the octahedral complexes of  $\text{Ni}^{2+}$ ?
- a) Both strong- and weak-field complexes are diamagnetic.  
b) The strong-field complex is diamagnetic and the weak-field complex is paramagnetic.  
c) The strong-field complex is paramagnetic and the weak-field complex is diamagnetic.  
d) Both strong- and weak-field complexes are paramagnetic.