Chemistry

Higher level

Paper 1A

Practice paper

Topic: Thermodynamics

1. Which set of enthalpy changes are all endothermic?
   A. Formation, Ionization, Neutralization
   B. Atomization, Second Electron Affinity, Lattice Dissociation
   C. Fusion, Condensation, First Electron Affinity
   D. Solution, Hydration, Vaporization

2. Which ion has the most exothermic enthalpy of hydration?
   A. Li^+
   B. Na^+
   C. Be^{2+}
   D. Mg^{2+}

3. Which combination of ΔH and ΔS will result in a reaction that is spontaneous only at temperatures above 500 K?
   A. ΔH = +100 kJ, ΔS = +200 J $K^{-}1$
   B. ΔH = +100 kJ, ΔS = -200 J $K^{-}1$
   C. ΔH = -100 kJ, ΔS = +200 J $K^{-}1$
   D. ΔH = -100 kJ, ΔS = -200 J $K^{-}1$

4. The standard entropy of elements in their stable state at 298 K is:
   A. Always zero.
   B. Always positive.
   C. Always negative.
   D. Zero for gases but positive for solids.

5. Which compound would you expect to have the highest lattice enthalpy of dissociation?
   A. NaCl
   B. KCl
   C. $MgCl_2$
   D. MgO

6. In a Born-Haber cycle for NaCl, which step corresponds to the process: $Cl(g) + e^- \rightarrow Cl^-(g)$?
   A. Lattice enthalpy
   B. Enthalpy of atomization
   C. Electron affinity
   D. Enthalpy of formation

7. For the process $H_2O(l) \rightarrow H_2O(g)$ at 100 degrees C, which statement is true?
A. $\Delta G^{\ominus}$ is positive.
B. $\Delta G^{\ominus}$ is negative.
C. $\Delta G^{\ominus}$ is zero.
D. $\Delta G^{\ominus}$ depends on the volume of the container.

8. Which of the following result in an increase in entropy?
I. $2NO_2(g) \rightarrow N_2O_4(g)$
II. $NH_4Cl(s) \rightarrow NH_3(g) + HCl(g)$
III. Boiling ethanol
A. I and II only
B. I and III only
C. II and III only
D. I, II and III

9. Theoretical lattice enthalpy assumes a purely ionic model. A large difference between theoretical and experimental lattice enthalpy suggests:
A. The compound is highly soluble in water.
B. The bonding has significant covalent character.
C. The ionic radii are very small.
D. The compound has a low melting point.

10. What is the sign of $\Delta G^{\ominus}$ for a reaction with a very large equilibrium constant (K >> 1)?
A. Strongly positive
B. Strongly negative
C. Zero
D. Depends on the units of K

11. Which processes are endothermic?
I. Second ionization energy of Mg
II. First electron affinity of oxygen
III. Second electron affinity of oxygen
A. I and II only
B. I and III only
C. II and III only
D. I, II and III

12. Which ion has the smallest enthalpy of hydration?
A. F^-
B. Cl^-

C. Br^-
D. I^-

13. Given standard entropy values: $S^\ominus(H_2)$ = 131, $S^\ominus(I_2)$ = 117, $S^\ominus(HI)$ = 206 J K^{-1} mol^{-1}. What is $\Delta S^\ominus$ for $H_2(g) + I_2(g) \rightarrow 2HI(g)$?
A. +164
B. -164
C. +42
D. -42

14. A reaction is spontaneous at all temperatures. What must be true?
A. $\Delta H < 0, \Delta S > 0$
B. $\Delta H > 0, \Delta S < 0$
C. $\Delta H < 0, \Delta S < 0$
D. $\Delta H > 0, \Delta S > 0$

15. Which statement about lattice energy is correct?
I. It increases as ionic charges increase.
II. It decreases as ionic radii increase.
III. It is always a negative value for the formation of a solid from gaseous ions.
A. I and II only
B. I and III only
C. II and III only
D. I, II and III

16. Which value is the standard Gibbs free energy of formation for an element in its standard state?
A. 0 $kJ\ mol^{-1}$
B. 100 $kJ\ mol^{-1}$
C. -298 $kJ\ mol^{-1}$
D. It varies with pressure.

17. For the reaction: $N_2(g) + O_2(g) \rightarrow 2NO(g)$, ΔH = +181 kJ. What can be deduced about the spontaneity at 298 K?
A. Spontaneous, because entropy increases.
B. Non-spontaneous, because it is endothermic and entropy change is small.
C. Spontaneous, because it is a gas-phase reaction.
D. Non-spontaneous, because NO is a radical.

18. Which combination represents the most stable ionic lattice?
A. Small highly charged cations and small highly charged anions.
B. Large lowly charged cations and large lowly charged anions.
C. Small lowly charged cations and large highly charged anions.
D. Large highly charged cations and small lowly charged anions.

19. Which thermodynamic quantity is related to the strength of electrostatic attraction between ions in a crystal?
A. Enthalpy of atomization
B. Enthalpy of hydration
C. Lattice enthalpy
D. Electron affinity

20. Which of the following reactions shows a decrease in entropy?
A. $C(s) + O_2(g) \rightarrow CO_2(g)$
B. $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$
C. $2H_2O(l) \rightarrow 2H_2(g) + O_2(g)$
D. $NaCl(s) \rightarrow Na^+(aq) + Cl^-(aq)$

21. The relationship $\Delta G^{\ominus} = -RT \ln K$ involves which units for R?
A. 8.31 J K^{-1} mol^{-1}
B. 0.0821 L atm K^{-1} mol^{-1}
C. 62.4 L mmHg K^{-1} mol^{-1}
D. 1.98 cal K^{-1} mol^{-1}

22. Which step in a Born-Haber cycle involves the largest energy absorbence for group 2 metals?
A. Enthalpy of atomization
B. First ionization energy
C. Second ionization energy
D. Bond enthalpy of the halogen

23. Which state has the highest entropy?
A. 1 mol of ice at 273 K
B. 1 mol of water at 273 K
C. 1 mol of water at 373 K
D. 1 mol of steam at 373 K

24. Which enthalpy change corresponds to: $M^+(g) + aq \rightarrow M^+(aq)$?
A. Enthalpy of solution

B. Enthalpy of hydration
C. Enthalpy of formation
D. Lattice enthalpy

25. A reaction has $\Delta G^{\ominus} = -50$ kJ. If the temperature is increased:
A. The reaction must become non-spontaneous.
B. The reaction becomes more spontaneous if ΔS is positive.
C. The equilibrium constant K must decrease.
D. The reaction rate must decrease.

26. Which of the following have $\Delta H^{\ominus}_f = 0$ at 298 K?
I. $O_2(g)$
II. C(diamond)
III. Hg(l)
A. I and II only
B. I and III only
C. II and III only
D. I, II and III

27. What is the entropy change for a perfectly ordered crystal at 0 K?
A. 0 $J K^{-1} mol^{-1}$
B. 1.0 $J K^{-1} mol^{-1}$
C. Infinity
D. It depends on the number of atoms.

28. Which of the following is true for the enthalpy of solution of a very soluble salt?
A. It must be very exothermic.
B. It must be very endothermic.
C. It can be exothermic or endothermic as long as ΔG is negative.
D. It must be zero.

29. Which factor increases the entropy of a gas at constant volume?
A. Decreasing the temperature
B. Adding more moles of gas
C. Increasing the pressure by adding an inert gas
D. Condensing the gas

30. Which is the correct order of decreasing lattice enthalpy?
A. LiF > LiCl > LiBr > LiI
B. LiI > LiBr > LiCl > LiF

C. $NaCl > MgCl_2 > AlCl_3$
D. $KCl > NaCl > LiCl$