Exam Three

1. In the presence of a strong octahedral ligand field, the number of unpaired electrons in Co(III) will be

A. 0 B. 2 C. 4 D. 6 E. None of these choices is correct.

2. According to Valence Bond theory, in the square planar $Ni(CN)_4^{2-}$ complex ion, the orbital hybridization pattern is:

A. sp^3 B. dsp^2 C. d^2sp D. d^2sp^3 E. None of these choices is correct.

3. Which of the following ions is most likely to form colored compounds?

A. Sc^{3+} B. Cu^+ C. Zn^{2+} D. Cr^{3+} E. Ca^{2+}

4. The main end use of sulfuric acid is

A. manufacture of iron and steel B. processing of petroleum C. production of fertilizers
D. production of explosives E. production of various other chemicals

5. Which of the following will be paramagnetic?

A. V^{5+} B. Ni^{2+} C. Mn^{7+} D. Ti^{4+} E. Zn

6. Which of the following ions could exist in either the high-spin or low-spin state in an octahedral complex?

A. Sc^{3+} B. Ni^{2+} C. Mn^{2+} D. Ti^{4+} E. Zn^{2+}

7. The ground state electronic configuration of Cr^{2+} is:

A. $[Ar]4s^13d^5$ B. $[Ar]4s^23d^4$ C. $[Ar]3d^4$ D. $[Ar]4s^13d^3$ E. $[Ar]4s^23d^2$

8. Write the formula for sodium tetracyanonickelate(II).

A. $Na[Ni(CN)_4]$ B. $Na[Ni(CN)_4]_2$ C. $Na_2[Ni(CN)_4]$ D. $Na_4[Ni(CN)_4]$
E. None of these choices is correct.

9. Which of the following transition elements can have an oxidation number of +7?

A. V B. Cr C. Mn D. Fe E. Co

10. Calcium oxide is added to molten iron in the production of carbon steel in order to

A. convert silicon and phosphorus oxides to slag which can be decanted from the molten steel.
B. serve as a scrubber to remove sulfur dioxide from the gases leaving the furnace.
C. remove any traces of acid which could weaken the steel.
D. add a small amount of oxygen to the steel to prevent corrosion and increase its strength.
E. create gangue.

11. Chromium and manganese are among the transition elements that form several different oxides. Which of the following statements characterize these oxides?

A. As the oxidation number on the metal increases, the valence-state electronegativity increases and the oxides change from acidic to basic.

B. As the oxidation number on the metal increases, the valence-state electronegativity increases and the oxides change from basic to acidic.

C. As the oxidation number on the metal increases, the valence-state electronegativity decreases and the oxides change from acidic to basic.

D. As the oxidation number on the metal increases, the valence-state electronegativity decreases and the oxides change from basic to acidic.

E. None of these choices is correct.

12. The process that selectively extracts a metal from its ore, by dissolving it, is called

A. roasting. B. leaching. C. smelting. D. flotation. E. hydration.

13. The process of converting metal sulfides to metal oxides is called

A. roasting. B. smelting. C. reduction. D. leaching. E. oxidation.

14. Which one of the following normally acts as a bidentate ligand in complexes with transition metal ions?

A. CN^- B. $EDTA^{4-}$ C. SCN^- D. ethylene diamine E. ethylene, C_2H_4

15. A certain transition element has the stable oxidation states of +2, +3, +4, +5, and +6. In which state will the element be most likely to form an ionic bond with chlorine?

A. +2 B. +3 C. +4 D. +5 E. +6

16. Which of the following ions could exist in only the high-spin state in an octahedral complex?

A. Cr^{2+} B. Mn^{4+} C. Fe^{3+} D. Co^{3+} E. Ni^{2+}

17. The crystal field splitting energy, Δ,

A. is larger for tetrahedral complexes than for octahedral complexes.

B. depends on the metal but not on the ligand.

C. determines the color of a complex.

D. is larger for ionic ligands like chloride than for molecular ligands like carbon monoxide, CO.

E. determines the charge of a complex.

18. The main effect of the biosphere on the chemistry of the earth's crust has been to

A. create a reducing atmosphere. B. create an oxidizing atmosphere.

C. increase the relative humidity. D. decrease the relative humidity.

E. increase the level of atmospheric carbon dioxide.

19. Which of the following octahedral complexes should have the largest crystal field splitting energy, Δ?

A. $[Cr(H_2O)_6]^{3+}$ B. $[Cr(SCN)_6]^{3-}$ C. $[Cr(NH_3)_6]^{3+}$ D. $[Cr(CN)_6]^{3-}$

E. $[Cr(en)_3]^{3+}$ (en = ethylenediamine)

20. Which of the following elements has the ground state electron configuration, $[Xe]4f^{14}5d^{10}6s^1$?

A. Hg B. Ag C. Hf D. Au E. Th

21. Which of the following is considered a bidentate ligand?

A. cyanide, CN^- B. thiocyanate, SCN^- C. oxalate, $C_2O_4^{2-}$ D. nitrite, NO_2^- E. hydroxide, OH^-

22. What elements are alloyed to make stainless steel?

A. Fe and C B. Fe and Mn C. Fe and Ni D. Fe and Ni E. Fe, Cr and Ni

23. The d_{xy} and the $d_{x^2-y^2}$ orbitals both lie in the xy plane, yet for a metal ion in an octahedral complex the energy of the d_{xy} orbital is lower than that of the $d_{x^2-y^2}$ orbital. Explain this using the arguments of crystal field theory.

24. Why is the +2 oxidation state so common among transition elements?

25. a. How can the formation of a complex ion be described in terms of a theory of acids and bases?

b. What is the essential requirement for a molecule or ion to act as a ligand?

Exam Three Key

1. (p. 1053) A

2. (p. 1047) B

3. (p. 1029) D

4. (p. 1014) C

5. (p. 1029) B

6. (p. 1053) C

7. (p. 1028) C

8. (p. 1040) C

9. (p. 1028) C

10. (p. 1001) A

11. (p. 1029) B

12. (p. 994) B

13. (p. 994) A

14. (p. 1039) D

15. (p. 1029) A

16. (p. 1053) B

17. (p. Sec. 23.5) C

18. (p. 983) B

19. (p. 1051) D

20. (p. 1024) D

21. (p. 1039) C

22. (p. 997) E

23. (p. 1049) The d_{xy} orbital lobes are directed between the x and y axes, whereas the $d_{x^2-y^2}$ orbital lobes point along these axes. Thus, four ligands with their lone pairs, approaching the central atom along the + and - directions of the x and y axes will interact more strongly (repulsively) with electrons in the $d_{x^2-y^2}$ orbital, raising it in energy above that of the d_{xy} orbital.
Difficulty: H

24. (p. 1028) The outermost (ns^2) electrons are easily lost, producing the +2 oxidation state.
Difficulty: E

25. (p. 1039) a. According to Lewis, in an acid-base reaction, the acid accepts an electron pair from a base. Thus, in the formation of a metal-ligand complex, the metal is an acid and the ligand is a base.
b. A ligand must have a lone pair of electrons available to donate in forming a bond with the metal.
Difficulty: M

Exam Three Summary

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