1. Given the balanced equation representing a reaction:

   $2Al(s) + 3Cu^{2+}(aq) \rightarrow 2Al^{3+}(aq) + 3Cu(s)$

   Which particles are transferred in this reaction?

   A) electrons B) neutrons
   C) positrons D) protons

2. In an oxidation-reduction reaction, the number of electrons lost is

   A) equal to the number of electrons gained
   B) equal to the number of protons gained
   C) less than the number of electrons gained
   D) less than the number of protons gained

3. In which type of chemical reaction are electrons transferred?

   A) organic addition
   B) oxidation-reduction
   C) double replacement
   D) acid-base neutralization

4. An oxidation-reduction reaction involves the

   A) sharing of electrons
   B) sharing of protons
   C) transfer of electrons
   D) transfer of protons

5. In a redox reaction, the total number of electrons lost is

   A) less than the total number of electrons gained
   B) greater than the total number of electrons gained
   C) equal to the total number of electrons gained
   D) equal to the total number of protons gained

6. Half-reactions can be written to represent all

   A) double-replacement reactions
   B) neutralization reactions
   C) fission and fusion reactions
   D) oxidation and reduction reactions

7. Given the balanced ionic equation:

   $2Al(s) + 3Cu^{2+}(aq) \rightarrow 2Al^{3+}(aq) + 3Cu(s)$
   Compared to the total charge of the reactants. the total charge of the products is

   A) less B) greater
   C) the same

8. Which change in oxidation number indicates oxidation?

   A) –1 to +2 B) –1 to –2
   C) +2 to –3 D) +3 to +2

9. Which changes occur when Pt^{2+} is reduced?

   A) The Pt^{2+} gains electrons and its oxidation number increases.
   B) The Pt^{2+} gains electrons and its oxidation number decreases.
   C) The Pt^{2+} loses electrons and its oxidation number increases.
   D) The Pt^{2+} loses electrons and its oxidation number decreases.

10. Which half-reaction correctly represents reduction?

    A) $Mn^{4+} \rightarrow Mn^{3+} + e^-$
    B) $Mn^{4+} \rightarrow Mn^{7+} + 3e^-$
    C) $Mn^{4+} + e^- \rightarrow Mn^{3+}$
    D) $Mn^{4+} + 3e^- \rightarrow Mn^{7+}$

11. During which process does an atom gain one or more electrons?

    A) transmutation B) reduction
    C) oxidation D) neutralization

12. The chemical process in which electrons are gained by an atom or an ion is called

    A) addition B) oxidation
    C) reduction D) substitution

13. In an oxidation-reduction reaction, reduction is defined as the

    A) loss of protons B) gain of protons
    C) loss of electrons D) gain of electrons

14. Given the balanced ionic equation:

$$Zn(s) + Cu^{2+}(aq) \rightarrow Zn^{2+}(aq) + Cu(s)$$

Which equation represents the oxidation half-reaction?

A) $Zn(s) + 2e^- \rightarrow Zn^{2+}(aq)$
B) $Zn(s) \rightarrow Zn^{2+}(aq) + 2e^-$
C) $Cu^{2+}(aq) \rightarrow Cu(s) + 2e^-$
D) $Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$

15. When a neutral atom undergoes oxidation, the atom's oxidation state

A) decreases as it gains electrons
B) decreases as it loses electrons
C) increases as it gains electrons
D) increases as it loses electrons

16. When a lithium atom forms an Li^+ ion, the lithium atom

A) gains a proton
B) gains an electron
C) loses a proton
D) loses an electron

17. Which type of reaction occurs when nonmetal atoms become negative nonmetal ions?

A) oxidation
B) reduction
C) substitution
D) condensation

18. In a redox reaction, how does the total number of electrons lost by the oxidized substance compare to the total number of electrons gained by the reduced substance?

A) The number lost is always greater than the number gained.
B) The number lost is always equal to the number gained.
C) The number lost is sometimes equal to the number gained.
D) The number lost is sometimes less than the number gained.

19. As a Ca atom undergoes oxidation to Ca^{2+}, the number of neutrons in its nucleus

A) decreases
B) increases
C) remains the same

20. In any redox reaction, the substance that undergoes reduction will

A) lose electrons and have a decrease in oxidation number
B) lose electrons and have an increase in oxidation number
C) gain electrons and have a decrease in oxidation number
D) gain electrons and have an increase in oxidation number

21. Which particles are gained and lost during a redox reaction?

A) electrons
B) protons
C) neutrons
D) positrons

22. Given the reaction:

$Mg(s) + 2\ H^+(aq) + 2\ Cl^-(aq) \rightarrow Mg^{2+}(aq) + 2\ Cl^-(aq) + H_2(g)$
Which species undergoes oxidation?

A) $Mg(s)$
B) $H^+(aq)$
C) $Cl^-(aq)$
D) $H_2(g)$

23. In any redox reaction, a reactant can undergo a decrease in oxidation number by

A) losing electrons, only
B) gaining electrons, only
C) losing protons, only
D) gaining protons, only

24. In a redox reaction, there is a conservation of

A) mass, only
B) charge, only
C) both mass and charge
D) neither mass nor charge

25. Given the lead-acid battery reaction:

$$Pb + PbO_2 + 2\ H_2SO_4 \rightarrow 2\ PbSO_4 + 2\ H_2O$$

Which electronic equation represents the half-reaction for the oxidation that occurs?

A) $Pb \rightarrow Pb^{2+} + 2\ e^-$
B) $Pb^{4+} + 4\ e^- \rightarrow Pb$
C) $Pb^{2+} + 2\ e^- \rightarrow Pb$
D) $Pb \rightarrow Pb^{4+} + 4\ e^-$

26. As an atom of nitrogen gains electrons, its oxidation number

A) decreases B) increases
C) remains the same

27. Given the reaction:

$$Zn(s) + 2HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$$

The oxidation number of Zn(*s*) increases because it

A) loses electrons B) gains electrons
C) loses protons D) gains protons

28. In the reaction

$$2\ Na + Cl_2 \rightarrow 2\ Na^+ + 2\ Cl^-,$$

what species is oxidized?

A) Na B) Cl_2 C) Na^+ D) Cl^-

29. Given the reaction:

$$3\ Ag + Au^{3+} \rightarrow 3\ Ag^+ + Au$$

Which equation correctly represents the oxidation half-reaction?

A) $3Ag + 3e^- \rightarrow 3Ag^+$
B) $3Ag \rightarrow 3Ag^+ + 3e^-$
C) $Au^{3+} + 3e^- \rightarrow Au$
D) $Au^{3+} \rightarrow Au + 3e^-$

30. In the reaction

$$2\ Fe^{3+} + S^{2-} \rightarrow 2\ Fe^{2+} + S^0,$$

the species oxidized is

A) Fe^{3+} B) S^{2-} C) Fe^{2+} D) S^0

31. Which half-reaction correctly represents reduction?

A) $S^{2-} + 2e^- \rightarrow S^0$
B) $S^{2-} \rightarrow S^0 + 2e^-$
C) $Mn^{7+} + 3e^- \rightarrow Mn^{4+}$
D) $Mn^{7+} \rightarrow Mn^{4+} + 3e^-$

32. Given the reaction:

$$2\ Fe^{3+} + Sn^{2+} \rightarrow 2\ Fe^{2+} + Sn^{4+}$$

Which species is reduced?

A) Fe^{3+} B) Sn^{2+} C) Fe^{2+} D) Sn^{4+}

33. Which oxidation number change could occur during an oxidation of an element?

A) +1 to –1 B) –2 to –3
C) +3 to + 1 D) +2 to +3

34. Which half-reaction correctly represents reduction?

A) $Sn^{2+} + 2e^- \rightarrow Sn^{4+}$
B) $Sn^{2+} \rightarrow Sn^{4+} + 2e^-$
C) $Sn^{2+} + 2e^- \rightarrow Sn^0$
D) $Sn^{2+} \rightarrow Sn^0 + 2e^-$

35. In the reaction

$$Zn + Cu^{2+} \rightarrow Zn^{2+} + Cu,$$

the Cu^{2+}

A) gains protons B) loses electrons
C) is reduced D) is oxidized

36. In the reaction

$$Co^0 + Cu^{2+} \rightarrow Co^{2+} + Cu^0,$$

which specie is reduced?

A) Co^0 B) Cu^0 C) Co^{2+} D) Cu^{2+}

37. In the half-cell reaction, $Ba^0 \rightarrow Ba^{2+} + 2e^-$, which is true of the barium atom?

A) It gains protons. B) It loses protons.
C) It gains electrons. D) It loses electrons.

38. Which half-reaction correctly represents reduction?

A) $Cr^3 + 3e^- \rightarrow Cr(s)$
B) $Cr^{3+} \rightarrow Cr(s) + 3e^-$
C) $Cr(s) \rightarrow Cr^{3+} + 3e^-$
D) $Cr(s) + 3e^- \rightarrow Cr^{3+}$

39. Which change occurs when an Sn^{2+} ion is oxidized?

A) Two electrons are lost.
B) Two electrons are gained.
C) Two protons are lost.
D) Two protons are gained.

40. Which half-reaction correctly represents a reduction reaction?

A) $Sn^0 + 2e^- \rightarrow Sn^{2+}$
B) $Na^0 + e^- \rightarrow Na^+$
C) $Li^0 + e^- \rightarrow Li^+$
D) $Br_2{}^0 + 2e^- \rightarrow 2\ Br^-$