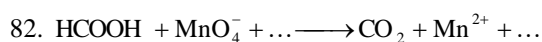
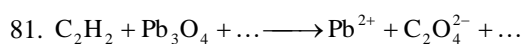
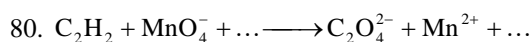


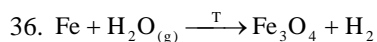
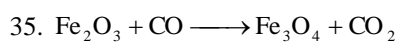
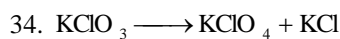
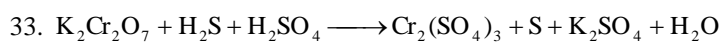
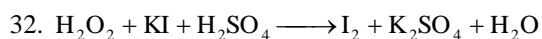
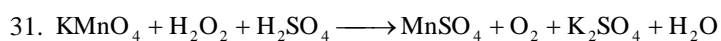
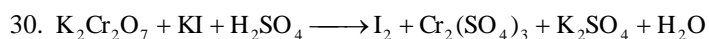
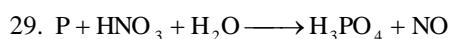
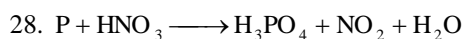
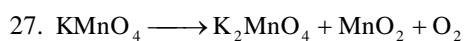
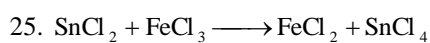
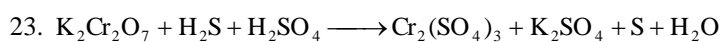
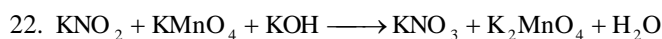
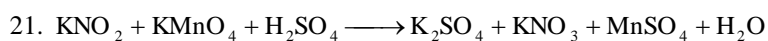
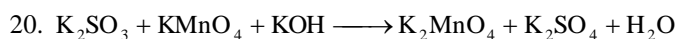
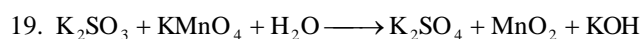
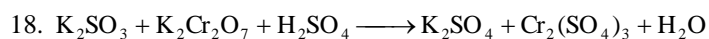
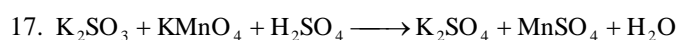
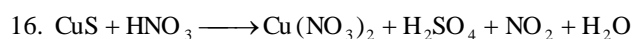
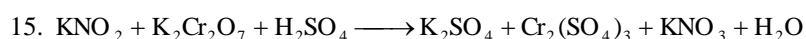
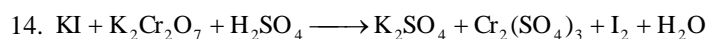
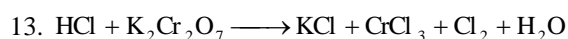
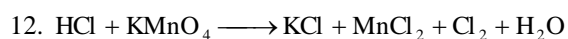
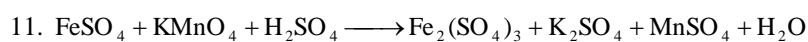
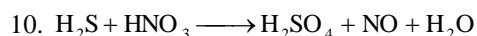
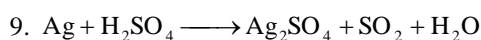
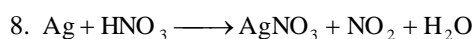
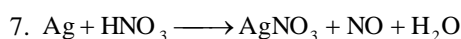
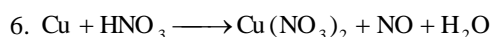
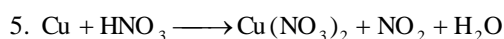
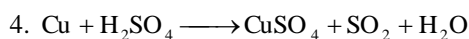
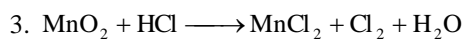
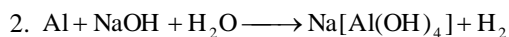
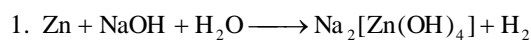
1. Dokończyć i zbilansować nie dokończone równania reakcji redoks w postaci jonowej skróconej:

1. $\text{AuCl}_4^- + \text{Fe}^{2+} \longrightarrow \text{Au} + \text{Fe}^{3+} + \text{Cl}^-$
2. $\text{Sn}^{2+} + \text{Fe}^{3+} \longrightarrow \text{Sn}^{4+} + \text{Fe}^{2+}$
3. $\text{Sn}^{2+} + \text{Hg}^{2+} \longrightarrow \text{Sn}^{4+} + \text{Hg}_2^{2+}$
4. $\text{Fe}(\text{CN})_6^{4-} + \text{I}_2 \longrightarrow \text{Fe}(\text{CN})_6^{3-} + \text{I}^-$
5. $\text{Fe}^{3+} + \text{I}^- \longrightarrow \text{I}_2 + \text{Fe}^{2+}$
6. $\text{Cr}_2\text{O}_7^{2-} + \text{Fe}^{2+} + \dots \longrightarrow \text{Cr}^{3+} + \text{Fe}^{3+} + \dots$
7. $\text{Zn} + \text{OH}^- + \text{H}_2\text{O} \longrightarrow [\text{Zn}(\text{OH})_4]^{2-} + \text{H}_2$
8. $\text{Cu} + \text{SO}_4^{2-} + \dots \longrightarrow \text{Cu}^{2+} + \text{SO}_2 + \dots$
9. $\text{Al} + \text{OH}^- + \text{H}_2\text{O} \longrightarrow [\text{Al}(\text{OH})_4]^- + \text{H}_2$
10. $\text{Cu} + \text{NO}_3^- + \dots \longrightarrow \text{Cu}^{2+} + \text{NO}_2 + \dots$
11. $\text{ClO}_3^- + \text{AsO}_3^{3-} \longrightarrow \text{Cl}^- + \text{AsO}_4^{3-}$
12. $\text{Cu} + \text{NO}_3^- + \dots \longrightarrow \text{Cu}^{2+} + \text{NO} + \dots$
13. $\text{Ag} + \text{NO}_3^- + \dots \longrightarrow \text{Ag}^+ + \text{NO}_2 + \dots$
14. $\text{Ag} + \text{NO}_3^- + \dots \longrightarrow \text{Ag}^+ + \text{NO} + \dots$
15. $\text{Zn} + \text{SO}_4^{2-} + \dots \longrightarrow \text{Zn}^{2+} + \text{S}^{2-} + \dots$
16. $\text{Cr}_2\text{O}_7^{2-} + \text{S}^{2-} + \dots \longrightarrow \text{Cr}^{3+} + \text{S} + \dots$
17. $\text{CuS} + \text{NO}_3^- + \dots \longrightarrow \text{Cu}^{2+} + \text{S} + \text{NO} + \dots$
18. $\text{Cr}_2\text{O}_7^{2-} + \text{I}^- + \dots \longrightarrow \text{Cr}^{3+} + \text{I}_2 + \dots$
19. $\text{Cr}^{3+} + \text{Cl}_2 + \dots \longrightarrow \text{CrO}_4^{2-} + \text{Cl}^- + \dots$
20. $\text{S} + \text{NO}_3^- + \dots \longrightarrow \text{SO}_2 + \text{NO}_2 + \dots$
21. $\text{Pb}_3\text{O}_4 + \text{Fe}^{2+} + \dots \longrightarrow \text{Pb}^{2+} + \text{Fe}^{3+} + \dots$
22. $\text{Pb}_3\text{O}_4 + \text{Cl}^- + \dots \longrightarrow \text{Pb}^{2+} + \text{Cl}_2 + \dots$
23. $\text{U}_3\text{O}_8 + \text{NO}_3^- + \dots \longrightarrow \text{UO}_2^{2+} + \text{NO} + \dots$
24. $\text{S}_2\text{O}_3^{2-} + \text{I}_2 \longrightarrow \text{S}_4\text{O}_6^{2-} + \text{I}^-$
25. $\text{S}_2\text{O}_3^{2-} + \text{Cl}_2 + \dots \longrightarrow \text{SO}_4^{2-} + \text{Cl}^- + \dots$
26. $\text{S}_2\text{O}_3^{2-} + \text{ClO}_3^- + \dots \longrightarrow \text{SO}_4^{2-} + \text{Cl}^- + \dots$
27. $\text{S}_4\text{O}_6^{2-} + \text{MnO}_4^- + \dots \longrightarrow \text{SO}_4^{2-} + \text{MnO}_2 + \dots$
28. $\text{S}_2\text{O}_3^{2-} + \text{Br}_2 + \text{H}_2\text{O} \longrightarrow \text{SO}_4^{2-} + \text{Br}^- + \text{H}^+$
29. $\text{S}_4\text{O}_6^{2-} + \text{Cl}_2 + \dots \longrightarrow \text{SO}_4^{2-} + \text{Cl}^- + \dots$
30. $\text{Fe}(\text{CN})_6^{3-} + \text{H}_2\text{O}_2 + \dots \longrightarrow \text{Fe}(\text{CN})_6^{4-} + \text{O}_2$
31. $\text{Fe}(\text{CN})_6^{4-} + \text{H}_2\text{O}_2 + \dots \longrightarrow \text{Fe}(\text{CN})_6^{3-} + \text{H}_2\text{O}$
32. $\text{As}_2\text{S}_3 + \text{ClO}_3^- + \dots \longrightarrow \text{As}^{3+} + \text{Cl}^- + \text{SO}_4^{2-}$
33. $\text{As}_2\text{S}_3 + \text{NO}_3^- + \dots \longrightarrow \text{AsO}_4^{3-} + \text{SO}_4^{2-} + \text{NO}_2 + \dots$
34. $\text{Fe}(\text{CN})_6^{4-} + \text{MnO}_4^- + \dots \longrightarrow \text{Fe}(\text{CN})_6^{3-} + \text{Mn}^{2+} + \dots$
35. $\text{MnO}_4^- + \text{H}_2\text{O}_2 + \dots \longrightarrow \text{Mn}^{2+} + \text{O}_2 + \dots$
36. $\text{Co}^{2+} + \text{NO}_2^- + \dots \longrightarrow \text{Co}(\text{NO}_2)_6^{3-} + \text{NO} + \dots$
37. $\text{Co}(\text{CN})_6^{4-} + \text{O}_2 + \text{H}_2\text{O} \longrightarrow \text{Co}(\text{CN})_6^{3-} + \text{OH}^-$
38. $\text{Al} + \text{NO}_2^- + \text{OH}^- + \text{H}_2\text{O} \longrightarrow \text{NH}_3 + \text{Al}(\text{OH})_4^-$
39. $\text{MnO}_4^- + \text{CN}^- + \text{H}_2\text{O} \longrightarrow \text{MnO}_2 + (\text{CN})_2 + \text{OH}^-$

40. $\text{Bi}_2\text{S}_3 + \text{NO}_3^- + \text{H}^+ \longrightarrow \text{Bi}^{3+} + \text{NO} + \text{S} + \text{H}_2\text{O}$
41. $\text{Cr}(\text{OH})_4^- + \text{H}_2\text{O}_2 + \dots \longrightarrow \text{CrO}_4^{2-} + \text{H}_2\text{O}$
42. $\text{Ag}_2\text{S} + \text{NO}_3^- + \dots \longrightarrow \text{Ag}^+ + \text{S} + \text{NO} + \dots$
43. $\text{Cu}^{2+} + \text{I}^- \longrightarrow \text{CuI} + \text{I}_2$
44. $\text{N}_2\text{H}_4 + \text{NO}_3^- + \dots \longrightarrow \text{NO}_2^- + \dots$
45. $\text{S} + \text{SO}_4^{2-} + \dots \longrightarrow \text{SO}_3^{2-} + \dots$
46. $\text{Mn}^{2+} + \text{MnO}_4^- + \dots \longrightarrow \text{MnO}_2 + \dots$
47. $\text{NH}_4^+ + \text{NO}_2^- \longrightarrow \text{N}_2 + \dots$
48. $\text{I}_2 + \dots \longrightarrow \text{I}^- + \text{IO}_3^- + \dots$
49. $\text{Cl}_2 + \dots \longrightarrow \text{Cl}^- + \text{ClO}_3^- + \dots$
50. $\text{Cl}_2\text{O}_6 + \dots \longrightarrow \text{ClO}_3^- + \text{ClO}_4^- + \dots$
51. $\text{BrO}_3^- + \text{Br}^- + \dots \longrightarrow \text{Br}_2 + \dots$
52. $\text{NO}_2^- + \dots \longrightarrow \text{NO}_3^- + \text{NO} + \dots$
53. $\text{N}_2\text{O}_4 + \dots \longrightarrow \text{NO}_2^- + \text{NO}_3^- + \dots$
54. $\text{SCN}^- + \text{NO}_3^- + \dots \longrightarrow \text{CO}_2 + \text{SO}_4^{2-} + \text{NO} + \dots$
55. $\text{As}_2\text{S}_3 + \text{NO}_3^- + \dots \longrightarrow \text{AsO}_4^{3-} + \text{SO}_4^{2-} + \text{NO}_2 + \dots$
56. $\text{SCN}^- + \text{I}_2 + \dots \longrightarrow \text{SO}_4^{2-} + \text{I}^- + \text{CN}^- + \dots$
57. $\text{SCN}^- + \text{IO}_3^- + \dots \longrightarrow \text{CN}^- + \text{SO}_4^{2-} + \text{I}^- + \dots$
58. $\text{SCN}^- + \text{MnO}_4^- + \dots \longrightarrow \text{CN}^- + \text{SO}_4^{2-} + \text{Mn}^{2+} + \dots$
59. $\text{Cu}_2\text{S} + \text{NO}_3^- + \dots \longrightarrow \text{Cu}^{2+} + \text{SO}_4^{2-} + \text{NO}_2 + \dots$
60. $\text{FeAsS} + \text{NO}_3^- + \dots \longrightarrow \text{Fe}^{3+} + \text{SO}_4^{2-} + \text{AsO}_4^{3-} + \text{NO}_2 + \dots$
61. $\text{FeCuS}_2 + \text{NO}_3^- + \dots \longrightarrow \text{Fe}^{3+} + \text{Cu}^{2+} + \text{SO}_4^{2-} + \text{NO} + \dots$
62. $\text{FeS}_2 + \text{NO}_3^- + \dots \longrightarrow \text{Fe}^{3+} + \text{SO}_4^{2-} + \text{NO} + \dots$
63. $\text{As}_2\text{S}_3 + \text{MnO}_4^- + \dots \longrightarrow \text{AsO}_4^{3-} + \text{SO}_4^{2-} + \text{Mn}^{2+} + \dots$
64. $\text{C}_6\text{H}_4\text{O}_2^{2-} + \text{I}_2 \longrightarrow \text{C}_6\text{H}_4\text{O}_2 + \text{I}^-$
65. $\text{MnO}_4^- + \text{C}_2\text{O}_4^{2-} + \dots \longrightarrow \text{Mn}^{2+} + \text{CO}_2 + \dots$
66. $\text{C}_6\text{H}_5\text{NO}_2 + \text{Sn}^{2+} + \dots \longrightarrow \text{Sn}^{4+} + \text{C}_6\text{H}_5\text{NH}_2 + \dots$
67. $\text{C}_6\text{H}_2(\text{NO}_2)_3\text{OH} + \text{Ti}^{3+} + \dots \longrightarrow \text{Ti}^{4+} + \text{C}_6\text{H}_2(\text{NH}_2)_3\text{OH} + \dots$
68. $\text{C}_6\text{H}_5\text{NO}_2 + \text{S}^{2-} + \dots \longrightarrow \text{C}_6\text{H}_5\text{NH}_2 + \text{S} + \dots$
69. $\text{C}_6\text{H}_4(\text{OH})_2 + \text{I}_2 + \dots \longrightarrow \text{C}_6\text{H}_4\text{O}_2 + \text{I}^- + \dots$
70. $\text{C}_3\text{H}_7\text{OH} + \text{CrO}_4^{2-} + \dots \longrightarrow \text{C}_2\text{H}_5\text{CHO} + \text{Cr}^{3+} + \dots$
71. $\text{C}_6\text{H}_4(\text{OH})_2 + \text{Cr}_2\text{O}_7^{2-} + \dots \longrightarrow \text{C}_6\text{H}_4\text{O}_2 + \text{Cr}^{3+} + \dots$
72. $\text{CO}(\text{NH}_2)_2 + \text{NO}_2^- + \dots \longrightarrow \text{N}_2 + \text{CO}_2 + \dots$
73. $\text{CO}(\text{NH}_2)_2 + \text{BrO}^- \longrightarrow \text{CO}_2 + \text{N}_2 + \text{Br}^- + \dots$
74. $\text{CS}(\text{NH}_2)_2 + \text{NO}_2^- \longrightarrow \text{CNS}^- + \text{N}_2 + \dots$
75. $\text{PtCl}_6^{2-} + \text{C}_3\text{H}_5(\text{OH})_3 + \dots \longrightarrow \text{CO}_2 + \text{C}_2\text{O}_4^{2-} + \text{Pt} + \text{Cl}^- + \dots$
76. $\text{PtCl}_6^{2-} + \text{HCOO}^- + \dots \longrightarrow \text{Pt} + \text{CO}_2 + \text{Cl}^- + \text{H}_2\text{O}$
77. $\text{CH}_3\text{CH}(\text{OH})\text{CH}_3 + \text{MnO}_4^- + \dots \longrightarrow \text{CH}_3\text{COCH}_3 + \text{Mn}^{2+} + \dots$
78. $\text{C}_2\text{H}_5\text{OH} + \text{Cr}_2\text{O}_7^{2-} + \dots \longrightarrow \text{CH}_3\text{COOH} + \text{Cr}^{3+} + \dots$
79. $\text{CH}_3\text{CHO} + \text{MnO}_4^- + \dots \longrightarrow \text{CH}_3\text{COOH} + \text{Mn}^{2+} + \dots$



2. Zbilansować równania reakcji redoks w postaci cząsteczkowej:

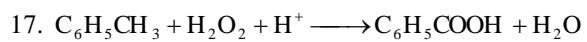
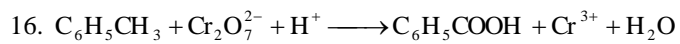
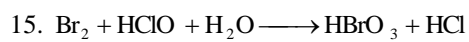
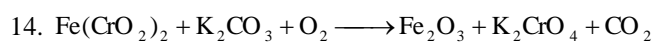
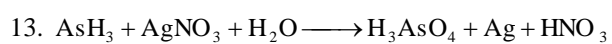
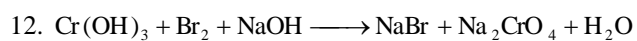
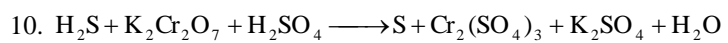


37. $(\text{NH}_4)_2\text{Cr}_2\text{O}_7 \longrightarrow \text{Cr}_2\text{O}_3 + \text{N}_2 + \text{H}_2\text{O}$
38. $\text{As}_2\text{S}_3 + \text{KNO}_3 + \text{H}_2\text{SO}_4 \longrightarrow \text{NO}_2 + \text{K}_2\text{SO}_4 + \text{K}_3\text{AsO}_4 + \text{H}_2\text{O}$
39. $\text{Cu}_2\text{S} + \text{KNO}_3 + \text{H}_2\text{SO}_4 \longrightarrow \text{CuSO}_4 + \text{K}_2\text{SO}_4 + \text{NO} + \text{H}_2\text{O}$
40. $\text{Cl}_2 + \text{KOH} \longrightarrow \text{KCl} + \text{KClO}_3 + \text{H}_2\text{O}$
41. $\text{Br}_2 + \text{KOH} \longrightarrow \text{KBr} + \text{KBrO}_3 + \text{H}_2\text{O}$
42. $\text{N}_2\text{O}_4 + \text{H}_2\text{O} \longrightarrow \text{HNO}_3 + \text{HNO}_2$
43. $\text{NH}_4\text{NO}_2 \longrightarrow \text{N}_2 + \text{H}_2\text{O}$
44. $\text{CH}_3\text{CH}_2\text{OH} + \text{K}_2\text{Cr}_2\text{O}_7 + \text{H}_2\text{SO}_4 \longrightarrow \text{CH}_3\text{COOH} + \text{Cr}_2(\text{SO}_4)_3 + \text{K}_2\text{SO}_4 + \text{H}_2\text{O}$
45. $\text{C}_3\text{H}_7\text{OH} + \text{KMnO}_4 + \text{H}_2\text{SO}_4 \longrightarrow \text{C}_2\text{H}_5\text{COOH} + \text{MnSO}_4 + \text{K}_2\text{SO}_4 + \text{H}_2\text{O}$
46. $\text{C}_2\text{H}_4 + \text{KMnO}_4 + \text{H}_2\text{O} \longrightarrow \text{C}_2\text{H}_4(\text{OH})_2 + \text{MnO}_2 + \text{KOH}$
47. $\text{C}_3\text{H}_6 + \text{KMnO}_4 + \text{H}_2\text{O} \longrightarrow \text{C}_3\text{H}_8\text{O}_2 + \text{MnO}_2 + \text{KOH}$
48. $\text{CH}_3\text{CH}(\text{OH})\text{CH}_3 + \text{K}_2\text{Cr}_2\text{O}_7 + \text{H}_2\text{SO}_4 \longrightarrow \text{CH}_3\text{COCH}_3 + \text{K}_2\text{SO}_4 + \text{Cr}_2(\text{SO}_4)_3 + \text{H}_2\text{O}$
49. $\text{C}_6\text{H}_5\text{CHO} + \text{Cu}(\text{OH})_2 \longrightarrow \text{Cu}_2\text{O} + \text{C}_6\text{H}_5\text{COOH} + \text{H}_2\text{O}$
50. $\text{HCHO} + [\text{Ag}(\text{NH}_3)_2]\text{OH} \longrightarrow \text{HCOOH} + \text{Ag} + \text{NH}_3 + \text{H}_2\text{O}$
51. $\text{MnO}_2 + \text{H}_2\text{C}_2\text{O}_4 + \text{H}_2\text{SO}_4 \longrightarrow \text{MnSO}_4 + \text{CO}_2 + \text{H}_2\text{O}$
52. $\text{C}_6\text{H}_5\text{NO}_2 + \text{Zn} + \text{HCl} \longrightarrow \text{C}_6\text{H}_5\text{NH}_2 + \text{ZnCl}_2 + \text{H}_2\text{O}$
53. $\text{HCHO} + \text{KMnO}_4 + \text{H}_2\text{SO}_4 \longrightarrow \text{HCOOH} + \text{MnSO}_4 + \text{K}_2\text{SO}_4 + \text{H}_2\text{O}$
54. $\text{HCOOH} + \text{KMnO}_4 + \text{H}_2\text{SO}_4 \longrightarrow \text{CO}_2 + \text{MnSO}_4 + \text{K}_2\text{SO}_4 + \text{H}_2\text{O}$
55. $\text{C}_6\text{H}_5\text{OH} + \text{Br}_2 \longrightarrow \text{C}_6\text{H}_2\text{Br}_3\text{OH} + \text{HBr}$
56. $\text{KIO}_3 + \text{KI} + \text{H}_2\text{SO}_4 \longrightarrow \text{I}_2 + \text{K}_2\text{SO}_4 + \text{H}_2\text{O}$
57. $\text{KI} + \text{Br}_2 + \text{H}_2\text{O} \longrightarrow \text{KIO}_3 + \text{HBr}$

3. Uzupełnić podane poniżej schematy równań. Wstawić w miejsce znaków zapytania brakujące reagenty, a następnie dobrać współczynniki stechiometryczne w tak uzyskanym równaniu reakcji:

1. $\text{Fe}^{2+} + \text{Cr}_2\text{O}_7^{2-} + ? \longrightarrow \text{Cr}^{3+} + ? + ?$
2. $\text{MnO}_4^- + \text{NO}_2^- + \text{H}^+ \longrightarrow \text{NO}_3^- + ? + ?$
3. $\text{MnO}_4^- + \text{NO}_2^- + \text{H}_2\text{O} \longrightarrow \text{NO}_3^- + ? + ?$
4. $\text{MnO}_4^- + \text{NO}_2^- + \text{OH}^- \longrightarrow \text{NO}_3^- + ? + ?$
5. $\text{Cr}_2\text{O}_7^{2-} + ? \longrightarrow \text{Cr}^{3+} + ? + ?$
6. $\text{FeSO}_4 + \text{K}_2\text{Cr}_2\text{O}_7 + \text{H}_2\text{SO}_4 \longrightarrow \text{Cr}_2(\text{SO}_4)_3 + ? + ? + ?$
7. $\text{K}_2\text{SO}_3 + \text{KMnO}_4 + ? \longrightarrow \text{MnSO}_4 + ? + ?$
8. $\text{KI} + ? + \text{H}_2\text{SO}_4 \longrightarrow \text{I}_2 + \text{MnSO}_4 + ? + ?$
9. $\text{PbS} + ? \longrightarrow \text{Pb}(\text{NO}_3)_2 + \text{S} + ? + \text{H}_2\text{O}$
10. $\text{SO}_2 + \text{HNO}_3 + ? \longrightarrow \text{H}_2\text{SO}_4 + \text{NO}$
11. $\text{FeSO}_4 + \text{K}_2\text{Cr}_2\text{O}_7 + ? \longrightarrow \text{Fe}_2(\text{SO}_4)_3 + ? + ? + \text{H}_2\text{O}$
12. $\text{Cu}_2\text{S} + \text{HNO}_3 \longrightarrow \text{S} + ? + ? + \text{H}_2\text{O}$
13. $\text{As}_2\text{S}_3 + \text{HNO}_3 + ? \longrightarrow \text{H}_3\text{AsO}_4 + ? + \text{NO}$
14. $\text{Cu} + ? \longrightarrow \text{Cu}(\text{NO}_3)_2 + \text{NO} + ?$
15. $\text{Cu} + \text{HNO}_3 \longrightarrow ? + \text{NO}_2 + ?$
16. $\text{Zn} + \text{HNO}_3 \longrightarrow \text{NH}_4\text{NO}_3 + ? + \text{H}_2\text{O}$
17. $\text{KMnO}_4 + \text{HCl} \longrightarrow \text{Cl}_2 + ? + ? + \text{H}_2\text{O}$
18. $\text{K}_2\text{Cr}_2\text{O}_7 + \text{NaCl} + \text{H}_2\text{SO}_4 \longrightarrow \text{Cl}_2 + ? + ? + ? + \text{H}_2\text{O}$

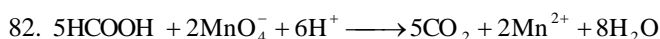
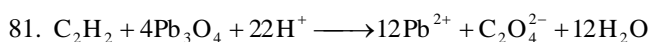
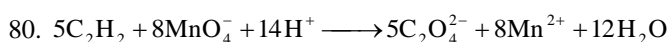
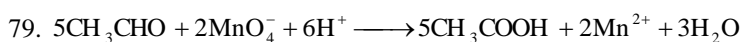
19. $C_2H_4 + KMnO_4 + H_2O \longrightarrow C_2H_4(OH)_2 + ? + ?$
 20. $C_2H_5OH + K_2Cr_2O_7 + H_2SO_4 \longrightarrow CH_3COOH + ? + ? + H_2O$
 21. $Zn + OH^- + ? \longrightarrow [Zn(OH)_4]^- + ?$
 22. $Al + OH^- + ? \longrightarrow [Al(OH)_4]^- + ?$
 23. $Mn(OH)_2 + Cl_2 + KOH \longrightarrow MnO_2 + ? + ?$
 24. $NaAsO_2 + I_2 + ? \longrightarrow Na_3AsO_4 + ? + ?$
 25. $HBr + H_2SO_4 \longrightarrow Br_2 + ? + ?$
 26. $KI + Fe_2(SO_4)_3 \longrightarrow I_2 + ? + ?$
 27. $HBr + KMnO_4 \longrightarrow MnBr_2 + ? + ? + ?$
 28. $Cu_2O + HNO_3 \longrightarrow NO + ? + ?$
 29. $K_2S + K_2MnO_4 + H_2O \longrightarrow S + ? + ?$
 30. $KI + K_2Cr_2O_7 + ? \longrightarrow I_2 + K_2SO_4 + ? + ?$
 31. $Na_2S_2O_3 + I_2 \longrightarrow Na_2S_4O_6 + ?$
 32. $P + KOH + ? \longrightarrow KH_2PO_4 + PH_3$
 33. $C_2O_4^{2-} + I_2 \longrightarrow CO_2 + ?$
 34. $Sb^{3+} + Zn + H^+ \longrightarrow SbH_3 + ? + ?$
 35. $FeS_2 + HNO_{3(stez)} \longrightarrow H_2SO_4 + ? + ? + ?$
 36. $K_2Cr_2O_7 + SO_2 + H_2SO_4 \longrightarrow K_2SO_4 + ? + ?$
 37. $Cr_2(SO_4)_3 + Br_2 + NaOH \longrightarrow Na_2CrO_4 + ? + ? + ?$
 38. $MnSO_4 + Br_2 + NaOH \longrightarrow Na_2MnO_4 + ? + ? + ?$
 39. $MnSO_4 + Br_2 + H_2O \longrightarrow MnO_2 + ? + ?$
 40. $FeCl_3 + KI \longrightarrow I_2 + ? + ?$
 41. $KMnO_4 + MnSO_4 + H_2O \longrightarrow MnO_2 + ?$
 42. $MnSO_4 + (NH_4)_2S_2O_8 + H_2O \longrightarrow MnO_2 + ? + ?$
 43. $KMnO_4 + SO_2 + H_2O \longrightarrow MnSO_4 + ? + ?$
 44. $Zn + NaNO_3 + NaOH \longrightarrow NH_3 + ? + ?$
 45. $Na_2O_2 + KI + H_2SO_4 \longrightarrow I_2 + ? + ? + ?$
 46. $HIO_3 + H_2SO_3 \longrightarrow I_2 + ? + ?$
 47. $Na_2CrO_2 + Br_2 + NaOH \longrightarrow NaBr + ? + ?$
 48. $KBr + KClO_3 + H_2SO_4 \longrightarrow Br_2 + KCl + ? + ?$
- 4.** Zbilansować równania reakcji redoks:
1. $ZnS + HNO_3^- + H^+ \longrightarrow Zn^{2+} + SO_4^{2-} + NO_2 + H_2O$
 2. $AgNO_3 + AsH_3 + H_2O \longrightarrow H_3AsO_4 + Ag + HNO_3$
 3. $KI + KIO_3 + H_2SO_4 \longrightarrow I_2 + K_2SO_4 + H_2O$
 4. $Na_2SO_3 + I_2 + NaOH \longrightarrow Na_2SO_4 + NaI + H_2O$
 5. $H_2S + H_2SO_3 \longrightarrow S + 3H_2O$
 6. $Fe_3O_4 + HNO_3 \longrightarrow Fe(NO_3)_3 + NO_2 + H_2O$
 7. $As_2O_3 + HNO_3 + H_2O \longrightarrow H_3AsO_4 + NO$
 8. $As_2S_3 + HNO_3 + H_2O \longrightarrow H_3AsO_4 + H_2SO_4 + NO$
 9. $PH_3 + KMnO_4 + H_2SO_4 \longrightarrow H_3PO_4 + MnSO_4 + K_2SO_4 + H_2O$



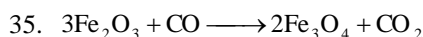
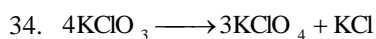
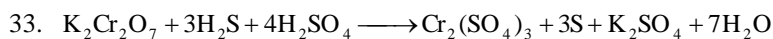
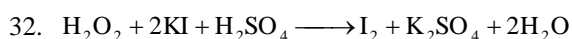
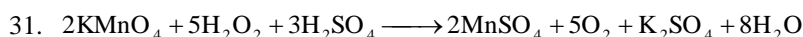
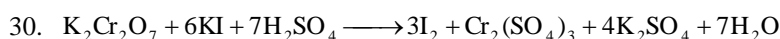
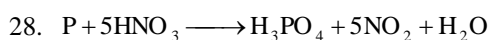
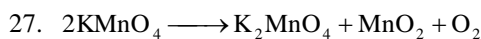
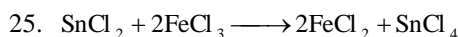
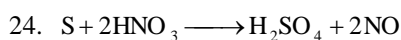
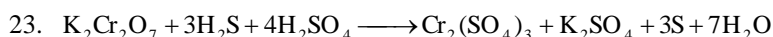
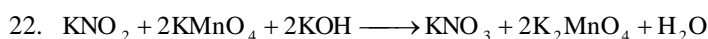
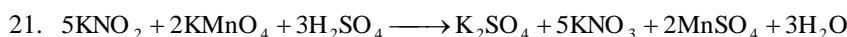
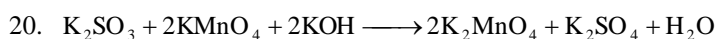
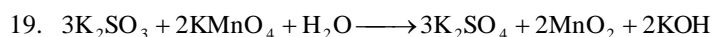
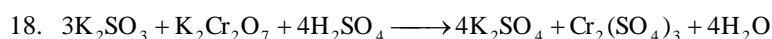
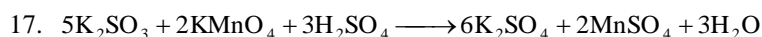
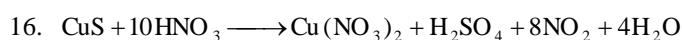
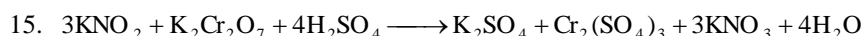
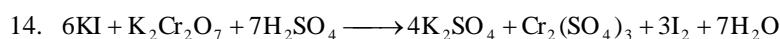
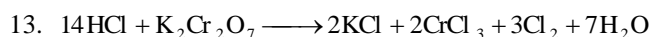
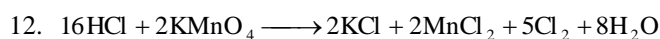
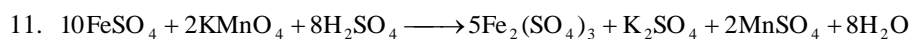
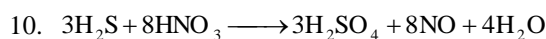
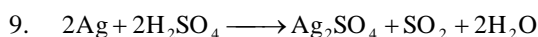
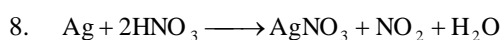
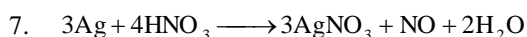
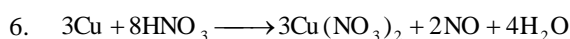
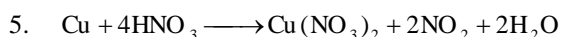
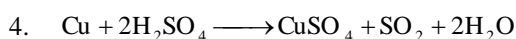
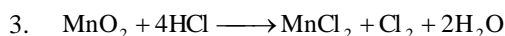
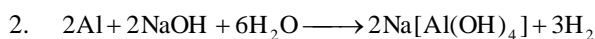
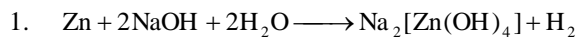
1.

1. $\text{AuCl}_4^- + 3\text{Fe}^{2+} \longrightarrow \text{Au} + 3\text{Fe}^{3+} + 4\text{Cl}^-$
2. $\text{Sn}^{2+} + 2\text{Fe}^{3+} \longrightarrow \text{Sn}^{4+} + 2\text{Fe}^{2+}$
3. $\text{Sn}^{2+} + 2\text{Hg}^{2+} \longrightarrow \text{Sn}^{4+} + \text{Hg}_2^{2+}$
4. $2\text{Fe}(\text{CN})_6^{4-} + \text{I}_2 \longrightarrow 2\text{Fe}(\text{CN})_6^{3-} + 2\text{I}^-$
5. $2\text{Fe}^{3+} + 2\text{I}^- \longrightarrow \text{I}_2 + 2\text{Fe}^{2+}$
6. $\text{Cr}_2\text{O}_7^{2-} + 6\text{Fe}^{2+} + 14\text{H}^+ \longrightarrow 2\text{Cr}^{3+} + 6\text{Fe}^{3+} + 7\text{H}_2\text{O}$
7. $\text{Zn} + 2\text{OH}^- + 2\text{H}_2\text{O} \longrightarrow [\text{Zn}(\text{OH})_4]^{2-} + \text{H}_2$
8. $\text{Cu} + \text{SO}_4^{2-} + 4\text{H}^+ \longrightarrow \text{Cu}^{2+} + \text{SO}_2 + 2\text{H}_2\text{O}$
9. $2\text{Al} + 2\text{OH}^- + 6\text{H}_2\text{O} \longrightarrow 2[\text{Al}(\text{OH})_4]^- + 3\text{H}_2$
10. $\text{Cu} + 2\text{NO}_3^- + 4\text{H}^+ \longrightarrow \text{Cu}^{2+} + 2\text{NO}_2 + 2\text{H}_2\text{O}$
11. $\text{ClO}_3^- + 3\text{AsO}_3^{3-} \longrightarrow \text{Cl}^- + 3\text{AsO}_4^{3-}$
12. $3\text{Cu} + 2\text{NO}_3^- + 8\text{H}^+ \longrightarrow 3\text{Cu}^{2+} + 2\text{NO} + 4\text{H}_2\text{O}$
13. $\text{Ag} + \text{NO}_3^- + 2\text{H}^+ \longrightarrow \text{Ag}^+ + \text{NO}_2 + \text{H}_2\text{O}$
14. $3\text{Ag} + \text{NO}_3^- + 4\text{H}^+ \longrightarrow 3\text{Ag}^+ + \text{NO} + 2\text{H}_2\text{O}$
15. $4\text{Zn} + \text{SO}_4^{2-} + 8\text{H}^+ \longrightarrow 4\text{Zn}^{2+} + \text{S}^{2-} + 4\text{H}_2\text{O}$
16. $\text{Cr}_2\text{O}_7^{2-} + 3\text{S}^{2-} + 14\text{H}^+ \longrightarrow 2\text{Cr}^{3+} + 3\text{S} + 7\text{H}_2\text{O}$
17. $3\text{CuS} + 2\text{NO}_3^- + 8\text{H}^+ \longrightarrow 3\text{Cu}^{2+} + 3\text{S} + 2\text{NO} + 4\text{H}_2\text{O}$
18. $\text{Cr}_2\text{O}_7^{2-} + 6\text{I}^- + 14\text{H}^+ \longrightarrow 2\text{Cr}^{3+} + 3\text{I}_2 + 7\text{H}_2\text{O}$
19. $2\text{Cr}^{3+} + 3\text{Cl}_2 + 16\text{OH}^- \longrightarrow 2\text{CrO}_4^{2-} + 6\text{Cl}^- + 8\text{H}_2\text{O}$
20. $\text{S} + 4\text{NO}_3^- + 4\text{H}^+ \longrightarrow \text{SO}_2 + 4\text{NO}_2 + 2\text{H}_2\text{O}$
21. $\text{Pb}_3\text{O}_4 + 2\text{Fe}^{2+} + 8\text{H}^+ \longrightarrow 3\text{Pb}^{2+} + 2\text{Fe}^{3+} + 4\text{H}_2\text{O}$
22. $\text{Pb}_3\text{O}_4 + 2\text{Cl}^- + 8\text{H}^+ \longrightarrow 3\text{Pb}^{2+} + \text{Cl}_2 + 4\text{H}_2\text{O}$
23. $3\text{U}_3\text{O}_8 + 2\text{NO}_3^- + 20\text{H}^+ \longrightarrow 9\text{UO}_2^{2+} + 2\text{NO} + 10\text{H}_2\text{O}$
24. $2\text{S}_2\text{O}_3^{2-} + \text{I}_2 \longrightarrow \text{S}_4\text{O}_6^{2-} + 2\text{I}^-$
25. $\text{S}_2\text{O}_3^{2-} + 4\text{Cl}_2 + 10\text{OH}^- \longrightarrow 2\text{SO}_4^{2-} + 8\text{Cl}^- + 5\text{H}_2\text{O}$
26. $3\text{S}_2\text{O}_3^{2-} + 4\text{ClO}_3^- + 6\text{OH}^- \longrightarrow 6\text{SO}_4^{2-} + 4\text{Cl}^- + 3\text{H}_2\text{O}$
27. $3\text{S}_4\text{O}_6^{2-} + 14\text{MnO}_4^- + 4\text{OH}^- \longrightarrow 12\text{SO}_4^{2-} + 14\text{MnO}_2 + 2\text{H}_2\text{O}$
28. $\text{S}_2\text{O}_3^{2-} + 4\text{Br}_2 + 5\text{H}_2\text{O} \longrightarrow 2\text{SO}_4^{2-} + 8\text{Br}^- + 10\text{H}^+$
29. $\text{S}_4\text{O}_6^{2-} + 7\text{Cl}_2 + 20\text{OH}^- \longrightarrow 4\text{SO}_4^{2-} + 14\text{Cl}^- + 10\text{H}_2\text{O}$
30. $2\text{Fe}(\text{CN})_6^{3-} + \text{H}_2\text{O}_2 + 2\text{OH}^- \longrightarrow 2\text{Fe}(\text{CN})_6^{4-} + \text{O}_2 + 2\text{H}_2\text{O}$
31. $2\text{Fe}(\text{CN})_6^{4-} + \text{H}_2\text{O}_2 + 2\text{H}^+ \longrightarrow 2\text{Fe}(\text{CN})_6^{3-} + 2\text{H}_2\text{O}$
32. $\text{As}_2\text{S}_3 + 4\text{ClO}_3^- \longrightarrow 2\text{As}^{3+} + 4\text{Cl}^- + 3\text{SO}_4^{2-}$
33. $\text{As}_2\text{S}_3 + 28\text{NO}_3^- + 16\text{H}^+ \longrightarrow 2\text{AsO}_4^{3-} + 3\text{SO}_4^{2-} + 8\text{NO}_2 + 8\text{H}_2\text{O}$
34. $5\text{Fe}(\text{CN})_6^{4-} + \text{MnO}_4^- + 8\text{H}^+ \longrightarrow 5\text{Fe}(\text{CN})_6^{3-} + \text{Mn}^{2+} + 4\text{H}_2\text{O}$
35. $2\text{MnO}_4^- + 5\text{H}_2\text{O}_2 + 6\text{H}^+ \longrightarrow 2\text{Mn}^{2+} + 5\text{O}_2 + 8\text{H}_2\text{O}$
36. $\text{Co}^{2+} + 7\text{NO}_2^- + 2\text{H}^+ \longrightarrow \text{Co}(\text{NO}_2)_6^{3-} + \text{NO} + \text{H}_2\text{O}$
37. $4\text{Co}(\text{CN})_6^{4-} + \text{O}_2 + 2\text{H}_2\text{O} \longrightarrow 4\text{Co}(\text{CN})_6^{3-} + 4\text{OH}^-$
38. $2\text{Al} + \text{NO}_2^- + \text{OH}^- + 5\text{H}_2\text{O} \longrightarrow \text{NH}_3 + 2\text{Al}(\text{OH})_4^-$

39. $2\text{MnO}_4^- + 6\text{CN}^- + 4\text{H}_2\text{O} \longrightarrow 2\text{MnO}_2 + 3(\text{CN})_2 + 8\text{OH}^-$
40. $\text{Bi}_2\text{S}_3 + 2\text{NO}_3^- + 8\text{H}^+ \longrightarrow 2\text{Bi}^{3+} + 2\text{NO} + 3\text{S} + 2\text{H}_2\text{O}$
41. $2\text{Cr}(\text{OH})_4^- + 3\text{H}_2\text{O}_2 + 2\text{OH}^- \longrightarrow 2\text{CrO}_4^{2-} + 8\text{H}_2\text{O}$
42. $3\text{Ag}_2\text{S} + 2\text{NO}_3^- + 8\text{H}^+ \longrightarrow 6\text{Ag}^+ + 3\text{S} + 2\text{NO} + 4\text{H}_2\text{O}$
43. $2\text{Cu}^{2+} + 4\text{I}^- \longrightarrow 2\text{CuI} + \text{I}_2$
44. $\text{N}_2\text{H}_4 + 5\text{NO}_3^- + 2\text{OH}^- \longrightarrow 7\text{NO}_2^- + 3\text{H}_2\text{O}$
45. $\text{S} + 2\text{SO}_4^{2-} + 2\text{OH}^- \longrightarrow 3\text{SO}_3^{2-} + \text{H}_2\text{O}$
46. $3\text{Mn}^{2+} + 2\text{MnO}_4^- + 2\text{H}_2\text{O} \longrightarrow 5\text{MnO}_2 + 4\text{H}^+$
47. $\text{NH}_4^+ + \text{NO}_2^- \longrightarrow \text{N}_2 + 2\text{H}_2\text{O}$
48. $3\text{I}_2 + 6\text{OH}^- \longrightarrow 5\text{I}^- + \text{IO}_3^- + 3\text{H}_2\text{O}$
49. $3\text{Cl}_2 + 6\text{OH}^- \longrightarrow 5\text{Cl}^- + \text{ClO}_3^- + 3\text{H}_2\text{O}$
50. $\text{Cl}_2\text{O}_6 + 2\text{OH}^- \longrightarrow \text{ClO}_3^- + \text{ClO}_4^- + \text{H}_2\text{O}$
51. $\text{BrO}_3^- + 5\text{Br}^- + 6\text{H}^+ \longrightarrow 3\text{Br}_2 + 3\text{H}_2\text{O}$
52. $3\text{NO}_2^- + 2\text{H}^+ \longrightarrow \text{NO}_3^- + 2\text{NO} + \text{H}_2\text{O}$
53. $\text{N}_2\text{O}_4 + 2\text{OH}^- \longrightarrow \text{NO}_2^- + \text{NO}_3^- + \text{H}_2\text{O}$
54. $\text{SCN}^- + 3\text{NO}_3^- + 2\text{H}^+ \longrightarrow \text{CO}_2 + \text{SO}_4^{2-} + 4\text{NO} + \text{H}_2\text{O}$
55. $\text{Sb}_2\text{S}_3 + 28\text{NO}_3^- + 16\text{H}^+ \longrightarrow 2\text{SbO}_4^{3-} + 3\text{SO}_4^{2-} + 28\text{NO}_2 + 8\text{H}_2\text{O}$
56. $\text{SCN}^- + 3\text{I}_2 + 8\text{OH}^- \longrightarrow \text{SO}_4^{2-} + 6\text{I}^- + \text{CN}^- + 4\text{H}_2\text{O}$
57. $\text{SCN}^- + \text{IO}_3^- + 2\text{OH}^- \longrightarrow \text{CN}^- + \text{SO}_4^{2-} + \text{I}^- + \text{H}_2\text{O}$
58. $5\text{SCN}^- + 6\text{MnO}_4^- + 8\text{H}^+ \longrightarrow 5\text{CN}^- + 5\text{SO}_4^{2-} + 6\text{Mn}^{2+} + 4\text{H}_2\text{O}$
59. $\text{Cu}_2\text{S} + 10\text{NO}_3^- + 12\text{H}^+ \longrightarrow 2\text{Cu}^{2+} + \text{SO}_4^{2-} + 10\text{NO}_2 + 6\text{H}_2\text{O}$
60. $\text{FeAsS} + 14\text{NO}_3^- + 12\text{H}^+ \longrightarrow \text{Fe}^{3+} + \text{SO}_4^{2-} + \text{AsO}_4^{3-} + 14\text{NO}_2 + 6\text{H}_2\text{O}$
61. $3\text{FeCuS}_2 + 17\text{NO}_3^- + 20\text{H}^+ \longrightarrow 3\text{Fe}^{3+} + 3\text{Cu}^{2+} + 6\text{SO}_4^{2-} + 17\text{NO} + 10\text{H}_2\text{O}$
62. $\text{FeS}_2 + 5\text{NO}_3^- + 4\text{H}^+ \longrightarrow \text{Fe}^{3+} + 2\text{SO}_4^{2-} + 5\text{NO} + 2\text{H}_2\text{O}$
63. $5\text{As}_2\text{S}_3 + 28\text{MnO}_4^- + 24\text{H}^+ \longrightarrow 10\text{AsO}_4^{3-} + 15\text{SO}_4^{2-} + 28\text{Mn}^{2+} + 12\text{H}_2\text{O}$
64. $\text{C}_6\text{H}_4\text{O}_2^{2-} + \text{I}_2 \longrightarrow \text{C}_6\text{H}_4\text{O}_2 + 2\text{I}^-$
65. $2\text{MnO}_4^- + 5\text{C}_2\text{O}_4^{2-} + 16\text{H}^+ \longrightarrow 2\text{Mn}^{2+} + 10\text{CO}_2 + 8\text{H}_2\text{O}$
66. $\text{C}_6\text{H}_5\text{NO}_2 + 3\text{Sn}^{2+} + 6\text{H}^+ \longrightarrow 3\text{Sn}^{4+} + \text{C}_6\text{H}_5\text{NH}_2 + 2\text{H}_2\text{O}$
67. $\text{C}_6\text{H}_2(\text{NO}_2)_3\text{OH} + 18\text{Ti}^{3+} + 18\text{H}^+ \longrightarrow 18\text{Ti}^{4+} + \text{C}_6\text{H}_2(\text{NH}_2)_3\text{OH} + 6\text{H}_2\text{O}$
68. $\text{C}_6\text{H}_5\text{NO}_2 + 3\text{S}^{2-} + 6\text{H}^+ \longrightarrow \text{C}_6\text{H}_5\text{NH}_2 + 3\text{S} + 2\text{H}_2\text{O}$
69. $\text{C}_6\text{H}_4(\text{OH})_2 + \text{I}_2 + 2\text{OH}^- \longrightarrow \text{C}_6\text{H}_4\text{O}_2 + 2\text{I}^- + 2\text{H}_2\text{O}$
70. $3\text{C}_3\text{H}_7\text{OH} + 2\text{CrO}_4^{2-} + 10\text{H}^+ \longrightarrow 3\text{C}_2\text{H}_5\text{CHO} + 2\text{Cr}^{3+} + 8\text{H}_2\text{O}$
71. $3\text{C}_6\text{H}_4(\text{OH})_2 + \text{Cr}_2\text{O}_7^{2-} + 8\text{H}^+ \longrightarrow 3\text{C}_6\text{H}_4\text{O}_2 + 2\text{Cr}^{3+} + 7\text{H}_2\text{O}$
72. $\text{CO}(\text{NH}_2)_2 + 2\text{NO}_2^- + 2\text{H}^+ \longrightarrow 2\text{N}_2 + \text{CO}_2 + 3\text{H}_2\text{O}$
73. $\text{CO}(\text{NH}_2)_2 + 3\text{BrO}^- \longrightarrow \text{CO}_2 + \text{N}_2 + 3\text{Br}^- + 2\text{H}_2\text{O}$
74. $2\text{CS}(\text{NH}_2)_2 + 2\text{NO}_2^- \longrightarrow 2\text{CNS}^- + 2\text{N}_2 + 4\text{H}_2\text{O}$
75. $3\text{PtCl}_6^{2-} + \text{C}_3\text{H}_5(\text{OH})_3 + 14\text{OH}^- \longrightarrow \text{CO}_2 + \text{C}_2\text{O}_4^{2-} + 3\text{Pt} + 18\text{Cl}^- + 11\text{H}_2\text{O}$
76. $\text{PtCl}_6^{2-} + 2\text{HCOO}^- + 2\text{OH}^- \longrightarrow \text{Pt} + 2\text{CO}_2 + 6\text{Cl}^- + 2\text{H}_2\text{O}$
77. $5\text{CH}_3\text{CH}(\text{OH})\text{CH}_3 + 2\text{MnO}_4^- + 6\text{H}^+ \longrightarrow 5\text{CH}_3\text{COCH}_3 + 2\text{Mn}^{2+} + 8\text{H}_2\text{O}$
78. $3\text{C}_2\text{H}_5\text{OH} + 2\text{Cr}_2\text{O}_7^{2-} + 16\text{H}^+ \longrightarrow 3\text{CH}_3\text{COOH} + 4\text{Cr}^{3+} + 11\text{H}_2\text{O}$



2.



36. $3\text{Fe} + 4\text{H}_2\text{O}_{(g)} \xrightarrow{\text{T}} \text{Fe}_3\text{O}_4 + 4\text{H}_2$
37. $(\text{NH}_4)_2\text{Cr}_2\text{O}_7 \longrightarrow \text{Cr}_2\text{O}_3 + \text{N}_2 + 4\text{H}_2\text{O}$
38. $\text{As}_2\text{S}_3 + 28\text{KNO}_3 + 8\text{H}_2\text{SO}_4 \longrightarrow 28\text{NO}_2 + 11\text{K}_2\text{SO}_4 + 2\text{K}_3\text{AsO}_4 + 8\text{H}_2\text{O}$
39. $3\text{Cu}_2\text{S} + 10\text{KNO}_3 + 8\text{H}_2\text{SO}_4 \longrightarrow 6\text{CuSO}_4 + 5\text{K}_2\text{SO}_4 + 10\text{NO} + 8\text{H}_2\text{O}$
40. $3\text{Cl}_2 + 6\text{KOH} \longrightarrow 5\text{KCl} + \text{KClO}_3 + 3\text{H}_2\text{O}$
41. $3\text{Br}_2 + 6\text{KOH} \longrightarrow 5\text{KBr} + \text{KBrO}_3 + 3\text{H}_2\text{O}$
42. $\text{N}_2\text{O}_4 + \text{H}_2\text{O} \longrightarrow \text{HNO}_3 + \text{HNO}_2$
43. $\text{NH}_4\text{NO}_2 \longrightarrow \text{N}_2 + 2\text{H}_2\text{O}$
44. $3\text{CH}_3\text{CH}_2\text{OH} + 2\text{K}_2\text{Cr}_2\text{O}_7 + 8\text{H}_2\text{SO}_4 \rightarrow 3\text{CH}_3\text{COOH} + 2\text{Cr}_2(\text{SO}_4)_3 + 2\text{K}_2\text{SO}_4 + 11\text{H}_2\text{O}$
45. $5\text{C}_3\text{H}_7\text{OH} + 4\text{KMnO}_4 + 6\text{H}_2\text{SO}_4 \longrightarrow 5\text{C}_2\text{H}_5\text{COOH} + 4\text{MnSO}_4 + 2\text{K}_2\text{SO}_4 + 11\text{H}_2\text{O}$
46. $3\text{C}_2\text{H}_4 + 2\text{KMnO}_4 + 4\text{H}_2\text{O} \longrightarrow 3\text{C}_2\text{H}_4(\text{OH})_2 + 2\text{MnO}_2 + 2\text{KOH}$
47. $3\text{C}_3\text{H}_6 + 2\text{KMnO}_4 + 4\text{H}_2\text{O} \longrightarrow 3\text{C}_3\text{H}_8\text{O}_2 + \text{MnO}_2 + 2\text{KOH}$
48. $3\text{CH}_3\text{CH}(\text{OH})\text{CH}_3 + \text{K}_2\text{Cr}_2\text{O}_7 + 4\text{H}_2\text{SO}_4 \rightarrow 3\text{CH}_3\text{COCH}_3 + \text{K}_2\text{SO}_4 + \text{Cr}_2(\text{SO}_4)_3 + 7\text{H}_2\text{O}$
49. $\text{C}_6\text{H}_5\text{CHO} + 2\text{Cu}(\text{OH})_2 \longrightarrow \text{Cu}_2\text{O} + \text{C}_6\text{H}_5\text{COOH} + 2\text{H}_2\text{O}$
50. $\text{HCHO} + 2[\text{Ag}(\text{NH}_3)_2]\text{OH} \longrightarrow \text{HCOOH} + 2\text{Ag} + 4\text{NH}_3 + \text{H}_2\text{O}$
51. $\text{MnO}_2 + \text{H}_2\text{C}_2\text{O}_4 + \text{H}_2\text{SO}_4 \longrightarrow \text{MnSO}_4 + 2\text{CO}_2 + 2\text{H}_2\text{O}$
52. $\text{C}_6\text{H}_5\text{NO}_2 + 3\text{Zn} + 6\text{HCl} \longrightarrow \text{C}_6\text{H}_5\text{NH}_2 + 3\text{ZnCl}_2 + 2\text{H}_2\text{O}$
53. $5\text{HCHO} + 2\text{KMnO}_4 + 3\text{H}_2\text{SO}_4 \longrightarrow 5\text{HCOOH} + 2\text{MnSO}_4 + \text{K}_2\text{SO}_4 + 3\text{H}_2\text{O}$
54. $5\text{HCOOH} + 2\text{KMnO}_4 + 3\text{H}_2\text{SO}_4 \longrightarrow 5\text{CO}_2 + 2\text{MnSO}_4 + \text{K}_2\text{SO}_4 + 8\text{H}_2\text{O}$
55. $\text{C}_6\text{H}_5\text{OH} + 3\text{Br}_2 \longrightarrow \text{C}_6\text{H}_2\text{Br}_3\text{OH} + 3\text{HBr}$
56. $\text{KIO}_3 + 5\text{KI} + 3\text{H}_2\text{SO}_4 \longrightarrow 3\text{I}_2 + 3\text{K}_2\text{SO}_4 + 3\text{H}_2\text{O}$
57. $\text{KI} + 3\text{Br}_2 + 3\text{H}_2\text{O} \longrightarrow \text{KIO}_3 + 6\text{HBr}$

3.

1. $6\text{Fe}^{2+} + \text{Cr}_2\text{O}_7^{2-} + 14\text{H}^+ \longrightarrow 2\text{Cr}^{3+} + 6\text{Fe}^{3+} + 7\text{H}_2\text{O}$
2. $2\text{MnO}_4^- + 5\text{NO}_2^- + 6\text{H}^+ \longrightarrow 5\text{NO}_3^- + 2\text{Mn}^{2+} + 3\text{H}_2\text{O}$
3. $2\text{MnO}_4^- + 3\text{NO}_2^- + \text{H}_2\text{O} \longrightarrow 3\text{NO}_3^- + 2\text{MnO}_2 + 2\text{OH}^-$
4. $2\text{MnO}_4^- + \text{NO}_2^- + 2\text{OH}^- \longrightarrow \text{NO}_3^- + 2\text{MnO}_4^{2-} + \text{H}_2\text{O}$
5. $\text{Cr}_2\text{O}_7^{2-} + 6\text{Cl}^- + 14\text{H}^+ \longrightarrow 2\text{Cr}^{3+} + 3\text{Cl}_2 + 7\text{H}_2\text{O}$
6. $6\text{FeSO}_4 + \text{K}_2\text{Cr}_2\text{O}_7 + 7\text{H}_2\text{SO}_4 \longrightarrow \text{Cr}_2(\text{SO}_4)_3 + 3\text{Fe}_2(\text{SO}_4)_3 + \text{K}_2\text{SO}_4 + 7\text{H}_2\text{O}$
7. $5\text{K}_2\text{SO}_3 + 2\text{KMnO}_4 + 3\text{H}_2\text{SO}_4 \longrightarrow 2\text{MnSO}_4 + 6\text{K}_2\text{SO}_4 + 3\text{H}_2\text{O}$
8. $10\text{KI} + 2\text{KMnO}_4 + 8\text{H}_2\text{SO}_4 \longrightarrow 5\text{I}_2 + 2\text{MnSO}_4 + 6\text{K}_2\text{SO}_4 + 8\text{H}_2\text{O}$
9. $\text{PbS} + 4\text{HNO}_3 \longrightarrow \text{Pb}(\text{NO}_3)_2 + \text{S} + 2\text{NO}_2 + 2\text{H}_2\text{O}$
10. $3\text{SO}_2 + 2\text{HNO}_3 + 2\text{H}_2\text{O} \longrightarrow 3\text{H}_2\text{SO}_4 + 2\text{NO}$
11. $6\text{FeSO}_4 + \text{K}_2\text{Cr}_2\text{O}_7 + 7\text{H}_2\text{SO}_4 \longrightarrow 3\text{Fe}_2(\text{SO}_4)_3 + \text{Cr}_2(\text{SO}_4)_3 + \text{K}_2\text{SO}_4 + 7\text{H}_2\text{O}$
12. $\text{Cu}_2\text{S} + 8\text{HNO}_3 \longrightarrow \text{S} + 2\text{Cu}(\text{NO}_3)_2 + 4\text{NO}_2 + 4\text{H}_2\text{O}$
13. $3\text{As}_2\text{S}_3 + 10\text{HNO}_3 + 4\text{H}_2\text{O} \longrightarrow 6\text{H}_3\text{AsO}_4 + 9\text{S} + 10\text{NO}$
14. $3\text{Cu} + 8\text{HNO}_3 \longrightarrow 3\text{Cu}(\text{NO}_3)_2 + 2\text{NO} + 4\text{H}_2\text{O}$
15. $\text{Cu} + 4\text{HNO}_3 \longrightarrow \text{Cu}(\text{NO}_3)_2 + 2\text{NO}_2 + 2\text{H}_2\text{O}$
16. $4\text{Zn} + 10\text{HNO}_3 \longrightarrow \text{NH}_4\text{NO}_3 + 4\text{Zn}(\text{NO}_3)_2 + 3\text{H}_2\text{O}$
17. $2\text{KMnO}_4 + 16\text{HCl} \longrightarrow 5\text{Cl}_2 + 2\text{MnCl}_2 + 2\text{KCl} + 8\text{H}_2\text{O}$
18. $\text{K}_2\text{Cr}_2\text{O}_7 + 6\text{NaCl} + 7\text{H}_2\text{SO}_4 \longrightarrow 3\text{Cl}_2 + \text{Cr}_2(\text{SO}_4)_3 + \text{K}_2\text{SO}_4 + 3\text{Na}_2\text{SO}_4 + 7\text{H}_2\text{O}$

19. $3\text{C}_2\text{H}_4 + 2\text{KMnO}_4 + 4\text{H}_2\text{O} \longrightarrow 3\text{C}_2\text{H}_4(\text{OH})_2 + 2\text{MnO}_2 + 2\text{KOH}$
 20. $3\text{C}_2\text{H}_5\text{OH} + 2\text{K}_2\text{Cr}_2\text{O}_7 + 8\text{H}_2\text{SO}_4 \longrightarrow 3\text{CH}_3\text{COOH} + 2\text{Cr}_2(\text{SO}_4)_3 + 2\text{K}_2\text{SO}_4 + 11\text{H}_2\text{O}$
 21. $\text{Zn} + 2\text{OH}^- + 2\text{H}_2\text{O} \longrightarrow [\text{Zn}(\text{OH})_4]^{2-} + \text{H}_2$
 22. $2\text{Al} + 2\text{OH}^- + 6\text{H}_2\text{O} \longrightarrow 2[\text{Al}(\text{OH})_4]^- + 3\text{H}_2$
 23. $\text{Mn}(\text{OH})_2 + \text{Cl}_2 + 2\text{KOH} \longrightarrow \text{MnO}_2 + 2\text{KCl} + 2\text{H}_2\text{O}$
 24. $\text{NaAsO}_2 + \text{I}_2 + 4\text{NaOH} \longrightarrow \text{Na}_3\text{AsO}_4 + 2\text{NaI} + 2\text{H}_2\text{O}$
 25. $2\text{HBr} + \text{H}_2\text{SO}_4 \longrightarrow \text{Br}_2 + \text{SO}_2 + 2\text{H}_2\text{O}$
 26. $2\text{KI} + \text{Fe}_2(\text{SO}_4)_3 \longrightarrow \text{I}_2 + \text{K}_2\text{SO}_4 + 2\text{FeSO}_4$
 27. $16\text{HBr} + 2\text{KMnO}_4 \longrightarrow 2\text{MnBr}_2 + 5\text{Br}_2 + 2\text{KBr} + 8\text{H}_2\text{O}$
 28. $3\text{Cu}_2\text{O} + 14\text{HNO}_3 \longrightarrow 2\text{NO} + 6\text{Cu}(\text{NO}_3)_2 + 7\text{H}_2\text{O}$
 29. $\text{K}_2\text{S} + \text{K}_2\text{MnO}_4 + 2\text{H}_2\text{O} \longrightarrow \text{S} + \text{MnO}_2 + 4\text{KOH}$
 30. $6\text{KI} + \text{K}_2\text{Cr}_2\text{O}_7 + 7\text{H}_2\text{SO}_4 \longrightarrow 3\text{I}_2 + 4\text{K}_2\text{SO}_4 + \text{Cr}_2(\text{SO}_4)_3 + 7\text{H}_2\text{O}$
 31. $2\text{Na}_2\text{S}_2\text{O}_3 + \text{I}_2 \longrightarrow \text{Na}_2\text{S}_4\text{O}_6 + 2\text{NaI}$
 32. $8\text{P} + 3\text{KOH} + 9\text{H}_2\text{O} \longrightarrow 3\text{KH}_2\text{PO}_4 + 5\text{PH}_3$
 33. $\text{C}_2\text{O}_4^{2-} + \text{I}_2 \longrightarrow 2\text{CO}_2 + 2\text{I}^-$
 34. $\text{Sb}^{3+} + 3\text{Zn} + 3\text{H}^+ \longrightarrow \text{SbH}_3 + 3\text{Zn}^{2+}$
 35. $\text{FeS}_2 + 8\text{HNO}_{3(\text{stez})} \longrightarrow 2\text{H}_2\text{SO}_4 + \text{Fe}(\text{NO}_3)_3 + 5\text{NO} + 2\text{H}_2\text{O}$
 36. $\text{K}_2\text{Cr}_2\text{O}_7 + 3\text{SO}_2 + \text{H}_2\text{SO}_4 \longrightarrow \text{K}_2\text{SO}_4 + \text{Cr}_2(\text{SO}_4)_3 + \text{H}_2\text{O}$
 37. $\text{Cr}_2(\text{SO}_4)_3 + 3\text{Br}_2 + 16\text{NaOH} \longrightarrow 2\text{Na}_2\text{CrO}_4 + 6\text{NaBr} + 3\text{Na}_2\text{SO}_4 + 8\text{H}_2\text{O}$
 38. $\text{MnSO}_4 + 2\text{Br}_2 + 8\text{NaOH} \longrightarrow \text{Na}_2\text{MnO}_4 + 4\text{NaBr} + \text{Na}_2\text{SO}_4 + 4\text{H}_2\text{O}$
 39. $\text{MnSO}_4 + \text{Br}_2 + 2\text{H}_2\text{O} \longrightarrow \text{MnO}_2 + 2\text{HBr} + \text{H}_2\text{SO}_4$
 40. $2\text{FeCl}_3 + 2\text{KI} \longrightarrow \text{I}_2 + 2\text{KCl} + 2\text{FeCl}_2$
 41. $2\text{KMnO}_4 + 3\text{MnSO}_4 + 2\text{H}_2\text{O} \longrightarrow 5\text{MnO}_2 + \text{K}_2\text{SO}_4 + 2\text{H}_2\text{SO}_4$
 42. $\text{MnSO}_4 + (\text{NH}_4)_2\text{S}_2\text{O}_8 + 2\text{H}_2\text{O} \longrightarrow \text{MnO}_2 + (\text{NH}_4)_2\text{SO}_4 + 2\text{H}_2\text{SO}_4$
 43. $2\text{KMnO}_4 + 5\text{SO}_2 + 2\text{H}_2\text{O} \longrightarrow 2\text{MnSO}_4 + \text{K}_2\text{SO}_4 + 2\text{H}_2\text{SO}_4$
 44. $4\text{Zn} + \text{NaNO}_3 + 3\text{NaOH} \longrightarrow \text{NH}_3 + 4\text{Na}[\text{Zn}(\text{OH})_4]$
 45. $\text{Na}_2\text{O}_2 + 2\text{KI} + 2\text{H}_2\text{SO}_4 \longrightarrow \text{I}_2 + \text{K}_2\text{SO}_4 + \text{Na}_2\text{SO}_4 + 2\text{H}_2\text{O}$
 46. $2\text{HIO}_3 + 5\text{H}_2\text{SO}_3 \longrightarrow \text{I}_2 + 5\text{H}_2\text{SO}_4 + \text{H}_2\text{O}$
 47. $\text{Na}_2\text{CrO}_2 + 2\text{Br}_2 + 4\text{NaOH} \longrightarrow \text{Na}_2\text{CrO}_4 + 4\text{NaBr} + 2\text{H}_2\text{O}$
 48. $6\text{KBr} + \text{KClO}_3 + 3\text{H}_2\text{SO}_4 \longrightarrow 3\text{Br}_2 + \text{KCl} + 3\text{K}_2\text{SO}_4 + 3\text{H}_2\text{O}$
- 4.**
1. $\text{ZnS} + 8\text{HNO}_3^- + 8\text{H}^+ \longrightarrow \text{Zn}^{2+} + \text{SO}_4^{2-} + 8\text{NO}_2 + 4\text{H}_2\text{O}$
 2. $8\text{AgNO}_3 + \text{AsH}_3 + 4\text{H}_2\text{O} \longrightarrow \text{H}_3\text{AsO}_4 + 8\text{Ag} + 8\text{HNO}_3$
 3. $5\text{KI} + \text{KIO}_3 + 3\text{H}_2\text{SO}_4 \longrightarrow 3\text{I}_2 + 3\text{K}_2\text{SO}_4 + 3\text{H}_2\text{O}$
 4. $\text{Na}_2\text{SO}_3 + \text{I}_2 + 2\text{NaOH} \longrightarrow \text{Na}_2\text{SO}_4 + 2\text{NaI} + \text{H}_2\text{O}$
 5. $2\text{H}_2\text{S} + \text{H}_2\text{SO}_3 \longrightarrow 3\text{S} + 3\text{H}_2\text{O}$
 6. $\text{Fe}_3\text{O}_4 + 10\text{HNO}_3 \longrightarrow 3\text{Fe}(\text{NO}_3)_3 + \text{NO}_2 + 5\text{H}_2\text{O}$
 7. $3\text{As}_2\text{O}_3 + 4\text{HNO}_3 + 7\text{H}_2\text{O} \longrightarrow 6\text{H}_3\text{AsO}_4 + 4\text{NO}$
 8. $3\text{As}_2\text{S}_3 + 28\text{HNO}_3 + 4\text{H}_2\text{O} \longrightarrow 6\text{H}_3\text{AsO}_4 + 9\text{H}_2\text{SO}_4 + 28\text{NO}$
 9. $5\text{PH}_3 + 8\text{KMnO}_4 + 12\text{H}_2\text{SO}_4 \longrightarrow 5\text{H}_3\text{PO}_4 + 8\text{MnSO}_4 + 4\text{K}_2\text{SO}_4 + 12\text{H}_2\text{O}$

10. $3\text{H}_2\text{S} + \text{K}_2\text{Cr}_2\text{O}_7 + 4\text{H}_2\text{SO}_4 \longrightarrow 3\text{S} + \text{Cr}_2(\text{SO}_4)_3 + \text{K}_2\text{SO}_4 + 7\text{H}_2\text{O}$
11. $2\text{Cr}(\text{OH})_3 + 3\text{H}_2\text{O}_2 + 4\text{KOH} \longrightarrow 2\text{K}_2\text{CrO}_4 + 8\text{H}_2\text{O}$
12. $2\text{Cr}(\text{OH})_3 + 3\text{Br}_2 + 10\text{NaOH} \longrightarrow 6\text{NaBr} + 2\text{Na}_2\text{CrO}_4 + 8\text{H}_2\text{O}$
13. $4\text{Fe}(\text{CrO}_2)_2 + 8\text{K}_2\text{CO}_3 + 7\text{O}_2 \longrightarrow 2\text{Fe}_2\text{O}_3 + 8\text{K}_2\text{CrO}_4 + 8\text{CO}_2$
14. $\text{Br}_2 + 5\text{HClO} + \text{H}_2\text{O} \longrightarrow 2\text{HBrO}_3 + 5\text{HCl}$
15. $\text{C}_6\text{H}_5\text{CH}_3 + \text{Cr}_2\text{O}_7^{2-} + 8\text{H}^+ \longrightarrow \text{C}_6\text{H}_5\text{COOH} + 2\text{Cr}^{3+} + 5\text{H}_2\text{O}$
16. $\text{C}_6\text{H}_5\text{CH}_3 + 3\text{H}_2\text{O}_2 + 6\text{H}^+ \longrightarrow \text{C}_6\text{H}_5\text{COOH} + 4\text{H}_2\text{O}$