

- According to Reference Table J, which metal will react spontaneously with  $\text{Ag}^+$  ions, but not with  $\text{Zn}^{2+}$  ions?
  - Cu
  - Au
  - Al
  - Mg
- Which will oxidize  $\text{Zn(s)}$  to  $\text{Zn}^{2+}$ , but will *not* oxidize  $\text{Pb(s)}$  to  $\text{Pb}^{2+}$ ?
  - $\text{Al}^{3+}$
  - $\text{Au}^{3+}$
  - $\text{Co}^{2+}$
  - $\text{Mg}^{2+}$
- Based on Reference Table J, which molecule-ion pair will react spontaneously at 298 K?
  - $\text{Cl}_2 + \text{F}^-$
  - $\text{I}_2 + \text{Br}^-$
  - $\text{F}_2 + \text{I}^-$
  - $\text{Br}_2 + \text{Cl}^-$
- According to Reference Table J, which metal will reduce  $\text{Ni}^{2+}$  to  $\text{Ni(s)}$ ?
  - $\text{Fe(s)}$
  - $\text{Cu(s)}$
  - $\text{Ag(s)}$
  - $\text{Au(s)}$
- According to Reference Table J, which metal will react spontaneously with  $\text{H}^+$ ?
  - Au
  - Ag
  - Cr
  - Cu
- According to Reference Table J, which redox reaction occurs spontaneously?
  - $\text{Cu(s)} + 2\text{H}^+ \rightarrow \text{Cu}^{2+} + \text{H}_2(\text{g})$
  - $\text{Mg(s)} + 2\text{H}^+ \rightarrow \text{Mg}^{2+} + \text{H}_2(\text{g})$
  - $2\text{Ag(s)} + 2\text{H}^+ \rightarrow 2\text{Ag} + \text{H}_2(\text{g})$
  - $2\text{Ag(s)} + 2\text{H}^+ \rightarrow 2\text{Ag}^{2+} + \text{H}_2(\text{g})$
- Based on the Activity Series, which ion will react spontaneously with  $\text{Co(s)}$ ?
  - $\text{Zn}^{2+}$
  - $\text{Al}^{3+}$
  - $\text{Li}^+$
  - $\text{Ag}^+$
- According to Reference Table J, which metal will react spontaneously with hydrochloric acid?
  - gold
  - silver
  - copper
  - zinc
- According to Reference Table J, which of these ions is most easily reduced?
  - $\text{Ca}^{2+}$
  - $\text{Cr}^{3+}$
  - $\text{Cu}^+$
  - $\text{Ag}^+$
- According to Reference Table J, which atom-ion pair will react spontaneously?
  - $\text{Ag} + \text{Au}^{3+}$
  - $\text{Pb} + \text{Co}^{2+}$
  - $\text{Ni} + \text{Al}^{3+}$
  - $\text{Zn} + \text{Ca}^{2+}$
- According to Reference Table J, which species is the strongest oxidizing agent?
  - $\text{Li(s)}$
  - $\text{Li}^+$
  - $\text{F}_2(\text{g})$
  - $\text{F}^-$
- Under standard conditions, which metal will react with 0.1 M HCl to liberate hydrogen gas?
  - Ag
  - Au
  - Cu
  - Mg
- Based on Reference Table J, which of the following elements will replace Pb from  $\text{Pb(NO}_3)_2(\text{aq})$ ?
  - $\text{Mg(s)}$
  - $\text{Au(s)}$
  - $\text{Cu(s)}$
  - $\text{Ag(s)}$
- Which metal reacts spontaneously with a solution containing zinc ions?
  - magnesium
  - nickel
  - copper
  - silver
- Based on Reference Table J, which of the following ions in aqueous solution is most easily oxidized?
  - $\text{I}^-$
  - $\text{Br}^-$
  - $\text{Cl}^-$
  - $\text{F}^-$
- According to Reference Table J, which halogen will react spontaneously with  $\text{Au(s)}$  to produce  $\text{Au}^{3+}$ ?
  - $\text{Br}_2$
  - $\text{F}_2$
  - $\text{I}_2$
  - $\text{Cl}_2$
- According to Reference Table J, which metal will react with 1 M  $\text{PbCl}_2$ ?
  - $\text{Au(s)}$
  - $\text{Ag(s)}$
  - $\text{Co(s)}$
  - $\text{Cu(s)}$
- Referring to Reference Table J, which reaction will not occur under standard conditions?
  - $\text{Sn(s)} + 2\text{HCl(aq)} \rightarrow \text{SnCl}_2(\text{aq}) + \text{H}_2(\text{g})$
  - $\text{Cu(s)} + 2\text{HCl(aq)} \rightarrow \text{CuCl}_2(\text{aq}) + \text{H}_2(\text{g})$
  - $\text{Ba(s)} + 2\text{HCl(aq)} \rightarrow \text{BaCl}_2(\text{aq}) + \text{H}_2(\text{g})$
  - $\text{Mg(s)} + 2\text{HCl(aq)} \rightarrow \text{MgCl}_2(\text{aq}) + \text{H}_2(\text{g})$
- Due to it having a low activity, which element can be found in nature in the free (uncombined) state?
  - Ca
  - Ba
  - Au
  - Al
- According to Reference Table J, which ion will oxidize Fe?
  - $\text{Zn}^{2+}$
  - $\text{Ca}^{2+}$
  - $\text{Mg}^{2+}$
  - $\text{Cu}^{2+}$
- Based on Reference Table J, which ion is most easily oxidized?
  - $\text{Br}^-$
  - $\text{Cl}^-$
  - $\text{F}^-$
  - $\text{I}^-$
- According to the Activity Series, which metal will react spontaneously with hydrochloric acid?
  - Ag
  - Hg
  - Cu
  - Ni
- According to Reference Table J, which of these metals will react most readily with 1.0 M HCl to produce  $\text{H}_2(\text{g})$ ?
  - Ca
  - K
  - Mg
  - Zn
- According to Reference Table J, which pair will react spontaneously at 298K?
  - $\text{Cu} + \text{H}_2\text{O}$
  - $\text{Ag} + \text{H}_2\text{O}$
  - $\text{Ca} + \text{H}_2\text{O}$
  - $\text{Au} + \text{H}_2\text{O}$

25. Based on Reference Table J, which metal will react with hydrochloric acid and produce  $H_2(g)$ ?
- 1) Au
  - 2) Cu
  - 3) Mg
  - 4) Ag
26. Based on Reference Table J, which of the following elements is the actively oxidized?
- 1) Fe
  - 2) Sr
  - 3) Cu
  - 4) Cr
27. Based on Reference Table J, which metal will react spontaneously with  $Al^{3+}$ ?
- 1) Co(s)
  - 2) Cr(s)
  - 3) Cu(s)
  - 4) Ca(s)
28. According to Reference Table J, which element will react spontaneously with  $Al^{3+}$  at 298 K?
- 1) Cu
  - 2) Au
  - 3) Li
  - 4) Ni
29. Based on Reference Table J, which oxidation is most likely to occur?
- 1)  $Cu \rightarrow Cu^{2+} + 2e^-$
  - 2)  $Mg \rightarrow Mg^{2+} + 2e^-$
  - 3)  $Ag \rightarrow Ag^{1+} + 1e^-$
  - 4)  $Au \rightarrow Au^{3+} + 3e^-$
30. According to Reference Table J, which will reduce  $Mg^{2+}$  to  $Mg(s)$ ?
- 1) Fe(s)
  - 2) Ba(s)
  - 3) Pb(s)
  - 4) Ag(s)
31. According to Reference Table J, which species can reduce  $Cr^{3+}$  ions?
- 1)  $Fe^{2+}$
  - 2)  $Sn^{2+}$
  - 3) Al
  - 4) Ni
32. According to Reference Table J, which species is most easily reduced?
- 1)  $F_2(g)$
  - 2)  $F^-$
  - 3)  $Li^+$
  - 4)  $Li(s)$
33. Which metal can replace Cr in  $Cr_2O_3$ ?
- 1) nickel
  - 2) lead
  - 3) copper
  - 4) aluminum
34. Based on Reference Table J, which reaction will take place spontaneously?
- 1)  $Mg(s) + Ca^{2+}(aq) \rightarrow Mg^{2+}(aq) + Ca(s)$
  - 2)  $Ba(s) + 2Na^+(aq) \rightarrow Ba^{2+}(aq) + 2Na(s)$
  - 3)  $Cl_2(g) + 2F^-(aq) \rightarrow 2Cl^-(aq) + F_2(g)$
  - 4)  $I_2(g) + 2Br^-(aq) \rightarrow 2I^-(aq) + Br_2(g)$
35. Based on Reference Table J, which reaction will take place spontaneously?
- 1)  $Cu + 2H^+ \rightarrow Cu^{2+} + H_2$
  - 2)  $2Au + 6H^+ \rightarrow 2Au^{3+} + 3H_2$
  - 3)  $Pb + 2H^+ \rightarrow Pb^{2+} + H_2$
  - 4)  $2Ag + 2H^+ \rightarrow 2Ag^+ + H_2$
36. According to Reference Table J, which reaction will take place spontaneously?
- 1)  $Ni^{2+} + Pb(s) \rightarrow Ni(s) + Pb^{2+}$
  - 2)  $Au^{3+} + Al(s) \rightarrow Au(s) + Al^{3+}$
  - 3)  $Sr^{2+} + Sn(s) \rightarrow Sr(s) + Sn^{2+}$
  - 4)  $Fe^{2+} + Cu(s) \rightarrow Fe(s) + Cu^{2+}$
37. Which element below can be used to replace chromium from its compound  $Cr_2O_3$ ?
- 1) Cu
  - 2) Pb
  - 3) Sn
  - 4) Al
38. The half-reaction  
 $2H^+(aq) + 2e^- \rightarrow H_2(g)$   
 will occur when  $H^+(aq)$  reacts with
- 1) Pb(s)
  - 2) Cu(s)
  - 3) Hg( $\ell$ )
  - 4) Ag(s)
39. According to Reference Table J, which metal will react with  $Zn^{2+}$  but will *not* react with  $Mg^{2+}$ ?
- 1) Al(s)
  - 2) Cu(s)
  - 3) Ni(s)
  - 4) Ba(s)
40. According to Reference Table J, which ion is most easily reduced?
- 1)  $Au^{3+}$
  - 2)  $Ni^{2+}$
  - 3)  $Al^{3+}$
  - 4)  $Mg^{2+}$
41. Based on Reference Table J, which metal will *not* react with 1 M HCl?
- 1) Au(s)
  - 2) Ni(s)
  - 3) Sn(s)
  - 4) Zn(s)
42. Based on the Activity Series, which ion will oxidize Pb to  $Pb^{2+}$ ?
- 1)  $Cu^{2+}$
  - 2)  $Ni^{2+}$
  - 3)  $Fe^{2+}$
  - 4)  $Zn^{2+}$
43. Lead is a product of the reaction between a solution of lead (II) nitrate and
- 1) Fe
  - 2) Cu
  - 3) Ag
  - 4) Au
44. According to Reference Table J, which is the strongest reducing agent?
- 1) Li(s)
  - 2) Na(s)
  - 3)  $F_2(g)$
  - 4)  $Br_2(\ell)$
45. According to reference Table J, which reaction will occur spontaneously?
- 1)  $CO^{2+} + Cu(s) \rightarrow Co(s) + Cu^{2+}$
  - 2)  $Ag^+ + Cu(s) \rightarrow Ag(s) + Cu^+$
  - 3)  $Fe^{2+} + Hg(\ell) \rightarrow Fe(s) + Hg^{2+}$
  - 4)  $Mg^{2+} + Sn^{2+} \rightarrow Mg(s) + Sn^{4+}$

## Reference Tables

**Table J**  
**Activity Series\*\***

Most	Metals	Nonmetals	Least
	Li	F <sub>2</sub>	
	Rb	Cl <sub>2</sub>	
	K	Br <sub>2</sub>	
	Ca	I <sub>2</sub>	
	Ba		
	Mg		
	Al		
	Ti		
	Mn		
	Zn		
	Cr		
	Fe		
	Co		
	Ni		
	Sn		
	Pb		
	H <sub>2</sub>		
	Cu		
	Ag		
	Au		

\*\*Activity series based on hydrogen standard

## Reference Tables

Table N  
Selected Radionuclides

Nuclide	Half-Life	Decay Mode	Nuclide Name
<sup>103</sup> Mo	2.66 d	β <sup>-</sup>	gold-198
<sup>107</sup> Cd	57.80 y	β <sup>-</sup>	cesium-137
<sup>125</sup> I	59.4 d	β <sup>-</sup>	cesium-137
<sup>137</sup> Cs	30.17 y	β <sup>-</sup>	cesium-137
<sup>139</sup> La	1.58 × 10 <sup>11</sup> y	α	francium-223
<sup>147</sup> Pm	2.42 × 10 <sup>5</sup> y	α	francium-223
<sup>151</sup> Eu	5.21 × 10 <sup>7</sup> y	α	francium-223
<sup>159</sup> Gd	15.6 d	β <sup>-</sup>	holmium-163
<sup>165</sup> Dy	12.3 y	β <sup>-</sup>	holmium-163
<sup>175</sup> Lu	121.01 d	β <sup>-</sup>	holmium-163
<sup>177</sup> Lu	6.65 d	β <sup>-</sup>	holmium-163
<sup>187</sup> Re	4.92 × 10 <sup>10</sup> y	α	radon-222
<sup>192</sup> Ir	74.03 d	β <sup>-</sup>	plutonium-239
<sup>198</sup> Au	2.697 d	β <sup>-</sup>	plutonium-239
<sup>201</sup> Tl	3.043 d	β <sup>-</sup>	plutonium-239
<sup>203</sup> Pb	16.68 h	β <sup>-</sup>	plutonium-239
<sup>210</sup> Pb	138.376 d	β <sup>-</sup>	plutonium-239
<sup>210</sup> Bi	5.012 × 10 <sup>4</sup> y	α	plutonium-239
<sup>210</sup> Po	138.376 d	α	plutonium-239
<sup>214</sup> Pb	26.827 min	β <sup>-</sup>	plutonium-239
<sup>214</sup> Bi	19.9 min	β <sup>-</sup>	plutonium-239
<sup>214</sup> Po	164.3 μs	α	plutonium-239
<sup>218</sup> Pb	3.10 min	β <sup>-</sup>	plutonium-239
<sup>218</sup> Ac	3.10 min	β <sup>-</sup>	plutonium-239
<sup>218</sup> Rn	3.8235 d	α	plutonium-239
<sup>222</sup> Rn	3.8235 d	α	plutonium-239
<sup>226</sup> Ra	1599 y	α	plutonium-239
<sup>228</sup> Ac	6.13 × 10 <sup>4</sup> y	β <sup>-</sup>	plutonium-239
<sup>228</sup> Th	1.41 × 10 <sup>8</sup> y	α	plutonium-239
<sup>232</sup> Th	1.41 × 10 <sup>10</sup> y	α	plutonium-239
<sup>235</sup> U	7.04 × 10 <sup>8</sup> y	α	plutonium-239
<sup>238</sup> U	4.468 × 10 <sup>9</sup> y	α	plutonium-239

ns = nanoseconds, s = seconds, min = minutes, h = hours, d = days, y = years

## Answer Key

1. 1
2. 3
3. 3
4. 1
5. 3
6. 2
7. 4
8. 4
9. 4
10. 1
11. 3
12. 4
13. 1
14. 1
15. 1
16. 2
17. 3
18. 2
19. 3
20. 4
21. 4
22. 4
23. 2
24. 3
25. 3
26. 2
27. 4
28. 3
29. 2

30. 2
  31. 3
  32. 1
  33. 4
  34. 2
  35. 3
  36. 2
  37. 4
  38. 1
  39. 1
  40. 1
  41. 1
  42. 1
  43. 1
  44. 1
  45. 2
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