Use the following video link to complete the worksheet:

<https://screencast-o-matic.com/watch/cqeqbY0Er6>

1. Click on “**Start**.” Observe the top four beakers … label them on the lines below the beakers:

\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_ ­­­­­­­­­­­­­­­\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_

2. Move the cursor over the Mg(NO3)2 (aq) beaker and LEFT click … draw the METAL ions from the simulation in the appropriate beaker ABOVE.

* Do the same for the Zn(NO3)2 (aq), Cu(NO3)2 (aq), AgNO3 (aq) beakers.

3. Click on “**Activity 1**.” Now click on “**Molecular Scale Reactions**.”

4. Drag the Copper metal and place it in the AgNO3 (aq) . Then, click the “Start” icon.

5. Once the simulation stops, click the “Step by Step” icon. Notice in this reaction that the \_\_\_\_\_\_\_\_\_\_\_ are transferred directly from a copper atom to two silver ions (Ag+). Write the SECOND equation:

Cu (s) + 🡪 +

6. Click “Start.” This is an \_\_\_\_\_\_\_\_\_\_\_\_\_-\_\_\_\_\_\_\_\_\_\_\_\_\_\_ reaction. When a pair of Ag+ ions collide at the surface of the copper electrode, a copper atom releases two \_\_\_\_\_\_\_\_\_\_ to the Ag+ ions. The Copper atom enters the solution as Cu+2 ions. The \_\_\_\_\_\_\_\_\_\_\_\_ half reaction is:

Cu (s) 🡪 + [*click “Next Step”]*

A neutral Copper atom loses \_\_\_\_ electrons and forms a Cu+2 ion. The oxidation state of Copper changes from \_\_\_\_\_ to \_\_\_\_. Notice there has been a \_\_\_\_\_\_\_ in oxidation state of the Copper atom. [*click “Next Step”*]

The Ag+ ion from the Silver I Nitrate solution captures one \_\_\_\_\_\_\_\_\_\_ and attaches on the copper electrode as neutral Silver atom. The \_\_\_\_\_\_\_\_\_\_\_ half reaction is:

Ag+ (aq) + 🡪 [*click “Next Step”]*

A Silver [Ag+ (aq) ] ion gains \_\_\_\_ electron to form a neutral Silver atom. The oxidation state of Silver changes from \_\_\_\_\_ to \_\_\_\_. [*click “Back” to return to the “Animations of the reactions in molecular level”]*

7. What happened to the Copper Metal in the Silver I nitrate solution?

8. Click “Reset.” Place the Copper metal into the Mg(NO3)2 (aq) beaker. Click “Start” to play the simulation. What happens?

9. Click “Reset.” Place the Copper metal into the Zn(NO3)2 (aq) beaker. Click “Start” to play the simulation. What happens?

10. Click “Reset.” Drag the magnesium metal and place it in the Cu(NO3)2 (aq) . Then, click the “Start” icon.

11. Once the simulation stops, click the “Step by Step” icon. Notice in this reaction that the \_\_\_\_\_\_\_\_\_\_\_ are transferred directly from a \_\_\_\_\_\_\_\_\_\_\_\_\_ atom to a Cu+2 ion. Write the SECOND equation:

Mg (s) + 🡪 +

12. Click “Start.” This is an \_\_\_\_\_\_\_\_\_\_\_\_\_-\_\_\_\_\_\_\_\_\_\_\_\_\_\_ reaction. When a Cu+2 ion collides at the surface of the Magnesium electrode, a Magnesium atom releases two \_\_\_\_\_\_\_\_\_\_ to the Cu+2 ion. The Magnesium atom enters the solution as Mg+2 ions. The \_\_\_\_\_\_\_\_\_\_\_\_ half reaction is:

Mg (s) 🡪 + [*click “Next Step”]*

A neutral Magnesium atom loses \_\_\_\_ electrons and forms a Mg+2 ion. The oxidation state of Magnesium changes from \_\_\_\_\_ to \_\_\_\_. Notice there has been a \_\_\_\_\_\_\_ in oxidation state of the Magnesium atom. [*click “Next Step”*]

The Cu+2 ion from the Copper II Nitrate solution captures two \_\_\_\_\_\_\_\_\_\_ and attaches on the Mg electrode as neutral Copper atom. The \_\_\_\_\_\_\_\_\_\_\_ half reaction is:

Cu+2 (aq) + 🡪 [*click “Next Step”]*

A Copper [Cu+2 (aq) ] ion gains \_\_\_\_ electrons to form a neutral Copper atom. The oxidation state of Copper changes from \_\_\_\_\_ to \_\_\_\_. [*click “Back” to return to the “Animations of the reactions in molecular level”]*

13. What happened to the Magnesium Metal in the Copper II nitrate solution?

14. Click “Back” to return to the screen that says, “Use the mouse to pick a metal …” Click on each metal (one at a time) beginning with Ag, and run the simulation to test which of the solutions leaves a “coating” on the metal. Complete the chart below to show your results:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Metal** | **Mg(NO3)2 (aq)** | **Zn(NO3)2 (aq)** | **Cu(NO3)2 (aq)** | **AgNO3 (aq)** |
| **Mg** |  |  |  |  |
| **Zn** |  |  |  |  |
| **Cu** |  |  |  |  |
| **Ag** | *No reaction* | *No reaction* | *No reaction* | *No reaction* |

Based on the table data, list the metals in order of most active to least active:

Why didn’t all the metals react in all the solutions?

15. Click on “Activity 4.” Then, click on the metal, “Ag.” Then, click on “Start.” When the simulation directs you to do so, click on “Remove” and observe the metal.

16. You should have noticed that acid did NOT react with the silver (Ag) metal. This is because silver metal is a relatively INACTIVE metal.

17. Repeat Activity 4 by testing ALL of the metals in order. Make a sketch below of the end result of the simulation for each metal:

Cu Fe Mg Ni Pb Sn Zn

18. Based on your drawings of the simulations, list the 8 metals in order from the most ACTIVE metal (*reacted the most/produced most bubbles/most metal disintegrated*) to the least active metal in the acid. Ag, Cu, Fe, Mg, Ni, Pb, Sn, Zn

**Most ACTIVE metal**  **Least Active metal**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |  |  |

|  |  |
| --- | --- |
| **Metal** | **SOP** |
| Mg(s) | 2.38 |
| Zn(s) | 0.76 |
| Fe(s) | 0.41 |
| Cu(s) | 0.34 |
| Ni(s) | 0.23 |
| Sn(s) | 0.14 |
| Pb(s) | 0.13 |
| H2(g) | 0.00 |
| Ag(s) | -0.80 |

19. How does the chart you just made using simulated results compare with the table of actual metallic activity? The chart to the right shows that Magnesium is the most active metal while silver is the least active of the metals listed. How do the others compare?

[SOP] refers to the Standard Oxidation Potential of each metal. The higher the value, the more likely the metal will lose electrons.

ANSWERS

1. Click on “**Start**.” Observe the top four beakers … label them on the lines below the beakers:

**Ag+**

**Cu+2**

**Zn+2**

**Mg+2**

**Mg(NO3)2 (aq) Zn(NO3)2 (aq) Cu(NO3)2 (aq) AgNO3 (aq)**

2. Move the cursor over the Mg(NO3)2 (aq) beaker and LEFT click … draw the METAL ions from the simulation in the appropriate beaker ABOVE.

* Do the same for the Zn(NO3)2 (aq), Cu(NO3)2 (aq), AgNO3 (aq) beakers.

3. Click on “**Activity 1**.” Now click on “**Molecular Scale Reactions**.”

4. Drag the Copper metal and place it in the AgNO3 (aq) . Then, click the “Start” icon.

5. Once the simulation stops, click the “Step by Step” icon. Notice in this reaction that the **electrons** are transferred directly from a copper atom to two silver ions (Ag+). Write the SECOND equation:

Cu (s) + **2 Ag+  (aq) 🡪 2 Ag (s) + Cu+2  (aq)**

6. Click “Start.” This is an **oxidation-reduction** reaction. When a pair of Ag+ ions collide at the surface of the copper electrode, a copper atom releases two **electrons** to the Ag+ ions. The Copper atom enters the solution as Cu+2 ions. The **oxidation** half reaction is:

**Cu (s)** 🡪 **Cu+2  (aq)** + **2 e-** [*click “Next Step”]*

A neutral Copper atom loses **2** electrons and forms a Cu+2 ion. The oxidation state of Copper changes from **0** to **+2**. Notice there has been a **gain** in oxidation state of the Copper atom. [*click “Next Step”*]

The Ag+ ion from the Silver I Nitrate solution captures one **electron** and attaches on the copper electrode as neutral Silver atom. The **reduction** half reaction is:

**Ag+ (aq)** + **1 e-** 🡪 **Ag (s)**  [*click “Next Step”]*

A Silver [Ag+ (aq) ] ion gains **1** electron to form a neutral Silver atom. The oxidation state of Silver changes from **+1** to **0**. [*click “Back” to return to the “Animations of the reactions in molecular level”]*

7. What happened to the Copper Metal in the Silver I nitrate solution?

**There is a silver metal coating on the copper strip.**

8. Click “Reset.” Place the Copper metal into the Mg(NO3)2 (aq) beaker. Click “Start” to play the simulation. What happens?

**The Cu+2 ions bounce off the Magnesium metal 🡪 no reaction**

9. Click “Reset.” Place the Copper metal into the Zn(NO3)2 (aq) beaker. Click “Start” to play the simulation. What happens?

**The Cu+2 ions bounce off the Zinc metal 🡪 no reaction**

10. Click “Reset.” Drag the magnesium metal and place it in the Cu(NO3)2 (aq) . Then, click the “Start” icon.

11. Once the simulation stops, click the “Step by Step” icon. Notice in this reaction that the **electrons** are transferred directly from a **Magnesium** atom to a Cu+2 ion. Write the SECOND equation:

**Mg (s) + Cu+2  (aq) 🡪 Cu (s) + Mg+2  (aq)**

12. Click “Start.” This is an **oxidation-reduction** reaction. When a Cu+2 ion collides at the surface of the Magnesium electrode, a Magnesium atom releases two **electrons** to the Cu+2 ion. The Magnesium atom enters the solution as Mg+2 ions. The **oxidation** half reaction is:

**Mg (s) 🡪 Mg+2  (aq) + 2 e-** [*click “Next Step”]*

A neutral Magnesium atom loses **2** electrons and forms a Mg+2 ion. The oxidation state of Magnesium changes from **0** to **+2**. Notice there has been a **gain** in oxidation state of the Magnesium atom. [*click “Next Step”*]

The Cu+2 ion from the Copper II Nitrate solution captures two **electrons** and attaches on the Mg electrode as neutral Copper atom. The **reduction** half reaction is:

**Cu+2 (aq) + 2 e- 🡪 Cu (s)**  [*click “Next Step”]*

A Copper [Cu+2 (aq) ] ion gains **2** electrons to form a neutral Copper atom. The oxidation state of Copper changes from **+2** to **0**. [*click “Back” to return to the “Animations of the reactions in molecular level”]*

13. What happened to the Magnesium Metal in the Copper II nitrate solution?

**There is a copper metal coating on the magnesium strip.**

14. Click “Back” to return to the screen that says, “Use the mouse to pick a metal …” Click on each metal (one at a time) beginning with Ag, and run the simulation to test which of the solutions leaves a “coating” on the metal. Complete the chart below to show your results:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Metal** | **Mg(NO3)2 (aq)** | **Zn(NO3)2 (aq)** | **Cu(NO3)2 (aq)** | **AgNO3 (aq)** |
| **Mg** | *No reaction* | ***Zinc coating*** | ***Copper coating*** | ***Silver coating*** |
| **Zn** | *No reaction* | *No reaction* | ***Copper coating*** | ***Silver coating*** |
| **Cu** | *No reaction* | *No reaction* | *No reaction* | ***Silver coating*** |
| **Ag** | *No reaction* | *No reaction* | *No reaction* | *No reaction* |

Based on the table data, list the metals in order of most active to least active:

**Mg 🡪 Zn 🡪 Cu 🡪 Ag**

Why didn’t all the metals react in all the solutions?

15. Click on “Activity 4.” Then, click on the metal, “Ag.” Then, click on “Start.” When the simulation directs you to do so, click on “Remove” and observe the metal.

16. You should have noticed that acid did NOT react with the silver (Ag) metal. This is because silver metal is a relatively INACTIVE metal.

17. Repeat Activity 4 by testing ALL of the metals in order. Make a sketch below of the end result of the simulation for each metal:

Cu Fe Mg Ni Pb Sn Zn

Dissolved fully – faster than other metals

Dissolved fully – fast, but not as fast as Mg

18. Based on your drawings of the simulations, list the 8 metals in order from the most ACTIVE metal (*reacted the most/produced most bubbles/most metal disintegrated*) to the least active metal in the acid. Ag, Cu, Fe, Mg, Ni, Pb, Sn, Zn

**Most ACTIVE metal**  **Least Active metal**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Mg | Zn | Fe | Cu | Ni | Sn | Pb | Ag |

|  |  |
| --- | --- |
| **Metal** | **SOP** |
| Mg(s) | 2.38 |
| Zn(s) | 0.76 |
| Fe(s) | 0.41 |
| Cu(s) | 0.34 |
| Ni(s) | 0.23 |
| Sn(s) | 0.14 |
| Pb(s) | 0.13 |
| H2(g) | 0.00 |
| Ag(s) | -0.80 |

19. How does the chart you just made using simulated results compare with the table of actual metallic activity? The chart to the right shows that Magnesium is the most active metal while silver is the least active of the metals listed. How do the others compare?

[SOP] refers to the Standard Oxidation Potential of each metal. The higher the value, the more likely the metal will lose electrons.

**From most to least active:**

**Mg will lose electrons to those below**

**Zn will lose electrons to those below and not with those above**

**Fe will lose electrons to those below and not with those above**

**Cu will lose electrons to those below and not with those above**

**Ni will lose electrons to those below and not with those above**

**Sn will lose electrons to those below and not with those above**

**Pb will lose electrons to those below and not with those above**

**H2 will lose electrons to those below and not with those above**

**Ag will not lose electrons to those above**