

## Dancing Elements

It's a chemistry brain training game that tests chemistry concepts along with aptitude and analytical ability.

### Mapped to

10<sup>th</sup> - Acids, Bases and Salts

7<sup>th</sup> - Acids, Bases and Salts

### It will test knowledge of

- Identification of Acids, Bases and Salts - 7<sup>th</sup>
- Action of indicators - 7<sup>th</sup>
- Definitions of acids, bases and salts - 10<sup>th</sup>
- Classification of acids, bases and salts - 10<sup>th</sup>

### Concepts

The ions will be given and a student have to form compounds using these ions, there will be constraint over the type of compound to be formed.

For eg.: Compound should be acid etc.

Ions:

When an element loses or gains electron it becomes ion.

Ions are of two types:

Cations: When an element loses electron(s), it gains positive charge and this kind of ion having positive charge is known as cation.

For eg:  $\text{Na}^+$ ,  $\text{Mg}^{2+}$ ,  $\text{Al}^{3+}$

Anions: When an element gain electron(s), it gains negative charge and this kind of ion having negative charge is known as anion.

For eg:  $\text{Cl}^-$ ,  $\text{O}^{2-}$ ,  $\text{SO}_4^{2-}$ ,  $\text{OH}^-$

NOTE: A ion can also be polyatomic like  $\text{OH}^-$

Key concept 1: A compound is formed when cation combine in definite proportion with anion.

Every ion have charge over them. This charge is known as valency.

Following cross multiplication of valency should be done for forming compound.



Cations having valencies are as follow:

- +1 : H (Hydrogen), Li (Lithium), Na (Sodium), K(Potassium)
- +2: Be (Beryllium), Mg (Magnesium)
- +3: B (Boron), Al (Aluminum)

Anions having valencies are as follows:

- 1: F (Fluorine), Cl (Chlorine), Br(Bromine), I (Iodine),  $\text{OH}^-$  (Hydroxyl ion),  $\text{NO}_3^-$ ,
- 2: O (Oxygen), S (Sulphur),  $\text{SO}_4^{2-}$  (Sulphate ion)
- 3:  $\text{PO}_3^{3-}$  (Phosphate ion)

A compound is acid if its cation is  $\text{H}^+$  (except  $\text{H}_2\text{O}$  its neutral).

A compound is basic if its anion is  $\text{OH}^-$ .

A compound is salt if its cation and anion are not  $\text{H}^+$  &  $\text{OH}^-$  respectively. (except  $\text{H}_2\text{O}$  its neutral).

## What student should learn through simulations?

1. User should be able to form compounds by joining one or more ions.
2. He should be able to identify between acid, bases and salts.

## Description

There will be some moving chemical elements (In this discussion, when we say “element”, we are not referring to the chemical meaning of elements, instead we mean any entity that appears in the leftmost rectangle - be it ions, atoms, molecules etc) like  $\text{Na}^+$ ,  $\text{Cl}^-$ ,  $\text{NH}_4^+$ ,  $\text{HSO}_4^-$  etc. Student has to select the pair of elements to form compounds based on some given constraint. These elements and constraints will keep changing with different level. More are the compounds formed, more would be the score.

But one level should not take more than 2 minutes, else it will be boring. So here we will be trying to do something like lumosity and elevate apps. In these apps, games are simple, but tests our analytical and aptitude approach.

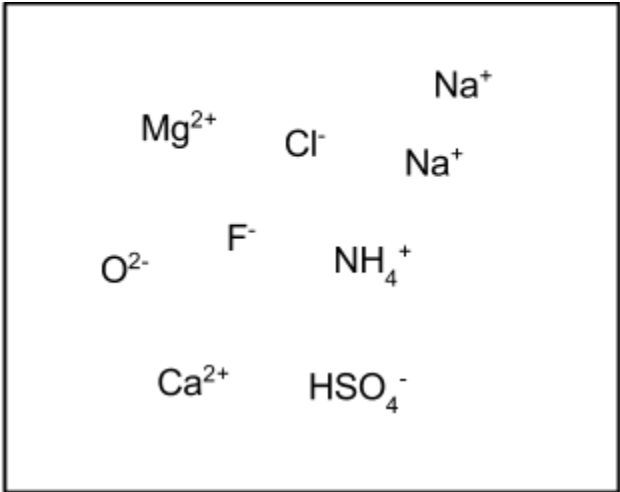
Same elements can be present in multiple times. This will test students knowledge of valency.

**Example:** A student will be asked to form as many compounds as possible from a given set of elements with a constraint, say, the compound should be acidic in nature.

## Snapshots

Following are an indicative snapshot of how the simulations can look.

Snap 1:

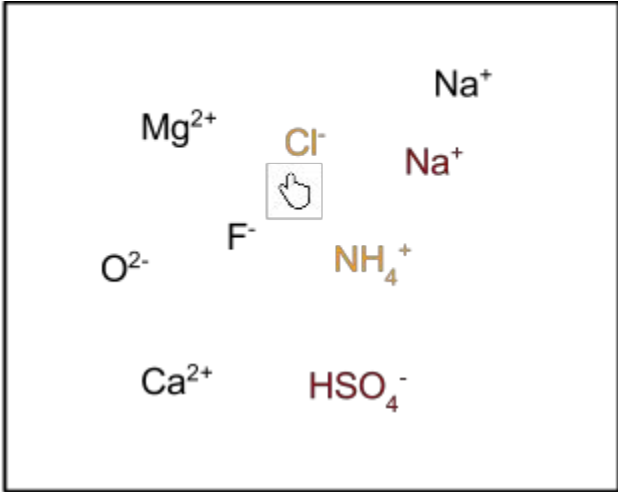
 <p>Mg<sup>2+</sup> Cl<sup>-</sup> Na<sup>+</sup> O<sup>2-</sup> F<sup>-</sup> NH<sub>4</sub><sup>+</sup> Ca<sup>2+</sup> HSO<sub>4</sub><sup>-</sup></p>	<p>Instructions: Select elements from adjacent rectangle and form as many as compounds possible with following constraint:</p> <p>Constraint: The compound should be acidic.</p>
<p>Compound formed will be shown here. More compounds = More score.</p>	

Score

In this stage (Initial stage):

- Elements are dancing. (The no. of elements can be randomised between some predefined range, Also same element can be present in multi times. Like Na<sup>+</sup> in given condition)
- Instructions are given on right dialog box.

Snap 2:

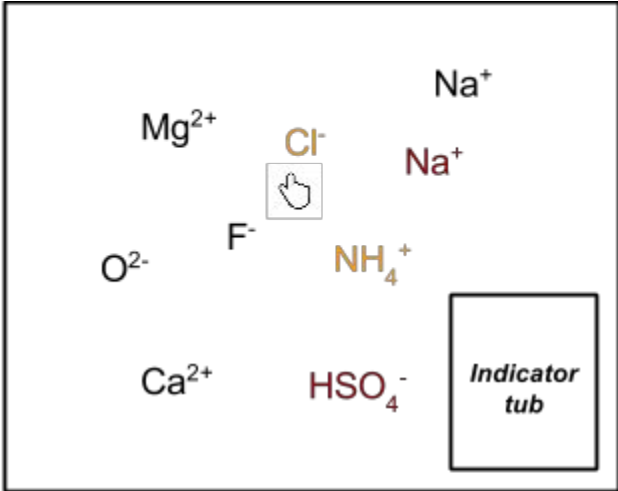
	<p>Instructions: Select elements from adjacent rectangle and form as many as compounds possible with following constraint:</p> <p>Constraint: The compound should be acidic.</p>
<p>NaHSO<sub>4</sub>, NH<sub>4</sub>Cl,</p>	

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In this stage (Mid stage)

- When one element is selected, it would increase in font size and would show a change in color ( an “interaction” to show that it is selected ). When it is paired with another element, it would also show the same color. (an “interaction” to show that it is paired with the previous element).
- The score will be increased if the pairing is done correctly (a user “interaction” to show correctness).
- The lower rectangular box shall have all paired elements as compounds.

### Snap 3: Easy stage with hint (Indicator tub)

	<p>Instructions: Select elements from adjacent rectangle and form as many as compounds possible with following constraint:</p> <p>Constraint: The compound should be acidic.</p>
<p>NaHSO<sub>4</sub>, NH<sub>4</sub>Cl,</p>	

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The indicator tub makes it easy to recognise the acids and bases by change of color.

When any formed acidic or basic compounds are dragged to **indicator tub**, it changes its color.

(The mentioned user “interactions” are just for indicative purpose, the UX/UI designer can use their own “interactions”. )

## Parameters

- Elements
- No. of dancing elements
- No. of cations & anions in the dancing elements
- Constraint

## Implementation

The different elements classified on the basis of their nature are:

Cations:  $\text{Na}^+$ ,  $\text{Mg}^{2+}$ ,  $\text{NH}_4^+$ ,  $\text{H}^+$ ,  $\text{Ca}^{2+}$ ,  $\text{K}^+$

Anions:  $\text{Cl}^-$ ,  $\text{CH}_3\text{COO}^-$ ,  $\text{SO}_4^{2-}$ ,  $\text{CO}_3^{2-}$ ,  $\text{NO}_3^-$ ,  $\text{HS}^-$ ,  $\text{OH}^-$ ,  $\text{O}^{2-}$

The elements classified on the basis of their valency are:

Valency\_1:  $\text{Na}^+$ ,  $\text{NH}_4^+$ ,  $\text{H}^+$ ,  $\text{K}^+$  ;  $\text{Cl}^-$ ,  $\text{CH}_3\text{COO}^-$ ,  $\text{HS}^-$ ,  $\text{NO}_3^-$ ,  $\text{OH}^-$

Valency\_2:  $\text{Mg}^{2+}$ ,  $\text{Ca}^{2+}$  ;  $\text{SO}_4^{2-}$ ,  $\text{CO}_3^{2-}$ ,  $\text{O}^{2-}$

For our convenience, we define

*base ions* as **either**  $\text{OH}^-$  or  $\text{O}^{2-}$

*acid ions* as **either**  $\text{NH}_4^+$  or  $\text{H}^+$

The solution will be considered valid only when following condition is fulfilled:

1. An anion and cation are joined together.
2. Valency\_1 element will require one element of valency\_1
3. Two Valency\_1 element will be required to form compound with valency\_2 element.
4. Valency\_2 elements will require two elements of valency\_1.
5. Valency\_2 elements will require one element of Valency\_2

**Acidic Compounds** - Those compounds which are formed when any anion ( except base ions) are paired with acid ions.

**Basic Compounds** - Those compounds which are formed when any cation (except acid ions) are paired with base ions.

**Salts:** Those compounds which are formed when cations and anions mix in appropriate numbers.

**Neutral:** Salts + H<sub>2</sub>O

### Hint Implementation

Single ion cannot be dragged to the indicator tub. Only a compound can be dragged to the tub.

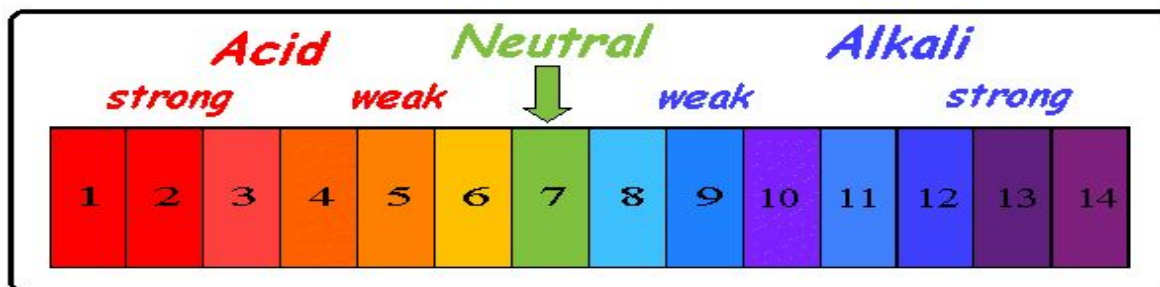
Two indicators will be used:

1. Litmus indicators: Common acid base indicator

- Initially the litmus solution will be purple in color.
- When acidic compound is dragged to the litmus indicator tub.
  - Color changes to red
- When basic compound is dragged to the litmus indicator tub
  - Color changes to blue
- When a neutral or salt is dragged to the litmus indicator tub
  - Color doesn't change

2. pH indicator: Universal indicator

Follow the following color chart:





### **Level 1 - Constraints & its solution** (Mapped to 7<sup>th</sup>)

1. Compound is sour in taste. (Constraint)  
Those compounds which are formed when any anion ( except base ions) are paired with acid ions.
2. Compound is corrosive in touch (Constraint)  
Those compounds which are formed when any anion ( except base ions) are paired with acid ions.
3. Compound is bitter in taste (Constraint)  
Those compounds which are formed when any cation ( except acid ions) are paired with base ions.
4. Compound is soapy in touch (Constraint)  
Those compounds which are formed when any cation ( except acid ions) are paired with base ions.
5. Compound will turn blue litmus red (Constraint)  
All acidic compounds
6. Compound will turn red litmus blue (Constraint)  
All basic compounds

## Level 2 - Constraints & its solution (Mapped to 10th)

All Level 1 constraints + followings:

1. Compounds should be acidic. (Constraint)  
Those compounds which are formed when any anion ( except base ions) are paired with acid ions.
2. Compounds should be basic. (Constraint)  
Those compounds which are formed when any cation ( except acid ions) are paired with base ions.
3. Compound should be a salt (Constraint)  
Those compounds which are formed when cations and anions mix in appropriate numbers.

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More constraints and solutions can be added very easily if a chemistry engine framework is applied to the simulation.

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## Test Cases

All test cases are discussed in constraint and its solution itself.

## References

- [Lumosity](#)
- NCERT Science Textbook 7th & 10th