

Students' Misconceptions in chemistry

Savita Ladage

savital@hbcse.tifr.res.in

**Homi Bhabha Centre for Science Education
Tata Institute of Fundamental Research
V.N. Purav Marg, Mankhurd,
Mumbai 88**

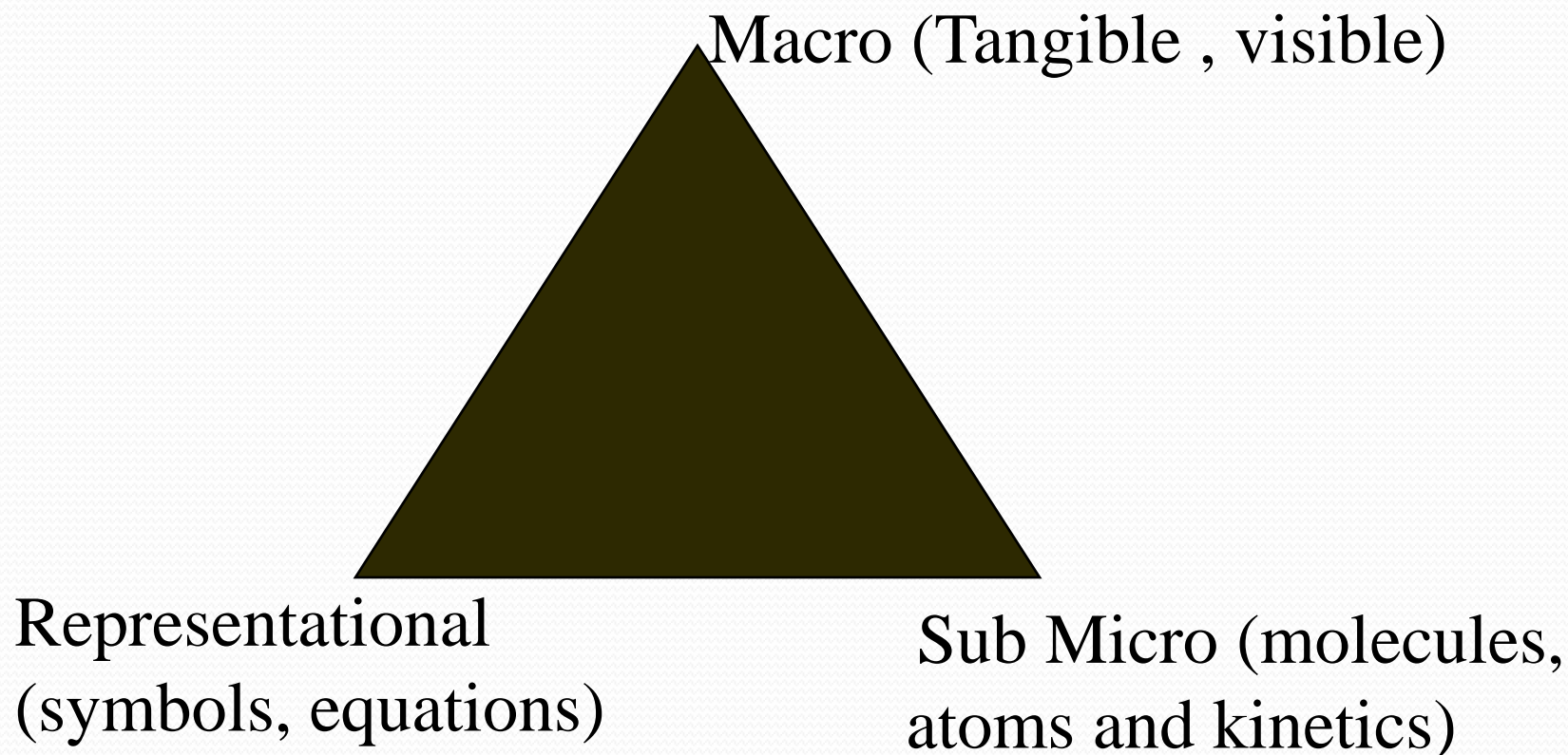


Outline of the Talk

- ❖ Why chemistry is difficult?
- ❖ Background regarding Misconceptions
- ❖ Tools used to study misconceptions
- ❖ Misconceptions in chemistry

Why chemistry is difficult?

Three components of chemistry



(Johnstone , A.H., 1991)

Background

Around 1960 (Sputnik wave)

Major Curriculum reforms

- Updating the subject matter (content was excellent, attractive and intellectually stimulating)
- Practical work (Discovery approach – emphasis on scientific processes) (away from Demonstrations)

End Result

- Failure of the 1960's curriculum reforms pushed a group of chemists asked questions about learning (against Teaching)
- Chemists had to pay attention to Psychology which started the field of research in chemistry education (late 1970s and early 80s)
- Misconceptions studies started in chemistry

Misconceptions

- *mis*: do not interpret as wrong – we assign them inferior status and start looking down upon them.
- *mis*: different from scientific concepts, there are reasons and we need to understand them,
- Most of us can have them, it is not true that only students will have them.

Constructivist Philosophy

- Students are not passive receptors of knowledge whereas they active constructors of the knowledge.
- New knowledge is always interpreted in terms of the old existing knowledge.
- Today, the position of learner more central to teaching learning process.

Tool: Diagnostic Tests

Consist of conceptual questions

Type of questions

Recall questions

What is symbol of potassium or what is formula of copper sulphate?

Algorithmic questions

ask students to use information or processes in a familiar way.

Write the electron configuration of a sodium atom and identify the number of electrons in outermost orbit.

Conceptual questions (Higher order questions)

present a unfamiliar or new chemical situation that a student has not trained with and ask the student to

- Justify a choice.
- Predict what happens next.
- Explain why something happens.
- Explain how something happens.
- Extract useful data from an excess of information.

Reference

<http://www.jce.divched.org/JCEDLib/QBank/collection/CQandChP/CQs/WhatAreCQs.html>

Examples of conceptual questions

Following is a list of properties of a sample of solid sulfur:

- i) Brittle crystalline solid
- ii) Melting point of 113°C .
- iii) Density of 2.1 g/cm^3
- iv) Combines with oxygen to form sulfur dioxide

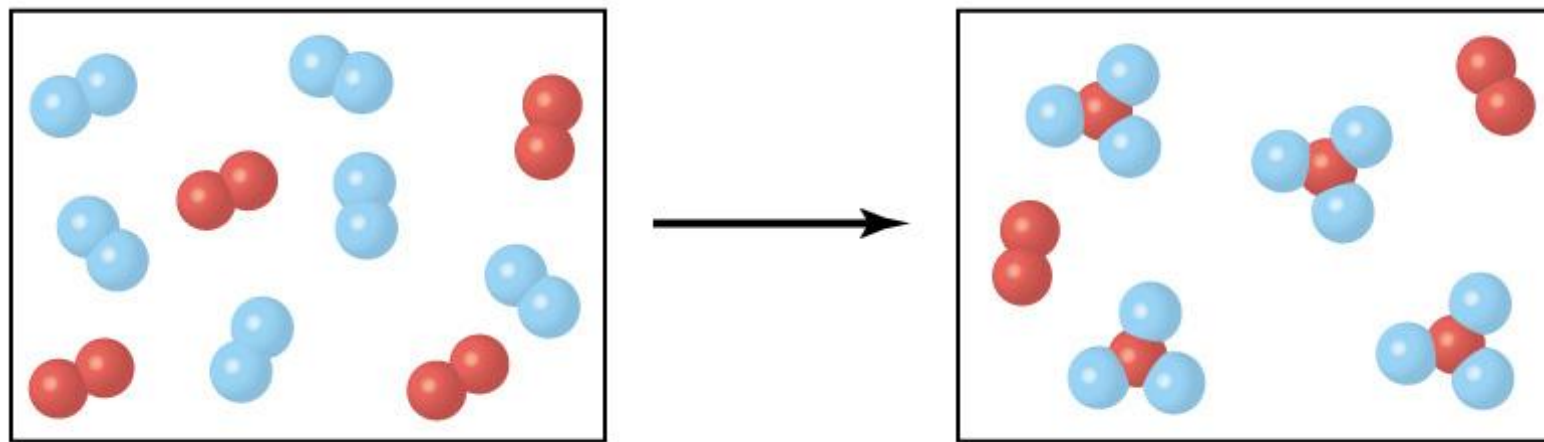
Which, if any, of these properties would be the same for one single atom of sulfur obtained from the sample?

- a) i and ii only
- b) iii and iv only.
- c) iv only.
- d) All of the properties.

Reference:

http://www.jce.divched.org/JCEDLib/QBank/collection/CQandChP/CQs/ConceptsInventory/pConcepts_Inventory.html

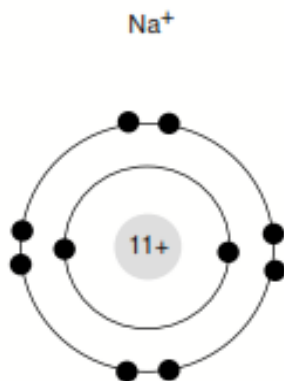
The following diagram represents the reaction of A_2 (red spheres) with B_2 (blue spheres):



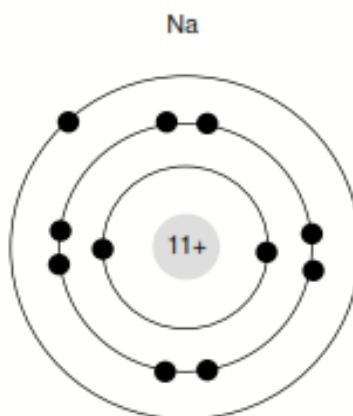
- Write a balanced equation for the reaction and identify the limiting reactant.
- How many moles of product can be made from 1.0 mol of A_2 and 1.0 mol of B_2 ?

Chemical stability (1)

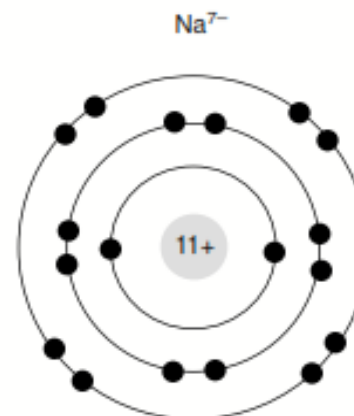
The diagrams below represent three chemical species:-



Sodium ion with
electronic configuration
of 2.8



Sodium atom with
electronic configuration
of 2.8.1



Sodium ion with
electronic configuration
of 2.8.8

1. Tick ☒ one of the four statements:

- ☐ Na^+ is more stable than Na
- ☐ Na^+ and Na are equally stable
- ☐ Na^+ is less stable than Na
- ☐ I do not know

Why did you think this was the answer?

2. Tick ✓ one of the four statements:

Why did you think this was the answer?

☐

Na is more stable than Na^{7-}

☐

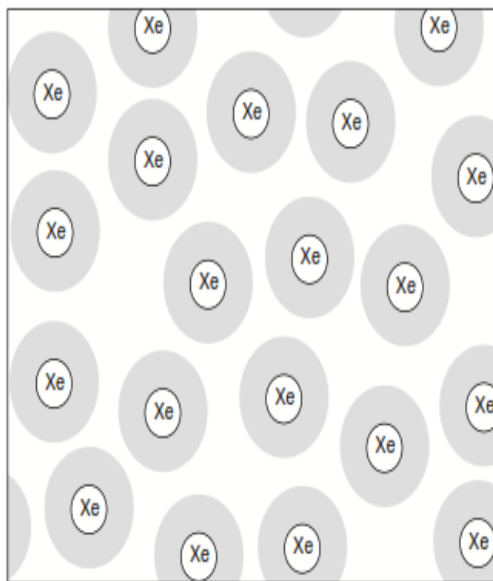
Na and Na^{7-} are equally stable

☐

Na is less stable than Na^{7-}

☐

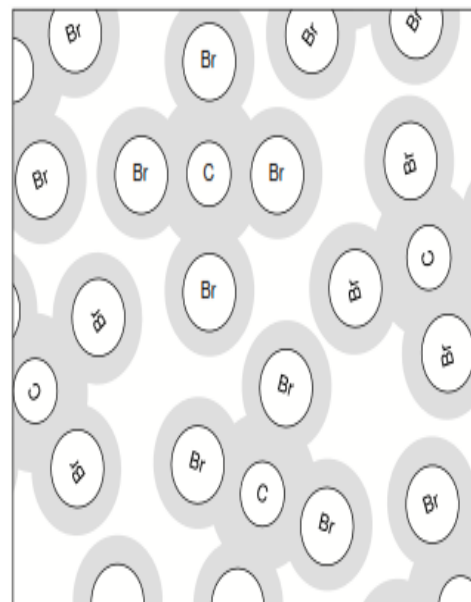
I do not know



5. This diagram shows particles in


I think this because

(Reference: <http://www.rsc.org/Education/Teachers/Resources/Books/Misconceptions.asp>)

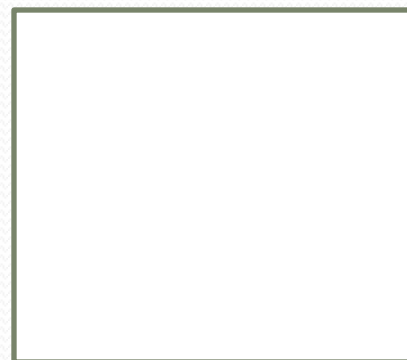
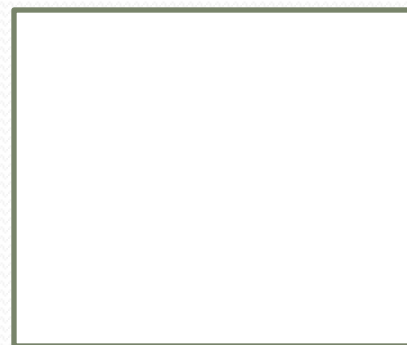


4. This diagram shows particles in

I think this because

If one atom of Hydrogen is shown as 
and one atom of oxygen is shown as 

Draw diagrams for following symbols



Tool :Clinical Interviews

Purpose

To understand the thinking and reasoning of Individuals (Often video recorded)

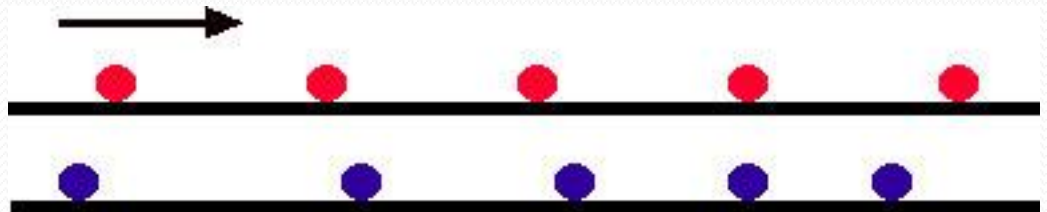
Caution (Most important)

The interviewer should not interfere with students thinking process

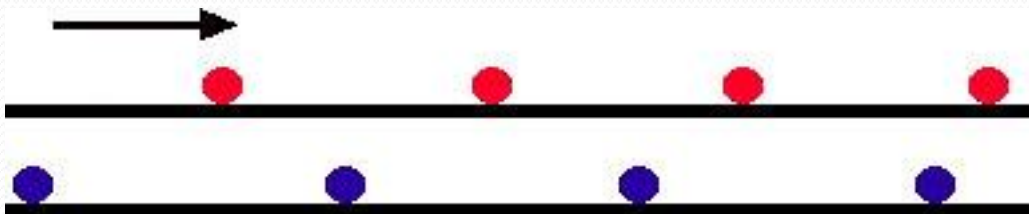
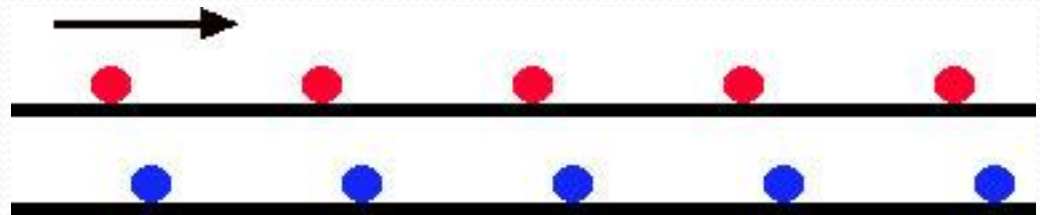
Examples in physics

Below is a diagram representing a strobe photograph of two balls rolling (to the right) parallel to each other along two tracks. Students are asked to select where the two balls have the same speed.

Misconception : Same position means same speed.






- Below is a strobe photograph of two balls rolling (to the right) parallel to each other on two tracks. Students are asked to determine which, if either, of the two balls is moving faster.
- Leading (following) particle moves at a faster (slower) speed.



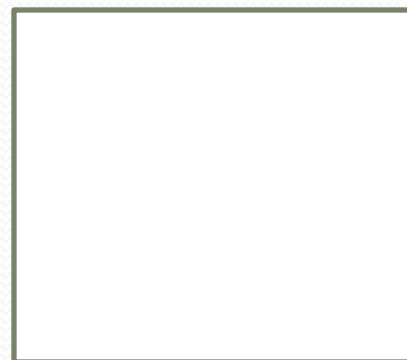
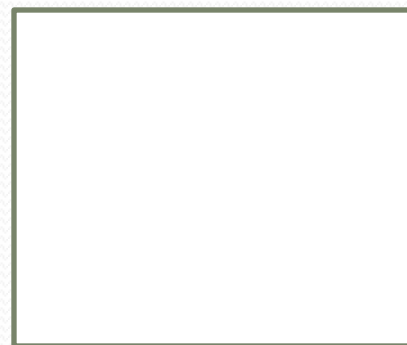
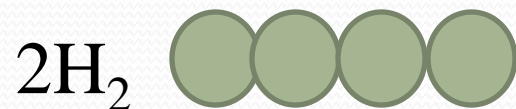
Misconceptions : some examples


- The pressure affects the shape of molecule.
- No reaction is possible at equilibrium (stand still)
- The molecules of same substance change shape in different states.
- The mass of the molecules differ in different states.
- A reaction between an acid and base always produces neutral salt.






- 
- Different materials (flour, nails, water) placed for a long time in a room which is at a certain temperature remain at different temperatures.
 - Collisions between particles cause heat.
 - Breaking chemical bonds releases energy.
 - Melting and dissolving are the same thing.
 - The space between atoms and molecules is not empty.

If one atom of Hydrogen is shown as 
and one atom of oxygen is shown as 

Draw diagrams for following symbols



If one atom of Hydrogen is shown as  then how will you represent 3H_2 ?

Answer      

Nitrogen  2NH_3     

Conclusions

- As a teacher we should be aware about misconceptions
- Learning environment is important and thus generate opportunities for engaging students in higher order processing
- Create opportunities so that help students to deal all three sides of chemistry triangle (activities, experiments, models, are important and to be designed carefully)



THANK YOU