Making a Model of a Superconductor Unit Cell

Materials: 16 copper atoms (Yellow),
20 oxygen atoms (White),
2 barium atoms (Green),
1 yttrium (Orange),
8 long bonds,
32 medium bonds,
8 short bonds.

The material you will be making a model of is commonly referred to as YBCO. This substance is better represented by: $YBa_2Cu_3O_7$. However, since these unit cells are arranged in layers to form a crystalline substance, some of the oxygen atoms are shared and/or missing between layers. So an even better formula for this substance is $YBa_2Cu_3O_{7-x}$.

Consult the diagram on back to create a three-dimensional model that represents a UNIT CELL of a superconducting substance.

Notice that the base is rectangular. This formation is referred to as orthogonal.
Notice in the base that two sides have direct Cu – Cu connections, while two sides have Cu – O – Cu connections. Notice that detail for each layer as you build the model.

Notice that one Barium atom is centered in the top "box" and one Barium atom is centered in the bottom "box," whereas one Yttrium atom is centered in the middle "box."
How can you "suspend" these atoms to indicate this location?
Consult your teacher for appropriate selected materials.

Use a small label created from paper and tape to label one of each of the different components of your model.

The general electron flow is through the horizontal Cu – O layers.
Indicate this on your model.

Evaluate your model.

What does this model accurately represent?

What does this model <u>not</u> accurately represent about the YBCO unit cell?

How could you improve this model or build a more representative model?

Teacher/KEY

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The material you will be making a model of is commonly referred to as YBCO (pronounced *ib-co*, or *why – bee – see – oh*). This substance is better represented by: $YBa_2Cu_3O_7$. However, since these unit cells are arranged in layers to form a crystalline substance, some of the oxygen atoms are shared and/or missing between layers. So an even better formula for this substance is $YBa_2Cu_3O_{7-x}$.

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Notice that one Barium atom is centered in the top "box" and one Barium atom is centered in the bottom "box," whereas one Yttrium atom is centered in the middle "box."
How can you "suspend" these atoms to indicate this location?
Consult your teacher for appropriate selected materials. ***String, tape, more bonds, etc.***

Use a small label created from paper and tape to label one of each of the different components of your model.

The general electron flow is through the horizontal Cu – O layers.
Indicate this on your model.

Evaluate your model.

What does this model accurately represent? ***General arrangement of the atoms; overall shape of the unit cell/crystal***

What does this model <u>not</u> accurately represent about the YBCO unit cell? ***Not to scale in many, many ways; interactions with the central bariums and yttrium; bond angles***

How could you improve this model or build a more representative model?
Any acceptable improvements, most based on size/scale and bond angles; "better" materials to allow for this