### [What is Save? - Computer Hope ← no hope](https://www.computerhope.com/jargon/s/save.htm)

https://www.computerhope.com › Dictionary › S - Definitions

HISPANIC! At the disco. I'm sorry.

<http://www.peck-polymers.com/rubber>

Material Science Notes

<http://webs.wichita.edu/scienceolympiad/Coaches_Workshop/Handouts/2013-2014/2014_Material_Science%20(C).pdf> ← important

<https://quizlet.com/158958492/flashcards>← also important

<https://quizlet.com/185769511/flashcards>←

<https://en.wikipedia.org/wiki/Plastic>

The vast majority of organic [polymers](https://en.wikipedia.org/wiki/Polymer) are formed from *chains of* [*carbon*](https://en.wikipedia.org/wiki/Carbon) *atoms*, 'pure' or with the addition of: [oxygen](https://en.wikipedia.org/wiki/Oxygen), [nitrogen](https://en.wikipedia.org/wiki/Nitrogen), or [sulfur](https://en.wikipedia.org/wiki/Sulfur)

The [backbone](https://en.wikipedia.org/wiki/Backbone_chain) is the part of the chain that is on the "main path", linking together a large number of [repeat units](https://en.wikipedia.org/wiki/Repeat_unit). To customize the properties of a plastic, different molecular groups "hang" from this backbone.

**Thermoplastics** are the plastics that, when heated, do not undergo chemical change in their composition and so can be molded again and again. Examples include: [polyethylene](https://en.wikipedia.org/wiki/Polyethylene) (PE), [polypropylene](https://en.wikipedia.org/wiki/Polypropylene) (PP), [polystyrene](https://en.wikipedia.org/wiki/Polystyrene) (PS) and [polyvinyl chloride](https://en.wikipedia.org/wiki/Polyvinyl_chloride) (PVC).

Thermoplastics can be remelted and reused, and thermoset plastics can be ground up and used as filler, although the purity of the material tends to degrade with each reuse cycle.

**Thermosets**, or **thermosetting polymers**, can melt and take shape only once: after they have solidified, they stay solid.[[13]](https://en.wikipedia.org/wiki/Plastic#cite_note-13) In the thermosetting process, a chemical reaction occurs that is irreversible.

1. [Polyethylene terephthalate](https://en.wikipedia.org/wiki/Polyethylene_terephthalate) (PET or PETE)
2. [High-density polyethylene](https://en.wikipedia.org/wiki/High-density_polyethylene) (HDPE)
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##### **Fillers**

Filler materials are most often added to polymers to improve tensile and compressive strengths, abrasion resistance, toughness, dimensional and thermal stability, and other properties. Materials used as particulate fillers include wood flour (finely powdered sawdust), silica flour and sand, glass, clay, talc, limestone, and even some synthetic polymers.Typically fillers are mineral in origin, e.g., [chalk](https://en.wikipedia.org/wiki/Chalk). Other fillers include: [starch](https://en.wikipedia.org/wiki/Starch), [cellulose](https://en.wikipedia.org/wiki/Cellulose), [wood flour](https://en.wikipedia.org/wiki/Wood_flour), [ivory dust](https://en.wikipedia.org/w/index.php?title=Ivory_dust&action=edit&redlink=1) and [zinc oxide](https://en.wikipedia.org/wiki/Zinc_oxide). most fillers are relatively [inert](https://en.wikipedia.org/wiki/Chemically_inert) and inexpensive materials, make the product cheaper by weight. [stabilizing additives](https://en.wikipedia.org/wiki/Stabilizer_(chemistry)) include [fire retardants](https://en.wikipedia.org/wiki/Fire_retardant), to lower the flammability of the material. some fillers are more chemically active and are called: [reinforcing agents](https://en.wikipedia.org/w/index.php?title=Reinforcing_agent&action=edit&redlink=1).

### **Stabilizers**

[Stabilizers](https://en.wikipedia.org/wiki/Stabilizer_(chemistry)) prolong the lifetime of the polymer by suppressing degradation that results from UV-light, oxidation, and other phenomena. Typical stabilizers thus absorb UV light or function as antioxidants.

##### **Plasticizers**

The flexibility, ductility, and toughness of polymers may be improved with the aid of additives called plasticizers. Their presence also produces reductions in hardness and stiffness. Plasticizers are generally liquids having low vapor pressures and low molecular weights. The small plasticizer molecules occupy positions between the large polymer chains, effectively increasing the interchain distance with a reduction in the secondary intermolecular bonding.

1-PETE 2–HDPE 3-PVC 4-LDPE 5-PP 6-PS 7-Other

Plastics type marks: the [resin identification cod](https://en.wikipedia.org/wiki/Resin_identification_code)e

Pure plastics have low **toxicity** due to their insolubility in water and because they are biochemically inert, due to a large molecular weight. Plastic products contain a variety of additives, some of which can be toxic.

### **Polymers**

**Mechanical properties:** Polymers are low density, but not as stiff or strong as metals or ceramics. They are extremely ductile and pliable, chemically inert in a multitude of environments, nonmagnetic (diamagnetic), and usually are not conductive (polymers with a backbone of alternative double and single bonded carbon can conduct electricity through the movements of free electron pairs). Polymers soften or decompose at modest temperatures.

*Degree of polymerization:* The degree of polymerization, or DP, is defined as the number of monomer units in a macromolecule or polymer molecule. A homopolymer contains only one type of monomer unit, and the number-average degree of polymerization is given by

*Mn*/*M*0

where M(n) is the number-average molecular weight and M(0) is the molecular weight of the monomer unit.

<https://scioly.org/wiki/index.php/Materials_Science#Rules_Review>

In continuum mechanics, **stress** is a physical quantity that expresses the internal forces that neighboring particles of a continuous material exert on each other, while strain is the measure of the deformation of the material.

In engineering, the transition from [elastic](https://en.wikipedia.org/wiki/Elasticity_(physics)) behavior to plastic behavior is called [yield](https://en.wikipedia.org/wiki/Yield_(engineering)).

Time dependent recoverable deformation under load is called **anelastic deformation**, while the characteristic recovery of temporary deformation after removal of load as a function of time is called **elastic aftereffect**. Time dependent i.e. progressive permanent deformation under constant load/stress is called **creep**.

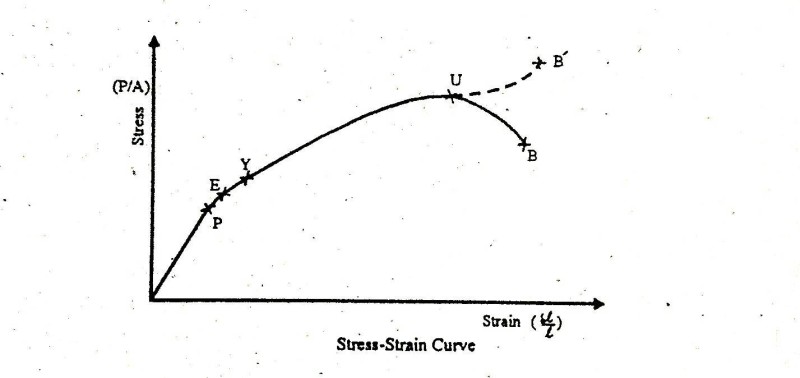
* Plastic deformation= permanent deformation (will not bounce/bend back like a spring)
* [Strength](https://en.wikipedia.org/wiki/Strength_of_materials): the strength of material is the amount of force it can withstand and still recover its original shape;
* Geometric stiffness: the geometric stiffness depends on shape, e.g. the bending stiffness of an [I beam](https://en.wikipedia.org/wiki/I_beam) is much higher than that of a rod made of the same steel, thus having the same rigidity, and same mass of material per length;
* [Hardness](https://en.wikipedia.org/wiki/Hardness): the hardness of a material defines the relative resistance that its surface imposes against the penetration of a harder body;
* [Toughness](https://en.wikipedia.org/wiki/Toughness): toughness is the amount of energy that a material can absorb before fracture.

Any [strain (deformation)](https://en.wikipedia.org/wiki/Deformation_(mechanics)) of a solid material generates an internal *elastic stress*, analogous to the reaction force of a [spring](https://en.wikipedia.org/wiki/Spring_(device)), that tends to restore the material to its original non-deformed state.

**Young's modulus**, also known as the [elastic modulus](https://en.wikipedia.org/wiki/Modulus_of_elasticity), is a measure of the [stiffness](https://en.wikipedia.org/wiki/Stiffness) of a solid material. It is a mechanical property of [linear](https://en.wikipedia.org/wiki/Linear_elasticity)[elastic](https://en.wikipedia.org/wiki/Elasticity_(physics)) solid materials. It defines the relationship between stress (force per unit area) and strain (proportional deformation) in a material.

**Poisson effect**, the phenomenon in which a material tends to expand in directions perpendicular to the direction of compression. Conversely, if the material is stretched rather than compressed, it usually tends to contract in the directions transverse to the direction of stretching.

**Tensile deformation** is deformation due to an object being pulled apart, as opposed to being pushed together (**compression deformation**) or pushed in opposite parallel directions (**shear deformation**).



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Up to **P**, stress and strain is proportional. Up to **E**, the material will bend back to original position. **Y** is where yield stress happens - material starts to bend exponentially. **Y** to **U** represents strain hardening **U** is where the material reaches breaking point.

recyclable 1 -- has a melting point of 255

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recyclable 6 -- melt at 100 to 120

PVC, or recyclable 3 -- melt at 75

### **Face Centered Cubic**

Also known as cubic close packed.

In the FCC cell, atoms are located at each of the 8 corners as well as in the centers of each of the 6 faces.

FCC follows an ABCABC close packing pattern - there are 3 repeating layers, where the atoms of the third layer are located above holes in the first and second layers.

FCC is the densest of the cubic packing arrangements, with an atomic packing factor of 0.74. Each unit cell contains 4 atoms and has a side length of

A=4R/2–√A=4R/2

.

Each atom in the FCC matrix has a coordination number of 12.



BCC Cell

### **Body Centered Cubic**

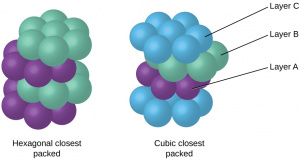
In the BCC cell, atoms are located at each of the 8 corners as well as in the center of the cubic cell.

BCC is less dense than FCC, with an atomic packing factor of 0.68. Each unit cell contains 2 atoms and has a side length of

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Each atom in the BCC matrix has a coordination number of 8.



HCP Cell

### **Hexagonal Close Packing**

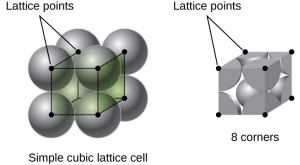
HCP is another close-packed arrangement.

The HCP cell is composed of two hexagons of 6 atoms each, an additional atom in the center of each hexagon, and a triangle of atoms in between the two hexagons.

HCP differs from FCC in that HCP follows an ABAB packing pattern - there are only 2 repeating layers, where the atoms of the third layer are located above the atoms of the first layer, not above gaps.

HCP also has an atomic packing factor of 0.74, the maximum possible. Each unit cell contains 6 atoms and has two parameters, A (side length) and B (height).

Each atom in the HCP matrix has a coordination number of 12.



SC Cell

### **Simple Cubic**

Simple cubic is a very basic arrangement, only containing atoms at each corner of the unit cell.

SC is the least dense, with an atomic packing factor of 0.52. Each unit cell contains 1 atom and has a side length of

A=2RA=2R

Each atom in the SC matrix has a coordination number of 6.

### **Atomic Packing Factor (APF)**

The atomic packing factor describes the amount of space occupied by atoms.

For example, in the simple cubic packing, each cell has side length 2R and contains 1 atom of radius R.

The volume occupied by the atom is

(4/3)π∗R3(4/3)π∗R3

, while the total volume is

(2R)3=8R2(2R)3=8R2

The fraction of space occupied by atoms is

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= [pi/6] = 0.524, exactly the amount listed above.

This equation will work for any of the other crystal structures assuming the correct side lengths are used.

## Organic Nomenclature

The most common system of naming organic compounds (hydrocarbons and derivative molecules) is the IUPAC system. You could also be tested on traditional names of some common compounds

Parent chain

The first step in naming an organic molecule is identifying the parent chain - a single continuous chain that forms the basis of the systematic IUPAC name. This typically also involves noting any functional groups and determining their precedence. The parent chain is determined by three characteristics, in order of precedence:

1) the chain that contains the largest number of the highest precedence [functional group](https://scioly.org/wiki/index.php/Materials_Science/Polymers#Functional_Groups).

2) the chain that contains the most double/triple bonds.

3) the longest chain.

Once the parent chain is determined, it is named based on its length. This forms the stem of the molecule's name.

Only the most common names are listed above.

For an alkane (an organic molecule with no double or triple bonds), "-ane" is appended to the end of the stem (if there is a suffix, append "-an"). Hence, a three-carbon chain (with the requisite hydrogen atoms attached) would be "propane".

The parent chain is numbered by assigning location numbers along the chain in both directions, and choosing a direction based on which one minimizes the lowest location number of:

1) suffix functional groups (i.e. whichever attached functional group type has the highest precedence)

2) multiple bonds

3) prefixes (i.e. both functional groups and side chains)

Substituents are attached to the stem as either prefixes or a suffix, and with associated location numbers. Most functional groups can be attached as either prefixes or suffixes - the highest-precedence of these will be the suffix, and the rest will be prefixes. Side chains and halogens are attached as suffixes.

### 

### **Multiple Bonds**

Double and triple bonds are identified by their first location when counting along the direction of numbering. For example, a 4-carbon chain with a double bond joining the second and third carbons would have a double bond at position 2. Double and triple bonds are denoted by adding "-ene" or "-yne" to the stem instead of "-ane", with the position number. For example, the previously described molecule would be "buta-2-ene", with the "a" after the stem for pronunciation purposes.

Although double and triple bonds are used as suffixes, they do not count as such suffix when evaluating functional groups. A stem can have both a multiple bond suffix and a functional group suffix (with the latter being attached after the former).

### 

### **Side chains**

Side chains are hydrocarbons that branch off of the parent chain. They are named similarly to the parent chain except with -yl: methyl, ethyl, propyl, etc.

They are identified by their location. For example, a propyl at position 3 would be "3-propyl", with a dash used to separate the components. If there are multiple side chains of the same length, use commas, and pre-prefixes (di-, tri-, tetra-, etc.). For example, if there are two ethyls at position 3 and one ethyl at position four, they would be collectively identified as "3,3,4-triethyl".

### 

### **Functional Groups**

Functional groups are parts of a molecule (moieties) that typically have unique chemical properties and affect the way an organic molecule behaves. They are attached to the parent carbon chain, or inserted in between the parent chain and a side chain, and are identified by their number (they can be attached to side chains as well, but the nomenclature for that is complicated and unlikely to show up in competitions). Functional groups also have an order of precedence. The type of functional group in a molecule with the highest precedence will be used in suffix form, while the rest will be used in prefix form.

Functional groups allowed under the [2018](https://scioly.org/wiki/index.php/2018) [rules](https://scioly.org/wiki/index.php/Rules_Manual) are listed below, in order of precedence. "R" refers to an arbitrary section of the molecule (in the usage below, excluding a single hydrogen). The prefixes for most higher-precedence groups are rarely used, since test questions are unlikely to include many different types of functional groups.



Additional resources

<https://scioly.org/wiki/index.php/2017_Test_Exchange#Materials_Science>

<https://en.wikipedia.org/wiki/Specified_Minimum_Yield_Strength>

<http://www.pcn.org/Technical%20Notes%20-%20Periodic%20Table%20of%20Polymers.htm>

<https://en.wikipedia.org/wiki/Young%27s_modulus>

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<http://webs.wichita.edu/scienceolympiad/Coaches_Workshop/Handouts/2013-2014/2014_Material_Science%20(C).pdf>

Maybe?

<https://www.degruyter.com/view/j/pac.2012.84.issue-2/pac-rec-10-12-04/pac-rec-10-12-04.xml>

<https://www.degruyter.com/downloadpdf/j/pac.2012.84.issue-2/pac-rec-10-12-04/pac-rec-10-12-04.pdf>

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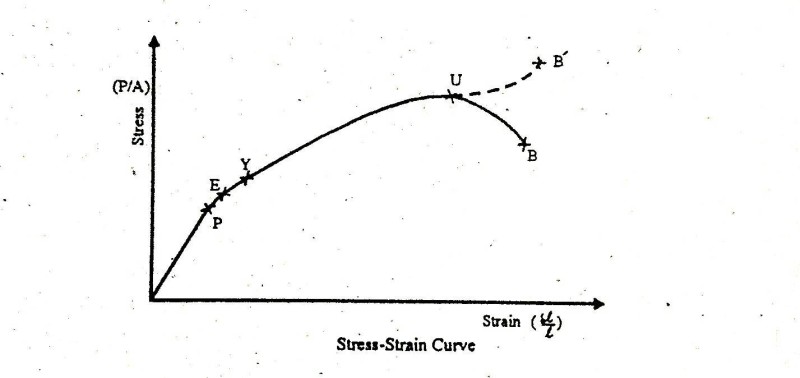
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Also known as cubic close packed.

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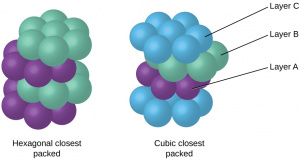
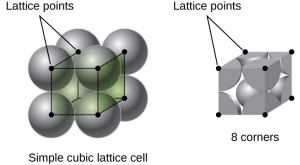
BCC Cell **Body Centered Cubic**

In the BCC cell, atoms are located at each of the 8 corners as well as in the center of the cubic cell.

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HCP Cell **Hexagonal Close Packing**

HCP is another close-packed arrangement.The HCP cell is composed of two hexagons of 6 atoms each, an additional atom in the center of each hexagon, and a triangle of atoms in between the two hexagons.HCP differs from FCC in that HCP follows an ABAB packing pattern - there are only 2 repeating layers, where the atoms of the third layer are located above the atoms of the first layer, not above gaps.HCP also has an atomic packing factor of 0.74, the maximum possible. Each unit cell contains 6 atoms and has two parameters, A (side length) and B (height).Each atom in the HCP matrix has a coordination number of 12.

SC Cell **Simple Cubic**

Simple cubic is a very basic arrangement, only containing atoms at each corner of the unit cell.SC is the least dense, with an atomic packing factor of 0.52. Each unit cell contains 1 atom and has a side length of A=2RA=2R Each atom in the SC matrix has a coordination number of 6.

### **Atomic Packing Factor (APF)**

### The atomic packing factor describes the amount of space occupied by atoms.

### For example, in the simple cubic packing, each cell has side length 2R and contains 1 atom of radius R.

### The volume occupied by the atom is

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2) the chain that contains the most double/triple bonds.

3) the longest chain.

Once the parent chain is determined, it is named based on its length. This forms the stem of the molecule's name. Only the most common names are listed above. For an alkane (an organic molecule with no double or triple bonds), "-ane" is appended to the end of the stem (if there is a suffix, append "-an"). Hence, a three-carbon chain (with the requisite hydrogen atoms attached) would be "propane". The parent chain is numbered by assigning location numbers along the chain in both directions, and choosing a direction based on which one minimizes the lowest location number of:

1) suffix functional groups (i.e. whichever attached functional group type has the highest precedence)

2) multiple bonds

3) prefixes (i.e. both functional groups and side chains)

Substituents are attached to the stem as either prefixes or a suffix, and with associated location numbers. Most functional groups can be attached as either prefixes or suffixes - the highest-precedence of these will be the suffix, and the rest will be prefixes. Side chains and halogens are attached as suffixes.

**Multiple Bonds**

Double and triple bonds are identified by their first location when counting along the direction of numbering. For example, a 4-carbon chain with a double bond joining the second and third carbons would have a double bond at position 2. Double and triple bonds are denoted by adding "-ene" or "-yne" to the stem instead of "-ane", with the position number. For example, the previously described molecule would be "buta-2-ene", with the "a" after the stem for pronunciation purposes.

Although double and triple bonds are used as suffixes, they do not count as such suffix when evaluating functional groups. A stem can have both a multiple bond suffix and a functional group suffix (with the latter being attached after the former).

**Side chains**

Side chains are hydrocarbons that branch off of the parent chain. They are named similarly to the parent chain except with -yl: methyl, ethyl, propyl, etc.

They are identified by their location. For example, a propyl at position 3 would be "3-propyl", with a dash used to separate the components. If there are multiple side chains of the same length, use commas, and pre-prefixes (di-, tri-,tetra-, etc.). For example, if there are two ethyls at position 3 and one ethyl at position four, they would be collectively identified as "3,3,4-triethyl".

### **Functional Groups**

Functional groups are parts of a molecule (moieties) that typically have unique chemical properties and affect the way an organic molecule behaves. They are attached to the parent carbon chain, or inserted in between the parent chain and a side chain, and are identified by their number (they can be attached to side chains as well, but the nomenclature for that is complicated and unlikely to show up in competitions). Functional groups also have an order of precedence. The type of functional group in a molecule with the highest precedence will be used in suffix form, while the rest will be used in prefix form.

Functional groups allowed under the [2018](https://scioly.org/wiki/index.php/2018) [rules](https://scioly.org/wiki/index.php/Rules_Manual) are listed below, in order of precedence. "R" refers to an arbitrary section of the molecule (in the usage below, excluding a single hydrogen). The prefixes for most higher-precedence groups are rarely used, since test questions are unlikely to include many different types of functional groups.