## Chemistry 1010

## **Plastics II**

#### Review

What is a polymer?

the molecules which are joined together to make a polymer What is a copolymer?

polymer made from more than one monomer

What natural polymers are formed from the following monomers?

nucleotides: DNA

glucose: starch, cellulose

amino acids: protein

What do we call artificial polymers? plastic

Why are they so useful?

they are cheap, strong, durable, flexible, light-weight, water proof, easy to color, easy to form into different shapes...

How are condensation polymers formed?

by joining functional groups together

What reactions can be used to form condensation polymers?

carboxylic acid + amine — > amide + water

carboxylic acid + alcohol ---- ester + water

How are addition polymers formed? by joining C=C together Draw the polymer that would be formed by joining the following monomers together.

a

/mer

#### What monomer(s) is the following polymer made from?



# Are either of these copolymers?

## How are addition polymers formed?

Addition polymers are formed when monomers containing C=C's react to form a carbon chain.

The simplest addition polymer is **polyethylene**, which is made by joining ethylene molecules together.

What happened?

a long chain of carbons was formed

one of the bonds in the C=C flipped over to attach to a C in the next molecule

something must also attach to the ends – we won't worry about that part

Since this is an organic molecule, it can also be represented with condensed structures, or line structures.

#### condensed structures:

$$H_2C = CH_2 + H_2C = CH_2 + H_2C = CH_2 \longrightarrow (CH_2 - CH_2 -$$

#### line structures:



There are two kinds of polyethylene:

high density polyethylene (HDPE)

contains regions where polymer strands line up

rigid, strong, heat resistant



low density polyethylene (LDPE)

contains randomly oriented polymer strands flexible, low melting







## **Other Examples of Addition Polymers**

Other addition polymers are made the same way as polyethylene.

The only difference is that they can have atoms other than H's attached to the C=C.

polypropylene





## polyvinyl chloride (PVC)











teflon

F F F F F F F + + F F F F F F F F F F F



## polystyrene







+

Rubber is made from the latex collected from rubber trees.

These trees grow in Japan, Malaysia, Indonesia, and so on.



#### Rubber is used to make:



#### Rubber has a property that is different from many polymers.

It is elastic – when stretched, it returns to its original shape.

This is the result of **cross-linking**. When the polymer strands are linked together, they spring back when pulled apart.

## What are plasticizers?

In their pure form, most polymers are stiff and brittle.

In order to make them flexible, small molecules called plasticizers are added.



As plastics age, the plasticizers gradually leak out.

This is why old plastic often breaks.

## What are some of the problems with plastic?

Although plastics are quite useful, there are a few problems associated with them.

1) What is plastic made from? petroleum



#### non-renewable resource

If we burn up all of our petroleum, we won't have any left to make plastics with.

## 2) Do plastics burn? yes



### they also produce toxic fumes

# Many of the people who die in house fires and plane crashes die of poisonous fumes from burning plastic.

## 3) What happens to plastic when you throw it away?



#### Nothing – it takes around 1000 years to break down.

The best solution is to reduce plastic waste, and recycle. Most cities now have curb-side recycling. In order for plastics to be recycled, they must be sorted.

Here are the codes imprinted in plastic to tell you what kind they are:



