

# AMIDES

- Amides are amine derivatives of carboxylic acids.
- Compounds with functional group  $\text{RCONH}_2$  or  $\text{RCONR}_2$ , where R and R' could be an organic group (alkyl or phenyl) or hydrogen(H)
- Naming an amide, the term amide is added to the ending of the parent name. The suffix '-ic' of the related acid is removed and replaced by 'amide' e.g.
  - Acetic acid  $\longrightarrow$  Acetamide
  - $\text{CH}_3\text{COOH}$   $\longrightarrow$   $\text{CH}_3\text{CONH}_2$
  - Ethanoic acid  $\longrightarrow$  Ethanamide
- The root name is based on the longest chain including the carbonyl group of the amide group.
- A carboxylic acid contains the  $-\text{COOH}$  and in amide the  $-\text{OH}$  part of the carboxylic acid is replaced by the  $-\text{NH}_2$  (amino) group so amide contain the  $-\text{CONH}_2$  group.
- Generally in IUPAC system of naming the final " -e" of the alkane is replaced by " amide". The substituents on nitrogen are indicated by the same method as in the common system. However, numbers are used for substituents on the parent chain e.g.

$\text{HCONH}_2$  Methanamide

$\text{CH}_3\text{CONH}_2$  Ethanamide

$\text{CH}_3\text{CH}_2\text{CONH}_2$  Propanamide

$\text{CH}_3\text{CH}_2\text{CH}_2\text{CONH}_2$  Butanamide

# CLASSIFICATION OF AMIDES

- Amides are classified as primary, secondary and tertiary

## PRIMARY AMIDES

- This contains  $\text{-NH}_2$  in its structure  $\text{RCONH}_2$  (that there is two hydrogen attached to N)
- They are named by changing the of the acid by dropping the “-oic acid” or “-ic acid” and adding “-amide”
- The carbonyl carbon is given the first location number and it is not necessary to include the location number in the name because it is assumed that the functional group will be on the end of the parent chain

$\text{HCONH}_2$  Methanamide (Formamide)

$\text{CH}_3\text{CONH}_2$  Ethanamide (Acetamide)

$\text{C}_6\text{H}_5\text{CONH}_2$  Benzamide

## SECONDARY AMIDES

- This contains -NH in its structure  $RCONHR'$  (that there is one hydrogen attached to N)
- They are named by using an upper case N to designate that the alkyl group is on the nitrogen
- Alkyl group attached to the nitrogen are named as substituents. The letter N used to indicate that they are attached to nitrogen
- $CH_3CH_2CONHCH_3$  N-methylpropanamide
- $CH_3CH_2CONHC_6H_5$  N-phenylpropanamide

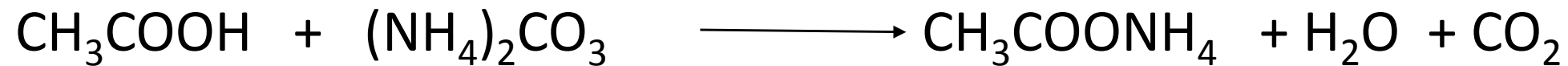
## TERTIARY AMIDES

- This contains -N in its structure  $CONR'R''$  (that there is no hydrogen attached to N)
- They are named in the same way as secondary amides but two Ns
- $CONR_1R_2$
- $HCON(CH_3)_2$  N, N-dimethylformamide or N, N-dimethylmethanamide
- $CH_3CON(CH_3)C_2H_5$  N-ethyl-N-methylethanamide

# PREPARATION OF AMIDES

## FROM AMMONIUM SALT OF CARBOXYLIC ACID

- The carboxylic acid is first converted into ammonium salt which then produces amide on heating
- The ammonium salt is formed by adding solid ammonium carbonate to an excess acid



- When the reaction is completed, the mixture is heated and the ammonium salt dehydrates producing amide  $\text{CH}_3\text{COONH}_4 \xrightarrow{\text{heat}} \text{CH}_3\text{CONH}_2 + \text{H}_2\text{O}$
- The excess ethanoic acid is there to prevent dissociation of the ammonium salt before it dehydrates

## FROM ACYL CHLORIDE

- Acylchloride is also known as acid chloride ( $\text{RCOCl}$ ). The chlorine atom is very easily replaced by other atom or group like  $-\text{NH}_2$  group to form an amide
- The acylchloride is added to a concentrated solution of ammonia in water but the reaction is exothermic and violent  $\text{CH}_3\text{COCl} + 2\text{NH}_3 \longrightarrow \text{CH}_3\text{CONH}_2 + \text{NH}_4\text{Cl}$

## FROM ACID ANHYDRIDES

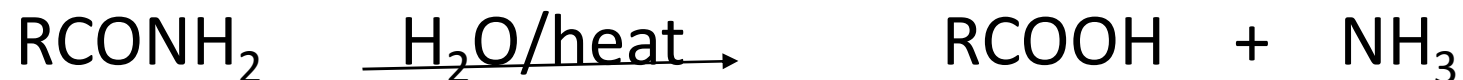
- An acid anhydride is obtained when a molecule of water is removed from two carboxylic acid (-COOH group)
- The reaction of acid anhydrides are like those of acylchlorides except that a molecule of carboxylic acid is produced e.g. if ethanoic anhydride is added to concentrated ammonia solution, ethanamide and ammonium ethanoate is formed



## CHEMICAL REACTIONS OF AMIDES

### HYDROLYSIS OF AMIDES

- This is a nucleophilic acyl substitution.
- Amides hydrolyse to the parent carboxylic acid and the appropriate amine using a strong acid or base



## DEHYDRATION OF AMIDES

- Amides are dehydrated to form nitrile group (-CN)
- The dehydration is done by heating a solid mixture of the amide with phosphorus(V) oxide,  $P_4O_{10}$  ( $P_2O_5$ )



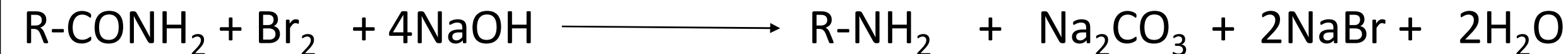
## REDUCTION REACTION

- Amides can be reduced to primary amines by reaction with lithiumaluminiumhydride( $LiAlH_4$ ) in dry ether at room temperature



## HOFMANN DEGRADATION

- This is a reaction between an amide and a mixture of bromine and sodium hydroxide solution
- The amide group loses the  $-CO$  part and become a primary amine with one less carbon atom than the original amide had



## REACTION WITH NITROUS ACID

- Amides react with nitrous acid to give carboxylic acids and nitrogen gas.
- Nitrous acid required is prepared in situ by reaction of sodium nitrite and hydrochloric acid



## AMPHOTERIC CHARACTER OF AMIDES

- Amides are feeble bases but are amphoteric in nature (that is they can behave as an acid and a base) due to resonance
- Acid character:  $2\text{CH}_3\text{CONH}_2 + \text{HgO} \longrightarrow (\text{CH}_3\text{CONH}_2)_2\text{Hg} + \text{H}_2\text{O}$
- Base character:  $\text{CH}_3\text{CONH}_2 + \text{HCl} \longrightarrow \text{CH}_3\text{COCl} + \text{NH}_3$

# USES OF AMIDES

- Amides are used widely in industries in producing plastic, rubber, paper, colour in crayons, pencils and ink as well as in water and sewage treatment
- Acrylamide and polyacrylamide are the products most widely used in above industries. However, acrylamide is a carcinogen so it can be used only if the chemicals are not intended for consumption
  - I. Polyacrylamide is used in treatment of drinking water and sewage
  - II. Amides are used in paper industry, being used as a binder and for retention aid for fibres. It also retains colour pigment on paper
  - III. Acrylamide is used:
    - a) To stabilize soil and help keep free sand able to flow so that it can fill mould
    - b) As a coating on many household appliances and car parts with thermosetting acrylics
    - c) In the cosmetic industry to prepare soap, hair products and preshave lotion
    - d) For explosive, adhesives, printing inks, latex thickness and emulsion stabilizers.