SYNTHESIS OF BENZIMIDAZOLE

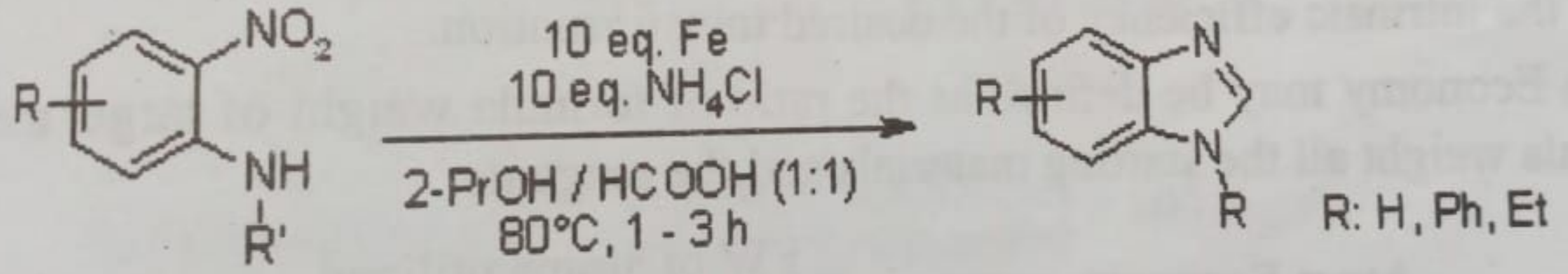
Ibuprofen

Alternative method with Atom Economy 77%.

(E) SYNTHESIS OF BENZIMIDAZOLE :

Benzmidazole is a heterocyclic aromatic organic compound consisting of fusion o
nzene and imidazole. They are bioactive. Many of the anthelmintic drugs belong to th
nzmidazole class of compounds. Benzmidazole fungicides are available in the marke
ey act by binding to the fungal microtubules and stop hyphal growth. It also resis
clear division. Several dyes are derived from benzmidazole.

Traditional synthesis of Benzmidazole



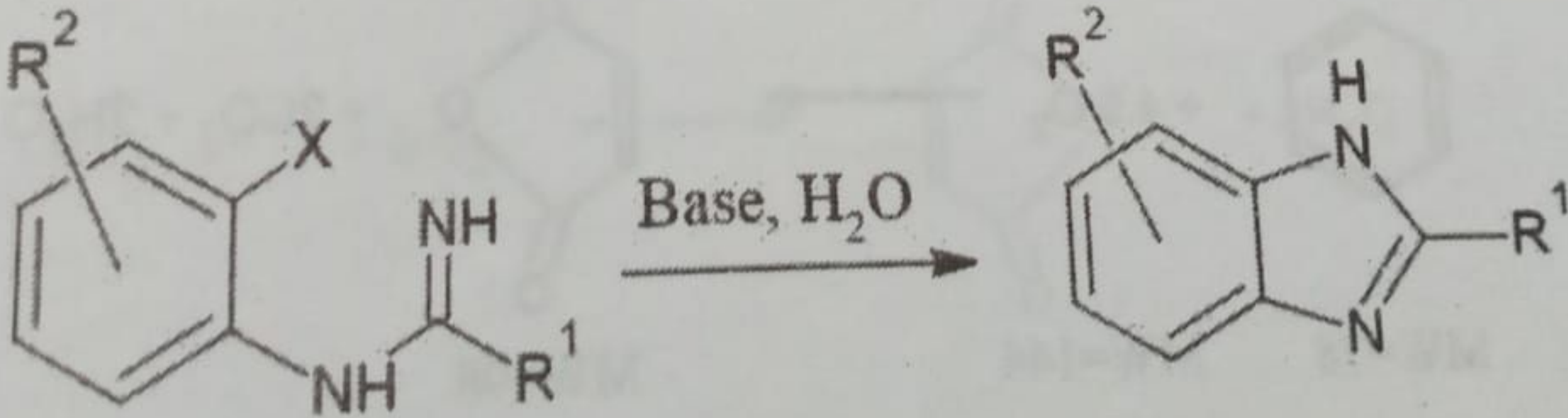
Aromatic and heteroaromatic 2-nitroamines can be converted into bicyclic 2
zimidazoles. This synthesis employs formic acid, iron powder, and NH_4Cl
itives to reduce the nitro group, and effects the imidazole cyclization. This synthe
ers high-yield within one to two hours.

Green Synthesis of Benzimidazole:

... be synthesized through a carbon-nitro

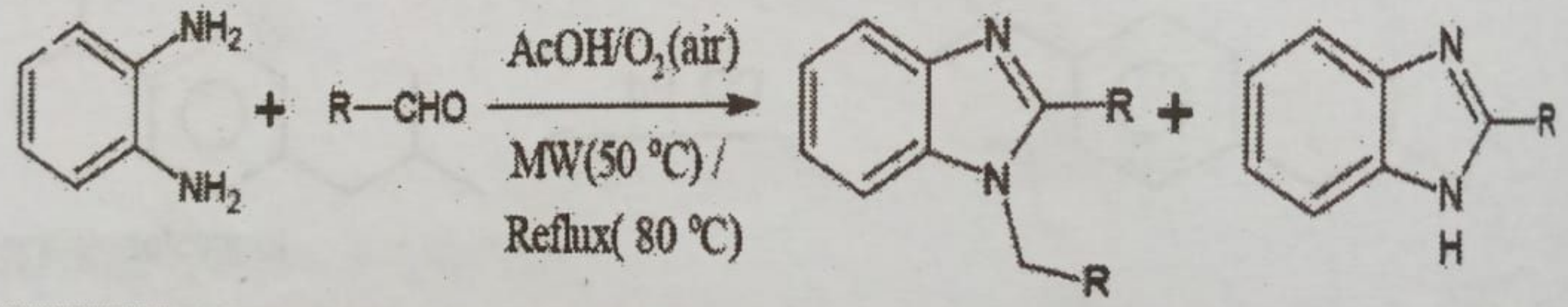
Green Synthesis of Benzimidazole:

(i) The benzimidazole ring system can be synthesized through a carbon-nitroger cross-coupling reaction in the presence of K_2CO_3 in water at 100 °C for 30h. Th intermolecular cyclization of N-(2-iodoaryl) benzamidine provides benzimidazol derivatives in moderate to high yields. The procedure occurs exclusively in water ar doesn't require the use of any additional reagent/catalyst. The methodology is high valuable from both environmental and economic points of view.



The green route occurs exclusively in water, and there is no need of any reagent or catalyst.

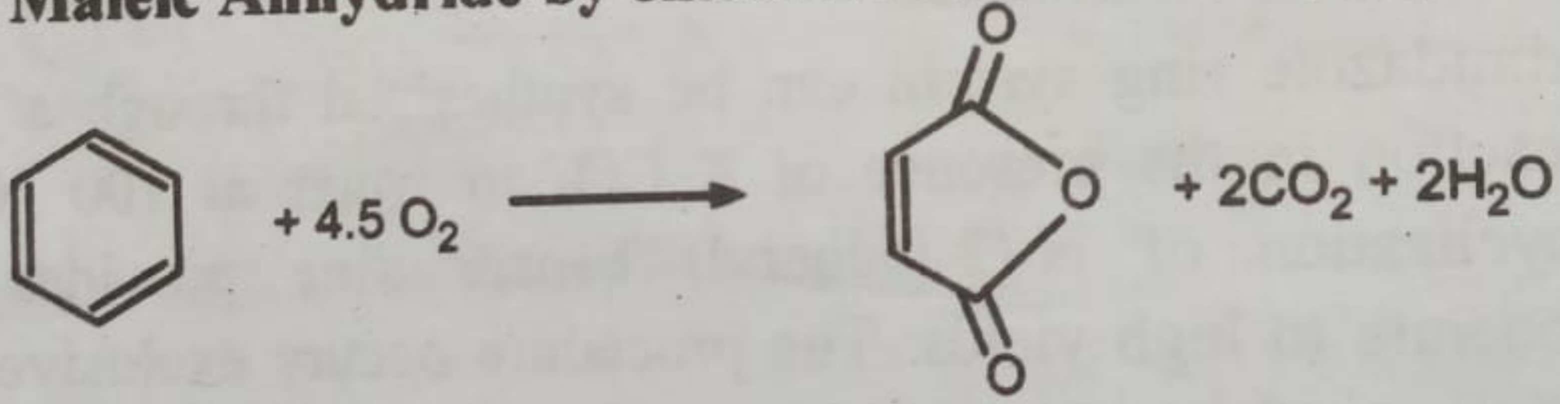
(ii) The benzimidazoles can also be synthesized by condensation of o-phenylenediamine with aldehydes promoted by acetic acid under microwave. The reaction doesn't involve any hazardous solvent. It is a mild and eco-friendly synthesis. It requires less reaction time and high yields of the products.



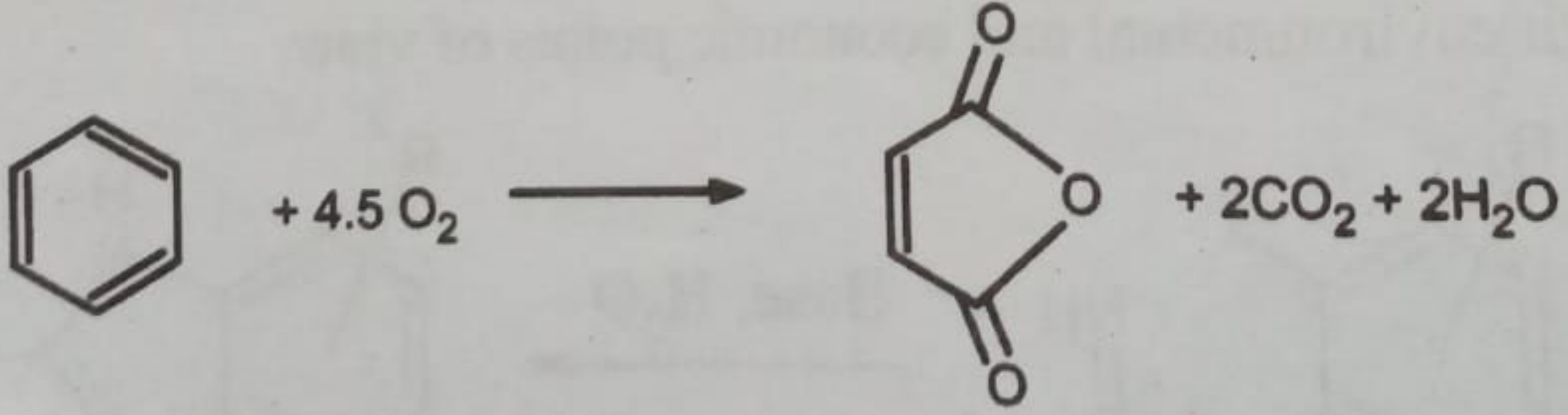
4 ATOM ECONOMY

NUMERICALS BASED ON ATOM ECONOMY:

1. **Calculate percentage economy for the following reaction:** [May 08, 10, Dec. 2012]
   Synthesis of Maleic Anhydride by oxidation of benzene



Solution :



MW=78 MW=144 MW=98

$$\%\text{Atom Economy} = \frac{\text{MW of product}}{\text{Total MW of reactant}} \times 100$$

$$= \frac{98}{78 + 144} \times 100$$

$$= \frac{98}{222} \times 100$$

$$= 44.1\%$$

Ans. % Atom Economy = 44.1

2. **Calculate the % Atom economy for the following reaction with respect to Allyl Chloride.** [Dec. 2008, 2011, 2014, 2017, 2018, May 2019]

$$CH_3 - CH = CH_2 + Cl_2 \rightarrow \underset{\text{Allyl chloride}}{Cl - CH_2 - CH = CH_2} + HCl$$

Solution :

$$\underset{MW=42}{CH_3 - CH = CH_2} + \underset{MW=71}{Cl_2} \rightarrow \underset{\substack{\text{Allyl chloride} \\ MW=76.5}}{Cl - CH_2 - CH = CH_2} + HCl$$

$$\%\text{Atom Economy} = \frac{\text{MW of product}}{\text{Total MW of reactant}} \times 100$$

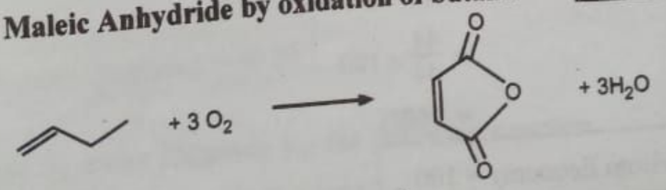
$$= \frac{76.5}{42 + 71} \times 100$$

$$= \frac{76.5}{113} \times 100$$

$$= 67.69\ \%$$

Ans. % Atom Economy = 67.69%

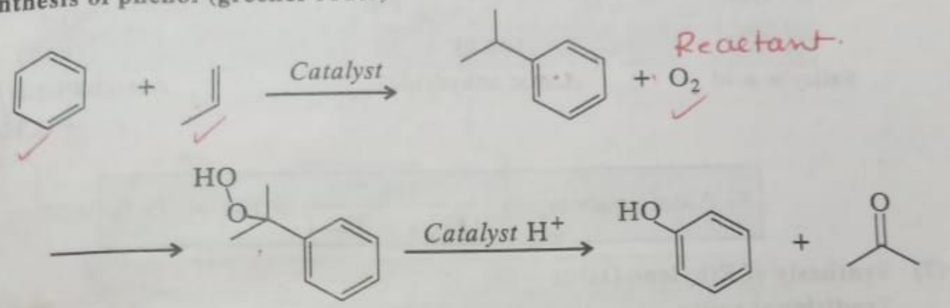
3. **Calculate percentage economy for the following reaction:** [May 2009, Dec. 2009]
Synthesis of Maleic Anhydride by oxidation of butane.



% Atom economy = Σ (Molecular weight of C_6H_6, H_2SO_4, NaOH)

$\boxed{\%\ \text{Atom economy} = 0.4353 \text{ or } 43.53\%}$

) Synthesis of phenol (greener route)



The synthesis of phenol and acetone via cumene production from benzene and propene.

	Reactants		Target		Waste	
	Empirical formula	**Molecular weight**	**Atoms utilized**	**Molecular weight**	**Atoms unutilized**	**Molecular weight**
	C_6H_6 C_3H_6 O_2	78.12 42.09 32.00	C_6H_5 H O	77.11 1.01 16.00	H C_3H_5 O	1.01 41.08 16.00
Total	$C_9H_{12}O_2$	152.21	C_6H_6O	94.12	C_3H_6O	58.09

$$\%\ \text{Atom economy} = \frac{\text{Molecular weight of } C_6H_6O}{\Sigma\ (\text{Molecular weight of } C_6H_6, C_3H_6, O_2)}$$

$\boxed{\%\ \text{Atom economy} = 0.6184 \text{ or } 61.84\%}$

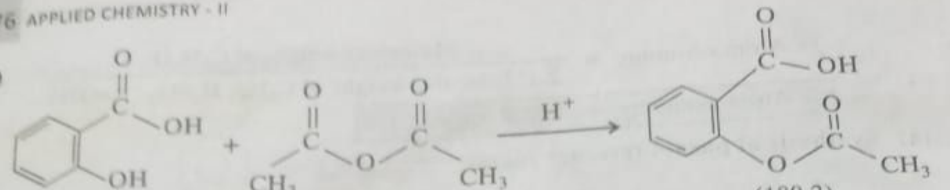
$$CH_3-CH_2-CH_2-CH_2-OH + NaBr + H_2SO_4 \longrightarrow CH_3-CH_2-CH_2-CH_2-Br + NaHSO_4 + H_2O$$

mula weight - (74) Butanol; (103); (98); $CH_3-CH_2-CH_2-CH_2-Br$ (137)

$$\%\ \text{Atom economy} = \frac{\text{Molecular weight of desired product}}{\text{Molecular weight of reactants}} \times 100$$

$$\boxed{\%\ \text{Atom economy} = \frac{137}{275} \times 100 = 50\%}$$ 77.10

(6)



(138.1) Salicylic acid + (102.1) Acetic anhydride $\xrightarrow{H^+}$ (180.2) Acetylsalicylic acid + CH_3COOH Acetic acid

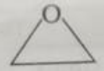
$$\% \text{ Atom economy} = \frac{180.2}{138.1 + 102.1} \times 100 = 75\ \%$$

(7) Synthesis of Ethylene Oxide

Traditional route

$$\underset{\substack{\text{Ethylene}\\(28.05)}}{=\!=} + \underset{(70.91)}{Cl_2} + \underset{(18.02)}{H_2O} \longrightarrow \underset{\text{Chlorohydrin (intermediate)}}{ClCH_2CH_2OH} + HCl$$

$$\underset{\text{(intermediate)}}{ClC_2H_4OH} + \underset{(74.09)}{Ca(OH)_2} \longrightarrow$$

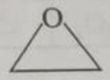


Ethylene oxide (44.05) $+ CaCl_2 + 2H_2O$

$$\% \text{ Atom economy} = \frac{44.05}{74.09 + 70.91 + 28.05 + 18.02} \times 100 = 23.05\ \%$$

Greener route

$$\underset{\substack{\text{Ethylene}\\(28.05)}}{=\!=} + \underset{\frac{1}{2}(32)}{\frac{1}{2}O_2} \xrightarrow{\textit{Catalyst}}$$



Ethylene oxide (44.05)

$$\% \text{ Atom economy} = \frac{44.05}{28.05 + 16} \times 100 = 100\ \%$$

(8) Synthesis of Dimethyl Carbonate

Traditional route

$$\underset{\substack{\text{Methonol}\\2(32.04)}}{2CH_3OH} + \underset{\substack{\text{Phosgene}\\(98.92)}}{Cl-\overset{\overset{\displaystyle O}{\|}}{C}-Cl} \longrightarrow \underset{\substack{\text{Dimethyl carbonate}\\(90.08)}}{CH_3O-\overset{\overset{\displaystyle O}{\|}}{C}-CH_3O} + 2HCl$$

$$\% \text{ Atom economy} = \frac{90.08}{2(32.04) + 98.92} \times 100 = 55.26\ \%$$