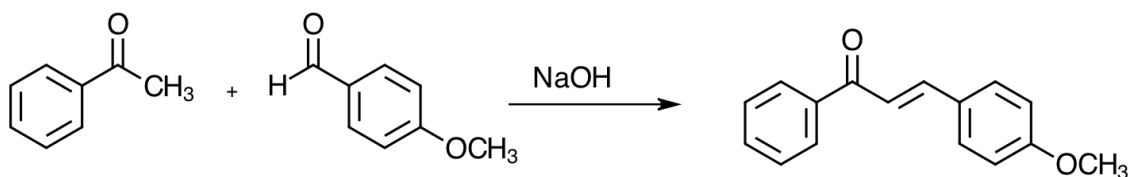


# Aldol Condensation

## Summary:

The Aldol Condensation is an important carbon-carbon bond forming reaction. In this classic reaction, an  $\alpha, \beta$ -unsaturated carbonyl compound is formed by a crossed-aldol condensation.



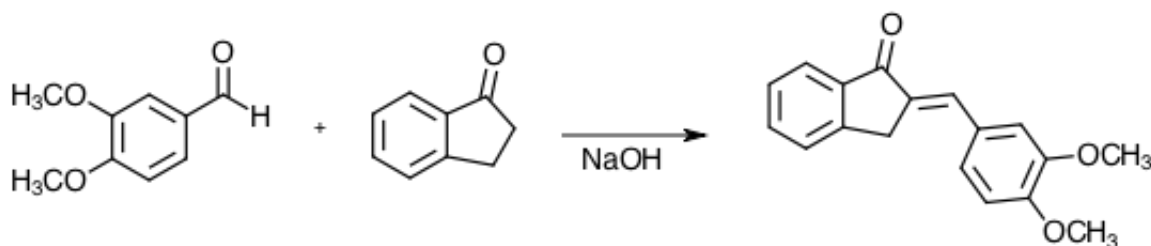
**Reference:** Preparation of trans-p-Anisalacetophenone, Experimental Organic chemistry, 2011, 5th Edition, Gilbert and Martin, p. 620.

Chemical Name Aldrich Catalog #	Amount per 100 students (g or mL)	EH&S	Purchasing cost per 100 students (\$)
p-anisaldehyde A88107	10 mL	<div><div></div><div></div><div></div><div></div></div>	\$4.29
Acetophenone A10701	10 mL	<div><div></div><div></div><div></div><div></div></div>	\$1.95
Sodium hydroxide 221465	25 g	<div><div>*C</div><div></div><div></div><div></div></div>	\$2.88
Water n/a	25 mL	<div><div></div><div></div><div></div><div></div></div>	n/w
Ethanol, 95% 459836	50 mL	<div><div></div><div></div><div></div><div></div></div>	\$3.88
Methanol 322415	500 mL	<div><div></div><div></div><div></div><div></div></div>	\$25.17

## Aldol Condensation: Greener Approach

### Summary:

This solventless aldol condensation\* allows for students to perform a base-catalyzed reaction by grinding two raw materials together and witnessing the melting of the reactants for the reaction to occur. The product is produced through aqueous work-up and recrystallized in ethanol/water.



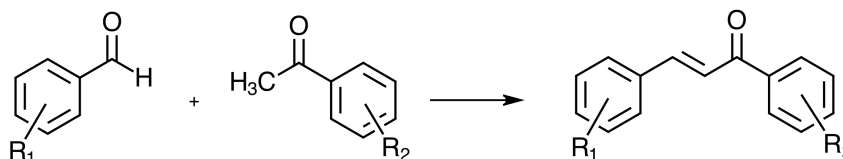
**Reference:** Solventless Reactions: The Aldol Reaction, Green Organic Chemistry – Strategies, Tools, and Laboratory Experiments, Doxsee, K.M. And Hutchison, J.E., Thompson Brooks/Cole, 2004, pp. 115-119

Chemical Name Aldrich Catalog #	Amount per 100 students (g or mL)	EH&S	Purchasing cost per 100 students (\$)
3,4-dimethoxybenzaldehyde 143758	12.5 g	<div><div></div><div></div><div></div></div>	\$3.65
1-indanone I2304	10 g	<div><div></div><div></div><div></div></div>	\$37.00
sodium hydroxide 221465	2.5 g	<div><div>*C</div><div></div><div></div></div>	\$0.29
Hydrochloric acid, 3M 320331	100 mL	<div><div></div><div></div><div></div></div>	\$0.98
Ethanol, 90% 792799	750 mL	<div><div></div><div></div><div></div></div>	\$3.64

# Aldol Condensation: Greener Approach

## Summary:

This solventless aldol condensation is the solvent-free synthesis of chalcones, made by mixing and matching various aldehydes and acetophenones. The reactions proceed by grinding in a mortar and pestle. The work-up of the chalcones are simple, involving only water. The final product can be recrystallized in ethanol, ethanol-water, or ethanol-toluene, depending on the product (see primary literature for typical yields and tables with properties of the product).





**Reference:** Solvent-free Synthesis of Chalcones, J. Chem. Educ., 2004, 81, 1345

	Chemical Name Aldrich Catalog #	Amount per 100 students (g or mL)	EH&S	Purchasing cost per 100 students (\$)
One of the following aldehydes are used (the amounts listed are the total amounts for each aldehyde needed if only that aldehyde was selected):	p-anisaldehyde A88107	34 g		\$4.71
	p-tolualdehyde T35602	30 g		\$7.43
	4-chlorobenzaldehyde 112216	35 g		\$5.58
	3-chlorobenzaldehyde C23403	35 g		\$44.57
	Benzaldehyde B1334	26.5 g		\$9.04
One of the following acetophenones are used (the amounts listed are the total amounts for each acetophenone needed if only that acetophenone was selected):	Acetophenone A10701	29 mL		\$5.09
	4'-methylacetophenone M26615	37.5 g		\$6.44
	4'-bromoacetophenone B56404	50 g		\$28.99
	4'-methoxyacetophenone 117374	33.5 g		\$7.99
	Sodium hydroxide 221465	10 g	*C	\$1.04
	Water n/a	1000 mL		n/w
	Ethanol, 95% 459836	500 mL		\$3.88
	Toluene 244511	250 mL		\$9.43

# Comparison: Aldol Condensation

## Comparison of greener and traditional lab:









- Greener methods introduces the concepts of solvent-free synthesis. However, solvents are required in the work-up of the reaction to produce the product.
- Greener processes avoids the use of methanol
- Purchasing costs are comparable

	Purchasing costs	Waste (per 100 students)	"Greener" benefits
Greener method – solventless aldol	\$48.25	875 mL liquid waste	
Greener method – solventless synthesis of chalcones	\$24.15 - \$87.91*	1 L liquid aqueous waste ~500 mL solvent waste (recrystallization)	
Traditional method	\$45.56	620 mL liquid waste	

Other greener lab options to explore:

- Green Chemistry Laboratory: Benign Synthesis of 4,6-Diphenyl[2,2']bipyridine via Sequential Solventless Aldol and Michael Additions, J. Chem. Educ. 2005, 82, 468-469
- A Green Enantioselective Aldol Condensation for the Undergraduate Organic Laboratory, J. Chem. Educ. 2006, 83, 1871-1872
- The Aldol Addition and Condensation: The Effect of Conditions on the Reaction Pathway, J. Chem. Educ. 2007, 84, 475-476

\* Purchasing cost depends on the aldehyde and acetophenone used in the experiment.

EHS Key:			Physical hazard		Very high hazard
			Toxicity/Health hazard		High hazard
			PBT		Moderate hazard
					Low hazard
					No data