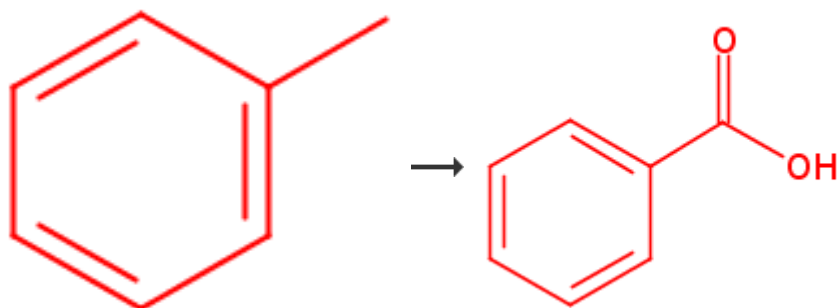


16. Single Step

94%

[Overview](#)**Steps/Stages**

- 1.1 R:H₂SO₄, R:KMnO₄, S:H₂O, S:CH₂Cl₂, rt → reflux; 30-40 min, reflux

Notes

phase transfer reagent used, optimization study, Reactants: 1, Reagents: 2, Solvents: 2, Steps: 1, Stages: 1, Most stages in any one step: 1

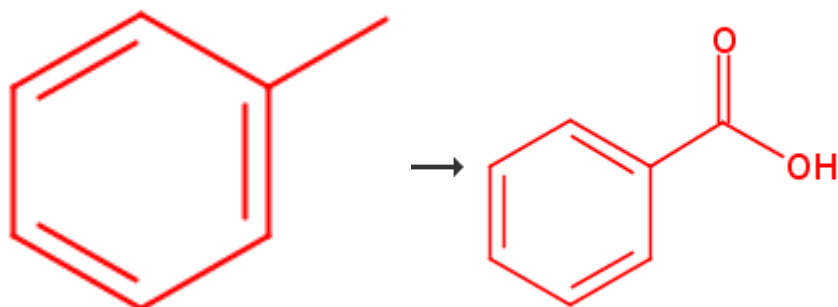
References

[Synthesis of benzoic acid by oxidation method based on phase transfer catalysis](#)

By Shao, Jingjing and Li, Xiaomei

From Huagong Shikan, 17(5), 44-46; 2003

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19. Single Step

90%

[Overview](#)**Steps/Stages**

- 1.1 R:KMnO₄, S:CH₂Cl₂, 3.00 h, reflux

Notes

ion exchange resin used as cat., Reactants: 1, Reagents: 1, Solvents: 1, Steps: 1, Stages: 1, Most stages in any one step: 1

References

[Ion exchange catalysis in oxidation of organic compounds with KMnO₄](#)

By Shaabani, Ahmad et al

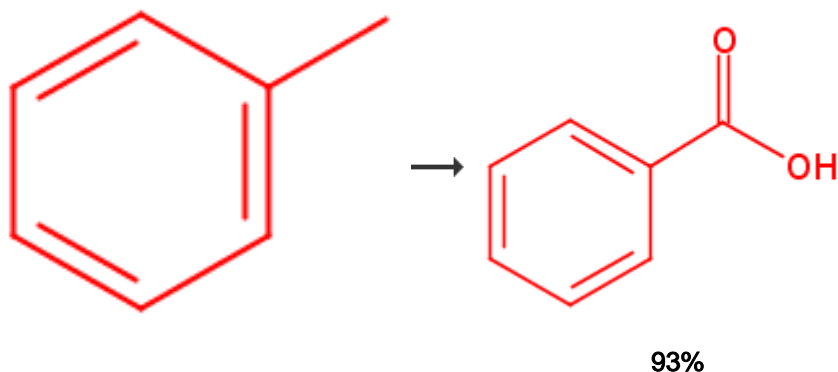
From Synthetic Communications, 33(6), 1057-1065; 2003

[Experimental Procedure](#)

General/Typical Procedure: **Oxidation of Indan with KMnO₄/IER** Indan (0.118 g, 1 mmol) was dissolved in CH₂Cl₂ (30mL) and placed in a round-bottomed flask with a magnetic stirrer. Finely ground KMnO₄ (1 g) and IER (1 g) was added and the mixture was stirred at reflux conditions and the extent of reaction monitored by using of TLC. After 7h, analysis of the: liquid phase by TLC indicated complete conversion to 1-indanone. The product was filtered through sintered glass and residue washed with CH₂Cl₂ (20mL). The solvent was evaporated to give a product (0.93mmol, 93%) which showed only one TLC spot and 2,4-DNP derivative of indanone. **Table 2**, Entry 10, yield 90%. M.p. of product (°C): 120-122 (121)^b

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28. Single Step



Overview

Steps/Stages

- 1.1 R:Me(CH₂)₁₆CO₂
 - •Na⁺, R:KMnO₄, S:H₂O

Notes

Reactants: 1, Reagents: 2, Solvents: 1, Steps: 1, Stages: 1, Most stages in any one step: 1

References

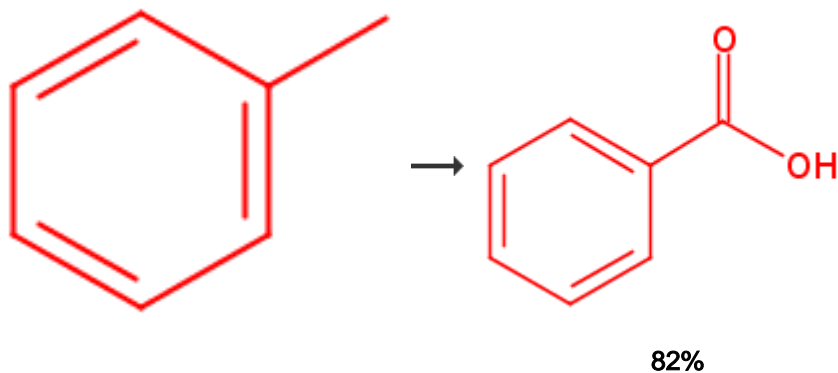
[Surfactant-assisted permanganate oxidation of aromatic compounds](#)

By Jursic, Branko

From Canadian Journal of Chemistry, 67(9), 1381-3; 1989

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45. Single Step



Overview

Steps/Stages

Notes

1.1 R:Me(CH₂)₁₅NMe₃ •Br, R:KMnO₄, S:H₂O

Reactants: 1, Reagents: 2, Solvents: 1, Steps: 1, Stages: 1, Most stages in any one step: 1

References

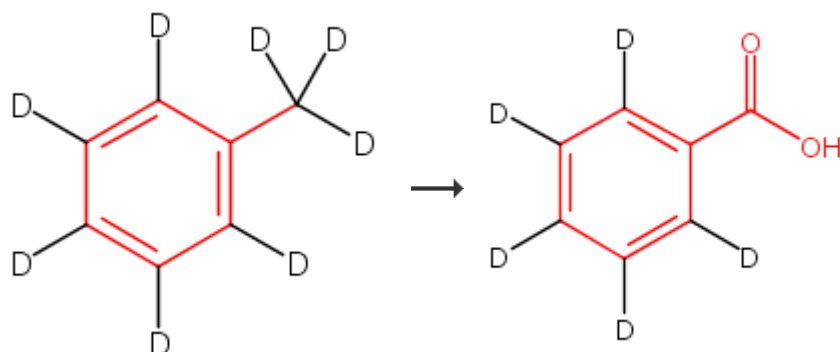
[Surfactant-assisted permanganate oxidation of aromatic compounds](#)

By Jursic, Branko

From Canadian Journal of Chemistry, 67(9), 1381-3; 1989

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46. Single Step



64%

Overview

Steps/Stages

- 1.1 R:Disodium carbonate, R:KMnO₄, S:H₂O, 8 h, reflux; reflux → rt
 1.2 R:HCl, S:H₂O, rt, acidify

Notes

Reactants: 1, Reagents: 3, Solvents: 1, Steps: 1, Stages: 2, Most stages in any one step: 2

References

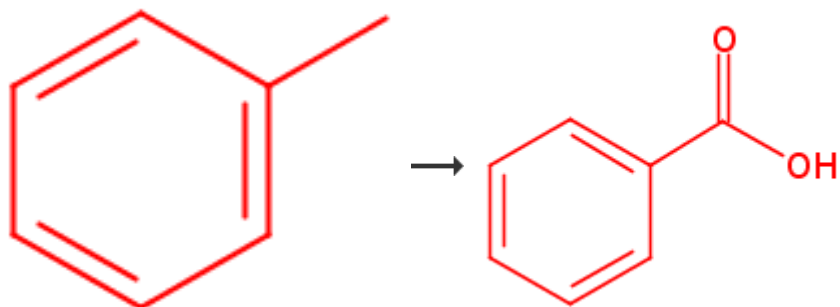
[Diastereoselective \[3+2\] Annulation of Aromatic/Vinylic Amides with Bicyclic Alkenes through Cobalt-Catalyzed C-H Activation and Intramolecular Nucleophilic Addition](#)

By Gandeepan, Parthasarathy et al

From Angewandte Chemie, International Edition, 55(13), 4308-4311; 2016

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50. Single Step



[Overview](#)**Steps/Stages**

- 1.1 R:KMnO₄, C:TEBAC, S:H₂O, 3.5 h, 92°C
1.2 R:HCl, S:H₂O

Notes

phase transfer catalysis, optimization study, optimized on temperature, reaction time and stoichiometry, yield depends on catalyst, Reactants: 1, Reagents: 2, Catalysts: 1, Solvents: 1, Steps: 1, Stages: 2, Most stages in any one step: 2

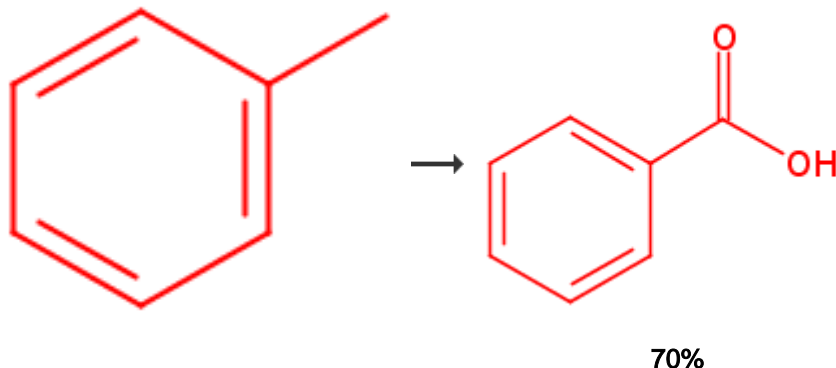
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[Synthesis and application of phase transfer catalyst triethylbenzylammonium chloride](#)

By Yang, Jianzhou et al

From Riyong Huaxuepin Kexue, 32(2), 35-39; 2009

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51. Single Step[Overview](#)**Steps/Stages**

- 1.1 R:KMnO₄, R:Me(CH₂)₁₅NMe₃•Br, S:H₂O, 130 min, 85°C
1.2 R:HCl, S:H₂O, rt, pH 1.5

Notes

Reactants: 1, Reagents: 3, Solvents: 1, Steps: 1, Stages: 2, Most stages in any one step: 2

References

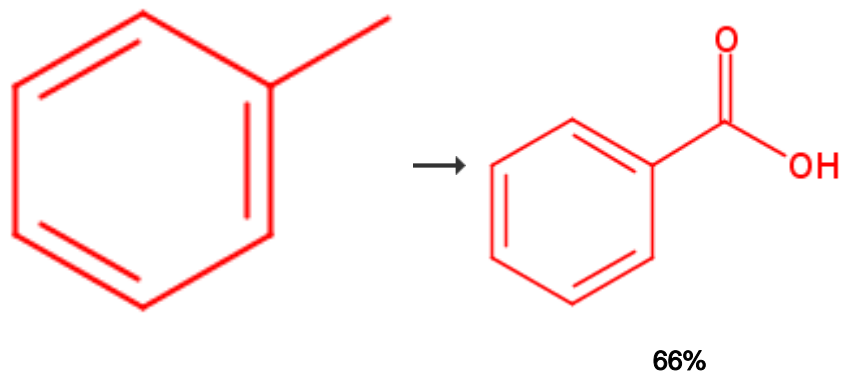
[Oxidation of aromatic hydrocarbons in phase transfer catalysis conditions](#)

By Morales, Juan Enrique Tacoronte et al

From Revista CENIC, Ciencias Quimicas, 36(2), 117-122; 2005

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52. Single Step



Overview

Steps/Stages

- 1.1 R:KMnO₄, C:Me(CH₂)₁₅NMe₃•Br, S:H₂O, 2 h, reflux; cooled
- 1.2 R:HCl, S:H₂O, pH 1-2

Notes

optimization study, optimized on reaction time, stirring speed, phase transfer catalysis, Reactants: 1, Reagents: 2, Catalysts: 1, Solvents: 1, Steps: 1, Stages: 2, Most stages in any one step: 2

References

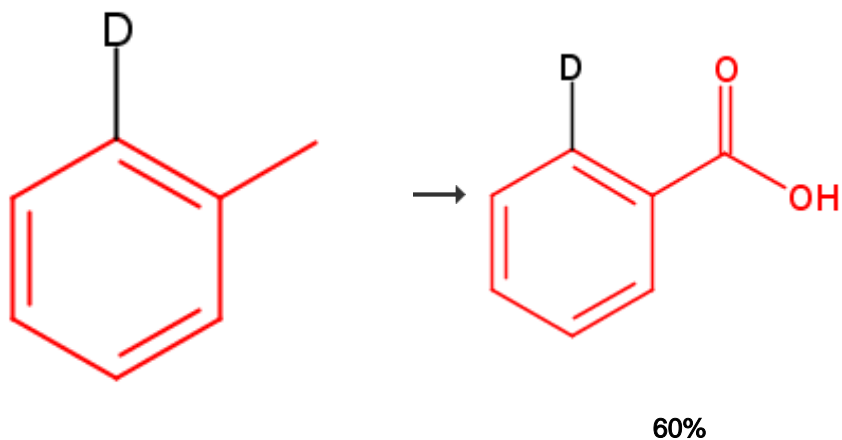
[Catalytic synthesis of benzoic acid with cetyltrimethylammounium bromide](#)

By Zhu, Feng-xiang et al

From Zhejiang Huagong, 41(4), 16-17; 2010

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58. Single Step



Overview

Steps/Stages

- 1.1 R:Disodium carbonate, R:KMnO₄, S:H₂O, 8 h, reflux
- 1.2 R:HCl, S:H₂O, acidify

Notes

Reactants: 1, Reagents: 3, Solvents: 1, Steps: 1, Stages: 2, Most stages in any one step: 2

References

[Use of aryl chlorides in palladium-catalyzed arylation of heterocycles, benzoates, and phenols.](#)

By Daugulis, Olafs and Chiong, Hendrich

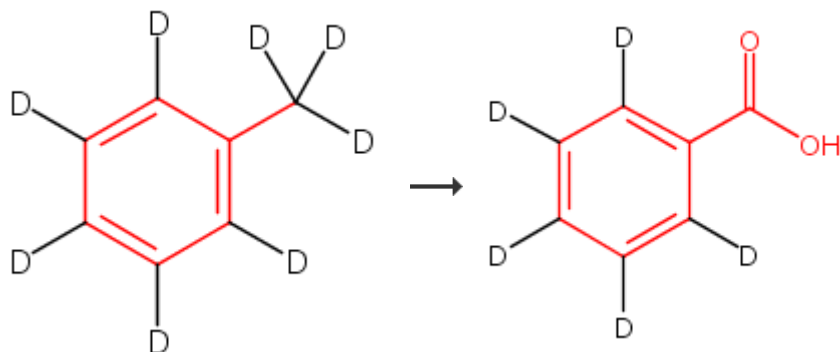
From U.S. Pat. Appl. Publ., 20090012293, 08 Jan 2009

Experimental Procedure

b) A round-bottom flask equipped with a stir bar and condenser was charged with 2-deuteriotoluene (2.9 g, 31 mmol), KMnO_4 (12 g 76 mmol), Na_2CO_3 (1.5 g, 14 mmol) and water (100 ml). The suspension was refluxed for 8 hours then cooled to room temperature. The mixture was filtered through a pad of Celite®, acidified with 12M HCl, and extracted with dichloromethane (3x20 mL). The dichloromethane layer was washed with water. The crude product was recrystallized from water to yield 2.3 g (60%) of 2-deuteriobenzoic acid as fine white needles. The deuterium content was checked by NMR and EI-MS.

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64. Single Step



Overview

Steps/Stages

1.1 R: KMnO_4 , C: Disodium carbonate, S: H_2O , reflux

Notes

Reactants: 1, Reagents: 1, Catalysts: 1, Solvents: 1, Steps: 1, Stages: 1, Most stages in any one step: 1

References

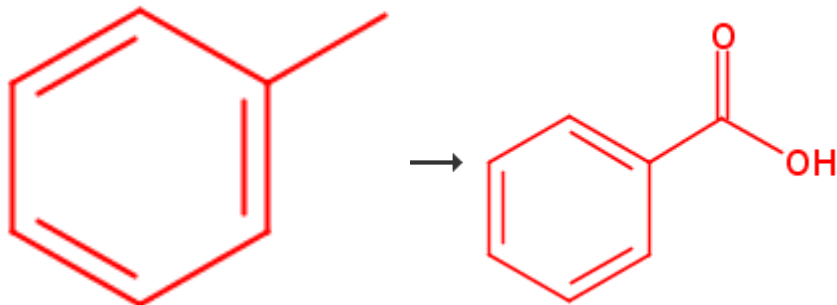
[Synthesis of Dibenzo\[c,e\]oxepin-5\(7H\)-ones from Benzyl Thioethers and Carboxylic Acids: Rhodium-Catalyzed Double C-H Activation Controlled by Different Directing Groups](#)

By Zhang, Xi-Sha et al

From *Angewandte Chemie, International Edition*, 54(18), 5478-5482; 2015

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65. Single Step



[Overview](#)**Steps/Stages**

1.1 R:KMnO₄, S:H₂O, 24 h, 180°C

Notes

thermal, other product also detected, autoclave used, Reactants: 1, Reagents: 1, Solvents: 1, Steps: 1, Stages: 1, Most stages in any one step: 1

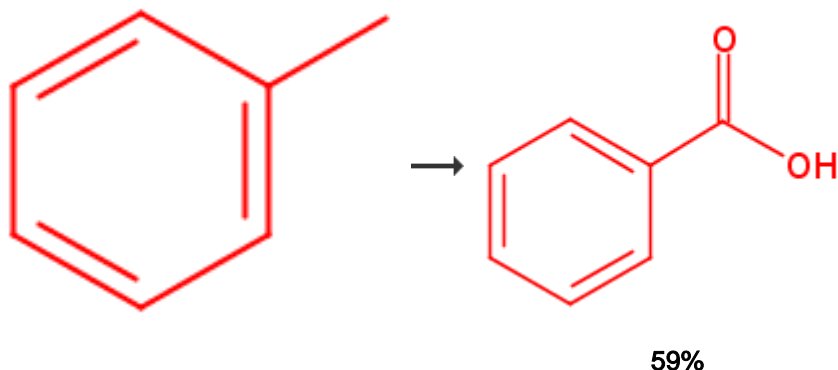
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[Hydrothermal synthesis and characterization of surface-modified δ-MnO₂ with high Fenton-like catalytic activity](#)

By Ma, Zichuan et al

From Catalysis Communications, 67, 68-71; 2015

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67. Single Step[Overview](#)**Steps/Stages**

1.1 R:KMnO₄, S:H₂O, 5 h, rt

1.2 R:EtOH, R:KOH, rt

1.3 R:HCl, S:H₂O, rt

Notes

hydrodynamic cavitation or ultrasound used; optimization study; optimized on cavitation generation method, pump discharge pressure, orifice plate, stoichiometry, Reactants: 1, Reagents: 4, Solvents: 1, Steps: 1, Stages: 3, Most stages in any one step: 3

References

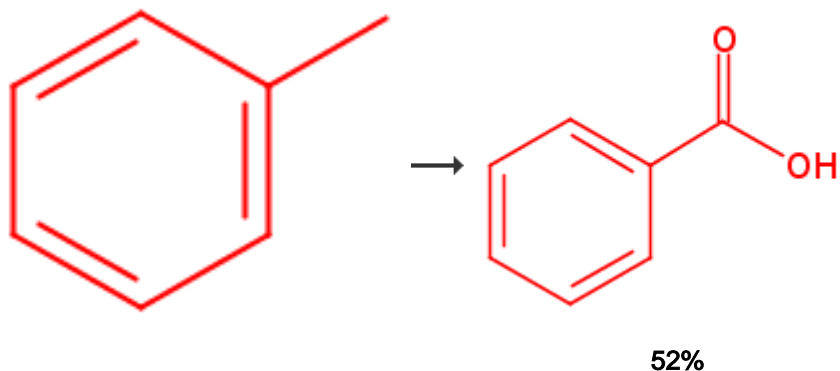
[Oxidation of alkylarenes to the corresponding acids using aqueous potassium permanganate by hydrodynamic cavitation](#)

By Ambulgekar, G. V. et al

From Ultrasonics Sonochemistry, 11(3-4), 191-196; 2004

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83. Single Step

[Overview](#)**Steps/Stages**

1.1 R:KMnO₄, C:1160635-88-0, S:H₂O, rt; 7 h, 90°C

Notes

Reactants: 1, Reagents: 1, Catalysts: 1,
Solvents: 1, Steps: 1, Stages: 1, Most stages
in any one step: 1

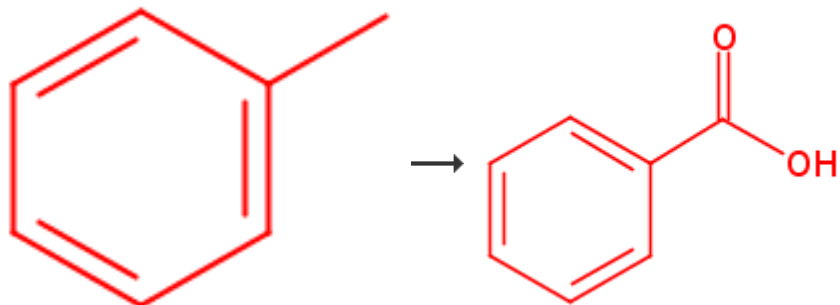
References

[Application of calixarene derivative in phase transfer catalysis reaction of potassium salt](#)

By Liu, Dongqing et al

From Faming Zhuanli Shenqing, 101433861,
20 May 2009

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87. Single Step[Overview](#)**Steps/Stages**

1.1 R:KMnO₄, C:TEBAC, S:H₂O, 2 h, 90-95°C

Notes

Reactants: 1, Reagents: 1, Catalysts: 1,
Solvents: 1, Steps: 1, Stages: 1, Most stages
in any one step: 1

References

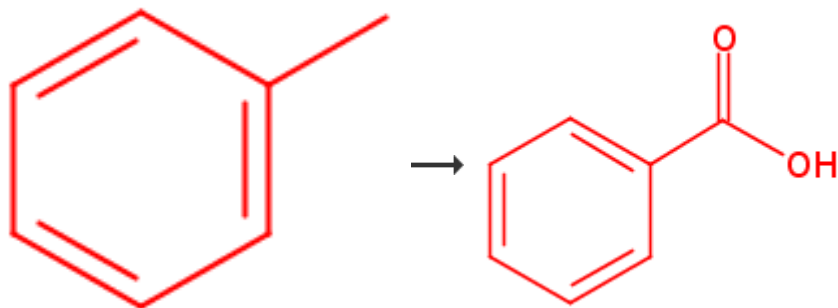
[Study on synthesis and applications of phase transfer catalyst TEBAC](#)

By Li, Yuhong and Meng, Xiaohua

From Baoji Wenli Xueyuan Xuebao, Ziran
Kexueban, 29(3), 40-42; 2009

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92. Single Step



Overview

Steps/Stages

- 1.1 R:KMnO₄, S:H₂O, 1 h, reflux
- 1.2 R:HCl, S:H₂O, acidify

Notes

green chemistry, optimization study, optimized on reaction time and stoichiometry, Reactants: 1, Reagents: 2, Solvents: 1, Steps: 1, Stages: 2, Most stages in any one step: 2

References

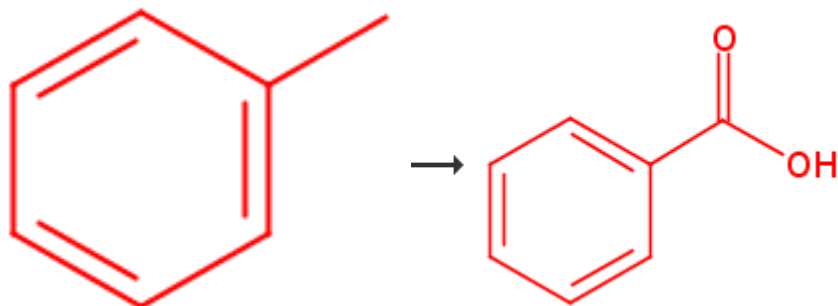
[Investigation on synthesis of benzoic acid](#)

By Yan, Yun et al

From Guangdong Huagong, 35(12), 20-22; 2008

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110. Single Step



Overview

Steps/Stages

Notes

1.1 R:KMnO₄, 3 h

Benzylic and Allylic Oxidations, Stage 1:
Hydrodynamic cavitation, Reactants: 1,
Reagents: 1, Steps: 1, Stages: 1, Most stages
in any one step: 1

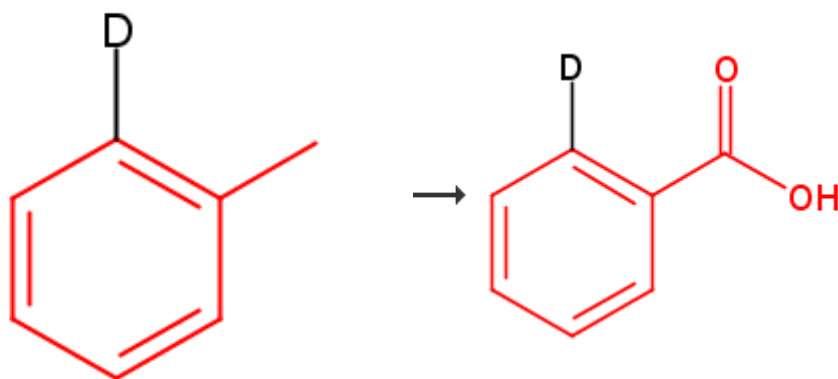
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[Potassium Permanganate](#)

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From e-EROS Encyclopedia of Reagents for
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134. Single Step

28%

Overview**Steps/Stages**1.1 R:Disodium carbonate, R:KMnO₄, S:H₂O, 8 h, reflux1.2 R:HCl, S:H₂O, acidify**Notes**

Reactants: 1, Reagents: 3, Solvents: 1, Steps:
1, Stages: 2, Most stages in any one step: 2

References

[Nickel\(0\)-Catalyzed Cyclization of N-Benzoylaminals for Isoindolinone Synthesis](#)

By Shacklady-McAtee, Danielle M. et al

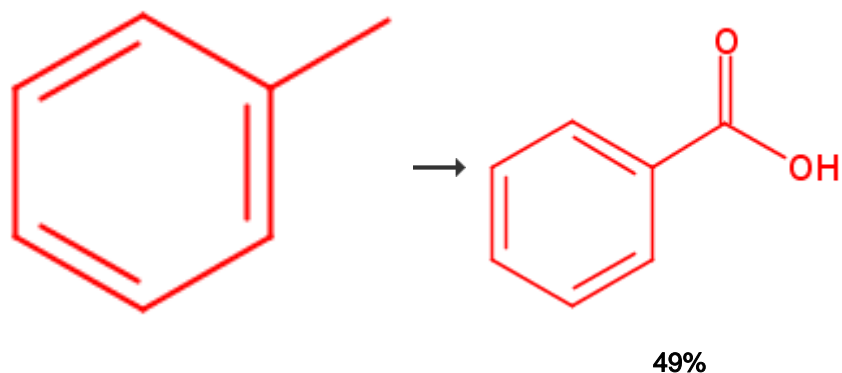
From Organic Letters, 13(13), 3490-3493;
2011

Experimental Procedure

In a 100-mL round-bottomed flask equipped with a reflux condenser, toluene **S25** (500 mg, 5.37 mmol, 1.0 equiv), KMnO₄ (2.08 g, 13.2 mmol, 2.45 equiv), Na₂CO₃ (257.3 mg, 2.43 mmol, 0.452 equiv) and H₂O (18 mL, 0.3 M) were heated at reflux. After 8 h, the brown mixture was cooled to room temperature and filtered through a Celite pad, which was then washed with H₂O (5 mL). The filtrate was acidified using concentrated HCl. The product was then extracted with CH₂Cl₂ (20 mL x 3). The combined organic layers were washed with H₂O (20 mL) and concentrated to give a white powder, which was recrystallized from hot H₂O. acid **S26** (187.9 mg, 28%) as white crystals. The spectral data for S26 matched that previously given in the literature.¹¹

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155. Single Step



Overview

Steps/Stages

1.1 R:KMnO₄, C:298-96-4, S:PhNO₂, S:H₂O

Notes

Reactants: 1, Reagents: 1, Catalysts: 1, Solvents: 2, Steps: 1, Stages: 1, Most stages in any one step: 1

References

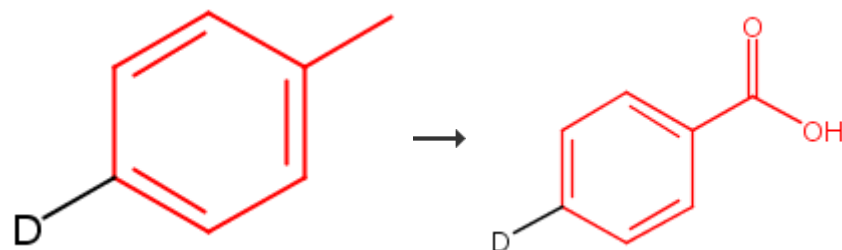
[Tetrazoles. XXV. Tetrazolium salts - new phase-transfer catalysts](#)

By Zhivich, A. B. et al

From Zhurnal Obshchei Khimii, 58(8), 1906-14; 1988

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158. Single Step



Overview

Steps/Stages

1.1 R:KMnO₄, C:Disodium carbonate

Notes

Reactants: 1, Reagents: 1, Catalysts: 1, Steps: 1, Stages: 1, Most stages in any one step: 1

References

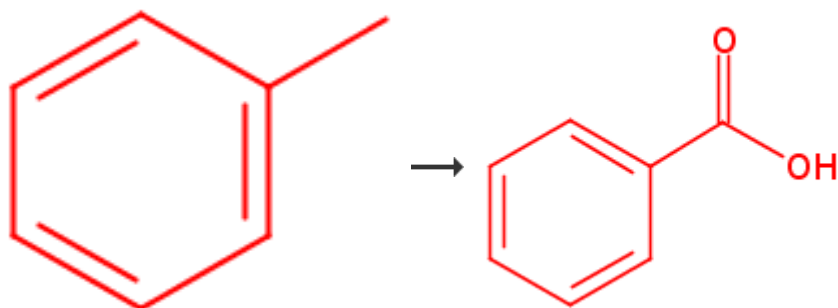
[Microbial transformations. Part 4\(1\). Regioselective para hydroxylation of aromatic rings by the fungus Beauveria sulfurescens. The metabolism of isopropyl phenylcarbamate \(Propham\)](#)

By Vigne, Bernard et al

From Tetrahedron, 42(9), 2451-6; 1986

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166. Single Step



41%

[Overview](#)

Steps/Stages

1.1 R:KOH, R:KMnO₄

Notes

REACTOR 180.deg. 1050, Reactants: 1, Reagents: 2, Steps: 1, Stages: 1, Most stages in any one step: 1

References

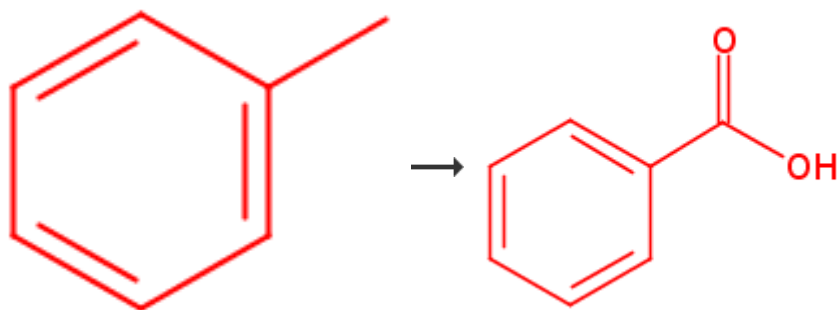
[Development and Application of a Continuous Microwave Reactor for Organic Synthesis](#)

By Cablewski, Teresa et al

From Journal of Organic Chemistry, 59(12), 3408-12; 1994

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167. Single Step



40%

[Overview](#)

Steps/Stages

1.1 R:KMnO₄, R:KOH, S:H₂O

Notes

microwave oven, Reactants: 1, Reagents: 2, Solvents: 1, Steps: 1, Stages: 1, Most stages in any one step: 1

References

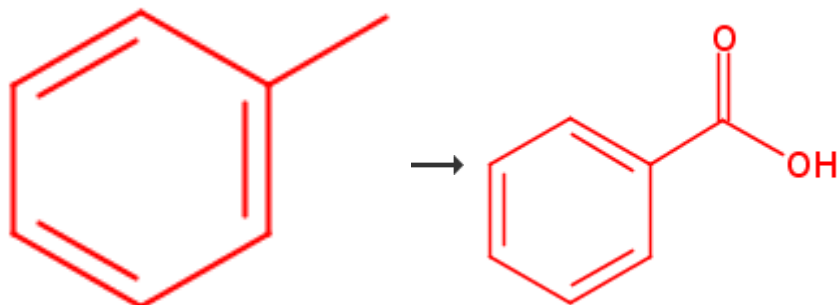
[The rapid synthesis of organic compounds in microwave ovens](#)

By Gedye, Richard N. et al

From Canadian Journal of Chemistry, 66(1), 17-26; 1988

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168. Single Step



31%

Overview

Steps/Stages

1.1 R:KMnO₄, C:TDA 1, S:PhMe, S:AcOH

Notes

Reactants: 1, Reagents: 1, Catalysts: 1, Solvents: 2, Steps: 1, Stages: 1, Most stages in any one step: 1

References

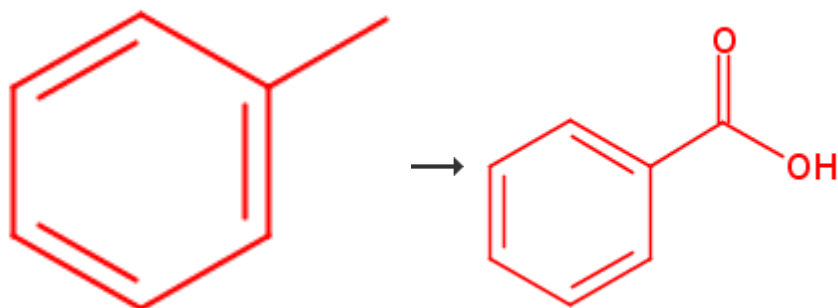
[Phase-transfer catalyzed permanganate oxidations using tris\[2-\(2-methoxyethoxy\)ethyl\]amine \(TDA-1\)](#)

By McKillop, Alexander and Mills, Lester S.

From *Synthetic Communications*, 17(6), 647-55; 1987

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173. Single Step



Overview

Steps/Stages

Notes

1.1 R:KMnO₄, S:C₅H₅N

Classification: Benzylic oxidation; #
 Conditions: KMnO₄ pyridine; # Comments: Ph
 represents aryl group, Reactants: 1, Reagents:
 1, Solvents: 1, Steps: 1, Stages: 1, Most
 stages in any one step: 1

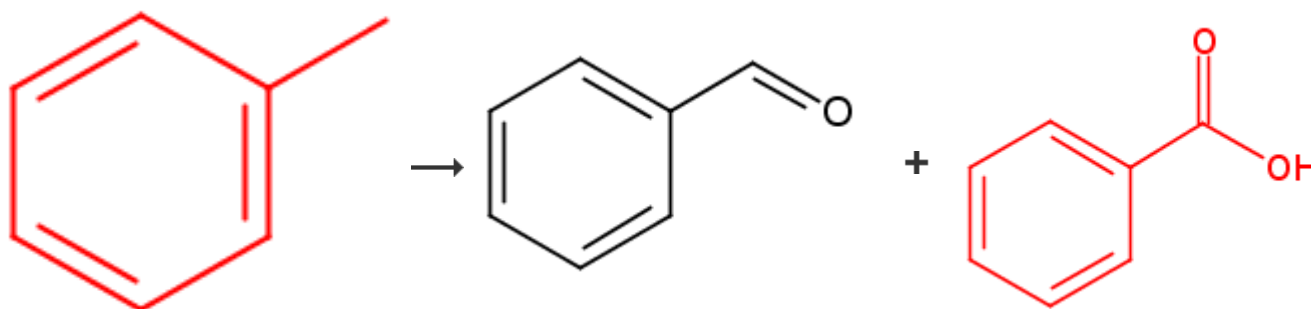
References

[Permanganate oxidation with pyridine as a solvent](#)

By Fujikawa, Fukujiro and Kobayashi,
 Tadayuki

From Yakugaku Zasshi, 64(No. 8A), 7; 1944

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253. Single Step**Overview****Steps/Stages**1.1 R:Et₃N, R:KMnO₄, S:H₂O, S:CHCl₃, S:MeCHClCH₂Cl1.2 R:H₂SO₄, S:H₂O**Notes**

either chlorinated solvent, Reactants: 1,
 Reagents: 3, Solvents: 3, Steps: 1, Stages: 2,
 Most stages in any one step: 2

References

[A convenient oxidation of benzylic methyl, methylene, and methine groups with potassium permanganate/triethylamine reagent](#)

By Li, Wen Shan and Liu, Lilian Kao

From Synthesis, (4), 293-5; 1989

Experimental Procedure

General/Typical Procedure: **Aryl Aldehydes 2a-e; General Procedure:** KMnO₄ (1.58g, 10mmol) and Et₃N (506 mg, 5mmol) are first mixed in a round-bottomed flask, followed by addition of distilled water (1 mL), and CHCl₃, (20 mL) or 1,2-dichloropropane (20 mL) under magnetic stirring. The permanganate color fades and the mixture turns into a brick color with a gentle evolution of heat within 3 min. After addition of the substrate 1 (5mmol), 6M H₂SO₄ (6mL) is added dropwise. Oxidation proceeds immediately at 20 °C as acid is introduced, and is completed after an additional stirring for 30 to 90 min at room temperature, as is indicated by TLC. The mixture remains homogeneous during the reaction. CHCl₃ (30 mL) is then added to the mixture, and the colloidal MnO₂ is filtered with the aid of silica gel (5 g) and CaCl₂ (1 g, also acts as dehydration agent). This operation also provides considerable purification, and concentration of the filtrate on a rotary evaporator usually leads to pure product, e.g. compounds **2a** and **2c**. When a mixture of products is obtained, e.g. **2c/3c** and **2d/3d** separation can be achieved by Hash chromatography on silica gel (Merck 70-230 mesh) using *n*-hexane/CHCl₃ (volume ratio 5:1 then 1:5 or pure CHCl₃) as eluents to obtain the pure product (Table 1). Benzoic acid (**3c**), yield 30%. mp (°C) or bp (°C)/mbar: 121 122, Molecular Formula or Lit. mp (°C) or bp (°C)/mbar: 179-184²⁶.

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