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Experiment-Based Risk Assessment Form

Name of Department	Chemistry	Name and Location of Lab	S7-04
Name of Laboratory	Advanced Chemistry Teaching Lab	Name of PI	Dr Foo Maw Lin
Name of Researcher/LO	Leng Zhi Jing, Dr Wong Ling Rong	Name of Activity/Experiment	Multi-step synthesis and Chiral Resolution of ibuprofen

No	Description/Details of Steps in Activity	Hazards	Possible Accident / Ill Health & Persons-at-Risk	Existing Risk Control (Mitigation)	Severity	Likelihood (Probability)	Risk Level	Additional Risk Control	Person Responsible	By (Date)
1	Addition of 12.0 ml p-isobutyacetophenone, 36 ml of cold methanol and 3.0 g of sodium borohydride into the conical flask	Sodium borohydride: flammable, irritant, toxic, corrosive	1. Fire hazard which may cause burns 2. May cause skin or eyes irritation 3. Can cause skin burns. 4. Harmful if swallowed or inhaled.	1. Keep sodium borohydride away from heat source 2. Ensure PPE (safety glasses, nitrile gloves, lab coat, covered shoes) are worn at all times 3. Perform reaction in a well-ventilated fumehood 4. No eating or drinking allowed in the lab	1	2	2			
		p-isobutyacetophenone: flammable, irritant	1. Fire hazard which may cause burns 2. Harmful if swallowed or inhaled. 3. Exposure to p-isobutyacetophenone. Irritation if in contact with skin and eyes.	1. Keep p-isobutyacetophenone away from heat source 2. Performed reaction in a well-ventilated fumehood. 3. Ensure PPE (safety glasses, nitrile gloves, lab coat, covered shoes) are worn at all times 4. No eating or drinking in the lab	2	1	2			
		Methanol: flammable, toxic	1. Fire hazard which may cause burns 2. Toxic when inhaled or in contact with skin or the eyes	1. Keep methanol away from heat source 2. Performed reaction in a well-ventilated fumehood. 3. Ensure PPE (safety glasses, nitrile gloves, lab coat, covered shoes) are worn at all times 4. Keep away from ignition source	2	1	2			
		Breakage of glassware.	1. Skin cuts and exposure to hazardous chemicals (sodium borohydride, p-isobutyacetophenone and methanol) from broken glassware	1. Ensure PPE (safety glasses, nitrile gloves, lab coat, covered shoes) are worn at all times. 2. Check glassware for cracks prior to use	2	1	1			
2	Addition 60 ml of 10% aqueous hydrochloric acid into the 100 ml conical flask	Chemical hazards: 10% aqueous HCl is a corrosive	burns if in contact with skin and eyes	1. Ensure PPE (safety glasses, nitrile gloves, lab coat, covered shoes) are worn at all times. 2. Perform reaction in a well-ventilated fumehood.	2	1	2			
		Breakage of glassware	1. Skin cuts and exposure to hazardous chemicals from broken glassware	1. Ensure PPE (safety glasses, nitrile gloves, lab coat, covered shoes) are worn at all times. 2. Check glassware for cracks prior to use.	2	1	2			
3	Reaction work up: extraction with diethyl ether (3 x 30 ml) using the separatory funnel.	Chemical hazards: Diethyl ether is flammable, an irritant to skin and eyes.	1. Possible fire when exposed. 2. Irritation if in contact with skin and eyes. 3. Harmful if swallow or inhaled.	1. Keep away from ignition source. 2. Ensure PPE (safety glasses, nitrile gloves, lab coat, covered shoes) are worn at all times. 3. Perform reaction in a well-ventilated fumehood.	2	1	2			

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		Human factor : Lack of skill / concentration / did not pay attention to the technique handling of separatory funnel in the experiment	1. Pressure generated from the extraction in the separatory funnel, causing splash, etc.	1. Conduct the experiment in well ventilated fumehood. 2. Cap the separatory funnel properly and open the tap gently in an inverted position to release pressure after shaking 3. Ensure PPE (safety glasses, nitrile gloves, lab coat, covered shoes) are worn at all times. 4. Wash with plenty of water on contaminated area if contact with skin or eyes. 5. Refer to the lab manual for the techniques of using the separatory funnel and watch the video guide. 6. Reminder from lecturer/graduate teaching assistant/lab technicians to students to release vapor pressure via the tip of the funnel and point it towards the fumehood, not anywhere else	2	1	2		
4	Addition of 30 ml of 12M cone hydrochloric acid into the round bottom flask.	Chemical hazards: 12M cone hydrochloric acid is a corrosive.	Burns if in contact with skins and eyes, burns to the respiratory tract if inhaled	1. Ensure PPE (safety glasses, nitrile gloves, lab coat, covered shoes) are worn at all times 2. Perform reaction in a well-ventiled fumehood	2	1	2		
		Breakage of glassware	1. Skin cuts and exposure to hazardous chemicals from broken glassware	1. Perform reaction in a well-ventilated fumehood 2. Ensure PPE (safetyglasses, nitrile gloves, lab coat, covered shoes) are worn at all times 3. Check glassware for cracks prior to use	2	1	2		
5	Add 1.0 g of magensium, add 6 ml of 1-chloro-1-(4-isobutylphenyl)ethane, 15 ml of tetrahydrofuran (THF) and 15 drops of 1,2-dibromoethane to the round bottom flask.	1-chloro-1-(4-isobutylphenyl)ethane	1. Exposure to hazardous chemicals 1-chloro-1-(4-isobutylphenyl)ethane, 1,2-dibromoethane and THF. 3. Harmful if swallowed or inhaled.	1. Ensure PPE (safety glasses, nitrile gloves, lab coat, covered shoes) are worn at all times 2. Perform reaction in a well ventilated fumehood 3. No eating or drinking allowed in the lab 4. Reminder from lecturer or graduate teaching assistants and technicians	1	2	2		
		1,2 dibromoethane is an irritant and may be carcinogenic	1. Irritation and burns if in contact with skins and eyes 2. Harmful if swallowed or inhaled. 3. May cause cancer with prolonged and repeated exposure	1. Ensure PPE (safety glasses, nitrile gloves, lab coat, covered shoes) are worn at all times 2. Perform reaction in a well ventilated fumehood 3. No eating or drinking allowed in the lab 4. Reminder from lecturer or graduate teaching assistants and technicians					
		THF is flammable, an irritant and harmful	1. Fire hazard if THF liquid and vapor are exposed to heat and possible burns 2. Irritation and burns if in contact with skins and eyes 3. Harmful if swallowed or inhaled.	1. Keep away from ignition source 2. Ensure PPE (safety glasses, nitrile gloves, lab coat, covered shoes) are worn at all times 3. Perform reaction in a well ventilated fumehood 4. Reminder from lecturer or graduate teaching assistants and technicians	2	1	2		
		Fire hazard Magnesium	1. Fire hazard if magnesium is exposed to heat or ignition source	1. Perform reaction in a well-ventilated fumehood 2. Keep away from ignition source	2	1	2		
		Breakage of glassware	1. Skin cuts and exposure to hazardous chemicals from broken glassware	1. Ensure PPE (safety glasses, nitrile gloves, lab coat, covered shoes worn at all times. 2. Check glassware for cracks prior to use	2	1	2		
6	Bubble about 8 litre of dry ice (CO2) into the reaction mixture, place the dry ice in a clean round bottom flask fitted with a rubber septum. Place a cannula between this round bottom flask and the reaction mixture.	Cold burns and asphyxiation	1. Possible cold burns if in direct contact with skin and eyes. 2. Possible asphyxiation if used in a small enclosed room	1. Perform reaction in a well -ventilated fumehood. 2. Ensure PPE (safety glasses, nitrile gloves, thermal gloves, lab coat, covered shoes) are worn at all times.	1	1	1		

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7	Reaction work up: extraction with Diethyl ether (3 x 30 ml) using the separatory funnel. Acidify the mixture with 6M hydrochloric acid. Combine the organic layers and extract with sodium hydroxide (2 x 40 ml).	Chemical hazards: Diethyl ether is flammable, an irritant to skin and eyes.	1. Possible fire when exposed. 2. Irritation if in contact with skin and eyes. 3. Harmful if swallow or inhaled.	1. Keep away from ignition source. 2. Ensure PPE (safety glasses, nitrile gloves, lab coat, covered shoes) are worn at all times. 3. Perform reaction in a well-ventilated fumehood.	2	1	2		
		Hydrochloric acid is corrosive	1. Burns if in contact with skins and eyes, burns to the respiratory tract if inhaled	1. Ensure PPE (safety glasses, nitrile gloves, lab coat, covered shoes) are worn at all times 2. Perform reaction in a well-ventilated fumehood	2	1	2		
		Sodium hydroxide is corrosive	1. Burns if in contact with skins and eyes	1. Ensure PPE (safety glasses, nitrile gloves, lab coat, covered shoes) are worn at all time					
		Human factor Lack of skill/ concentration / did not pay attention to the technique handling of separatory funnel in the experiment.	1. Pressure generated from the extraction in the separatory funnel, causing splash etc.	1. Conduct the experiment in well ventilated fumehood. 2. Cap the separatory funnel properly and open the tap gently in an inverted position to release pressure after shaking 3. Ensure PPE (safety glasses, nitrile gloves, lab coat, covered shoes) are worn at all times 4. Refer to the lab manual for the techniques of using the separatory funnel.	2	1	2		
8	Add 3.0 g of racemic ibuprofen and 30 ml of 0.25 M potassium hydroxide to the flask. With stirring heat the solution in a water bath to an internal temperature of 75-85 C. Next add 0.9 ml of S-(-)-alpha-phenylethylamine dropwise to the reaction mixture.	Chemical hazards: 1. Ibuprofen, S-(-)-alpha-phenylethylamine and is toxic and irritant to the skin and eyes	1. Harmful if swallowed or absorbed through skin 2. Irritation and burns if in contact with skin and eyes for ibuprofen S-(-)-alpha-phenylethylamine	1. Ensure PPE (safety glasses, nitrile gloves, lab coat, covered shoes) are worn at all times 2. No eating or drinking allowed in the lab	2	1	2		
		0.25 M potassium hydroxide is corrosive	1. Burns if in contact with skins and eyes	1. Ensure PPE (safety glasses, nitrile gloves, lab coat, covered shoes) are worn at all time	2	1	2		
		Breakage of glassware and thermometer	1. skin cuts and exposure to hazardous chemicals from broken glassware	1. Ensure PPE (safety glasses, nitrile gloves, lab coat, covered shoes) are worn at all times. 2. Check glassware for cracks prior to use. 3. Perform reaction in a well-ventilated fumehood	2	1	2		
9	Recrystallization using 2-propanol.	Chemical hazards: 2-propanol is an irritant	1. Flammable -Fire hazard if ignited and this may cause burns 2. irritation and burns if in contact with skin and eyes. Harmful if swallowed or inhaled	1. Keep away from ignition source 2. Ensure PPE (safety glasses, nitrile gloves, lab coat, covered shoes) are worn at all times 3. Perform reaction in a well ventilated fumehood 4. No eating or drinking allowed in the lab	1	2	2		
		Breakage of glassware, dropper, beaker and conical flask	1. Irritation if in contact with skin or eyes (2-propanol). 2. Skin cuts and exposure to hazardous chemicals from broken glassware	1. Perform reaction in a well-ventilated fumehood 2. Ensure PPE (safety glasses, nitrile gloves, lab coat, covered shoes worn at all times. 3. Check glassware for cracks prior to use	2	1	2		
10	Prepare a standard solution of your resolved ibuprofen in 10 ml volumetric flask using ethanol. Load this solution into a polarimeter cell.	Chemical hazards: 1. Ibuprofen, S-(-)-alpha-phenylethylamine and is toxic and irritant to the skin and eyes	1. Harmful if swallowed or absorbed through skin 2. Irritation and burns if in contact with skin and eyes for ibuprofen S-(-)-alpha-phenylethylamine	1. Ensure PPE (safety glasses, nitrile gloves, lab coat, covered shoes) are worn at all times 2. No eating or drinking allowed in the lab	2	1	2		
		Ethanol and its vapor are flammable in air and may be an irritant	1. Fire hazard if ethanol and its vapor are exposed to heat. 2. Liquid ethanol and its vapour be an irritant to the eyes	1. Keep away from ignition source. 2. Perform reaction in a well-ventilated fumehood. 3. Ensure PPE (safety glasses, nitrile gloves, lab coat, covered shoes) are worn at all times	2	1	2		


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		Breakage of polarimeter cell	1. Skin cuts and exposure to hazardous chemicals from broken glassware.	Ensure PPE (safety glasses, nitrile gloves and oven thick gloves, lab coat, covered shoes) are worn at all times. 2. Check glassware for cracks prior to use. 3. Refer to the instruction manual for the techniques of operating the polarimeter instrument and watch the video guide.	2	1	2		
		Electric hazard - polarimeter	Electric shock to the user in case of contact.	1. Ensure PPE (safety glasses, nitrile gloves, lab coat, covered shoes) are worn at all times. 2. Check electrical equipment and mechanical stirrer for broken wirings prior to use. 3. Reminder from lecturer or graduate teaching assistant or lab technicians., do not touch power source and parts with wet bare hands.	2	1	2		
11	Reaction work up: extract the compound into diethyl ether (3 x 15 ml). The combined organic layers is washed with 15 ml of water and then 15 ml of brine. Dry the organic layer with anhydrous sodium sulfate.	Diethyl ether is flammable, an irritant to skin and eyes.	1. Possible fire when exposed. 2. Irritation if in contact with skin and eyes. 3. Harmful if swallow or inhaled.	1. Keep away from ignition source. 2. Ensure PPE (safety glasses, nitrile gloves, lab coat, covered shoes) are worn at all times. 3. Perform reaction in a well- ventilated fumehood.	2	1	2		
		Anhydrous sodium sulfate may be an irritant	2. Irritation and if in contact with skin and eyes.	1. Ensure PPE (safety glasses, nitrile gloves, lab coat, covered shoes) are worn at all times.	2	1	2		
		Human factor Lack of skill/ concentration / did not pay attention to the technique handling of separatory funnel in the experiment.	1. Pressure generated from the extraction in the separatory funnel, causing splash etc.	1. Conduct the experiment in well ventilated fumehood. 2. Cap the separatory funnel properly and open the tap gently in an inverted position to release pressure after shaking 3. Ensure PPE (safety glasses, nitrile gloves, lab coat, covered shoes) are worn at all times 4. Refer to the lab manual for the techniques of using the separatory funnel.	2	1	2		
12	Recovery of (-)-Ibuprofen from the Filtrate : Add 25 ml of 2M sulfuric acid to the filtrate obtained. Stir the solution for five minutes. Extract the compound into diethyl ether (3 x 15 ml). The combined organic layers is washed with 15 ml of water and then 15 ml of brine. Dry the organic layer with anhydrous sodium sulfate.	Diethyl ether is flammable, an irritant to skin and eyes.	1. Possible fire when exposed. 2. Irritation if in contact with skin and eyes. 3. Harmful if swallow or inhaled.	1. Keep away from ignition source. 2. Ensure PPE (safety glasses, nitrile gloves, lab coat, covered shoes) are worn at all times. 3. Perform reaction in a well- ventilated fumehood.	2	1	2		
		Anhydrous sodium sulfate may be an irritant	2. Irritation and if in contact with skin and eyes.	1. Ensure PPE (safety glasses, nitrile gloves, lab coat, covered shoes) are worn at all times.	2	1	2		
		Sulfuric acid is corrosive	1. Burns if in contact with skins and eyes, burns to the respiratory tract if inhaled	1. Ensure PPE (safety glasses, nitrile gloves, lab coat, covered shoes) are worn at all times 2. Perform reaction in a well-ventilated fumehood	2	1	2		
		Human factor Lack of skill/ concentration / did not pay attention to the technique handling of separatory funnel in the experiment.	1. Pressure generated from the extraction in the separatory funnel, causing splash etc.	1. Conduct the experiment in well ventilated fumehood. 2. Cap the separatory funnel properly and open the tap gently in an inverted position to release pressure after shaking	2	1	2		

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13	Preparing ibuprofen sample (0.05g) for melting point determination	Chemical hazards: 1. Ibuprofen, S-(-)-alpha-phenylethylamine and is toxic and irritant to the skin and eyes	1. Harmful if swallowed or absorbed through skin 2. Irritation and burns if in contact with skin and eyes for ibuprofen S-(-)-alpha-phenylethylamine	1. Ensure PPE (safety glasses, nitrile gloves, lab coat, covered shoes) are worn at all times 2. No eating or drinking allowed in the lab	2	1	2		
		Surface of the melting point instrument may be hot	1. Finger burns from hot surface	1. Ensure PPE (safety glasses, nitrile gloves and oven thick gloves, lab coat, covered shoes) are worn at all times.					
		Electric hazard - melting point instrument	Electric shock to the user in case of contact.	1. Ensure PPE (safety glasses, nitrile gloves, lab coat, covered shoes) are worn at all times. 2. Check electrical equipment for broken wirings prior to use. 3. Reminder from lecturer or graduate teaching assistant or lab technicians., do not touch power source and parts with wet bare hands.	2	1	2		
		Breakage of melting point tubes	1. Cuts from broken glass	1. Ensure PPE (safety glasses, nitrile gloves and oven thick gloves, lab coat, covered shoes) are worn at all times. 2. Check glassware for cracks prior to use 3. Handle melting point tube with care	2	1	2		
14	Analysis of product using FTIR.	Electric hazard - FTIR	Electric shock to the user in case of contact.	1. Ensure PPE (safety glasses, nitrile gloves, lab coat, covered shoes) are worn at all times. 2. Check electrical equipment for broken wirings prior to use. 3. Reminder from lecturer or graduate teaching assistant or lab technicians., do not touch power source and parts with wet bare hands.	2	1	2		
		Radiation hazard: Infrared radiation from spectrophotometer	Exposure to laser beam can cause eye damage injury.	1. Avoid looking into the laser. When in doubt, consult the technician/GTA before using the instrument. 2. GTA to demonstrate and supervise the use of FT-IR. 3. Always close instrument cover before running sample measurements	1	1	1		
15	Preparing 1H NMR sample in chloroform-d.	Chemical hazard: Chloroform-d is an irritant, suspect carcinogen and toxic.	1. Chloroform-d is acutely toxic when consumed or inhaled. 2. It can also cause skin corrosion and serious eye damage. 3. It is a suspect carcinogenic. Repeated, prolonged exposure can cause specific target organ toxicity	1. Perform reaction in a well-ventilated fumehood. 2. Ensure PPE (safety glasses, nitrile gloves, lab coat, covered shoes) are worn at all times. 3. No eating or drinking allowed in the lab	2	1	2		
		Breakage of glassware, dropper, NMR tube.	Skin cuts and exposure to hazardous chemicals from broken glassware (NMR tube)	1. Perform reaction in a well-ventilated fumehood. 2. Ensure PPE (safety glasses, nitrile gloves, lab coat, covered shoes) are worn at all times. 3. Check glassware for cracks prior to use.	2	1	2		

Name Dr Foo Maw Lin
Signature _____

Name A/P Yeo Boon Siang
Signature 

Next Revision date 19/6/2025
(Maximum 3 years)

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