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Experiment-Based Risk Assessment Form

Name of Department	Chemistry	Location of Lab	S7-04
Name of Laboratory	Advanced Chemistry Teaching Lab	Name of PI (lecturer-in-charge)	Dr Foo Maw Lin
Name of LO	Leng Zhi Jin, Wong Ling Rong	Name of Activity/Experiment	CM5176 GIST Preparation of four-legged molybdenum piano stool and its catalytic application in olefin epoxidation

Hazard Identification				Risk Evaluation & Control						
No	Description / Details of Steps in Activity	Hazard(s)	Possible Accident(s) or ill Health, and Persons-at-Risk	Existing Risk Control (Mitigation)	Severity	Likelihood (probability)	Risk Level	Additional Risk Control	Person Responsible	By (Date)
1	Add 5 mmol of Mo(CO) ₆ in a two neck flask with reflux condenser (Connected to schlenk line) and rubber septum. Evacuate and backfill with N ₂ , inject 20 ml of dry THF, followed by 3 ml of NaCp solution (2M in THF, 6 mmol)	Broken glassware, Sharp needles	Cuts from broken glassware and puncture from needles	Visual inspection of glassware, Broken glassware should not be used. Handle glassware and needles carefully. Wear gloves when handling glassware and needle.	1	1	1			
		Mo(CO) ₆ : toxic	Mo(CO) ₆ is toxic if swallowed, contact with skin or inhaled	Fumehood serve as work area for isolation of chemicals and venting of toxic fumes. Lab coat, safety glasses and gloves serves as protective barrier to prevent skin/eye contact.	2	1	2			
		THF: irritant, carcinogenic, flammable	Fires from ignition of THF (auto ignition temperature 321°C) or NaCp/THF. THF: irritating to lungs, skin irritation and poisonous if swallowed. NaCp/THF in contact with water releases hydrogen which may ignite. Irritation on inhalation. Possible carcinogen, harmful if inhaled. cause eye irritation. May cause damage to liver, kidney through prolonged or repeated procedure	Fumehood serve as work area for isolation of chemicals and venting of toxic fumes. Lab coat, safety glasses and gloves serves as protective barrier to prevent skin/eye contact. Keep flammable solvents such as THF away from open flames/heat sources.	2	1	2			
2	Heat the mixture using an oil-bath till the solution starts weakly boiling and reflux for 12 hours	Broken glassware	Cuts from broken glassware a	Visual inspection of glassware, Handle glassware and needles carefully. Wear gloves when handling glassware and needle.	2	1	2			
		Hot surface: Hotplate, Hot liquid: oil bath	Temperature runaway of hotplate, burns from touching hotplate	Temperature of oil bath is controlled by a controller.	2	1				
		Change in water pressure causing leak and hotplate to be wet	Possible electric shock from wet electrical equipment (hotplate)	All water hoses will be secured with cable ties.	2	1				
	Cool the RBF with ice-bath. Add 2.5 ml of deionized water, 8 ml of diethyl ether and 2 ml of glacial acetic acid and stir for 20 min	Broken glassware,	Cuts from broken glassware. Harmful if inhaled. Causes eye irritation.	Visual inspection of glassware. Broken glassware should not be used. Handle glassware. Wear gloves when handling glassware.	2	1	2			

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3		Harmful and Flammable chemical: diethyl ether	Fires from autoignition of ether (160°C). ether: irritating to lungs and may cause dizziness when inhaled. Skin irritation and poisonous if swallowed.	Keep away from ignition sources. Handle diethyl ether in the fumehood. Wear lab coat, safety glasses and gloves. Do not eat or drink in the lab.	2	1	2		
		Volatile Flammable and Corrosive chemical: glacial acetic acid	Glacial acetic acid: irritating to lungs, skin irritation and poisonous if swallowed. Harmful if inhaled. Causes eye irritation. May ignite if in contact with a heat source	Keep away from ignition sources. Handle glacial acetic acid in the fumehood. Wear lab coat, safety glasses and gloves. Do not eat or drink in the lab.	2	1	2		
4	Add 5 mmol of N-bromosuccinimide (NBS) in 10 ml of THF and stir for another 30 min. Transfer to separating funnel and add 10 ml of deionized water, separate the organic and aqueous layer	Broken glassware	Cuts from broken glassware. NBS: irritating to lungs, skin irritation and poisonous if swallowed. Harmful if inhaled. Causes eye irritation.	Visual inspection of glassware. Broken glassware should not be used. Handle glassware . Wear gloves when handling glassware.	2	1	2		
		THF: irritant, carcinogenic, flammable	Fires from ignition of THF (auto ignition temperature 321°C) or NaCp/THF. THF: irritating to lungs, skin irritation and poisonous if swallowed. NaCp/THF in contact with water releases hydrogen which may ignite. Irritation on inhalation. Possible carcinogen, harmful if inhaled. Can cause eye irritation. May cause damage to liver, kidney through prolonged or repeated procedure	Fumehood serve as work area for isolation of chemicals and venting of toxic fumes. Lab coat, safety glasses and gloves serves as protective barrier to prevent skin/eye contact. Keep flammable solvents such as THF away from open flames/heat sources.	2	1	2		
		Harmful chemical: NBS. Incompatible to strong oxidizing agents, strong acids and base	Harmful if swallowed. May cause skin burns and eye damage.	Fumehood serve as work area for isolation of chemicals and venting of toxic fumes. Lab coat, safety glasses and gloves serves as protective barrier to prevent skin/eye contact. Keep flammable solvents such as THF away from	2	1	2		
5	Extract with ether (20 ml x 3). Combine the ether extracts and dry over anhydrous Na ₂ SO ₄ . Remove all solvent in rotavap	Broken glassware	Cuts from broken glassware.	Visual inspection of glassware. Broken glassware should not be used. Handle glassware . Wear gloves when handling glassware.	2	1	2		
		Harmful and Flammable chemical: diethyl ether	Fires from autoignition of ether (160°C). ether: irritating to lungs and may cause dizziness when inhaled. Skin irritation and poisonous if swallowed.	Keep away from ignition sources. Handle diethyl ether in the fumehood. Wear lab coat, safety glasses and gloves. Do not eat or drink in the lab.	2	1	2		
		Evacuated system : vacuum	Possible implosion from the use of cracked round bottomed flasks or glass adapters	Inspect glassware before using on the rotary evaporator	2	1	2		
		Irritant: Na ₂ SO ₄	Can cause eye or skin irritation.	Wear lab coat, safety glasses and gloves.	2	1	2		
6	Using column chromatography with silica-gel as stationary phase and ethyl acetate/hexane as eluent.	Broken glassware	Cuts from broken glassware.	Visual inspection of glassware. Broken glassware should not be used. Handle glassware . Wear gloves when handling glassware.	2	1	2		
		Silica gel for column chromatography	Silica gel: irritating to lungs, skin irritation. May damaging to respiratory system with excessive inhalation of small particles.	Handle silica gel only in the fumehood. Wear a mask when handling silica gel	2	1	2		

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		Volatile, harmful and irritant chemical: ethyl acetate	Can cause eye irritation and is flammable. Fires from autoignition of ethyl acetate (410 °C).	Fumehood serve as work area for isolation of chemicals and venting of toxic fumes. Lab coat, safety glasses and gloves serves as protective barrier to prevent skin/eye contact. Keep flammable solvents such as ethyl acetate away from open flames/heat sources	1	1	1			
		Volatile, harmful, irritant and flammable chemical: hexane	Health hazard when inhaled, skin irritant and flammable. Fires from autoignition of hexane (225 °C).	Fumehood serve as work area for isolation of chemicals and venting of toxic fumes. Lab coat, safety glasses and gloves serves as protective barrier to prevent skin/eye contact. Keep flammable solvents such as hexane away from open flames/heat sources	2	1	2			
7	Rotavap off solvent and take ¹ H NMR of the product CpMo(CO) ₃ Br using CDCl ₃ as solvent	Evacuated system : vacuum	Possible implosion from the use of cracked round bottomed flasks or glass adapters	Inspect glassware before using on the rotary evaporator	2	1	2			
		Toxic and suspect carcinogen chemical: CDCl ₃	Harmful if swallowed. Toxic if inhaled, Irritant to skin and eyes. Causes damage to organs (Liver, Kidney) through prolonged or repeated exposure. May cause cancer.	Fumehood serve as work area for isolation of chemicals and venting of toxic fumes. Lab coat, safety glasses and gloves serves as protective barrier to prevent skin/eye contact. No eating and drinking allowed in the lab.						
		CpMo(CO) ₃ Br	CpMo(CO) ₃ Br is toxic and may be an irritant	Lab coat, safety glasses and gloves serves as protective barrier to prevent skin/eye contact.						
		Broken glassware, chemical hazard, flammable chemical:	Cuts from broken glassware. Fumes of the solution is irritating to lung, skin and eyes.	Wear gloves, safety glasses and lab coat, inspect NMR tubes carefully for chipped edges or cracks. For additional risk mitigation, please refer to (1).	2	1	2			
14	Add cis cyclooctene (3.65 mmol), mesitylene (1 g internal standard) and compound MoCp(CO) ₃ Br to 50 ml RBF in air	Hazardous and flammable chemical: cyclo-octene, mesitylene	Fires from autoignition of cyclo-octene (280 °C) and mesitylene (559 °C).	Visual inspection of glassware. For additional risk mitigation, please refer to (No. 1).	2	1	2			
		Toxic and Irritant chemical MoCp(CO) ₃ Br	MoCp(CO) ₃ Br is irritating to lungs, skin irritation and poisonous if swallowed.	Lab coat, safety glasses and gloves serves as protective barrier to prevent skin/eye contact.	2	1	2			

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15	Heat the mixture to 55°C using oil-bath, add 0.1 ml of tert butyl hydroperoxide	Hazardous and flammable chemical: tert-butyl hydroperoxide	Fires from autoignition of tert-butyl hydroperoxide (238 °C), decomposes at 89°C. Tert-butyl hydroperoxide is irritating to lungs, skin irritation and poisonous if swallowed	Control of temperature by automatic controller with secondary thermometer present in oil bath. Lab coat, safety glasses and gloves serves as protective barrier to prevent skin/eye contact.	2	1	2		
16	Using a plastic pipette, take 0.1 ml of sample in regular time intervals of 5 min, 30 min, 1 hr, 2hr, 3hr, 4 hr. Dilute with 1 ml of CH ₂ Cl ₂ , filter the resulting slurry through cotton wool	Hazardous chemical: CH ₂ Cl ₂	CH ₂ Cl ₂ is irritating to lungs, skin irritation and poisonous if swallowed. Damage to central nervous system from repeated exposure	Fumehood serve as work area for isolation of chemicals and venting of toxic fumes. Lab coat, safety glasses and gloves serves as protective barrier to prevent skin/eye contact. No eating and drinking allowed in the lab.	2	1	2		
17	Use a gas chromatograph (GC) to analyze the filtrate	From GC: Asphyxiation hazard from helium gas leak	Suffocation from lack of oxygen	Ensure all gas connections are tight and room is well ventilated	2	1	2		
		Electrical hazard	Electrical shock	Check all electrical wiring before using the equipment. Ensure instrument is properly ground and no fraying wires and the area is dry. Operate with dry hands.	2	1	2		

Conducted By

Name Dr. Foo Maw Lin

Signature _____

Date _____

Approved By

Name Yeo BS

Signature 

Approval date 11-Jun-22 Next Revision date 10-Jun-25

(Maximum 3 years)