

SAMPLE -- Job Safety Assessment Form

**AICHe ChemE Car Competition
Department of Chemical Engineering
Michigan Technological University**

Equipment Name: AICHe Chem-E-Car	JSA Author: Terry Mazure
Room Number/Building: SB006 Chem Sci	Faculty Supervisor: Dr. Jason Keith
Revision #: 3	Revision Date: October 9, 2006

Purpose of Experiment / Equipment: Briefly describe what this experiment is designed to achieve and the types of data collected.

The purpose of this JSA is to describe the safety hazards and procedures associated with the fabrication and proper operation of the MTU Chem-E-Car at Michigan Technological University and at the National AICHe Conference in San Francisco, CA.

Personal Protective Equipment (PPE): Check all PPE worn during the entire experiment. Do not list these in the procedure section.

<input type="checkbox"/> Long Pants	<input checked="" type="checkbox"/> Safety Glasses	<input type="checkbox"/> Hard Hat	<input type="checkbox"/> Apron
<input type="checkbox"/> Long Sleeves	<input type="checkbox"/> Splash Goggles	<input type="checkbox"/> Insulated Gloves	<input type="checkbox"/> Ear Protection
<input type="checkbox"/> Non-porous Shoes	<input type="checkbox"/> Face Shield	<input type="checkbox"/> Chemical Gloves	<input type="checkbox"/> Other:

Hazard Summary: Check all general hazards that are likely to be encountered during this experiment and list the major source of the hazard.

Hazard	Major Source of Hazard
<input checked="" type="checkbox"/> Toxicity	Primary toxic chemicals include potassium iodide, sodium thiosulfate, sulfuric acid, and ammonium chloride.
<input type="checkbox"/> Fire/Flammability	
<input checked="" type="checkbox"/> Reactivity	Primary reactive chemicals include sulfuric acid and potassium iodide
<input type="checkbox"/> Pressure Hazard	
<input checked="" type="checkbox"/> Electrical Shock	An electrical circuit is being used and provides potential for minor electrical shocks.
<input checked="" type="checkbox"/> Mechanical Hazard	Rotating metal gears and wheels/axles can provide possible pinch points.
<input type="checkbox"/> Hot Surfaces/ High Temp > 150 F	
<input type="checkbox"/> Biohazard	
<input type="checkbox"/> Laser Radiation	
<input type="checkbox"/> Ionizing radiation	
<input type="checkbox"/> Other: _____	
<input type="checkbox"/> Other: _____	

Expected Operating Conditions:

Temperature	Pressure
Normal: room temperature	Normal: ambient
Minimum:	Minimum:
Maximum:	Maximum:

Special Fabrication or Operating Conditions: Check all that apply.

Unattended Operation: <input type="checkbox"/>	Drying Oven: <input type="checkbox"/>
Regulated Chemicals: <input type="checkbox"/>	Class 3b or 4 Lasers: <input type="checkbox"/>
Pressures Exceeding 35 atm (515 psia) or Equipment Specifications: <input type="checkbox"/>	
Temperatures Exceeding 1000°C or Equipment Specifications: <input type="checkbox"/>	

Available Safety Equipment: Provide the location of each item shown below. Show the location of this equipment on the attached floor plan. If not available, type "NA" in the field.

Item	Location
Fire Extinguisher:	Next to SB006 entrance door
Eyewash:	Next to SB006 entrance door
Safety Shower:	Next to SB006 entrance door
Telephone:	Next to SB006 entrance door
First Aid Kit:	Next to SB006 entrance door
Other:	
Other:	

Spill Response Supplies: Provide the location of each item shown below. Show the location of this equipment on the attached floor plan. If not available, type "NA" in the field.

Item	Location
Spill Kit:	Above lab bench surface on north wall
Floor-Dri:	In the spill kit
Spill Dikes:	In the spill kit
Sodium Bicarbonate:	By the sink
Drain Plugs:	
Spill Pillows:	
Mercury Spill Kit:	Above lab bench surface on north wall
Other:	
Other:	

Required Attachments:

<input checked="" type="checkbox"/> Diagram of process or equipment Label all valves and identify all equipment for reference in procedure.
<input checked="" type="checkbox"/> Laboratory Floor Plan Identify the location of your experiment and all safety and spill response equipment.
<input type="checkbox"/> Equipment Specifications Include materials of construction, maximum temperature and pressure, standard operating values, and any other specifications important to the safe operation.
<input checked="" type="checkbox"/> Material Safety Data Sheets (MSDS) Include for all reactants, products and any intermediate or other chemicals which may occur.

Additional Attachments: As necessary.

<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>

Chemical Information Page

Fill in as much data below as available. If data are not available, leave the field blank.
List all chemicals, including reactants, products, intermediates, solvents, and any others used.

Chemical Properties and Hazards

Chemical Name	Physical State S, L, G	NFPA Ratings*				Incompatible Chemicals List chemicals present within the laboratory, and any others that may come in contact.	Flash Point Temp.	Flammability Limits	
		H	F	S	Sp.			LFL	UFL
Water	L	0	0	0		Strong acids, strong bases			
3% Hydrogen Peroxide	L	2	0	1		Heavy metals, salts, strong oxidizers			
Sulfuric Acid	L	3	0	2	W	Potassium chlorate, potassium perchlorate, potassium permanganate, sodium, lithium, bases, organic material, halogens, metal acetylides, oxides and hydrides, metals, strong oxidizing and reducing agents			
Cornstarch, Technical	S	1	1	0					
Sodium Acetate Anhydrous	S	1	1	0		Strong oxidizing agents, explosive mixture may be formed with fluorine or potassium nitrile			
Potassium Iodide	S	2	0	2	2	Oxidizing agents, acids, organic materials, metals (aluminum, brass, magnesium, cadmium, antimony, copper, nickel) their salts/alloys, and reducing agents			
Sodium Thiosulfate	S	1	0	1		Strong oxidizers, salts			
Manganese Dioxide	S	1	0	1		Strong oxidizers, strong acids, strong reducing agents, nitrates, combustible materials hydrogen peroxide, azides, chlorine, chlorates, chlorine trifluoride			
Ammonium Chloride	S	2	0	0		Strong acids, strong bases, lead & silver salts, bromine trifluoride & bromine pentafluoride, potassium chlorate			
Zinc	S	1	0	0		Acids, bases, strong oxidizers			
Activated Carbon	S	0	0	0		Strong oxidizers			

*NFPA Ratings: H – Health, F – Flammability, S – Stability, Sp. – Special

Chemical Toxicology, Regulation and Disposal: List the same chemicals that appear above, in the same order.

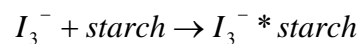
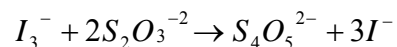
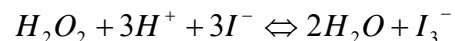
Chemical Name	Toxicology			Hazardous Waste Number [#]	Regulated? See Safety Manual	Personal Protective Equipment Specific to this Chemical
	TWA	PEL	Other			
Water					<input type="checkbox"/>	
3% Hydrogen Peroxide		1.4 mg/m ³			<input type="checkbox"/>	
Sulfuric Acid	0.2 mg/m ³	1 mg/m ³			<input type="checkbox"/>	Chemical Gloves, Splash Goggles
Cornstarch, Technical		1.5 mg/m ³			<input type="checkbox"/>	
Sodium Acetate Anhydrous					<input type="checkbox"/>	
Potassium Iodide					<input type="checkbox"/>	
Sodium Thiosulfate					<input type="checkbox"/>	
Manganese Dioxide					<input type="checkbox"/>	
Ammonium Chloride					<input type="checkbox"/>	
Zinc					<input type="checkbox"/>	
Activated Carbon					<input type="checkbox"/>	

[#]See Chemical Engineering Hazardous Waste Manual.

Chemical Reactions: Provide details below on any chemical reaction(s) that occur in your process. Please show the species involved, the stoichiometry and the heat of reaction, if available. Also list side reactions and any other reactions that may impact safety. You cannot type subscripts in the form field provided – use the names for the species and the stoichiometric coefficients.

Clock Reaction

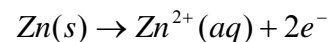
Solution Reactions:



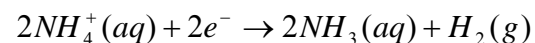
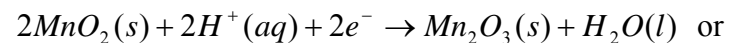
$\Delta H_f = \text{negligible}$

Battery Reaction

Anode:



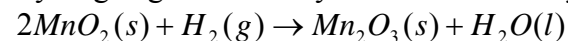
Cathode:



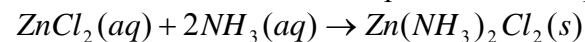
Hydrogen ions for the reduction of manganese are provided by ammonium via the following reaction:



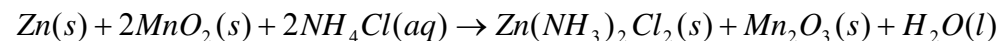
Hydrogen gas formed by the reduction of hydrogen from ammonium is oxidized by manganese dioxide to water via the following reaction:



The ammonia formed in this process is incorporated as a ligand with zinc chloride:



Overall Reaction:



Fabrication Hazard Summary – Check all hazards that are likely to be encountered during your Chem.-Car construction. List the major source(s) of the hazard and describe how the hazard(s) will be controlled.

Hazard	Major Source(s) of Hazard	Control Method(s)	PPE Required
<input type="checkbox"/> Arc welding			
<input type="checkbox"/> Gas welding			
<input type="checkbox"/> Lathe			
<input type="checkbox"/> Milling machine			
<input checked="" type="checkbox"/> Handheld power tools	Shock hazard from electric drill	Do not use power tools in a wet environment. Do not use power tools on or around the compressed activated carbon. Dust is conductive and can cause shocks.	Insulated gloves when necessary Safety glasses
<input type="checkbox"/> Drill press			
<input type="checkbox"/> Pressure > ambient			
<input type="checkbox"/> Pressure < ambient			
<input checked="" type="checkbox"/> Electrical	Shock hazard from power tools Ignition source	Handle power tools and electrified equipment with care. Do not use power tools in a wet environment or near flammable materials.	
<input checked="" type="checkbox"/> Other mechanical hazards	Pinch Hazard	Be careful to avoid pinching clothes are fingers with the metals gears.	
<input checked="" type="checkbox"/> Hot Surfaces/ High Temp > 150 F	Heating of cornstarch solution	Do not touch hot surface or beaker while heating. Use caution when extracting solution from the beaker to be used. Allow the solution to cool before disposal.	Safety glasses Insulated gloves
<input type="checkbox"/> Cold Surfaces/ Low Temp < 0 F			
<input checked="" type="checkbox"/> Paint spraying	Respiration hazard Flammability hazard	Be sure when spraying the car with paint to be in an area of high ventilation and away from open flame or other ignition sources.	Respirator mask.

<input type="checkbox"/> Flammable materials (Solid, liquid, or gas)			
<input checked="" type="checkbox"/> Toxic materials (Solid, liquid, or gas)	Toxicity Hazard from ingestion of chemicals: Sulfuric Acid, Potassium Iodide, Ammonium Chloride	Use gloves, stainless steel spatula, and goggles when handling these chemicals. Always mix in glass containers or vials.	Safety glasses. Chemical gloves.
<input checked="" type="checkbox"/> Reactive materials (Solid, liquid, or gas)	Reactivity Hazard DO NOT mix Ammonium Chloride with Potassium Iodide DO NOT mix Manganese Dioxide with Hydrogen Peroxide	The chemicals that are predetermined for mixing are not toxic but avoid mixture with other chemicals not intended, including those listed in the Chemical Information page. Clean all surfaces and glassware after use.	Safety glasses
<input type="checkbox"/> Ionizing radiation			
<input type="checkbox"/> Laser radiation			
<input type="checkbox"/> Asphyxiates			
<input type="checkbox"/> Open flames, exclusive of welding			

Operational Hazard Summary – Check all hazards that are likely to be encountered during the operation of your Chem.-Car. List the major source(s) of the hazard and describe how the hazard(s) will be controlled.

Hazard	Major Source(s) of Hazard	Control Method(s)	PPE Required
<input type="checkbox"/> Flammable materials (Solid, liquid, or gas)			
<input checked="" type="checkbox"/> Toxic materials (Solid, liquid, or gas)	Toxicity Hazard from ingestion of chemicals: Sulfuric Acid, Potassium Iodide, Ammonium Chloride	Use gloves, stainless steel spatula, and goggles when handling these chemicals. Always mix in glass containers or vials.	Safety glasses. Chemical gloves.
<input checked="" type="checkbox"/> Reactive materials (Solid, liquid, or gas)	Reactivity Hazard DO NOT mix Ammonium Chloride with Potassium Iodide DO NOT mix Manganese Dioxide with Hydrogen Peroxide	The chemicals that are predetermined for mixing are not toxic but avoid mixture with other chemicals not intended, including those listed in the Chemical Information page. Clean all surfaces and glassware after use.	Safety glasses
<input type="checkbox"/> Pressure > ambient			
<input type="checkbox"/> Pressure < ambient			
<input checked="" type="checkbox"/> Electrical	Ignition Source Shock Hazard	The electrical circuit board can cause a spark; keep away from flammable materials. Be aware of any liquid sources which may short-circuit the power supply or circuit board	
<input checked="" type="checkbox"/> Rotating equipment	Pinch Hazard from rotating gears and axle	Be aware of the turning gears on the vehicle's motor and axle. All rotating equipment on the car will be protected. Do not wear loose clothing when working around rotating equipment. Maintenance on moving parts will only be conducted with the supply power	

		removed.	
<input checked="" type="checkbox"/> Pinch points	Pinch hazards exist between car frame and wheels and in the gears	All hazardous pinch points will be covered. Maintenance on moving parts will only be conducted with the supply power removed.	
<input checked="" type="checkbox"/> Hot Surfaces/ High Temp > 150 F	Heating of cornstarch solution	Do not touch hot surface or beaker while heating. Use caution when extracting solution from the beaker to be used. Allow the solution to cool before disposal.	Safety glasses Insulated gloves
<input type="checkbox"/> Cold Surfaces/ Cold Temp < 0 F			
<input type="checkbox"/> Biohazard			
<input type="checkbox"/> Laser radiation			
<input type="checkbox"/> Ionizing radiation			
<input type="checkbox"/> Asphyxiates			
<input type="checkbox"/> Steam			
<input type="checkbox"/> Open flames			
<input type="checkbox"/> Other: _____			
<input type="checkbox"/> Other: _____			

Job Safety Assessment Form Safe Operating Procedures Page

The following are the standard operating procedures for developing the reaction mixture and servicing the AICHe vehicle.

Sequence of Steps	Potential Hazards	Procedure to Control Hazard	PPE or Equipment Required
Preparation of Reaction Solutions			
<u>Clock Reaction</u>			
<u>Solution A: Starch Solution</u>			
<ol style="list-style-type: none"> Obtain about 150 milliliters of tap water. Pour water into a 250 ml flask and place on a magnetic stirrer/hot plate. Saturate the water with cornstarch to form a milky white solution. Bring to a boil until the solution has a slight blue tint (check with a blank white sheet). 			
<u>Solution B: Sodium Thiosulfate</u>			
<ol style="list-style-type: none"> Measure 0.79 g of sodium thiosulfate. Place the sodium thiosulfate into a 250 milliliter flask. Measure 100 milliliter of tap water and pour into the 250 milliliter flask. Mix the solution on a magnetic stirrer. 	Toxicity Hazard	Remember to handle all chemicals safely. Do not ingest, and avoid eye contact or excessive skin contact.	Safety glasses Chemical gloves Spill containment
<u>Solution C: Potassium Iodide</u>			
<ol style="list-style-type: none"> Measure 1.66 g of potassium iodide. Place the potassium iodide into a 250 milliliter flask. Measure 100 milliliter of tap water and pour into the 250 milliliter flask. Mix the solution on a magnetic stirrer. 	Toxicity Hazard	Remember to handle all chemicals safely. Do not ingest, and avoid eye contact or excessive skin contact.	Safety glasses Chemical gloves Spill containment

<p>Batteries</p> <p><u>Preparation of electrolyte</u></p> <ol style="list-style-type: none"> 1. Measure 200 grams of ammonium chloride and add to a 1L flask. 2. Measure 100 grams of zinc chloride and add to the 1L flask. 3. Dilute with distilled water to 1L or until saturated. <p><u>Preparation of cathode</u></p> <ol style="list-style-type: none"> 1. Measure up to 50 grams of activated carbon powder and add to a plastic bottle. 2. Add ~50 mL of electrolyte solution to the bottle and mix until carbon enters the solution. 3. Measure 200 grams of manganese dioxide and add to a 250 mL beaker. 4. Pour the electrolyte-carbon solution into the manganese dioxide and stir until the manganese dioxide is completely wetted. Add more electrolyte if necessary. <p><u>Preparation of cells</u></p> <ol style="list-style-type: none"> 1. Using newspaper, form a cup to fit inside the zinc wire coil and place in cell. 2. Add equal parts of the manganese dioxide solution to the newspaper cup in each cell. 3. Fill cell with electrolyte. 			
Emergency Shutdown			
<ol style="list-style-type: none"> 1. Turn the switch to the Off position thereby turning off the power to the car electronics. 2. Remove any chemical contents from the clock reaction located on the circuit board and pour down the sink. Flush with plenty of water. 	Toxicity Hazard	Remember to handle all chemicals safely. Do not ingest, and avoid eye contact or excessive skin contact.	Safety glasses Chemical gloves

6. Measure the distance the vehicle has traveled from the starting line to the point it has stopped.			
Shutdown Procedure			
1. Turn the switch to the Off position thereby turning off the power to the car electronics. 2. Remove any chemical contents from the vehicle and pour down the sink. Flush with plenty of water.			
Cleanup / Waste Disposal			
1. Remove any chemical contents from the clock reaction located on the circuit board and pour down the sink. Flush with plenty of water. 2. Make sure to rinse and dry all beakers.	Toxicity Hazard	Remember to handle all chemicals safely. Do not ingest, and avoid eye contact or excessive skin contact.	Safety glasses