M° Lab

Field Notebook

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This M° Lab Field Notebook is the property of

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otherwise known as

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If found, its return to
M° Lab at the Ministry of Supply is requested.

10.08 M° Lab Field Notebook

Acknowledgements

M°

Ministry of Supply, Inc.

A special thanks to our partners at Mbadika for their continuous work in making STEM education available to all. This kit has been supported through the generous support of our customers, team, partners as well as Outlast Technologies, Singtex, and The Good Pencil Company.

Mbadika, Inc.

This work is a dedication to Dr. Marvin Richard McCray, the inspiration and true foundation for the creation and preservation of Mbadika's spirit to ensure ideas and those who create them will always have a voice and platform.

Special Thanks to the McCray Family (especially Brenda, Gabrielle, Calvin, Andrew, Ezekiel, Armani, and Amyrah) for providing a nurturing home and environment to allow such a project to bloom.

In addition, a sincere thank you to the entire Mbadika team as well as Andres Mendez Perez, Monique Douglas, David Palomares, Rosie Weinberg, Luc Chabot, Mikell Taylor, Veronica Armstrong, Vianna Gendraw, Jade Porter Connor, and Jay Santana for their work and contributions to this project.

Finally, an enormous thank you to our partners, Ministry of Supply, and the entire team for helping bring this project to life, a true example of Mens et Manus.

Mission Brief

Welcome Agent to M° Lab!

The Apollo uniform, named in honor of the first NASA mission to the Moon, utilizes NASA technology in order to create the foundation for our Agent's uniforms since the founding of the Ministry of Supply.

In recent weeks, our highly trained Agents have encountered a new, unique global challenge that has rendered the standard issue uniform, the Apollo, inept or unsuitable for future missions. While the present Apollo uniforms were designed for the world we knew, it is no longer engineered for the world we face now.

We've always understood teamwork is key to creating solutions to challenges we face in our everyday lives. Hence, we've joined forces to help train and work with new Agents like yourself in order to bring forth new ideas to tackle this challenge.

M° Lab is a collaboration between MLAB [Mbadika (BAH-GEE-KAH) Laboratory] and the Ministry of Supply, in order to bring ideas to life by engineering better.

Your mission, should you chose to accept; Re-Design the Apollo Uniform.

It's time to get started. Mens et Manus,

M° Lab Meeting Notes:

Mission 10.08.01	Fabric Basics
Mission Objective	**Learn the properties of the Apollo uniform through exploring fabric construction.**

The most important tool of a Ministry of Supply agent is the Apollo uniform.

Therefore, it is important when redesigning the Apollo uniform to select fabrics that are constructed and engineered to perform and last in any environment an agent might face.

Currently, the Ministry of Supply uses a variety of fabrics in order to accommodate the various needs of its agents including comfort, performance, and style (they are secret agents after all). Whether it is outrunning a robotic cheetah or traveling to environments with extreme temperatures, there is a Ministry of Supply fabric to address any challenge an agent may encounter.

In this M^O Lab assignment, we will explore popular Ministry of Supply fabrics utilized in the production of our present Apollo uniform including Aero, Aero Zero, Apollo, Kinetic, and Velocity fabrics in order to understand fabrics and their construction.

For this mission, you will need the following;

	Materials		**Tools**
	Phase Change Material (PCM) Vial		H_2O (Water)
	Aero Fabric Swatch		Tweezers
	Aero Zero Fabric Swatch		Scissors
	Apollo Fabric Swatch		Inch Glass
	Kinetic Fabric Swatch		Eye Dropper
	Velocity Fabric Swatch		
	S. Cafe Pellets		

Yarn

Fabrics are made of yarns. Yarn can come from a wide variety of materials such as natural materials derived from plants and animals like cotton, wood, silk, and wool, as well as lab-made or synthetic materials like acrylic and polyester from plastic bottles (PET) which are produced with the assistance of chemicals. Depending on the requirements for the fabric, such as being machine washable, comfortable, or long-lasting, either yarn could be appropriate for use as a fabric.

Utilizing the inch glass, we can observe the differences between natural and synthetic yarns.

Image A
Natural Yarn
{Reference Image: 200x Velocity Fabric}

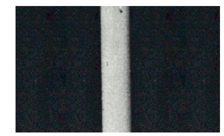


Image B
Synthetic Yarn
{Reference Image: 200x Aero Fabric}

In Image A, we observe a natural yarn made from wood that appears soft and feathery, similar to cotton candy. In Image B, we observe a synthetic yarn made from plastic bottles (PET) that appears long and continuous, similar to a spool of wire.

Using a few tools available in our kit, we can determine whether a fabric is composed of a natural or synthetic yarn by conducting a simple test using a few tools available in our kit.

Experiment 10.08.01A | Yarn Analysis

Use the tweezers and scissors in your kit to pull and cut some yarn off of each of the Ministry of Supply fabric swatches.

Once you have a sample yarn from each fabric, use the inch glass to examine the yarn(s) and write down your observations below;

Table 10.08.01Ai

Natural	Synthetic	Ministry of Supply Fabrics
		Aero Fabric Swatch
		Aero Zero Fabric Swatch
		Apollo Fabric Swatch
		Kinetic Fabric Swatch
		Velocity Fabric Swatch

Field Tip: If you are unsure if a fabric is composed of natural or synthetic yarn, use your eye dropper and add a drop of H_20 to the fabric. If the fabric absorbs the water, it's a natural yarn as synthetic yarns don't absorb water. This is how we are able to use PET not only as a synthetic yarn but also as a material for plastic water bottles.

Given the work environments of a typical agent, special yarns composed of phase change materials (PCMs) and coffee grounds are engineered at the Ministry of Supply to ensure the fabrics which comprise the Apollo uniform perform regardless of the situation.

Phase Change Materials (PCMs)
Phase Change Materials or PCMs are materials containing paraffin wax, which acts as a rechargeable battery by absorbing and releasing heat through melting and solidifying. The process in which the paraffin wax melts and solidifies or changes between a liquid and solid phase is known as a phase change. Hence, materials that utilized this process are known as phase change materials.
We can observe this effect for ourselves.

Experiment 10.08.01B | PCM Analysis
Hold the PCM Vial in your hand and measure how long it takes for the material to change from a solid to a liquid. Once a liquid, remove your hand from the vial and measure how long it takes for the material to return to a solid state. Note anything you may observe, including how does the vial feel?

Phase Change	Time [00:00]	Field Notes
Solid. —> Liquid		
Liquid —-> Solid		

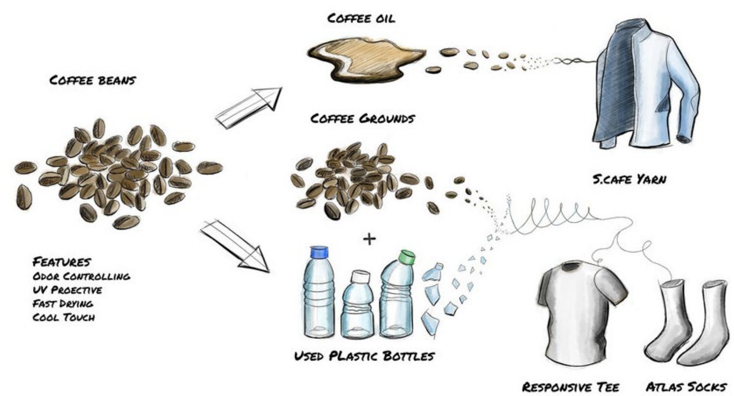
The unique ability of PCMs to absorb and release heat is utilized by NASA as a temperature regulating material in space suits in order to keep astronauts comfortable in space regardless of the environment.

When an astronaut is too hot, PCMs in the space suit absorb the heat from their body in order to cool their body in a process similar to sweat. When the astronaut's body temperature is too cold, the PCMs in the space suit release the stored heat in order to warm their body. This allows for the astronaut to explore the depths of space without the risk of hyperthermia (body temperature is too high) or hypothermia (body temperature is too low).

Did you know?
Phase Change Materials (PCMs) are an example of a NASA Spinoff, inventions developed for space but tweaked for use on Earth. Examples of NASA Spinoffs include velcro, eyeglasses, and memory foam. Learn more at: https://homeandcity.nasa.gov/

Odor-Control Yarn
In certain situations, even releasing a scent can lead to undesirable situations.

Surprisingly, coffee beans are a natural palette cleanser that help absorb odor molecules, both pleasant and unpleasant. Utilizing a chemical process that mixes coffee grounds and polyester into pellets and later yarn, the Ministry of Supply is able to engineer a yarn which controls for odor by acting as an "odor sponge".



Experiment 10.08.01C | Odor-Control Analysis
Obtain a pair of worn, closed toed shoes (i.e. sneakers, loafers, or slippers) and open the packet of S.Cafe pellets and from your kit.

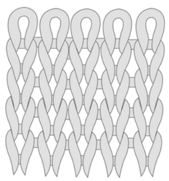
Place the S.Cafe pellets into one of the shoes while keeping the other shoe empty as your control. Leave the shoes undisturbed for at least 1 hour.

Smell the shoe treated with S.Cafe pellets, then the untreated shoe.
Write down your observations. What do you observe?

Field Notes

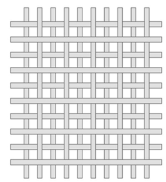
Fabric

Once a yarn is selected, natural or synthetic, it can be transformed into fabric through various methods including by being knit or woven.



Knit

A single yarn is looped continuously to produce a series of connected loops.
Soft, Stretchy



Woven

Multiple yarns overlap to create a criss-cross pattern or a grain.
Firm, Stiff

Given how the yarn is arranged, knitted and woven fabrics behave differently and provide different properties. For example, knitted fabrics are soft and stretchy, which makes them great for scarves and shirts while woven fabrics are firm and stiff, which makes them great for jackets and pants. In addition, the different properties of each allow us to identify whether we have a knitted and woven fabric based on how they behave in a series of tests.

Experiment 10.08.01D | Knit vs. Woven Fabrics

Use the inch glass in your kit to identify whether a Ministry of Supply fabric is knitted or woven based on the examples above of knitted and woven fabrics.

Knitted	Woven	Ministry of Supply Fabrics
		Aero Fabric
		Aero Zero Fabric
		Apollo Fabric
		Kinetic Fabric*
		Velocity Fabric

Field Tip: The Kinetic fabric looks like a knit and a woven, which allows for it to be stretchy and have structure. However, it is a knitted fabric known as a warp knit.

Extra Mile: Visit the Ministry of Supply website (ministryofsupply.com) and note which Ministry of Supply garments use each type of fabric.

Mission 10.08.02	Performance Tests
Mission Objective	**Learn fabric construction through the conduction of performance tests.**

In the pursuit of a re-imagined Apollo uniform, it is important to choose the right fabric to suit an agent's needs. For instance, a uniform that is comfortable to wear, performs well and is durable. Therefore, in order to choose the right fabric, we'll perform a few experiments to determine the best fabrics for our mission.

In this M° Lab assignment, we will conduct a series of tests on popular Ministry of Supply fabrics utilized in the production of the present Apollo uniform including Aero, Aero Zero, Apollo, Kinetic, and Velocity fabrics in order to understand their fabric construction.

For this mission, you will need the following;

	Materials		Tools
	Aero Fabric Swatch		Sandpaper
	Aero Zero Fabric Swatch		Inch Glass
	Apollo Fabric Swatch		Ruler
	Kinetic Fabric Swatch		Eye Dropper
	Velocity Fabric Swatch		$H_2$0 (Water)
	Vial of Coffee Grounds		

On this mission, we will be conducting [3] tests in order to analyze Ministry of Supply fabrics based on elasticity, durability, and moisture-wicking abilities.

Elasticity or Stretch Test

Fabrics constructed with a loose knit, loose weave (i.e. woven), or contain elastic can be stretched. In M° Lab, a tensile strength machine is used to stretch the fabric and determine its elasticity as well as how well a fabric maintains it's properties after wear. However, we can conduct a simple test simply using a ruler.

Experiment 10.08.02A | Elasticity Test

• Use the ruler from your kit in order to test the elasticity of Ministry of Supply fabrics and record their stretch ratios.
• Place a fabric swatch over the ruler. Measure the length. Record.
• Pull as hard as you can lengthwise. Measure the length. Record.
• Divide the starting length by the stretched length, this is the stretch ratio.
• Repeat by stretching fabric swatches width-wise.

Table 10.08.02Ai

Materials	Length	Stretch Length	Stretch Ratio [Length: Stretch Length]
Aero Fabric Swatch			
Aero Zero Fabric Swatch			
Apollo Fabric Swatch			
Kinetic Fabric Swatch			
Velocity Fabric Swatch			

Table 10.08.02Aii

Materials	Width	Stretch Width	Stretch Ratio [Width: Stretch Width]
Aero Fabric Swatch			
Aero Zero Fabric Swatch			
Apollo Fabric Swatch			
Kinetic Fabric Swatch			
Velocity Fabric Swatch			

Durability Test

When a fabric has a pulled yarn or a loose thread, it is due to yarn being pulled out or being snagged out of the fabric. In M° Lab, a random tumble pill machine is used to tumble fabric swatches along spikes in order to create pulled yarns.

After a given number of revolutions, the number of pulled yarns or pilling are counted to determine the fabric's durability.
The range is [1] for severe pilling to [5] for no pilling.

We can conduct a simple pilling test using a piece of sandpaper.

Experiment 10.08.02B | Durability Test

• Use the sandpaper and inch glass from your kit in order to test the durability of Ministry of Supply fabrics and record their pillage.
• Hold the fabric swatch down on a flat surface.
• Rub the piece of sandpaper across the fabric swatch in different directions.
• Use your inch glass and count the number of pulled yarns. Record.

In order to create your pillage scale, label the fabric swatch with the lowest number of pulled yarns [1] and the next lowest [2] until you label the fabric swatch the greatest amount of pulled yarns [5].

Table 10.08.02Bi

Materials	Number of Pulled Yarns	Pillage [Scale 1-5] 1 - Severe Pillage 5 - No Pillage
Aero Fabric Swatch		
Aero Zero Fabric Swatch		
Apollo Fabric Swatch		
Kinetic Fabric Swatch		
Velocity Fabric Swatch		
Vial of Coffee Grounds		

Did you know?
A PUGH is a chart that allows engineers to analyze and compare the properties of various options (i.e. pillage) in order to select the best option (i.e. fabric) in a quantifiable or numeric method.

Extra Mile: Transform the results of the stretch test into a PUGH Chart like the durability test.

Table 10.08.02Bii

Materials	Stretch Ratio Length	Stretch Length [Scale 1-5]	Stretch Ratio Width	Stretch Width [Scale 1-5]
Aero Fabric Swatch				
Aero Zero Fabric Swatch				
Apollo Fabric Swatch				
Kinetic Fabric Swatch				
Velocity Fabric Swatch				

Moisture-Wicking Test

Water is a distinctive molecule, which allows for the development of fabrics that react to moisture. One method of moisture-wicking is known as horizontal transfer in which moisture is spread over a large surface area on fabric allowing it to dry faster. Similar to elasticity and durability, the yarn shape affects the way moisture spreads in fabric.

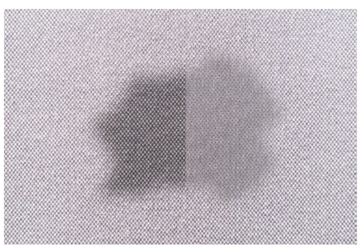


Image A
Synthetic Fabric
{Moisture Test}

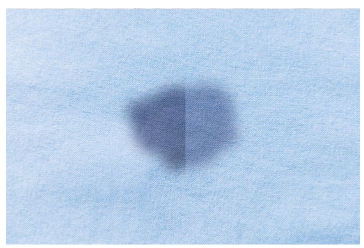


Image B
Natural Fabric
{Moisture Test}

For example, in synthetic fabrics, moisture is spread across the yarn increasing the surface area so it dries faster. In contract, in natural fabrics, moisture is absorbed in one spot decreasing the surface area - so it dries slower.

We can conduct a simple moisture wicking test using a ruler, an eye dropper, and a small amount of water.

Experiment 10.08.02C | Moisture-Wicking Test

- Use the ruler and eye dropper from your kit alongside a small container of water and a timer in order to test and record the moisture-wicking properties of Ministry of Supply fabrics.
- Place the fabric swatch on a flat surface.
- Use the eyedropper to drop [3] drops of water in one spot on the fabric swatch.
- After [3 seconds], measure the width of the spot. Record.
- After [1 minute], measure the width of the spot. Record.
- After [15 minutes], measure the width of the spot. Record.

Table 10.08.02Ci

Materials	Width of Spot [3 seconds]	Width of Spot [1 min]	Width of Spot [15 min]	Width of Spot [Scale 1-5] 1 - Dry 5- Moist
Aero Fabric Swatch				
Aero Zero Fabric Swatch				
Apollo Fabric Swatch				
Kinetic Fabric Swatch				
Velocity Fabric Swatch				

After conducting [3] tests in order to explore the fabric construction of Ministry of Supply fabrics, we are able to create a complete PUGH chart to select the best fabric based on the properties we desire for the Apollo uniform.

Table 10.08.02Cii

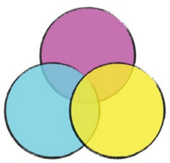
Materials	Stretch Test [1-5]	Durability Test [1-5]	Moisture Wicking Test [1-5]	Best Fabric Score [S+D+M]
TEST	2.5	2.5	2.5	7.5
Aero Fabric Swatch				
Aero Zero Fabric Swatch				
Apollo Fabric Swatch				
Kinetic Fabric Swatch				
Velocity Fabric Swatch				

Mission 10.08.03	The Science of Dyeing
Mission Objective	Learn the chemistry required to dye natural and synthetic fabrics.

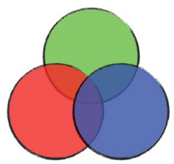
When we think about refreshing a Ministry of Supply invention, such as the Apollo uniform, we can utilize a variety of different approaches including new shapes or silhouettes, fabrics, but also color.

Color is the property of an object to create a unique sensation on the eye due to the way an object reflects or emits light. For example, a red apple appears red to the eye because it reflects red light.

Color can be created in two ways; **Additive Color** and **Subtractive Color**.



Additive Color



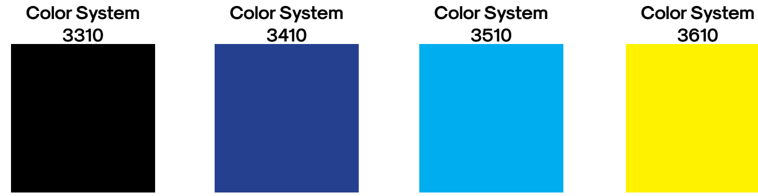
Subtractive Color

Additive Color is the process in which color is made by mixing light, in particular Red, Green, and Blue (RGB) light, to create a spectrum of colors. Example: a computer screen.

Subtractive Color is the process in which color is made by reflecting light by mixing colors or pigments, like Red, Blue, or Yellow (RBY), in order to only reflect a particular color. Example: a piece of printed paper.

Did you know?
Printers utilize subtractive color by mixing [4] pigmented inks, Cyan (a light blue), Magenta, Yellow, and Black [CMYK], to create the wide range of colors needed for black/white and colored prints. This is why packaging on black print cartridges display a Black dot while color print cartridges display a Cyan, Magenta, and Yellow dot.

Based on the Ministry of Supply fabric swatches in your kit, you will notice our core color palette or the colors we use to create Ministry of Supply products, is as follows; Blues and Grays with Neutrals (i.e. White, Tan, etc.).



In the review and selection process of a sample, we are looking for [2] things; Hue and Saturation

Hue: The Color of the dye - does a Blue look too Red, Green, or Yellow
Saturation: The Volume of the color - does it appear saturated (bright) or does it appear muted (dark, dull).

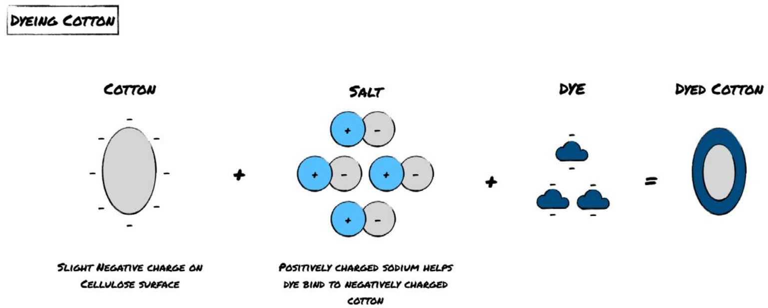
In the pursuit of an updated color palette, it is important to choose the right colors to suit an agent's needs. For instance, a uniform that is fashionable but also subtle. A necessity for agents to operate in the field with minimal risk of exposure. Therefore, we'll perform a few experiments to determine our colors and the best dye blends to achieve them.

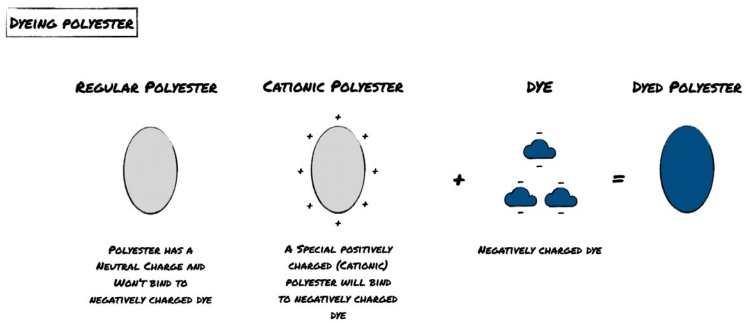
In this M° Lab assignment, we will conduct a series of lab dips on popular Ministry of Supply fabrics utilized in the production of the present Apollo uniform including Aero, Aero Zero, Apollo, Kinetic, and Velocity fabrics in order to achieve our desired color palette.

There are [3] ways of dyeing;
Piece Dye: Raw fabric (called greige due to its grey or beige appearance) is dyed producing a consistent color on the fabric.
Yarn Dye: Yarn is dyed and then woven or knit with other yarns to create a pattern.
Garment Dye: A finished garment or fabric is dyed as a whole which softens the garment and produces slight color variation.

We will be conducting a garment dye in order to develop our updated color palette. In order to dye the fabric, we will be using a solution dye in which a pigment is dissolved in water. It's the most versatile and cost effective method to dye fabrics, however it utilizes a lot of water.

Different yarns absorb dye differently due to the magnetic charges on them. Therefore, we need to make sure that the dye will be attracted to the yarn like a magnet. We do this by adding salt to natural fabrics (i.e. cotton) or an acid like vinegar to synthetic fabrics (i.e. polyester) to help the dye bind to the yarn.





On this mission, we will be developing [3] solution dyes, [1] natural dye and [2] synthetic dyes, in order to analyze potential color palettes and dye solutions.

For this mission, you will need the following;

	Materials		Tools
	Atlas Grey Gradient Socks		Tweezers
	Aero Fabric Swatch		Rubber Bands
	Aero Zero Fabric Swatch		Binder Clips
	NaCl (Salt)		Dye Tray
	Vinegar		(2) Beakers
	Vial of Synthetic Dye (i.e. Graphite)		
	Vial of Synthetic Dye (i.e. Sapphire)		
	Vial of Coffee Grounds		
	H_20 (Water)		

ADVISORY:
Before we begin, ensure you are conducting the following experiments on a flat surface with a protective covering (i.e. plastic tablecloth, newspaper, or cardboard). In addition, you MUST WEAR GLOVES (which are provided in your kit) AND PROTECTIVE CLOTHING (no fancy dress for this assignment) while conducting these experiments to protect yourself and others.

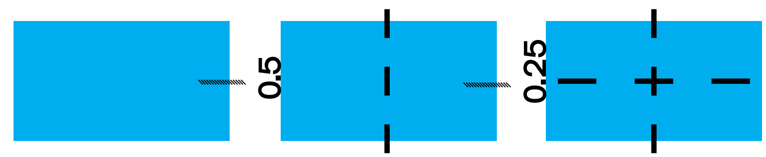
Once you've completed your safety check, you may proceed.

Dye Blend	Materials	Tools
Natural Dye	Vial of Coffee Grounds Vinegar H_20 (Water) [0.5] Aero Fabric Swatch [cut in half]	Beaker Dye Tray Tweezers Round Spatula Gloves

Field Tip: If you desire to experiment with creating a unique treatment of a fabric with a natural dye as well as a synthetic dye, we recommend using the Aero fabric swatch. Never mix the dye solutions.

Complete one dye bath and allow for the fabric to completely dry before attempting another dye solution.

How To: 0.5 | 0.25 Fabric Swatches



Natural Dye Test
In this experiment, we will be testing natural dye solutions, composed of coffee grounds, utilizing salt and vinegar in order to produce a dye solution that achieves our desired hue, saturation, and evenness (or equal coverage of the dye on the desired fabric or yarn).

Field Tip: Given this a natural dye utilizing coffee grounds, our color spectrum spans from light tan to dark brown.

Experiment 10.08.03A | Natural Dye

• Use the beaker, dye tray, tweezers, stirrer, eye dropper, coffee grounds, vinegar, salt, and swatches from your kit alongside a small container of water and a timer in order to test and record your observations of the performance of Ministry of Supply fabrics in a naturally dye solution.
• Fill up 0.25 of your Dye Tray (i.e. ~250mL) with H_20 (Water) and microwave until warm, but not boiling.
• Use a beaker and measure 50mL of coffee grounds. Add grounds to your dye tray. Mix.
• Rinse the beaker. Use your eye dropper to measure 6mL vinegar into the beaker.
• Use your eye dropper to measure 2mL of NaCl (salt) in the second beaker.*
If using your eye dropper is too tedious, a pinch of NaCl is ~0.30mL.
Therefore, 2mL of NaCl is ~6-7 pinches.

Field Tip: Make sure you know which beaker is the Natural Dye - NaCl beaker and the Natural Dye - Vinegar beaker.

• Add equal parts of the coffee mixture from the dye tray to each beaker to make a 50mL solution. Mix.
• Take your 0.25 Aero Fabric Swatches and place one in each beaker.
• Stir with tweezers for 30 seconds. Set a timer for 15 minutes and let it sit. If you desire a deeper brown, allow for additional time.
• Record your observations.
• Rinse the fabric swatches with cold H_20 until the water runs clear, which means excess dye has been removed.
• Rinse your dye tray and beakers.
• Place fabric swatches in each beaker and fill with cold H_20.
• Allow fabric swatches to soak for 10 minutes.
• Rinse each fabric swatch with mild dish washing detergent or soap and let it dry. Record your observations.
• Upon completion, clean your supplies in order to conduct experiments in the future.

Fabric	Dye Solution	Mix	Field Notes
0.25 Aero Fabric	1:5 Natural Dye (i.e. Coffee)	6mL Vinegar in 50mL Beaker	
0.25 Aero Fabric	1:5 Natural Dye (i.e. Coffee)	2mL NaCl (Salt) in 50 mL Beaker	

Synthetic Dye Test

In this experiment, we will be testing synthetic dye solutions, composed of synthetic dye of our choosing, utilizing salt, vinegar, and dish washing liquid in order to produce a dye that achieves our desired hue, saturation, and evenness (or equal coverage of the dye on the desired fabric or yarn).

Field Tip: Given this a synthetic dye, our color spectrum depends on the synthetic dye color chosen and the amount of dye in our solution.
After initial tests, adjust synthetic dye amounts as desired in order to achieve your desired color.

Experiment 10.08.03B | Synthetic Dye

• Use the beaker, dye tray, tweezers, stirrer, eye dropper, synthetic dye, vinegar, salt, and swatches from your kit alongside a small container of water and a timer in order to test and record your observations of the performance of Ministry of Supply fabrics in a synthetic dye solution.
• Fill up 0.5 of your Dye Tray (i.e. ~500mL) with H_20 (Water) and microwave until warm, but not boiling.
• Select which synthetic dye (graphite or sapphire) you wish to utilize to create a dye solution.
• Use your beaker to measure and add 25mL of your synthetic dye - graphite or sapphire - to your dye tray. Mix.
• Rinse the beaker. Use your eye dropper to measure 2mL vinegar into the beaker.
• Use your eye dropper to measure 1mL of NaCl (salt) in the second beaker.

Field Tip: If using your eye dropper is too tedious, a pinch of NaCl is ~0.30mL.
Therefore, 1mL of NaCl is ~3-4 pinches.

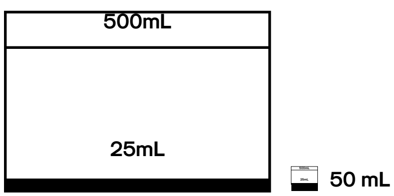
• Add equal parts of the synthetic dye solution from the dye tray to each beaker until a 50mL is created in each beaker. Mix.
• Take your 0.25 Aero Zero fabric swatches and place one in each beaker.
• Stir with tweezers for 30 seconds. Set a timer for 5 minutes and let it sit.
• Rinse fabric swatches in cool H_20 until H_20 begins to run clear.
• Wash the fabric swatches in warm H_20 with mild detergent or soap, rinse, and dry. Record your observations.
• Set a timer for an additional 5 minutes. Record.
• Upon completion, clean your supplies, except your dye tray with your synthetic dye solution, in order to conduct additional experiments.
• DON'T DUMP YOUR DYE SOLUTION FROM YOUR DYE TRAY. YOU WILL NEED IT FOR EXPERIMENT 10.08.03C.

Table 10.08.03Bi : [Synthetic Dye Solution: 5 minutes]

Fabric	Dye Solution	Mix	Field Notes
0.25 Aero Fabric	1:25 Synthetic Dye (i.e. Graphite o/ Sapphire)	2mL Vinegar in 50mL Beaker	
0.25 Aero Fabric	1:25 Synthetic Dye (i.e. Graphite o/ Sapphire)	1mL NaCl (Salt) in 50mL Beaker	

Did you know?
A "1:25 Synthetic Dye Solution" is a description of the amount of synthetic dye to water in the dye solution. For example, in our dye solution, we have 25mL of synthetic dye to 500mL of $H_2$0 which means for every [1] part of synthetic dye there are [25] parts of $H_2$0.

If we made a 1:25 synthetic dye solution in our beaker, it would be 2.5mL of synthetic dye to 50mL of $H_2$0.



Question:
Which synthetic dye solution performed the best in achieving the desired color? What did you notice happen to the fabric swatches after the initial dye solution bath? Do you notice differences between using a synthetic dye versus a natural dye? Similarities?

After conducting experiments on natural dye and synthetic dye solutions, it's time to create our desired color palette for the Apollo uniform.

Experiment 10.08.03C | Make a Dye Blend

- Use the beakers, dye tray with your synthetic dye solution from Experiment 10.08.03B, tweezers, stirrer, vinegar, salt, and swatches from alongside a small container of water and a timer in order to test and record your observations of the performance of Ministry of Supply fabrics in a synthetic dye solution.
- Use your dye tray with your synthetic dye solution from Experiment 10.08.03B as your master dye solution.
- Using your beakers, develop at least (2) unique synthetic dye solutions using your master dye solution while utilizing your knowledge of dyes, additives (i.e. NaCl, vinegar, etc.), dye bath time, etc.
- Test your dye solutions using your Aero Zero fabric swatches.
- Record the process in order to create your unique dye solution.

Field Tip: Don't forget to name your unique synthetic dye solution.

- **Example**: "Chroma Grey"
- **Description**: Dark Blue w/ Grey undertones synthetic dye solution
- **Dye Solution Process**

1:25 Synthetic Dye Solution
Master Dye Solution:
20mL of synthetic dye sapphire to 500mL of H_2O.
Pour master dye solution into 50mL beaker and add 0.5mL synthetic dye graphite to solution.
Add 1mL NaCl to enhance color.
Dye Time: 10 min
Small Batch Solution:
2.0mL of synthetic dye sapphire and 0.5mL of synthetic dye graphite to 50mL of H_2O.
Add 1mL NaCl to enhance color.
Dye Time: 10 min

Afterwards, clean your supplies in order to conduct experiments in the future.

Fabric	Dye Solution	Mix	Field Notes
0.25 Aero Fabric	1:25 Synthetic Dye (i.e. Graphite o/ Sapphire)	2mL Vinegar in 50mL Beaker	
0.25 Aero Fabric	1:25 Synthetic Dye (i.e. Graphite o/ Sapphire)	1mL NaCl (Salt) in 50mL Beaker	

- Once you've developed a unique synthetic dye solution(s) that produces your desired color or color palette, you will create a new synthetic dye solution in your dye tray in order to dye your Atlas Socks.
- Fill up 0.5 of your Dye Tray (i.e.~500mL) with H_20 (Water) and microwave until warm, but not boiling.
- Select which unique dye solution blend you wish to utilize to create a dye solution.
- Use your beaker to measure your natural dye or synthetic dye - graphite and/or sapphire - to your dye tray. Mix. Rinse the beaker.
- Use your eye dropper to measure any vinegar or NaCl needed into the beaker. Mix.

Field Tip: If using your eye dropper is too tedious, a pinch of NaCl is ~0.30mL. Therefore, 1mL of NaCl is ~3-4 pinches.

- Add one sock to your dye tray and ensure it is completely submerged.
- Set a timer for desired dye bath time and ensure every [1 minute] during the first [5 minutes] you stir the sock in your unique dye solution with tweezers.
- After desired dye bath time, remove Atlas sock from the dye tray.
- Repeat for the other Atlas sock.
- Rinse both Atlas socks in cool H_20 until H_20 begins to run clear.
- Wash the socks in warm H_20 with mild detergent or soap, rinse, and dry.
- Record your observations. Upon completion, clean your supplies.

Field Notes

Field Tip: If the fabric (i.e. a grey gradient Atlas socks) you are dyeing is not a uniform color, the dye will produce a lighter or deeper hue based on the pre-existing color.

Mission 10.08.04	Water and Stain Repellents
Mission Objective	**Learn about water-resistant coatings on fabrics**

When we think about comfort and performance, we typically don't take into account the importance of a fabric to minimize discomfort and decreased performance due to exposure to sudden or sustained moisture (i.e. sweat, snow, and rain).

As we complete our reinvention of the Apollo uniform, we can utilize water-resistant materials in order to combat the consequences of moisture.

In this M° Lab assignment, we will conduct a series of tests on a few Ministry of Supply fabrics utilized in present production as well as our Atlas socks from Experiment 10.08.03C in order to understand the importance of water-resistant coatings for the Apollo uniform.

For this mission, you will need the following;

	Materials		Tools
	[2] 0.25 Aero Fabric Swatches (from Experiment 10.08.03)		Tweezers
	0.5 Kinetic Fabric Swatch [cut in half]		Ruler
	0.5 Apollo Fabric Swatch [cut in half]		Eye Dropper
	0.5 Velocity Fabric Swatch [cut in half]		Dye Tray
	1 Pair of Atlas Socks (Dyed)		Binder Clips
	Colored Liquid (i.e. Juice, Coffee, Tea)		Inch Glass
	DWR in Spray Bottle		
	H_20 (Water)		

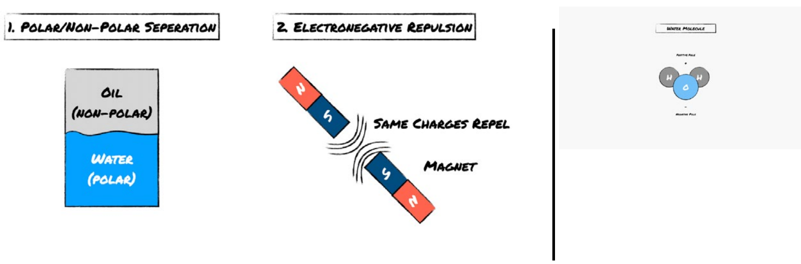
There are two methods of keeping agents dry in their uniforms; waterproof and water repellent/resistant.

Waterproof: keeping water from going through the fabric
Water repellent/resistant: keeping water off the fabric

Often, waterproof and water repellent are used interchangeably, however there is a key distinction between the two. For example, with enough rain, a water repellent fabric will become wet.

Water repellents keep fabric dry by pushing $H_2$0 (water) droplets away from the fabric which causes the $H_2$0 droplets to "bead up" into balls and roll off the fabric surface. How? Polarity.

Polarized molecules repel and attract each other, due to their electromagnetic charge just like magnets.

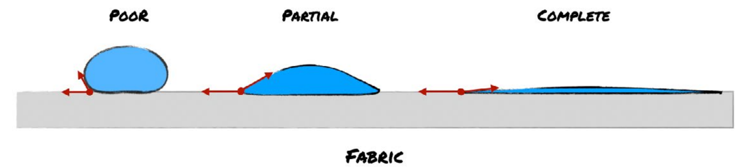


Water is a polarized molecule due to the presence of slightly positive charge on hydrogen (H_1) and a slightly negative charge on oxygen (O_8), which produce a net zero charge.

This allows for $H_2$0 to repel and attract other polarized molecules while maintaining its status as a neutral substance. Given the oxygen molecule is larger than the hydrogen molecules, we can repel $H_2$0 by introducing a slightly negative molecule to a fabric, such as a slightly negative charge fluorine (F) molecule.

This repulsive force is critical to the function of water repellents, in particular durable water repellents or DWRs.

Did you know?
You've probably heard the saying 'oil and water don't mix' to describe individuals who are polar opposites. It's true, they don't. $H_2$0 is a polar substance (which means it has a +/- charge, like a magnet) and oil is nonpolar (which means it has a neutral charge), meaning they repel each other. Hence, traditional water repellents include oils and wax, such as using paraffin wax and beeswax, in order to repel moisture from artwork and clothing.



When a fabric is treated with a DWR, its negatively charged molecules push the $H_2$0 molecules away from the fabric. This increases the surface tension and decreases the contact angle (the angle between the fabric and $H_2$0 droplet), which we can observe as the $H_2$0 beading up on the fabric.

As we did in Experiment 10.08.02C, we can witness this effect by conducting a simple moisture wicking test using a ruler, an eye dropper, and a small amount of $H_2$0.

ADVISORY: Before we begin, you must ensure you are conducting the following experiments on a flat surface with a protective covering (i.e. plastic tablecloth, newspaper, or cardboard). In addition, YOU MUST WEAR GLOVES (which are provided in your kit) and PROTECTIVE CLOTHING (no fancy dress for this assignment) WHILE CONDUCTING THESE EXPERIMENTS to protect yourself and others. Once you've completed your safety check, you may proceed.

Experiment 10.08.04A | DWR v. non-DWR Test
• Use the ruler, eye dropper, and inch glass from your kit alongside a small container of water and a timer in order to test and record the moisture wicking properties of Ministry of Supply fabrics.
• Place the 0.25 Aero fabric swatch on a flat surface.
• Spray half the Aero fabric swatch with an even coating of DWR or [4-5] sprays of DWR.
• After [1 hour], use the eyedropper to drop [3] drops of $H_2$0 in one spot on the untreated side of the Aero fabric swatch then repeat for the DWR treated side of the fabric swatch.
• After [15 seconds], look at the spots using an inch glass and observe the shape of $H_2$0. Record your observations.
• After [1 minute], look at the spots using an inch glass and observe the shape of $H_2$0 and the fabric (is it completely, partially, or slightly wet).
• Record your observations.
• Repeat for the 0.25 Kinetic fabric swatch.

Extra Mile: After [5 minutes], tilt the fabric and see if the water droplets roll off. Record your observations

Table 10.08.04Ai

	Field Notes [15 seconds]	**Field Notes [1 minute]**	**Field Notes [5 minutes]**
0.25 Aero Fabric Swatch			
0.25 Kinetic Fabric Swatch			
0.25 Aero Fabric Swatch w/ DWR			
0.25 Kinetic Fabric Swatch w/ DWR			

Question:
Which Ministry of Supply fabric caused a water droplet to form into a bead? Which one allowed the water to seep through?
Which Ministry of Supply fabric do you believe was or wasn't pre-treated with DWR?
Extra Mile: Conduct Experiment 10.08.04A with the Apollo and Velocity fabric swatches. What do you observe?

Field Notes

While we've witnessed the water repellent power of DWR on Ministry of Supply fabrics, let's explore if those repellent properties apply to stains as well.

Experiment 10.08.04B | Colored Liquid Repellent Test

• Use the ruler, eye dropper, and inch glass from your kit alongside a small container of a colored liquid (i.e. juice, coffee, or tea) and a timer in order to test and record the stain repellent properties of Ministry of Supply fabrics.
• Place the 0.25 Aero fabric swatch with DWR on a flat surface.
• Use the eyedropper to drop [3] drops of colored liquid in one spot on the Aero fabric swatch with DWR.
• After [1 minute], look at the spots using the inch glass and observe the shape of H_20. Record your observations.
• After [5 minutes], look at the spots using the inch glass and observe the shape of H_20 and the fabric (is it completely, partially, or slightly wet). Record your observations.
• Repeat for the 0.25 Kinetic fabric swatch with DWR.

Extra Mile: Tilt the fabric and see if the water droplets roll off.
Record your observations.
Field Tip: If the liquid doesn't roll off the fabric swatch, try rinsing with water.

Table 10.08.04Bi

	Liquid [i.e. Juice, Coffee, Tea]	Field Notes [1 minute]	Field Notes [5 minutes]
0.25 Aero Fabric Swatch w/ DWR			
0.25 Kinetic Fabric Swatch w/ DWR			

Question:
What are additional ways DWR can be used to repel water and stains?

Field Notes

Extra Mile: Try spraying DWR on your sneakers and observe if they are easier to clean and maintain.

Now we've observed the water and stain repellent properties of DWR treated fabrics, let's explore the performance and comfort of the Ministry of Supply fabric before and after DWR treatment using our Atlas socks from Experiment 10.08.03C.

Experiment 10.08.04C | The Atlas Sock Test

• Use the dye tray, eye dropper, and spray bottle with DWR from your kit alongside a small container of water, a timer, and your feet in order to test and record the moisture-wicking properties of your Atlas socks.
• Fill up 0.5 of your Dye Tray (i.e. ~500mL) with cold H_20 (Water) and place it on the floor.
• Place one Atlas sock on a protected flat surface and spray the entire sock with an even coating of DWR or [5-10] sprays of DWR. Flip the Atlas sock over and apply an even coating of DWR. Allow for the entire Atlas sock to dry for [1 hour].
• After [1 hour], place the Atlas sock treated with DWR on one foot and the untreated Atlas sock on the other foot.
• Fill your eye dropper with H_20.
• On your foot bearing the Atlas sock treated with DWR, count how many H_20 droplets on your sock are required before you can feel H_20.
• Record your observations.
• Repeat with the non-DWR treated Atlas sock.

Allow your Atlas socks to completely dry before moving on to the next steps.

On your foot bearing the Atlas sock treated with DWR, start your timer and place your foot In the dye tray until your toes are completely submerged.

Stop the timer once you feel your toes begin to feel wet. Record the time.

Repeat with the non DWR treated Atlas sock on a dry foot.
Using the binder clips, hang each Atlas sock and set a timer for how long it takes for each sock to dry. Record the time.

Table 10.08.04Ci

	# of H_20 Drops	Wet [00:00]	Dry [00:00]
Atlas Sock w/ DWR			
Atlas Sock w/o DWR			

Extra Mile: Allow your Atlas socks to completely dry and conduct an all-day test, in which you wear your Atlas socks to conduct your day to day activities including exercise.
What differences do you notice between the DWR and non-DWR treated Atlas socks?

Field Notes

ADVISORY: After completing Experiment 10.08.04C, treat the originally non-DWR treated Atlas sock with DWR in order for both Atlas socks to enjoy water and stain repellent properties.

Table 10.08.04D

Ombre Pattern	Tie Dye Pattern	Cloud Pattern	Shibori Pattern
Slowly dip only the top or bottom of the fabric swatch in the dye solution. The dye will work through the fabric through capillary action.	Use rubber bands to tightly bind the fabric swatch in a bundle. Dip the bundle in the dye solution in order to achieve the desired effect.	Use a spray bottle filled with the dye solution in order to spray the dye directly on the fabric swatches. The spray bottle produces a cloud effect on the fabric.	Use binder clips to secure the ends of a fan fold fabric swatch. Dip the fabric swatch in the dye solution in order to achieve the desired effect.

Mission 10.08.05	Making the Apollo Uniform
Mission Objective	**Learn how to create a face mask and an outfit.**

In your previous missions, we've explored the wide spectrum of Ministry of Supply fabrics including their construction, the dyeing process, as well as their water and stain repellent properties in order to re-imagine the Apollo uniform.

Now, let's begin the process of reimagining the Apollo uniform.

Designing and creating an entire Apollo Uniform is no easy feat or task. Therefore, we will start with a more manageable mission to help design and develop the Apollo Uniform; a Mask.

Masks are an important part of protecting our agents as well as preventing the spread of diseases by preventing droplets of our breath from spreading into the air. In addition, by designing a mask as the first component of our Apollo Uniform, it will allow for us to prototype a design in a manageable way.

In this M° Lab assignment, we will undergo the process of bringing our Mask to life and create a template for the rest of our Apollo uniform.

For this mission, you will need the following;

	Materials		Tools
	Aero Fabric Swatch [2]		Tweezers
	Aero Zero Fabric Swatch [2]		White Colored Pencil
	Apollo Fabric Swatch [2]		Scissors
	Kinetic Fabric Swatch [2]		Ruler
	Velocity Fabric Swatch [2]		Fabric Bonding Glue
	H20 (Water)		Round Spatula
	Fabric Glue		Dye Tray
	Elastic Loops		Binder Clips [4]
	Filter10 Filter		Rubber Bands [3]
	Velcro Dots [3]		

Masks need to be effective, including demonstrating a resistance to pathogens or virus-carrying droplets, moisture wicking as well as breathability and comfort.

Did you know?
Pathogens, such as viruses, can travel through Masks on water and sweat droplets. Hence, it's important to always ensure your Mask stays dry in order for it to efficiently protect you and others from pathogens.

Therefore, when we are selecting fabrics, we have to ensure the fabrics we select address the aforementioned parameters or requirements for our Mask.

Based on the PUGH Chart (Table 10.08.02Ci) you completed for Experiment 10.08.02C, fill out the following Table to determine which fabrics meet those parameters.

In order to develop a simple Mask, we will need to select [2] fabric swatches;
Inner Layer; which acts as a protective layer by minimizing the spread of pathogen droplets to others
Outer Layer; which protects the face from external pathogen droplets

Based on Table 10.08.02Ci, which Ministry of Supply Fabrics will you use to create your Mask?

Table 10.08.05Ai

Fabric[1] (Inner Layer) 2 Fabric Swatches	
Fabric[2] (Outer Layer) 2 Fabric Swatches	

Once we have selected a fabric swatch for our Mask, we need to select at least one color based on the colors and dye solutions we developed in Experiment 10.08.03C. Select which color(s) you will use for your Mask.

Table 10.08.05Aii

Fabric Swatch	Color Name/Number | Dye Solution
Fabric[1] (Inner Layer)	
Fabric[2] (Outer Layer)	

Finally, we must select a pattern for our Mask.

We can develop very unique patterns using a variety of techniques and tools as shown in Table 10.08.04D. Select which pattern you will use for your Mask.

Experiment 10.08.05A | Mask Dye Pattern
Use the scissors, binder clips, gloves, dye tray, eye dropper, and tweezers from your kit alongside a small container of H_20 (Water) and a timer in order to dye your Mask.

Field Tip: This experiment will create a shibori pattern on the mask.
If you want your Mask to display a different pattern, refer to Table 10.08.05iii, including Tie-Dye, Cloud, and Ombré.
• Select your [4] Ministry of Supply fabric swatches for your Mask;
[2] fabric swatches for Fabric[1] (inner layer)
[2] fabric swatches for Fabric[2] (outer layer)
• Place the Mask Template A on one of your fabrics, attach with a binder clip, and use your white colored pencil to trace an outline of your mask to cut.
• Remove the binder clip and set it aside. Repeat for the other fabric swatches.
• Double-check your outline and then cut the fabric swatch with your scissors.
• Fan-fold each fabric swatch until you form a long rectangle and secure with a binder clip on each edge.

ADVISORY: PREPARE YOUR WORK AREA AND WEAR GLOVES, AS WELL AS ANY ADDITIONAL PROTECTIVE CLOTHING DESIRED, FOR DYING YOUR FABRIC SWATCHES.

• Fill up 0.5 of your Dye Tray (i.e. ~500mL) with H_20 and microwave until warm, but not boiling.
• Select which unique dye solution blend you wish to utilize to create a dye solution from Table 10.08.04.
• Use your beaker to measure your synthetic dye - graphite and/or sapphire - to your dye tray.
• Mix. Rinse the beaker. Use your eye dropper to measure any vinegar or NaCl needed. Mix.

Field Tip: If using your eye dropper is too tedious, a pinch of NaCl is ~0.30mL. Therefore, 1mL of NaCl is ~3-4 pinches.
• Add selected fabric swatches to your dye tray and ensure your fabric swatch is completely submerged.
• Set a timer for desired dye bath time. Stir the fabric swatch every [1] minute during the first 5 minutes in your unique dye solution then allow it to rest.
• After desired dye solution time, remove the fabric swatch from the dye tray. DO NOT REMOVE BINDER CLIPS.
• Repeat for the other fabric swatches you desire to dye in the dye solution.
• Rinse both fabric swatches in cool H_20 until H_20 begins to run clear.
• Carefully remove the binder clips and unfold the fabric swatches.
• Wash the fabric swatches in warm H_20 with mild detergent or soap, rinse, and dry. Upon completion, clean your supplies.
• Allow to completely dry before conducting Experiment 10.08.05B.

Experiment 10.08.05B | DIY Mask

- Use the scissors, binder clips, elastic threads, gloves, round spatula, fabric glue, and velcro dots from your kit in order to assemble your mask.
- Align and place [2] fabric swatches of Fabric[1] together with a binder clip.
- Repeat with the other [2] fabric swatches of Fabric[2].
- Use Mask Template B as well as a white colored pencil to trace an outline on the top and bottom of each fabric swatch.
- Cut the lines on the sides of the dyed fabric swatches, as indicated on your Mask Template B, as these will serve as placeholders for your elastic threads.
- Using your round spatula, on the longest side of your Fabric[1] swatches, apply a thin layer of fabric glue from the white outline to the edge of the fabric.
- Use a binder clip to secure. Let it dry completely. Repeat for the pair of Fabric[2] swatches.

Field Tip: Use [2] binder clips on the top edge of your fabric swatches to hold them together.

- Insert Fabric[2] swatches in between the layers of the Fabric[1] swatches in a way that it creates a diamond gap as shown below.
- Open the mask with the adhered long edge in the middle with a Fabric[1] and Fabric[2] swatch on each side.
- Lift the top fabric swatch and place an elastic thread on each side of your mask, ensuring a portion of each elastic thread goes through the holes on each side and are aligned.
- Starting at the bottom edge, between the layers of fabric swatches, apply a thin layer of fabric glue using your round spatula along the space between your white outline and the edge of the fabric. Press the edge with your finger.
- Place [2] binder clips on the bottom edge to ensure adhesion until dry.
- Using your round spatula, between the layers of fabric swatches on the sides, apply a thin layer of fabric glue from the white outline and the edge of the fabric except the holes housing your elastic thread.
- Place [1] binder clip on each side, between the holes for elastic thread, to ensure adhesion until dry.
- On the top edge, on the top facing fabric, make a hem using your round spatula and apply a thin layer of fabric glue along the white outline to the edge of the fabric. Then, fold the edge backwards until it touches the white outline. Press the folded fabric with your finger to seal.

- On the top edge, on the top facing fabric, make a hem using your round spatula and apply a thin layer of fabric glue along the white outline to the edge of the fabric. Then, fold the edge backwards until it touches the white outline. Press the folded fabric with your finger to seal.
- Remove the adhesive backs from [3] velcro dots and place them on the marked circles across the top of the mask. Then, flip the mask over and repeat ensure velcro dots are aligned with those placed on the other side.
- Allow the mask to completely dry for at least 2 hours before turning the mask inside out. Try on the mask and adjust the elastic threads.

• Once adjusted, open the top of the mask, by separating the velcro dots, in order to place a filter in the mask. Allow the fabric glue to dry for at least 24-48 hours before washing the mask.

Now, it’s your time to design the Apollo Uniform 2.0. Mens et Manus.

Ministry of Supply°