Lead Information Packet
Module 2: Chromatography
5th Grade

This document is not intended to give you all of the information you need to lead the module. It is only intended to be a reference during the module. You can find the complete instructions at http://www.chem.ucsb.edu/scitrek/module as well as the student notebook and the picture packet used during the module.

Note: We highly recommend that teachers complete the final conclusion assessment outside of SciTrek time.

Important Things to Remember During the Module

1. You are responsible for keeping track of time in the classroom and making sure that ALL activities run smoothly. There will be a time card in the lead box with suggested times to start/stop each activity.
2. You are responsible for keeping volunteers and students on track.
3. Walk around during times volunteers are working with students and help struggling groups/subgroups.

Types of Documents:

Student Notebook:
One given to every student and is filled out by the student. In these instructions, the examples are rectangular and filled out in black.

Notepad:
One given to every group and is filled out by the volunteer. In these instructions, the examples are squarer and filled out in blue.

Picture Packet:
One per class that, if needed, the lead fills out. In these instructions, the examples are rectangular, labeled, and, if applicable, filled out in blue.
In these instructions, all other example documents are labeled.

Day 1: Conclusion Assessment/Observations/Variables

Schedule: You are responsible for BOLD sections

Introduction (SciTrek Lead) – 2 minutes
Conclusion Assessment (SciTrek Lead) – 10 minutes
Observation Discussion (SciTrek Lead) – 2 minutes
Observations (SciTrek Volunteers) – 26 minutes
Variable Discussion (SciTrek Lead) – 5 minutes
Variables (SciTrek Volunteers) – 12 minutes
Wrap-Up (SciTrek Lead) – 3 minutes

Preparation:

1. If the classroom has a document camera, ask the teacher to use it for the class question (front cover, student notebook).
2. Make sure that volunteers are setting up for the initial observation. Details of how to do this are on a picture in the volunteer boxes.
**Observations**

**Experimental Set-Up:**
- Graduated cylinder with 2 mL of water
- Paper 11.5 cm high with line on it at 2 cm
- Black Mr. Sketch pen
- Timer
- 5 boxes of crayons
- Test tube and test tube holder

**Time 0**
- Picture: Small black dot on line (1 cm)
- Observation/Measurement: Strip out into test tube with water

**Time 1**
- Picture: Black turned into a smear (got longer)
- Observation/Measurement: Orange seen

**Time 2**
- Picture: Small black dot turned into a smear (got longer)
- Observation/Measurement: Blue, pink, red, orange all seen

**Variables**

<table>
<thead>
<tr>
<th>Variable</th>
<th>How will changing this variable affect the smear?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pen type</td>
<td>Smears will be longer if the type is</td>
</tr>
<tr>
<td>Paper type</td>
<td>Smears will be longer if the paper type is</td>
</tr>
<tr>
<td>Liquid type</td>
<td>Smears will be longer if the liquid type is</td>
</tr>
<tr>
<td>Time</td>
<td>If there is more time, there will be more separation between colors, and the smear will be longer</td>
</tr>
<tr>
<td>Pen color</td>
<td>Pens that are different colors will have smears that are the same height, but different colors</td>
</tr>
</tbody>
</table>

**Notebook Pages and Notepad Pages:**

- Last Revised: 1/6/2020
**Introduction:** (2 minutes – Full Class – SciTrek Lead)

- Introduce the module/SciTrek volunteers.

**Conclusion Assessment:** (10 minutes – Full Class – SciTrek Lead)

- Pass out assessments.
- Page 1: Read each statement and have students circle if statement is a claim, data, or opinion.
- Page 2: Have students underline controls, circle changing variable(s), and box information about data collection on the results table. Then have them decide if the group could make a conclusion.
- Page 2: Read each statement and have students identify if the statement is a claim or data and then circle if statement is a correct claim, correct data, or incorrect based on the results table.
- Page 3: Repeat the process for page 3.
- Collect assessments.

**Observation Discussion:** (2 minutes – Full Class – SciTrek Lead)

- Review the definition of an observation (a description using your five senses).
- Have students move to their groups.
  - If a student does not have a nametag, identify the group with the least number of students in it and write the student’s name on one of the extra nametags that are in the lead box using that color of marker.

**Observations:** (26 minutes – Groups – SciTrek Volunteers)

- Walk around and help groups that are struggling.
- Make sure that groups are moving along and only spending ~6 minutes on the experimental set-up, ~2 minutes setting up the experiment, ~7 minutes with the strip in the water (they should not remove their strip from the water at time 1), and ~11 minutes measuring the smear.

**Variable Discussion:** (5 minutes – Full Class – SciTrek Lead)

- Have groups share what they did/learned.
  - They put a strip of paper with a black dot on it into a test tube with water; over time the dot spread out into a smear that had many colors.
- Ask the students what the most interesting thing they observed was, and have them decide as a class to investigate the question: What variables affect smears?
  - Write the class question on the front cover of the example notebook and have students copy the question onto their notebook.
- Review the definition of a variable (something in an experiment that can be changed).
- Explore one possible changing variable with the class and have students share how/why this variable might affect the height and color of the smear.

**Variables:** (12 minutes – Groups – SciTrek Volunteers)

- Walk around and help groups that are struggling.
- Make sure volunteers are having their group come up with three possible variables as well as how/why these variables might affect smears.
- Make sure students are generating at least one additional variable by themselves.
Wrap-Up: (3 minutes – Full Class – SciTrek Lead)

- Have each group share one variable with the class and how/why they think it will affect smears.

Day 2: Question/Materials Page/Experimental Set-Up/Procedure

Schedule: You are responsible for BOLD sections

**Introduction (SciTrek Lead) – 13 minutes**

**Question (SciTrek Volunteers) – 10 minutes**

**Materials Page (SciTrek Volunteers) – 7 minutes**

**Experimental Set-Up (SciTrek Volunteers) – 8 minutes**

**Procedure (SciTrek Volunteers) – 19 minutes**

**Wrap-Up (SciTrek Lead) – 3 minutes**

Preparation:

1. If the classroom has a document camera, ask the teacher to use it for the question (page 4, student notebook), materials page (lead box), experimental set-up (page 5, student notebook), and example Day 1 strip (page 1, picture packet).
2. Have volunteers set out notebooks to allow students within the same subgroup to work together.
   a. If students are not in the classroom before SciTrek starts, have volunteers set out the notebooks where students should sit when they come into the classroom.
   b. If students are in the classroom before SciTrek starts, have volunteers set out the notebooks where they want students to sit and students will move to these spots after the introduction.

**Notebook Pages**

**Materials Page**

You will only have access to the following materials.

1. For each bolded word, circle if it is a changing variable and underline if it is a control (example changing variables: the type of pen, example control: liquid type).
2. For variables that are controls, select 1 value.
3. For variables that are changing variables, select a value and write the trial letter (A,B,C) or (1,2,3) next to each value. Example: if you change the X variable, you can choose a color or a liquid. You could write “A” next to the color blue and “B” next to the liquid type. 

General Materials:
- Enamel paper
- Graph paper
- White paper
- White board
- Microwaves
- Dry ice
- Fume hoods
- Fume hoods (non-toxic)
- Fume hoods (toxic)
- Fume hoods (nitrogen)
- Fume hoods (oxygen)
- Fume hoods (argon)
- Fume hoods (helium)
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**Introduction: (13 minutes – Full Class – SciTrek Lead)**

- If needed, have volunteers set out notebooks so students are sitting next to members of their subgroup.
- Review the class question and what they learned last SciTrek visit.
- Review experimental considerations with the class (top of page 4, student notebook):
  - You will only have access to the materials on the materials page.
  - The strips of paper cannot be in the liquid for more than 5 minutes.
  - All strips of paper must be put into the liquid at the same time.
- Design an example experiment with the class.
  - For the changing variables, pick two changing variables (example: liquid amount and pen color) (page 4, student notebook).
    - Makes sure one of the variables allows you to choose numerical values (example: liquid amount)
  - Show students how to write the question.
    - If we change the pen color and liquid type, what will happen to the height and color of the smear?
  - Fill out the materials page for the example experiment (lead box).
    - First: underline controls and circle the changing variables.
    - Second: select values for the controls and changing variables.
      - Write trial letters next to changing variables values.
      - Allow students to choose the values for the changing variables, but not for the controls.
  - Fill out the experimental set-up for the example experiment (only trials A and B for the changing variable) (page 5, student notebook).
    - Draw and additional line under the controls list for another control and its value.
    - If students choose to change 3 variables, there will be one additional blank for controls. Lead students to come up with cork placement/on.
Read the example procedure step that includes the changing variable at the top of page 6 in the student notebook.

**Question:** (10 minutes – Subgroups – SciTrek Volunteers)

- Walk around and help subgroups that are struggling.
- **MAKE SURE VOLUNTEERS ARE NOT GIVING ADVICE ON HOW MANY CHANGING VARIABLES TO USE.**
- Make sure subgroups are only picking changing variable(s) that are allowed.
- Try to encourage subgroups to pick different changing variables.
- Make sure for the second part of the question (what you are measuring/observing) that students are specific (example: they should write, “the height and color of the smear,” and not just “the smear”).

**Materials Page:** (7 minutes – Subgroups – SciTrek Volunteers)

- Walk around and help subgroups that are struggling.
- Make sure subgroups are underlining their controls and circling their changing variable(s).
- Make sure subgroups are filling out the materials page correctly and completely.

**Experimental Set-Up:** (8 minutes – Subgroups – SciTrek Volunteers)

- Walk around and help subgroups that are struggling.
- Make sure that within one subgroup, all students have the same order for their changing variable(s) values.
- Make sure all control blanks are filled out.

**Procedure:** (19 minutes – Subgroups – SciTrek Volunteers)

- Walk around and help subgroups that are struggling.
- Make sure procedures are concise, but still include all values of the changing variable, controls, and what data will be collected.

**Wrap-Up:** (3 minutes – Full Class – SciTrek Lead)

- Tell students what they will do next time.

**Day 3: Results Table/Experiment/Graph/Conclusion Activity**

**Schedule:** You are responsible for **BOLD** sections

- **Introduction (SciTrek Lead) – 8 minutes**
- Results Table (SciTrek Volunteers) – 3 minutes
- Experiment (SciTrek Volunteers) – 17 minutes
- Graph (SciTrek Volunteers) – 10 minutes
- **Conclusion Activity (SciTrek Lead) – 20 minutes**
- Wrap-Up (SciTrek Lead) – 2 minutes
Preparation:

1. If the classroom has a document camera, ask the teacher to use it to show the filled out results table (page 2, picture packet), graph (page 8, student notebook), and conclusion activity (pages 9 and 10, student notebook).
2. Make sure that volunteers are pouring liquids into the small cups and putting test tubes in the test tube stands.
3. Have volunteers set out notebooks.
   a. If students are not in the classroom before SciTrek starts, have volunteers set out the notebooks where students should sit when they come into the classroom.
   b. If students are in the classroom before SciTrek starts, have volunteers set out the notebooks where they want students to sit and students will move to these spots after the introduction.

Picture Packet Page and Notebook Pages:

![Picture Packet Page](image1)

![Results Table](image2)

Page 2, Picture Packet
**Introduction:** (8 minutes – Full Class – SciTrek Lead)

- If needed, have volunteers set out notebooks.
- Make sure that volunteers are setting up for the experiments.
- Review the class question.
- Use the checklist on the top of page 8 (student notebook) to go over how to graph results.
  - Stress the importance of step 4 to ensure that students’ graphs are in increasing order.
  - A filled out results table is on page 2 of the picture packet, use this data for the graph.
  - Only graph the results for the first two smallest smear heights (0 cm and 7 cm).

**Results Table:** (3 minutes – Subgroups – SciTrek Volunteers)

- Walk around and help subgroups that are struggling.
- Make sure students are underlining controls, circling changing variables, and boxing data collection.
- Make sure that control values are written in trial A with an arrow through the rest of the trials and that changing variable(s) values are written in each trial’s box.

**Experiment:** (17 minutes – Subgroups – SciTrek Volunteers)

- Walk around and help subgroups with their experiment, and make sure they will finish their experiment on time.
  - Make sure that students are drawing their initial dot height line, labeling the strips, and labeling the test tube stand with pencil.
  - Make sure that students are putting all the strips into the test tubes at the same time.
  - Make sure to remove all of the liquids as soon as students are done with them.
  - Make sure students are drawing the liquid line as soon as the strips come out of the test tubes.
Graph: (10 minutes – Subgroups – SciTrek Volunteers)

- Walk around and help subgroups that are struggling.
- If none of the dots smeared, students can graph the liquid height instead of smear height.
  - If this is the case, the subgroup should go back and revise their question to be about liquid height.
- Make sure that students are graphing their data from smallest smear/liquid height to largest smear/liquid height.
- Make sure students have their changing variable values (example: water), not the trial letters (example: trial B), on the x-axis.
- Make sure students are writing the numerical value of the smear/liquid height on top of each column.

Conclusion Activity: (20 minutes – Full Class – SciTrek Lead)

- MAKE SURE TO START THE CONCLUSION ACTIVITY AT LEAST 15 MINUTES BEFORE THE END OF THE HOUR, EVEN IF STUDENTS ARE NOT DONE WITH THEIR GRAPHS.
- Review the definition of a conclusion (claim supported by data) (page 9, student notebook).
- Review the definition of a claim (a statement that can be tested).
  - Have students give a few examples of claims.
- Review the forms of data (observations/measurements).
- Read each statement.
  - Have students independently circle if each statement is a claim, data, or opinion.
  - When applicable, underline controls (descriptive numbers), box data collection, and double underline opinions.
  - Discuss each statement as a class and have students box the correct answer.
    - Students should not erase their original answers.
  - For claim statements, have students tell you what data would need to be collected to back up the claim.
  - For data statements, have students tell you the claim that it could be paired with to make a conclusion.
    - **Letter a:** McDonald’s served [100 customers] and Taco Bell served [75 customers]
      - **Data**
        - Possible Claim: McDonalds serves more customers than Taco Bell
    - **Letter b:** blue is the best color
      - **Opinion**
    - **Letter c:** butterflies that are larger than 15 cm are attracted to bright colors
      - **Claim**
        - 15 cm is not a data measurement. It is called a descriptive number because it describes a control in the experiment.
        - Possible Data: counting the number of butterflies that land on bright colored paper compared to the number of butterflies that land on black or brown paper.
    - **Letter d:** ice was [observed] floating on water
      - **Data (Data Collected: observed ice)**
        - Possible Claim: ice is less dense than water
    - **Letter e:** people buy more pizza than hamburgers
      - **Claim**
        - Possible Data: count the number of people that buy pizza and hamburgers
- **Letter f:** the average male blue whale weighs 91,000 kg, while the average female blue whale weighs 122,000 kg
  - **Data**
    - Possible Claim: female blue whales weigh more than male blue whales
- **Letter g:** the tastier the fruit the more bugs on the fruit
  - **Opinion**

- Read the directions on page 10, student notebook.
- Have students make matches between claims and data and then share out matches.
  - **Correct matches**
    - Sony TVs are brighter than Samsung TVs, because Sony TVs give off 20 lumens of light and Samsung TVs give off 10 lumens of light.
    - The color purple is made from blue and red, because when blue and red paint were mixed the paint was observed to turn purple.
- Discuss why the statement “Wind turbines produce less energy than solar panels in California” does not match with “wind turbines produce 6,000 MW of energy and solar panels produce 5,000 MW of energy.”
- Discuss that only the claim can be changed when data and claims do not match.
- If there is extra time you can continue on to the next page of the conclusion activity.

**Wrap-Up:** (2 minutes – Full Class – SciTrek Lead)

- Tell students what they will do next time.

**Day 4: Conclusion Activity/Conclusion/Question/Materials Page/Experimental Set-Up/Procedure**

**Schedule:** You are responsible for **BOLD** sections

- **Introduction (SciTrek Lead) – 2 minutes**
- **Conclusion Activity (SciTrek Lead) – 25 minutes**
- **Conclusion (SciTrek Volunteers) – 5 minutes**
- **Question (SciTrek Volunteers) – 5 minutes**
- **Materials Page (SciTrek Volunteers) – 5 minutes**
- **Experimental Set-Up (SciTrek Volunteers) – 5 minutes**
- **Procedure (SciTrek Volunteers) – 11 minutes**
- **Wrap-Up (SciTrek Volunteers) – 2 minutes**

**Preparation:**

1. If the classroom has a document camera, ask the teacher to use it for the conclusion activity (pages 11-13, student notebook).
2. Have volunteers set out notebooks.
   - a. If students are not in the classroom before SciTrek starts, have volunteers set out the notebooks where students should sit when they come into the classroom.
   - b. If students are in the classroom before SciTrek starts, have volunteers pass out student notebooks to them. They will move to their subgroup seats after the conclusion activity.
Notebook Pages and Materials Page:

SCIENTIFIC PRACTICES

Conclusions:

<table>
<thead>
<tr>
<th>Variables</th>
<th>Trial A</th>
<th>Trial B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paper Type</td>
<td>Black</td>
<td>Red</td>
</tr>
<tr>
<td>Pen Color</td>
<td>Blue</td>
<td>Red</td>
</tr>
<tr>
<td>Initial Dot Height</td>
<td>3 cm</td>
<td>3 cm</td>
</tr>
</tbody>
</table>

Final Observations/Measurements:

- Smear Height: 3 cm, 4 cm
- Liquid Height: 3 cm, 5 cm
- Others: Green, Blue, Red, Yellow

1. Directions: Step a labeled as A. Following directions below, choose the correct answer if the statement is correct, correct data, or incorrect. Statements are INCORRECT if the statement is not correct, data, or incorrect.

   a. the stronger the crucible, the larger the smear height
   b. the crucible was observed to contain green dye
   c. black pen types are made up of different dye colors
   d. black crayons are observed to contain green dye

2. Directions: Decide if a claim/conclusion can be made for each of the following results tables and graph.

   Table A
<table>
<thead>
<tr>
<th>Variables</th>
<th>Trial A</th>
<th>Trial B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Print Type</td>
<td>Water</td>
<td>Soap</td>
</tr>
<tr>
<td>Pen Color</td>
<td>Original</td>
<td>Black</td>
</tr>
<tr>
<td>Initial Dot Height</td>
<td>3 cm</td>
<td>3 cm</td>
</tr>
</tbody>
</table>

   Table B
<table>
<thead>
<tr>
<th>Variables</th>
<th>Trial A</th>
<th>Trial B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Print Type</td>
<td>Water</td>
<td>Soap</td>
</tr>
<tr>
<td>Pen Color</td>
<td>Original</td>
<td>Black</td>
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<tr>
<td>Initial Dot Height</td>
<td>3 cm</td>
<td>3 cm</td>
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</tbody>
</table>

   Table C
<table>
<thead>
<tr>
<th>Variables</th>
<th>Trial A</th>
<th>Trial B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Print Type</td>
<td>Water</td>
<td>Soap</td>
</tr>
<tr>
<td>Pen Color</td>
<td>Original</td>
<td>Black</td>
</tr>
<tr>
<td>Initial Dot Height</td>
<td>3 cm</td>
<td>3 cm</td>
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</tbody>
</table>

   Graph D
<table>
<thead>
<tr>
<th>Smear Height</th>
<th>Trial A</th>
<th>Trial B</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 cm</td>
<td>3 cm</td>
<td></td>
</tr>
</tbody>
</table>

3. Making a Conclusion from Your Data

   How many changing variables did you have in your experiment? ____________

   Can you make a conclusion from your data? YES/NO

   If NO
   Why? I cannot make a conclusion because I changed more than 1 variable in my experiment.

   If YES
   We can conclude ____________________________

   because ____________________________

   SciTrek Member Approval ____________
Making a Conclusion from Your Data

How many changing variables did you have in your experiment? _________________

Can you make a conclusion from your data?  
☐ YES  ☐ NO

IF NO

Why? ________________________________________________________________

IF YES  CONCLUSION

We can conclude that the thinner the liquid, the smaller the smear height.

Because the smear for the paper in soap was 1.5 cm high, and the smear for the paper in water was 10 cm high.

Scientific Member Approval ________________________  14

Changing Variable(s) (Independent Variable(s))

For your second experiment decide which variable(s) (max three) that you would like to test.

Changing Variable 1:  pen color

Changing Variable 2 (optional): ____________________________

Changing Variable 3 (optional): ____________________________

QUESTION

Question our group will investigate:

- If we change the pen color, what will happen to the height of the smear?

Scientific Member Approval 62

Get a materials page from your SciTrek volunteer and fill it out before moving onto the experimental set-up.

EXPERIMENTAL SET-UP

Determine the values of your changing variable(s) (except pen color) from the materials page and write the values (ex: blue) for your four trials under each strip of paper.

- Changing Variable(s):
  1. pen color  1) purple  light green  orange  black
  2)  1
  3)  1

Controls (variables you will hold constant):

Determine the variables that you will hold constant and indicate the specific value you will use in all your trials.

- Container / Test Tube  pen type / Mr. Sketch
  - Liquid type: water
  - Liquid amount: 5 ml
  - Paper type: original cork placement

Scientific Member Approval 65

Materials Page
Introduction: (2 minutes – Full Class – SciTrek Lead)

- If needed, have volunteers pass out notebooks.
- Review class question and what they did last SciTrek visit.

Conclusion Activity: (25 minutes – Full Class – SciTrek Lead)

- Review the definition of a conclusion (claim supported by data).
- Have students identify and circle the changing variables, underline the controls, and box information about data collection on the results table (page 11, student notebook).
- Read each statement.
  - As a class, discuss if each statement is a claim or data and write a C or D on the line.
  - Have students help you annotate the statement by circling changing variables (every claim statement will have a changing variable), underlining controls, and boxing data.
  - Have students look at the results table to see if the statement is a correct claim, correct data, or incorrect.
    - Statements are incorrect if they are not supported by the results table or if they have not been tested.
- Questions used for statements that are claims:
  - What type of statement is this and how do you know?
  - What would need to be the changing variable for this claim to be correct?
  - Is that variable a changing variable in the experiment?
    - If answer is yes
      - Is this claim consistent with the data?
      - Is the statement a correct claim, correct data, or incorrect?
    - If answer is no
      - Is the statement a correct claim, correct data, or incorrect?
• Questions used for statements that are data:
  - What type of statement is this and how do you know?
  - Is the data correct based on the results table?
  - Is this statement a correct claim, correct data, or incorrect?
• Letter a: the paper type affects the height the liquid travels up the paper
  - Claim/Incorrect (Variable Held Constant)
• Letter b: black pen types are made up of different dye colors
  - Claim/Correct Claim
• Letter c: when a black dot sits in water for 5 min, different pen types give different smear heights
  - The number in this claim is a descriptive number.
  - Letter d: the black Crayola was observed to contain green dye
  - Data/Incorrect
• Have students determine data that backs up claim b.
  - Black Mr. Sketch was observed to contain green, blue, and red dyes while black Crayola contained yellow, blue, and red dyes.
• Have students repeat the process for page 12.
• Letter a: the stronger the pen odor the larger the smear height
  - Claim/Incorrect (No Data Gathered)
• Letter b: the black pen had a smear height of 3 cm and the red pen had a smear height of 1.5 cm
  - Data/Correct Data
• Letter c: black and red pen are made from green dye
  - Claim/Incorrect (Inconsistent with Data)
• Letter d: the thicker the liquid the shorter the smear height
  - Claim/Incorrect (More than One Changing Variable)
• Go over the two questions on the bottom of page 12.
• On page 13, have students identify and circle the changing variable(s), underline the controls, and box information about data collection and then determine if the group can make a conclusion.
• Tell students they will now determine if they can make a conclusion from their first experiment and then design another experiment.

**Conclusion: (5 minutes – Subgroups – SciTrek Volunteers)**

- If subgroups have not finished the graph DO NOT make them go back and finish it. Most likely these subgroups will not be able to make a conclusion; therefore, they will not use the data from their first experiment.
- Walk around and help subgroups that are struggling.
- Subgroups that can make a conclusion will need more help than those that cannot.
  - If a group can make a conclusion make sure they are making a claim and using data to support it.

**Question: (5 minutes – Subgroups – SciTrek Volunteers)**

- Walk around and help subgroups that are struggling.
- Make sure that subgroups are only picking one changing variable.
- Try to encourage subgroups to pick different changing variables.
- Make sure for the second part of the question (what you are measuring/observing) that students are specific (example: they should write “the height and color of the smear” and not just “the smear”).
Materials Page: (5 minutes – Subgroups – SciTrek Volunteers)

- Walk around and help subgroups that are struggling.
- Make sure subgroups are underlining their controls and circling their changing variable.
- Make sure subgroups fill out the materials page correctly and completely.

Experimental Set-Up: (5 minutes – Subgroups – SciTrek Volunteers)

- Walk around and help subgroups that are struggling.
- Make sure that within one subgroup all students have the same order for their changing variable values.
- Make sure all control blanks are filled out.

Procedure: (11 minutes – Subgroups – SciTrek Volunteers)

- Walk around and help subgroups that are struggling.
- Make sure procedures are concise, but still include all values of the changing variable, controls, and what data will be collected.

Wrap-Up: (2 minutes – Full Class – SciTrek Lead)

- Tell students what they will do next time.

Day 5: Results Table/Experiment/Graph/Conclusion

Schedule: You are responsible for BOLD sections

Introduction (SciTrek Lead) – 20 minutes
Results Table (SciTrek Volunteers) – 5 minutes
Experiment (SciTrek Volunteers) – 20 minutes
Graph (SciTrek Volunteers) – 5 minutes
Conclusion (SciTrek Volunteers) – 8 minutes
Wrap-Up (SciTrek Lead) – 2 minutes

Preparation:

1. If the classroom has a document camera, ask the teacher to use it for the conclusion example (page 18, student notebook).
2. Make sure that volunteers are pouring liquids into the small cups and putting test tubes in the test tube stands.
3. Have volunteers set out student notebooks.
   a. If students are not in the classroom before SciTrek starts, have volunteers set out the notebooks where students should sit when they come into the classroom.
   b. If students are in the classroom before SciTrek starts, have volunteers pass out student notebooks to them. They will move to their subgroup seats after the introduction.
SCIENTIFIC PRACTICES

Conclusions

Question: If we change the paper height, what will happen to the liquid height?

<table>
<thead>
<tr>
<th>Variables</th>
<th>Trial A</th>
<th>Trial B</th>
<th>Trial C</th>
<th>Trial D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Containers</td>
<td>Test Tube</td>
<td>Test Tube</td>
<td>Test Tube</td>
<td>Test Tube</td>
</tr>
<tr>
<td>Time</td>
<td>3 min</td>
<td>3 min</td>
<td>3 min</td>
<td>3 min</td>
</tr>
<tr>
<td>Liquid Type</td>
<td>Water</td>
<td>Water</td>
<td>Water</td>
<td>Water</td>
</tr>
<tr>
<td>Liquid Amount</td>
<td>2 ml</td>
<td>2 ml</td>
<td>2 ml</td>
<td>2 ml</td>
</tr>
<tr>
<td>Paper Type</td>
<td>Original</td>
<td>Original</td>
<td>Original</td>
<td>Original</td>
</tr>
<tr>
<td>Pen Color</td>
<td>Black</td>
<td>Black</td>
<td>Black</td>
<td>Black</td>
</tr>
<tr>
<td>Pen Type</td>
<td>Mr. Sketch</td>
<td>Mr. Sketch</td>
<td>Mr. Sketch</td>
<td>Mr. Sketch</td>
</tr>
<tr>
<td>Initial Dot Height</td>
<td>2 cm</td>
<td>2 cm</td>
<td>2 cm</td>
<td>2 cm</td>
</tr>
<tr>
<td>Paper Height</td>
<td>5 cm</td>
<td>10 cm</td>
<td>15 cm</td>
<td>20 cm</td>
</tr>
</tbody>
</table>

Write conclusion from the results above:

We can conclude that the liquid will reach the top of the paper if the paper is 11 cm or shorter because when the paper height was 5 cm, the liquid height was 5 cm (same as the paper height) and when the paper height was 20 cm, the liquid height was only 11 cm (not the top of the paper).

RESULTS

Table

<table>
<thead>
<tr>
<th>Variables</th>
<th>Trial E</th>
<th>Trial F</th>
<th>Trial G</th>
<th>Trial H</th>
</tr>
</thead>
<tbody>
<tr>
<td>Containers</td>
<td>Test Tube</td>
<td>Test Tube</td>
<td>Test Tube</td>
<td>Test Tube</td>
</tr>
<tr>
<td>Time</td>
<td>4.5 min</td>
<td>4.5 min</td>
<td>4.5 min</td>
<td>4.5 min</td>
</tr>
<tr>
<td>Liquid Type</td>
<td>Water</td>
<td>Water</td>
<td>Water</td>
<td>Water</td>
</tr>
<tr>
<td>Liquid Amount</td>
<td>6 ml</td>
<td>6 ml</td>
<td>6 ml</td>
<td>6 ml</td>
</tr>
<tr>
<td>Paper Type</td>
<td>Original</td>
<td>Original</td>
<td>Original</td>
<td>Original</td>
</tr>
<tr>
<td>Pen Color</td>
<td>purple</td>
<td>light green</td>
<td>orange</td>
<td>black</td>
</tr>
<tr>
<td>Pen Type</td>
<td>Mr. Sketch</td>
<td>Mr. Sketch</td>
<td>Mr. Sketch</td>
<td>Mr. Sketch</td>
</tr>
<tr>
<td>Initial Dot Height</td>
<td>3 cm</td>
<td>3 cm</td>
<td>3 cm</td>
<td>3 cm</td>
</tr>
<tr>
<td>Cork Placement</td>
<td>on</td>
<td>on</td>
<td>on</td>
<td>on</td>
</tr>
</tbody>
</table>

The independent variable(s) are the changing variable(s) and the dependent variables are the smear height, liquid height, and others.

RESULTS

Graph

Check off the steps as you complete them:

- Write what you measured (example: smear height in cm) on the y-axis title (vertical).
- Determine an appropriate scale which will allow you to graph all of your data points and write the numbers on the graph's x-axis.
- Write your changing variable (x-axis, and y-axis (example: liquid type) on the x-axis (horizontal).
- Changing variables and y-axis will only be filled if you have 3 or 3 changing variables.
- On your results table, label your measurements Trial 1 to 4, with being the trial with the smallest measurement and the last trial with the largest measurement.
- Plot your data in increasing order.
- Write each of the changing variable values (example: soap) for the trial that you labeled under the x-axis.
- Graph your data for that trial and write the measurement above the bar.
- Repeat the process for the other trials.

CONCLUSION

Generate a claim about how your changing variable affected your results.

(Example: The shorter the paper the shorter the smear (height).)

What data do you have to support your claim?

(Example: The shorter the paper the shorter the smear (height).)

Can you test the first part (claim) of the conclusion?

☐ YES ☐ NO (If you checked this box go back and revise your claim so that it can be.)

The second part of the conclusion is data because it contains an observation...

I acted like a scientist when I observed the colors of the smears and measured the smear heights.
Introduction: (20 minutes – Full Class – SciTrek Lead)

- If needed, have volunteers pass out notebooks.
- Make sure that volunteers are setting up for the experiments.
- Review the class question.
- Have students identify and circle the changing variable, underline the controls, and box information about data collection on the data table (page 18, student notebook).
- Have students identify the question the group was investigating.
- From the data, have students tell you how to draw the strips, smears, and water lines so that students can visualize the experiment.

- Have students make a conclusion from the data.
  - We can conclude the liquid will reach the top of the paper if the paper is 11 cm or shorter, because when the paper height was 5 cm, the liquid height was 5 cm (same as the paper height) and when the paper height was 20 cm the liquid height was only 11 cm (not the top of the paper).

Results Table: (5 minutes – Subgroups – SciTrek Volunteers)

- Walk around and help subgroups that are struggling.
- Make sure students are underlining controls, circling changing variables, and boxing data collection. 
- Make sure that control values are written in trial E with an arrow through the rest of the trials and that changing variable values are written in each trial’s box.

Experiment: (20 minutes – Subgroups – SciTrek Volunteers)

- Walk around and help subgroups with their experiment and make sure they will finish their experiment on time.
  - Make sure that students are drawing the initial dot height line, labeling the strips, and labeling the test tube stand with pencil.
  - Make sure that students are putting all the strips into the test tubes at the same time.
  - Make sure to remove all of the liquids as soon as students are done with them.
  - Make sure students are drawing the liquid line as soon as the strips come out of the test tubes.

Graph: (5 minutes – Subgroups – SciTrek Volunteers)

- Walk around and help subgroups that are struggling.
- If none of the dots smeared, students can graph the liquid height instead of smear height.
  - If students have to graph liquid height, have them go back and modify their question to be about liquid height.
• Make sure that students are graphing their data from smallest smear/liquid height to largest smear/liquid height.
• Make sure students have their changing variable values (example: water), not trial letters (example: trial B), on the x-axis.
• Make sure that students are writing the numerical value of the smear/liquid height on top of each column.

**Conclusion:** *(8 minutes – Subgroups – SciTrek Volunteers)*

• Walk around and help subgroups that are struggling.
• Make sure that subgroups are generating a claim (ideally the claim will allow them to make a prediction about future experiments) and using data to back it up.
  o If subgroups use an observation as data, make sure their data statement includes “we observed.”
  o Do not reference trial letters in the conclusion.
• If subgroups do not finish their conclusions, they can work on them during the next SciTrek visit.
• Volunteers struggle with conclusions, therefore, try to check at least one conclusion from each group.

**Wrap-Up:** *(2 minutes – Full Class – SciTrek Lead)*

• Tell students what they will do next time.
• Have students attach their strips via their nametag to one of the notebooks in their group.

**Day 6: Conclusion/Poster Making**

**Schedule:** *You are responsible for BOLD sections*

- **Introduction (SciTrek Lead) – 2 minutes**
- **Conclusion (SciTrek Volunteers) – 18 minutes**
- **Poster Making (SciTrek Volunteers) – 35 minutes**
- **Wrap-Up (SciTrek Lead) – 5 minutes**

**Preparation:**

1. Ask the classroom teacher for a place to leave the student posters.
2. Have volunteers set out notebooks.
   a. If students are not in the classroom before SciTrek starts, have volunteers set out the notebooks where students should sit when they come into the classroom.
   b. If students are in the classroom before SciTrek starts, have volunteers set out the notebooks where they want students to sit and students will move to these spots after the introduction.
CONCLUSION

We can conclude that the pen color does not
greatly affect the smear height, but does
affect the color of the smear.

What data do you have to
support your claim?
(Remember to
include your measurements
and/or observations.)

Can you test the first part (claim) of the conclusion?

☑ Yes  ☐ No  (If you checked this box go back and revise your claim so that it can be.)

The second part of the conclusion is data because it contains an observation.

I acted like a scientist when I observed the color of the smear
and measured the smear heights.

A larger version of this poster is in your lead box.
Introduction: (2 minutes – Full Class – SciTrek Lead)

- If needed, have volunteers set out notebooks.
- Review the class question.
- Tell the students that they will be finishing their conclusion, filling out the sentence frame “I acted like a scientist when,” and making a poster today.

Conclusion: (18 minutes – Full Class – SciTrek Volunteers)

- Walk around and help subgroups that are struggling.
- Make sure that subgroups are generating a claim (ideally the claim will allow them to make a prediction about future experiments) and using data to back it up.
  - If subgroups use an observation as data, make sure their data statement includes “we observed.”
  - Do not reference trial letters in the conclusion.
- Volunteers struggle with conclusions, therefore, try to check at least one conclusion from each group.
- Have students fill out the sentence frame on page 21, “I acted like a scientist when.”

Poster Making: (35 minutes – Subgroups – SciTrek Volunteers)

- Help volunteers glue poster pieces onto the posters. When gluing, make sure that you or the volunteers (not the students) are gluing the poster in the exact order that is shown on the diagram and that the poster has a landscape orientation.
  - Do not let the volunteers forget to glue the strips onto the poster.
- Make sure that the student in each subgroup who is presenting the results graph has a sentence frame sticker in their notebook and the volunteer has gone over how to present the four sentences with the student several times.
- Each student should have the part(s) that they are presenting highlighted and numbered in their notebook. (1) scientists’ names, (2) question, (3) experimental set-up, (4) procedure, (5) results graph, and (6) conclusion) (see pictures above).
  - Mind the volunteers that if a student is presenting multiple parts, they should have multiple sections highlighted and numbered in their notebook.
- Volunteers often forget to highlight student notebooks, so make sure this is done before Day 7.
Wrap-Up: (5 minutes – Full Class – SciTrek Lead)

- Ask students the following questions:
  - How did you act like a scientist during this project?
  - What did you do that scientists do?

Day 7: Poster Presentations

Schedule: You are responsible for BOLD sections

Introduction (SciTrek Lead) – 2 minutes
Practice Posters (SciTrek Volunteers) – 5 minutes
Poster Presentations (SciTrek Volunteers/SciTrek Lead) – 51 minutes
Wrap-Up (SciTrek Lead) – 2 minutes

Preparation:

1. If the classroom has a document camera, ask the teacher to use it for the notes on presentations (page 3-4, picture packet).
2. Give the teacher the QR code and ask them to take the survey on the website about their experiences with the SciTrek program.
3. Organize posters so that experiments featuring the same changing variable will be presented back to back.
4. Have volunteers pass out notebooks.

Picture Packet Pages: (Student notebook pages 22 and 23 are identical to picture packet pages 3 and 4, but have space for only 8 subgroups.)
Introduction: (2 minutes – Full Class – SciTrek Lead)

- If needed, have volunteers pass out notebooks.
- Tell students that they will have 5 minutes to practice their posters.
- DO NOT GIVE STUDENTS MORE THAN 5 MINUTES OR YOU WILL RUN OUT OF TIME FOR PRESENTATIONS.

Practice Posters: (5 minutes – Subgroups – SciTrek Volunteers)

- Organize posters so that experiments featuring the same changing variable are presented back to back.
- Make sure students are reading from their notebook and practicing the poster in the following order: 1) scientists’ names, 2) question, 3) experimental set-up, 4) procedure, 5) results graph, and 6) conclusion. They will NOT read the “I acted like a scientist when” or results table from their poster.

Poster Presentations: (51 minutes – Full Class – SciTrek Volunteers/SciTrek Lead)

- Have students present their posters.
- While posters are being presented, record each subgroup’s changing variable values and their data on pages 3 and 4 of the picture packet while students record the information on pages 22 and 23 of their notebooks.
  - After subgroups read their question, stop the presentation and have the class identify the changing variable. Then record it in the picture packet. If needed, change smear height to liquid height.
  - When groups read their graph, record the values of the changing variable and their measurements.
- After each presentation, ask students:
  - What questions do you have for this group?
  - Can someone summarize what we learned from this group?
- Record what they learned under the summary on pages 3 and 4 of the picture packet, while students record the summary on pages 22 and 23 of their notebooks.
- Students will not record information about their own subgroup’s poster presentation.
- After all presentations are over, have students tell you the variable values that they would select to make the longest smear.

Wrap-Up: (2 minutes – Full Class – SciTrek Lead)

- Tell the students that the volunteers that have been working with them are undergraduate and graduate students that volunteer their time so that they can do experiments. Have the students say thank you to the volunteers. This is the last day with their SciTrek volunteers, therefore, they should say goodbye to them.
- Tell students to remove the paper part of their nametag from the plastic holder and that they can keep the paper nametag but need to give the plastic holder back to their SciTrek volunteer.
Day 8: Draw a Scientist/Tie to Standards/Content Assessment

We highly recommend that teachers complete the final conclusion assessment prior to Day 8 of the module. The suggested times in the lesson plan below are assuming that the conclusion assessment was given prior to SciTrek arriving.

Schedule: You are responsible for BOLD sections

**Times if teacher gave assessment prior to SciTrek:**
- Draw a Scientist (SciTrek Lead) — 5 minutes
- Tie to Standards (SciTrek Lead) — 45 minutes
- Content Assessment (SciTrek Lead) — 10 minutes

**Times if SciTrek must give assessment:**
- Conclusion Assessment (SciTrek Lead) — 10 minutes
- Draw a Scientist (SciTrek Lead) — 5 minutes
- Tie to Standards (SciTrek Lead) — 35 minutes
- Content Assessment (SciTrek Lead) — 10 minutes

Preparation:

1. Ask the teacher if they completed the SciTrek final survey, if not give them the QR code and ask them to go to the website (at a later time) and fill out the survey.
2. If the classroom has a document camera, ask the teacher to use it for the Tie to Standards activity (pages 24-26, student notebook) and Tie to Standards picture (page 5, picture packet).
3. Tape up the Matter Chart.
4. Have pure substances available for use during the Tie to Standards activity.
5. Pass out notebooks.
6. If the teacher is not leading the Tie to Standards activity, give them an extra student notebook and have them fill it out with their students to follow along.
7. Remind the teacher to give you their lab coat at the end of the day.

Notebook Pages and Chart:

![Matter Chart](image)
**Conclusion Assessment:** (10 minutes – Full Class – Given By Classroom Teacher Prior to SciTrek)

- Pass out assessments.
- Page 1: Read each statement and have students circle if statement is a claim, data, or opinion.
- Page 2, Part 1: Have students underline controls, circle changing variable(s), and box information about data collection on the data table.
- Page 2, Part 2: Have students decide if the group could make a conclusion.
- Page 2, Part 3: Read each statement and have students identify if the statement is a claim or data and then circle if statement is a correct claim, correct data, or incorrect based on the results table.
- Page 3: Repeat the process for page 3.
- Page 4: Have students answer the questions.
- Collect assessments.

**Draw a Scientist:** (5 minutes – Full Class – SciTrek Lead)

- Pass out the draw a scientist page.
- Give students exactly 4 minutes to draw a picture of a scientist.
- If the students drew a specific person, have them write who they drew on the line at the bottom of the page. Have them leave it blank if it is just a general person/picture.
- Collect assessment
Mysterious Robbery (12 minutes)

- Explain to students that 10 years ago a robbery happened that was never solved. The police have contacted you to solve the cold case. At the time of the crime, a note written in black pen was passed to the teller which read “Give me all your money.” The teller handed over the money but kept the note. In the confusion that followed, the robber managed to get away. At the time there were eight suspects. Each of these suspects was found with a black pen on them (which the police still have). The only other evidence that the police have from the original crime was the note.
  - If asked, tell students that no fingerprints or DNA were found.
- Have students determine how they could help the police solve the crime.
  - If they took all the pens, they could determine what colors the black pens separate into and match it to the colors the pen on the note separated into.
- Ask students if it would be easier to identify the robber’s pen if they had a tall or short smear.
  - Tall smear.
- Have students help you decide which values of the variables they should tell the police to use to produce the biggest smear for question 1 (page 24, student notebook).
  - Time: 10 minutes
  - Liquid type: Water
  - Liquid amount: Liquid level just below the dot
- Tell students that you gave the police their suggested values and they ran the test. Show them the data (page 5, picture packet).
- Have the students identify the robber and then write a conclusion about their findings for question 2. Make sure that for the data statement contains “we observed.”

Mixture Discussion (10 minutes)

- Ask students what they have learned about black ink and have them fill in question 3.
  - Black ink is a mixture.
Tell students the definition of matter and ask them if several objects around the room are matter. Then tell them that things like dreams, ideas, and energy are not matter.

- Write in “matter” in the top box in the chart on question 4.

Ask students if the black ink is matter and then tell them the definition of a mixture and review mixtures.

- Write in “mixture” in the bottom left box of the chart for question 4.
- Give the example mixture of Lucky Charms and have students identify the parts of the mixture.
- Have students come up with at least one other mixture that can be distinguished by eye and record it and its parts on the Matter Chart.
- Tell students that sometimes you cannot see the individual parts of a mixture, and give the examples of the black pen and air. Have students give you the parts of the mixture for air and record them on the Matter Chart.
- Have students come up with one other mixture that cannot be distinguished by eye and record it and its parts on the Matter Chart.

Tell students that mixtures can be separated into pure substances. Review the definition of a pure substance with the students from the Matter Chart.

- Write in “pure substance” in the bottom right box of the chart for question 4.
- Give the example of water. Have students come up with two more pure substances and record them on the Matter Chart.

Tell students that mixtures can be separated into pure substances by using differences in the physical properties of the parts of the mixture.

- Write in “physical property” on the line under “matter” on the chart for question 4.
- Tell students that a physical property is a property that can be measured or observed without changing the substance. Then have students fill the definition in in question 5.
- Ask students what physical properties they could use to separate the Lucky Charms, and record these properties under “physical properties” on question 4.
  - Make sure students record the physical property (example: color) and not the values of the property (example: red, blue, etc.)
  - If the blanks are not all filled it is okay. You can add more physical properties as you go.
- Have students identify physical properties of the black ink and paper, and record these values in question 6 and 7.
  - If students come up with a physical property that is not on the list, add it to the list in question 4.
  - If you run out of room write the additional properties in the margins.
- Ask students the following questions:
  - Is black ink a mixture or a pure substance? (mixture)
  - Were we able to separate the black ink into parts? (yes)
- Ask students if all physical properties can be used to separate mixtures (question 8). For instance, if we know that the ink is made up of red and blue dyes, would that help us separate the mixture? (no)
- Ask students the following questions:
  - How were we able to separate out the different dye colors? (put the strips in liquids)
  - Why did some colors travel farther up the paper than others? (some dyes are attracted to water more than the paper and were carried up the strip farther)
- Tell students that the physical property that we were using to separate the blank ink was the “attraction to water” and “attraction to paper”.
- Show students the example strip from Day 1 (page 1, picture packet) and have them answer questions 10 and 11.
Separating Mixtures/Physical Properties (7 minutes)

- Show students the jar of water and sand (Tie to Standards box) and have them determine the following:
  - Physical properties of each component of the mixture (example: liquid and solid).
  - If the physical property they identified would be useful in separating the mixture.
  - If water and sand are pure substances.
- Record any new types of physical properties students come up in question 4.

Pure Substances (16 minutes)

- Tell students that physical properties can also be used to identify pure substances and have students fill out question 13.
- Pass out the labeled pure substances.
- Have students write down the physical properties of each of the pure substances.
- Collect labeled pure substances and pass out lettered pure substances.
- Have students identify the lettered pure substances.

Content Assessment: (10 minutes – Full Class – SciTrek Lead)

- Pass out content assessments.
- Read each question to students.
- Collect content assessments.

Extra Practice Solutions: