

<p>differences in air resistance (drag).</p> <ul style="list-style-type: none"> • The motion of an object can be described by its position, direction and speed. • An object's inertia causes it to continue moving in its original direction unless it is acted upon by a force to change its speed and/or direction. • In the design of structures there is a need to consider factors such as function, materials, safety, cost and appearance. 	<ul style="list-style-type: none"> • How can one increase the drag of a parachute allowing it to stay in the air a longer period of time? • What makes the objects move the way they do? • How are unbalanced and balanced forces related to an object's motion? • What causes changes in motion? • What forces affect a structure's ability to withstand stress?
<p>What simple content objectives/goals do you want to accomplish with this investigation? (see district curriculum documents)</p>	<p>What simple process skills do you want to improve with this investigation?</p>
<p>Students will understand that</p> <ul style="list-style-type: none"> • Air exists as a substance and can act against objects (can exert a force). • The force of air against objects is called air resistance or drag. • The greater the surface area of an object the greater the drag. • The force acting on a parachute are gravity pulling down and drag pulling it up. • Evaluate the benefits and drawbacks of materials and designs considering factors such as function, safety, cost, and appearance. • Evaluate forces that influence motion. • Calculate the average speed of a moving object. 	<p>Raising questions Investigable / testable questions (variables)</p> <p>This is a foundation inquiry - participants will experience all phases of the inquiry.</p>
<p>What phase of this investigation will you provide the most modeling/templates/mini-lessons/scaffolding for better skill development?</p>	
<p>*The focus of this investigation is to focus on teaching strategies to support phase 1 - Generating Questions and Turning Questions into investigable/testable questions</p>	

Materials/Resources:
<p>Parachutes kit - Prepare initial tray with:</p> <ul style="list-style-type: none"> • 1 10" square napkin • 4 pieces of light string about 10 inches long • 1 piece of string about 4.5 inches long • 1 dime size washer • 1 handout - Parachutes: Making, Testing, and Observing Parachutes • 1 roll of scotch tape <p>Demonstration Parachute</p>

Chart paper with the following headings - Shape, Materials, Size, Strings, Weight
Chart paper with sample investigable and non-investigable questions for discussion

Chart paper and markers

Science notebooks

large index cards and masking tape or large post-it notes

Planning and Investigating with Parachutes - template

Preparing to Share Results and Sharing Out - template

Structure of Inquiry Poster (poster size)

Guide for Planning an Inquiry Investigation - Parachutes - copy of "this document"

*** Need a room with high ceilings and room to toss parachutes - best to do it inside as the wind outside makes it harder to come to conclusions about what is influencing the parachutes fall.

What kinds of investigations do you anticipate students designing?

Shape of parachute

Material of parachute

Size of parachute

String - kind and length

Amount of weight

PHASE 1 - Observing and Questioning

INQUIRY STARTERS

- What is the launching activity or **inquiry starter** for the investigation?
- What will be your **inquiry starter prompt**? How will you "invite" your audience to work with the materials?
- What **materials** will you use for the inquiry starters?
- How will you **elicit and collect or display student's questions**? Will they share questions orally? In writing?
- **Choosing investigation questions**: How will you help your students determine which questions they can choose from to investigate? How will you or the students form investigation groups?

Time/ Materials	Task	Hints
5 min	<ul style="list-style-type: none"> • Participants can sit at random tables - or number them off so they are working with someone new - work in groups of 3 people • Post/refer to schedule on chart paper • Set the context - personal experience of inquiry - all 3 phases with a middle school content goal (see right side) • Based on the Exploratorium's work • If you were going to do this with students it would take you a little longer and may be designed a little differently. • Participants will need their journals to record their investigation data and their thoughts. 	<p>** place masking tape on walls to post index cards</p> <ul style="list-style-type: none"> • <i>The inquiry we are about to do was designed to have learners experience all three phases of inquiry in an effort to learn some science</i> • <i>We're going to do what might normally be about a 3-hour inquiry on magnets (spread over 2 -3 days) designed for middle school students. However we are going to do the entire process today in about two and one half hours.</i> • <i>For the most part, the inquiry today is the same as the one that the students have done in the classroom, the major differences are that we will stop periodically to discuss design aspects that are important to teaching the inquiry and that we will not have a break like the students might have at the end of Phase 1 and/or Phase 2.</i> • <i>We're all going to start exploring with a sample parachute. As you explore with your parachute, I'm going to ask you to have one person in your group record some of the things you noticed and some of the things you wonder about magnets. We will then take a look at the questions to determine which questions we can investigate today with the materials at hand. Then you will have a chance to choose a question and work with a partner to investigate your question. At the end, everyone will get a chance to share what they found out.</i>

		<p><i>To conclude this activity we will have a reflective discussion about inquiry and strategies to support some of the critical elements of inquiry.</i></p> <p>Review the 3 phases of inquiry (see poster)</p> <p>Inquiry has specific content goals with emphasis on phase 1 process skills. We will spend most of our time on phase 1. Given time we may work quickly through phase 2 and 3.</p>
5 min	<ul style="list-style-type: none"> • Inquiry starter - We are going to start the inquiry with an activity meant to get people engaged about ideas about parachutes. • Pass out tray with starter materials to each group - show the pre-made parachute and model how to make it • Demonstrate how to throw parachute based on directions on the direction hand-out 	Encourage participants to record observations in journal/notbook. (students would get more time)
15	<ul style="list-style-type: none"> • Participants build, test and observe their parachutes • Record observations (I notice...) and questions (I wonder...) in journal <p>OR</p> <ul style="list-style-type: none"> • Have them use index cards and write an observation on one side and question they have on the other side 	<p>Circulate and help people to make and test parachutes. Help facilitate by using prompts such as:</p> <ul style="list-style-type: none"> • "It seems you are puzzled by....." • "It seems like you have a question about" • "What about..." • "I found it interesting when..." • "I noticed..." • "I wonder..."
5	<ul style="list-style-type: none"> • Have participants return to seats and write as many observations and questions about their parachutes - things they noticed and further questions they have (at least 6) 	<p>Some may want to use the I notice...I wonder format others will use different types of formats</p> <p>Have participants hold their index cards for the discussion on variables and investigable questions</p> <p>Have two sample questions on chart paper for next discussion (one investigable and 1 non-investigable)</p>

10	<ul style="list-style-type: none"> • Tell participants that there are two main types of questions - investigable/testable and non-investigable • Have participants discuss the differences and sort their index cards • Come to a common definition of investigable and non-investigable • Model two examples on chart paper. Discuss the first question on chart paper - is it investigable? If not, how can we make it investigable? - work in small groups and share • Have participants sort their index cards into two piles - investigable and non-investigable. 	<p>Investigable questions = questions that can be investigated here and now with materials that are available to us within a reasonable time frame - Example "Will a round parachute work better than a square parachute?"</p> <p>Non-investigable questions = can't be investigated in the here and now - Example "How do you steer a parachute?"</p> <p>Neither type of question is better than the other, but today the intention is to use hand-on materials to conduct investigations in the next couple of hours - we want to focus today on investigable questions - In week 2 we will look more at non-investigable questions</p>
15	<ul style="list-style-type: none"> • Introduce and discuss "Fair Test" concept, independent variable, dependent variable • Introduce variable scan - Make T chart - Introduce independent variable, dependent variable and variables that are kept constant. • Turn and talk about other variables • Share 	<p>T-Chart lists all the possible independent variables on one side and all the possible dependent variables on the other side - note variables that are kept constant on the bottom - discuss how these can change</p>
5	<ul style="list-style-type: none"> • Discuss how questions can be phrased more specifically in the middle/HS school vs elementary 	<p>Share the format: "How does __IV__ affect the __DV__"</p>
8	<ul style="list-style-type: none"> • Have participants turn a non-investigable question into an investigable question • Have participants' select 5 questions and post them in the room. 	<ul style="list-style-type: none"> • Discuss what happens if students do not generate questions under a particular category - content goal

PHASE 2 - Planning and Investigating

INVESTIGATION

- What **additional materials** will you introduce? How will you introduce additional materials participants can use to study the phenomena?
- How will you manage/organize materials, set up and clean up?
- How will you support the groups in **planning** their investigation? Will you provide criteria or planning sheets?
- How will you facilitate during the investigation?

Time/ Materials	Task	Hints
7 All kit materials	<ul style="list-style-type: none"> • Introduce the planning template(s) • Review additional materials that are available 	Refer to Inquiry Map - We are now moving into phase 2
30	<ul style="list-style-type: none"> • Form groups - Gallery Walk - have participants read through the questions and chose one that interests them and pair up into groups of 3. Use the planning template to create a QUICK plan, investigate and record observations/results in notebook 	<p>Groups will want additional time, but encourage them to be as quick as possible -encourage groups to limit trials today for sake of time</p> <p>Classroom note - students would need more time and there would be more of an emphasis on science note-booking skills & revising.</p> <p>Remind participants that <i>"A good plan may still need revisions after you start conducting the investigation. These adjustments should be noted in your journal"</i></p> <p><i>"You will have approx. 30 minutes to: carry out your investigation, make observations, ask further questions, talk to each other about your observations and ideas, propose explanations, and record your observations and explanations using charts, diagrams, and through writing."</i></p> <p>Remind groups that if they get stuck, they can:</p> <ol style="list-style-type: none"> 1. walk around the room to see what other groups are doing 2. ask another group for advice 3. ask the facilitator for advice <p>reflect in your journal</p>

10	<ul style="list-style-type: none"> • With about 5 minutes left, pass out the "Planning to Share Results" template and encourage participants to begin to wrap up their investigation and to consider how they would share their results with others. • Finish investigation and start preparing for presentation 	Classroom note - students would need more time and more of an emphasis might be on writing and revising and rehearsing their sharing , creating a visual, etc.
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PHASE 3 - Interpreting Results and Communicating

SHARING RESULTS AND PROCESSING FOR MEANING

- How will investigation groups present what they have learned from their investigations? (visual, oral presentation, combination, etc.) How will you decide the order of the presentations? (by similar questions, content goals, random, etc.)
- How will the facilitator synthesize the knowledge and findings of the participants for the group?

Time/ Materials	Task	Hints
5	<ul style="list-style-type: none"> • Tell the participants - there are two main things you want to think about - 1. What your results tell you about your question 2. Communicate your findings (and how you got them) to the rest of the group • Use the template to help prepare you for sharing out - 2-3 minutes per group 	<p>Refer to Inquiry Map - We are now starting phase 3</p> <p>Focus on the highlights of your investigation - not a step by step description</p> <p>Highlight the prompts on the sharing template</p> <p>Discuss difference between all groups sharing out and groups sharing in smaller settings</p>
Approx 8 groups = 16 minutes	<ul style="list-style-type: none"> • Have groups share in larger groups of 3-4 groups together. (time permitting •)Groups have 2 minutes each to share • As each group finishes, ask if there are any questions and ask a group with a related investigation to go next 	<p>One person should time - 2-3 minutes each group</p> <p>Ask for a group to volunteer or select a group to start prior to sharing session (group that finished early)</p>
8	<ul style="list-style-type: none"> • Synthesis - • We've just spent about an hour investigating parachutes and hearing about each other's investigations. During this process we've found you some information about parachutes. For example, we have learned that • Also during this process we learned a lot about doing 	<p><u>Synthesis Includes:</u></p> <ul style="list-style-type: none"> • Different forces were influencing motion. <ul style="list-style-type: none"> • Air exists as a substance and can act against objects (can exert a force). • The force of air against objects is called air resistance or drag. • The force acting on a parachute are gravity pulling down and drag pulling it up. • Different materials and/or designs have benefits / drawbacks such as: <ul style="list-style-type: none"> • The greater the surface area of an object the greater the drag.

	<p>inquiry in general and some of the skills that are important in inquiry learning. For example, we asked many questions and chose ones that could lead to investigations. We made investigation plans and then carried them out. And we presented what we found out from the investigations to each other. These are important skills and the more we able are to carry them out well, the better we will be able to learn through inquiry.</p>	<ul style="list-style-type: none"> • Groups found that flexible materials make better parachutes because they unfold into a parachute shape easily. • Groups found that larger parachutes work better than smaller parachutes because they catch more air, as long as they are not too heavy. <p>With time...</p> <ul style="list-style-type: none"> • Calculate the average speed of a moving object.
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PROFESSIONAL DEVELOPMENT NOTES

<p>15 min</p> <p>Chart paper Markers</p>	<p>Chart talk</p>	<ul style="list-style-type: none"> • Participants will walk around the room (in their investigation group) and transfer strategies to chart paper (reflective of what they are already doing in the classroom or what they just saw modeled). Each chart paper will have one of the following headings. (15 minutes) <ul style="list-style-type: none"> • GENERATING/RAISING QUESTIONS • COLLECTING AND SORTING QUESTIONS • FORMING GROUPS • DEVELOPING FAIR TESTS AND PLANS • MANAGING AND ORGANIZING MATERIALS • DATA COLLECTION AND ORGANIZATION • COMMUNICATING RESULTS • ORDER OF GROUPS SHARING • QUESTIONS NOT INVESTIGATED •
<p>15 min</p>	<p>Facilitator will ask a participant sitting next to each chart paper to debrief.</p>	<ul style="list-style-type: none"> • Participants don't need to type - as tomorrow we will share a typed list of these strategies
<p>5</p>	<p>Share "Guide for Planning an Inquiry Investigation - Parachutes" = copy of "this document"</p>	<ul style="list-style-type: none"> • Format used for sharing overall inquiry design - you will be using this format on Saturday to start designing an inquiry for your unit.

Planning and Investigating with Parachutes

Pick a partner, choose a question to investigate and make a plan.
On your plan below, record the materials you might need and the steps you think you need to do to help you answer your question.

Consider the following questions:

- What parts of the parachute and the way you launch it will stay the same? What things will you change?
- What will you observe or measure to answer your question? (e.g. speed, accuracy, path of descent, etc.)

Investigation Question:

Materials Needed for Investigation:

My first step will be to ...

My next step(s) will be ...

Make and test your parachute(s). Record your results in your notebook.

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Wallingford Public Schools

Based on The Exploratorium's Institute for Inquiry Classroom Strategies for Inquiry 2005

Preparing to Share Results & Sharing Out

What was your question?

What did you test?

What did you find out?

We think this happened because...

PREPARE TO SHARE YOUR IDEAS WITH THE GROUP

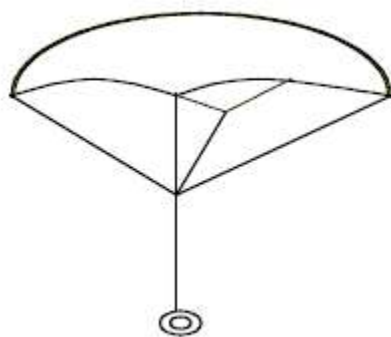
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EXPLORATORIUM INSTITUTE FOR INQUIRY

Making, Testing, and Observing Parachutes

Make A Parachute

1. Use a 10" square napkin
 2. Cut 4 pieces of string 10 inches long
 3. Using a small piece of tape securely tape a string to each corner
 4. Tie the free ends of the 4 strings together in a knot. Be sure the strings are all the same length
 5. Tie a single string about 4 1/2 inches long to the knot
 6. Tie a small washer to the free end of the string
 7. Pull the parachute up in the center. Make it as flat as possible
 8. Fold the parachute twice (as demonstrated)
 9. Lay the string with washer on top of the folded side
- Throw the parachute up into the air (underhanded with washer side up as demonstrated)
 - Repeat. Try to keep tosses the same



Record your observations and questions in your notebook

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Planning Template

Group Name(s):

Investigation Question / Problem statement

Independent variable: _____

Dependent variable(s): _____

Variables kept constant: (at least 3) _____

Hypothesis

Procedure

1. First

2. Next

3. Then

Materials:

Results: Quantitative and Qualitative data
(Include diagrams and tables)

Preparing to Share

2-3 minutes to share a summary

Group Name(s):

What was your investigation question / problem statement?

What did you do?

What did you find out?

We think this happened because...

What would you do differently if you were given more time to investigate this question?

What new question(s) do you have?

Parachutes

(Materials for 30 teachers - Professional Development)

25-50	10" square napkins
25-50	Assorted larger/smaller napkins
1 large roll	Light weight string
1 roll each	Assorted kinds of string (different weights - not really heavy)
50-100	Dime size washers
50	Washers - slightly lighter than the dime size
50	Washers - slightly heavier than the dime size (ex. $\frac{3}{4}$ ")
15	Rolls of scotch tape
1 roll	Wax paper
1 roll	Aluminum foil
15	scissors
15	rollers
1 box	Large paper clips
1 box	Small paper clips
5 kinds	Assorted light weight material - approx 1mX1m
5	Plastic garbage bags - any size - thinner plastic
5	Gallon plastic bags
1	newspaper
5-10	Pieces tissue paper
5	Pieces construction paper
15	Cafeteria trays/shoe boxes
20	Flexible meter sticks
15	Science notebooks

Phase 1 - Materials - Prepare String in small bags

1 Set of materials per 2 persons (15 set ups total)

1 10" square paper napkin

4 pieces of light weight string 10 inches long

1 piece of string about 4 1/2 inches long

1 dime-size washer

1 Science Notebook for each person (optional)

1 roll of scotch tape (for every 2-3 people)