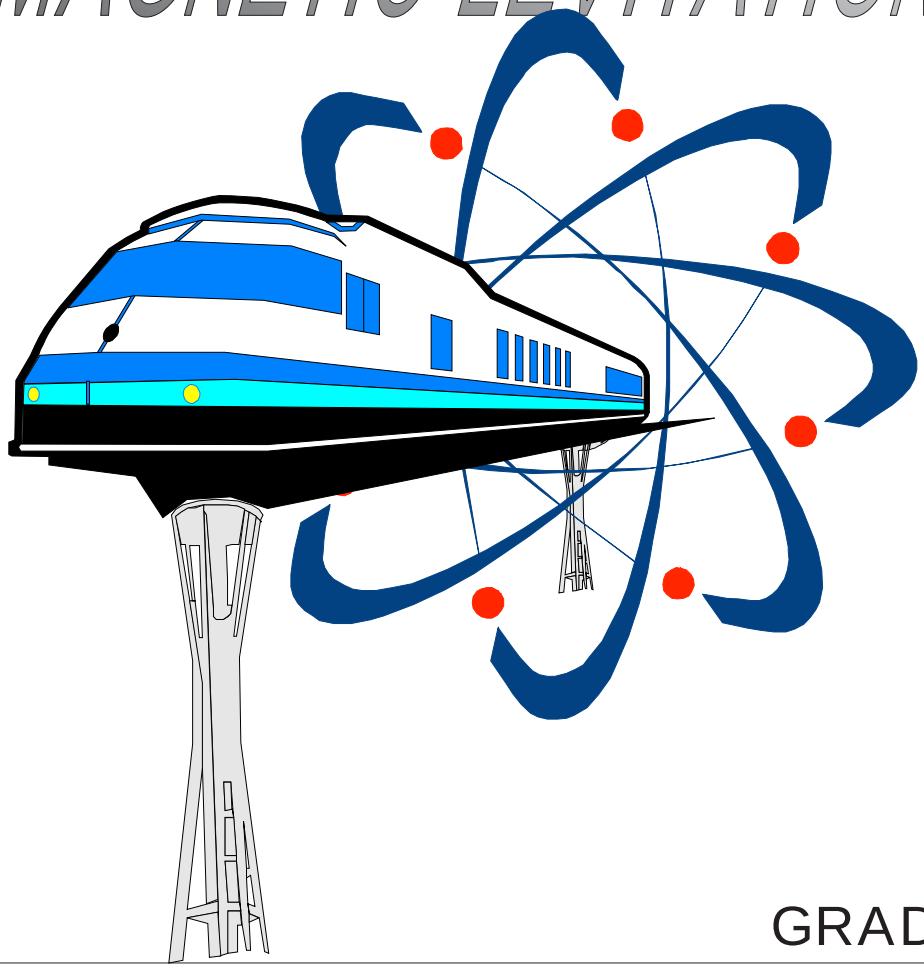
Introduction to Technology

MAGNETIC LEVITATION



GRADE 6

BIGELOW

MIDDLE SCHOOL
Newton, MA

TECHNOLOGY EDUCATION

0920

PROBLEM GUIDELINES

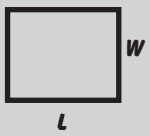
The object of this TLA is to design and build a Magnetic Levitation Vehicle that will travel down eight feet of track in the shortest amount of time, powered only by wind. The catch is, you are only allowed to use post-consumer materials.

1. Students will break up in small teams.. Each team (2-3 students) will design one Mag Lev vehicle using only POST - CONSUMER materials. (Materials that will be thrown away or better yet be recyclable).
2. Materials will be the sole responsibility of the students to gather with the exception of glue, scissors, tape, etc.
3. You must use at least three different types of post - consumer materials in the construction of your racer.
4. The base of the racer can be no wider than 2.5 inches and no longer than 5 inches.
5. The maximum area of the sail shall not exceed 144 square inches.
6. Each group will get three attempts to complete the course. You will have time between each race to make modifications to your racer.
7. If a team fails to complete the course a “DNF” (Did not finish) will be recorded.

When you meet as a team you should:

- Review the problem and specifications.
- Once each team member has drawn at least 2 sketches/pictures of possible racer designs, the team should review them and select a final design.
- REMEMBER: Some times the best solution is a combination of several ideas.
- HINT: The object is to make the racer travel 8 feet in the shortest period of time. This means the more air the sail can gather, the faster the racer will proceed. (Aerodynamics, weight, height, width, symmetry, and material properties, all contribute to the performance of your racer)

Area Formulas

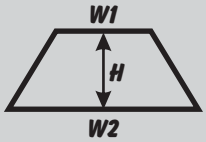


RECTANGLE OR SQUARE

L X W

TRIANGLE

½-H X W



TRAPEZOID

(½-W1 + ½-W2) X H

CIRCLE

3.14 X R^2

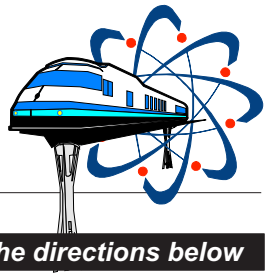
L=LENGTH H=HEIGHT R=RADIUS

Possible Materials

note cards	zip-lock bags	tin foil
straws	paper bags	drink stirrers
toothpicks	tissue paper	bottle caps
popsicle sticks	construction paper	news paper
sandwich bags	cardboard	mylar balloons

NAME: _____ CLASS: _____.

DESIGN SHEET



Step 1 Identify the need or the problem — **Write down the directions below**

What do we have to do for this challenge?

_____

_____

_____

_____

Standards we must meet

Maximum base length: _____

Maximum base width: _____

Maximum sail area: _____

How many different materials: _____

Step 2 Research the need or the problem — **Fill out the Research Worksheet for homework**

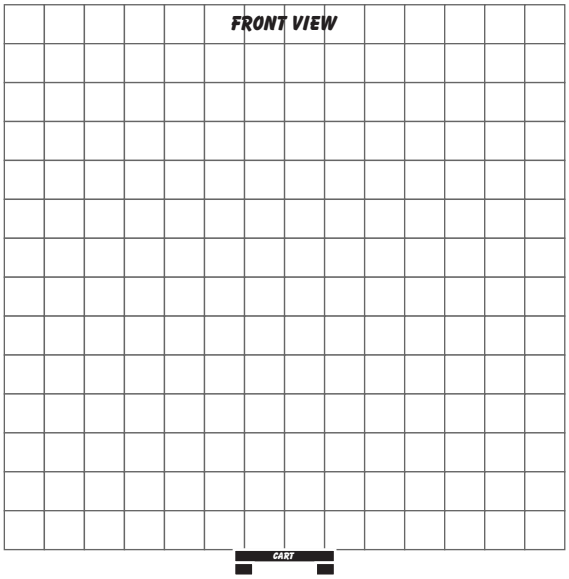
Use the back side of this sheet to do your research

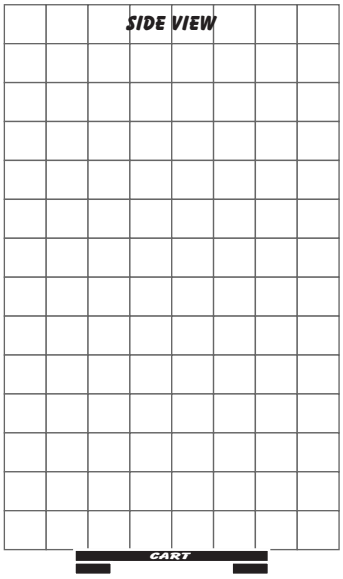
Step3 Develop possible solutions — **Sketch two designs for a Meg-Lev Racer below**

Draw 2 possible solutions for the problem. Make sure you draw a front and a side view for each of your ideas

SKETCH 1

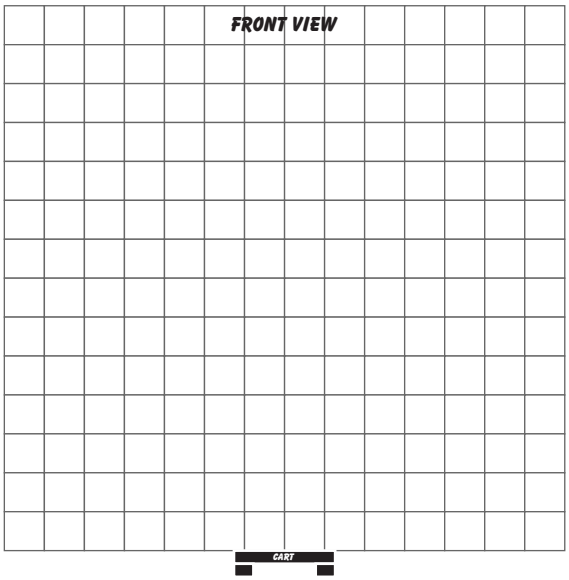
Each square = 1”

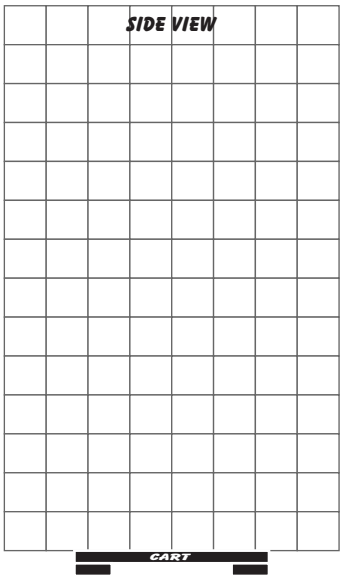




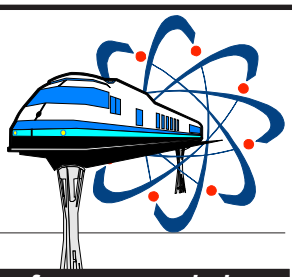
SKETCH 2

Each square = 1”





NAME: _____ CLASS: _____.



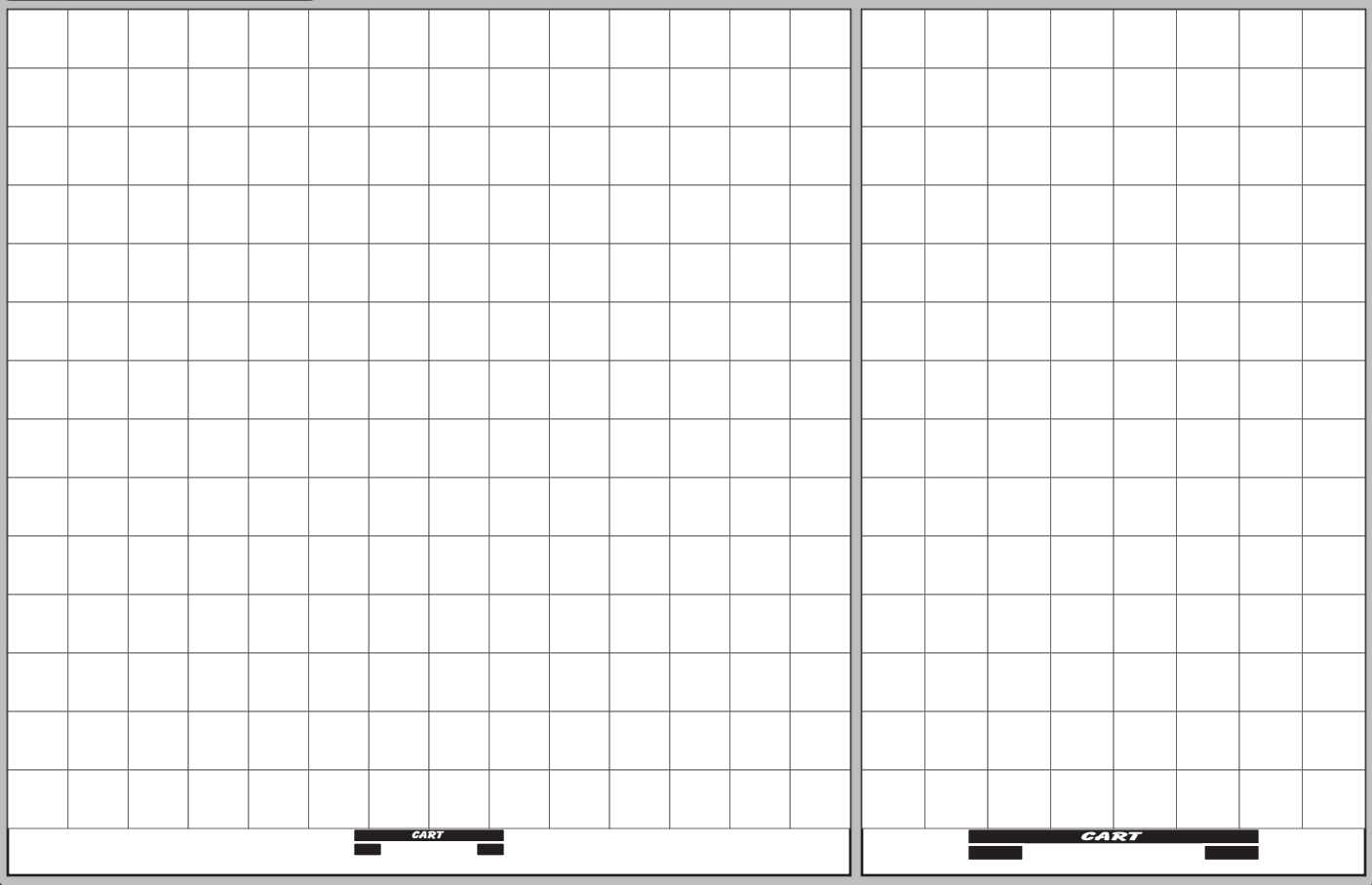
FINAL DESIGN

Step 4 Select the best possible solution — **Draw a final design of your racer below**

Include dimensions and the materials you plan to use.

SCALE: Each square = 1”

final design



MATERIALS:

Sail Frame:_____ Sail:_____

Mast:_____ Base:_____

Area of the Sail (use formulas on Problem Guidelines page) :_____

STOP **Get approval from Mr. Whitman before you go on**

Step 5 Construct a prototype of your solution — **Make your Mag Lev Racer**

List the steps you took to construct your racer

1 _____
2 _____
3 _____
4 _____
5 _____
6 _____
7 _____
8 _____

Step 6 Test and evaluate your solution — **DO NOT turn on the fan for this step**

Place the vehicle on the track and list any problems

_____
_____
_____

List how you intend to fix the problems

_____
_____
_____

NAME: _____ CLASS: _____.

Test Data

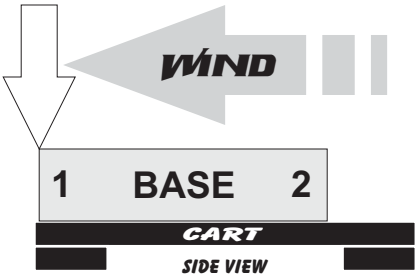
Step 1 Label the base of your racer as shown in the following diagram:

Write the number 1 on one end of the base and the number 2 on the other end.

Step 2 Place your racer on the Mag-Lev Cart and test your racer in each of the 6 locations below:

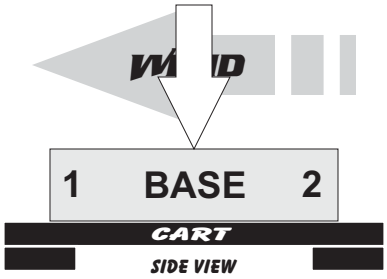
#1 as FRONT

Align to front of cart



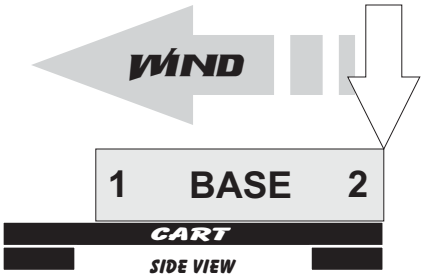
TIME: _____

Align to center of cart



TIME: _____

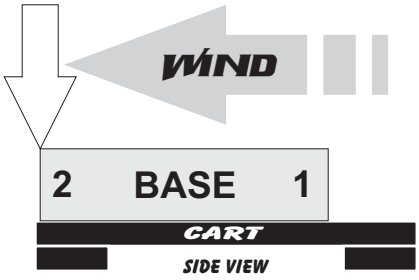
Align to back of cart



TIME: _____

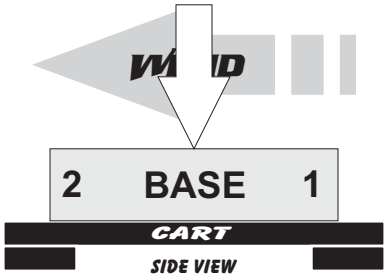
#2 as FRONT

Align to front of cart



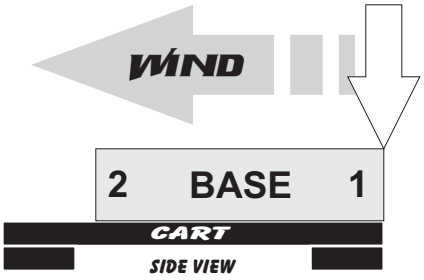
TIME: _____

Align to center of cart



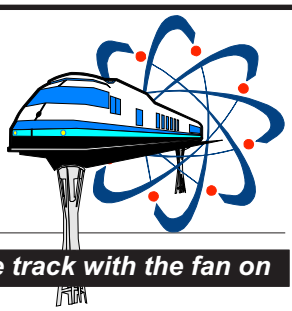
TIME: _____

Align to back of cart



TIME: _____

NAME: _____ **CLASS:** _____.



RE-DESIGN & EVALUATE

Step 7 Communicate the solution — *Test your racer on the track with the fan on*

Test your racer on the track several times and record what happens

Observations	List any problems you find

Step 8 Redesign and / or rebuild your solution — *Fix your racer until it works perfectly*

List the things that you changed on your racer	List the ways the changes effected your racer

Step 9 Evaluation — *How did your racer perform?*

What was the best improvement that you made to your racer?

_____

What was the area of your final sail design in inches? (refer back to the Problem Guidelines page for formulas)

_____

What sail shape did you and your team finally decide on? Explain why you decided on that shape?

_____

_____

In the spaces provided, draw what your final racer design looked like and list the actual materials you used.

FRONT VIEW

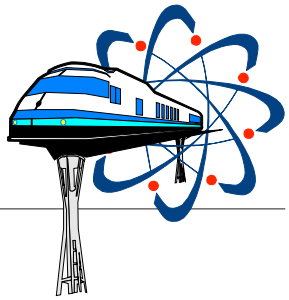
CART

SIDE VIEW

CART

MATERIALS: Sail Frame:_____ Sail:_____
Mast:_____ Base:_____

NAME: _____ CLASS: _____.



SUMMARY SHEET

Answer the following questions as completely as you can

1. How does magnetic levitation work?_____.
_____.

2. List at least two common uses for magnetic levitation?_____.
_____.

3. List at least two advantages of Mag Lev trains over fuel burning trains?_____.
_____.
_____.

4. List one example of a transportation system that travels across or through:
   - Land: _____.
   - Water: _____.
   - Air: _____.
   - Space: _____.

5. What was the total area of your sail?(multiply the length x the width)_____.

6. After a few test runs, what were some of the changes and refinements you made to your racer to improve it's performance?_____.
_____.
_____.

7. What do you feel is the most important factor in making your race vehicle the fastest?_____.
_____.

8. What sail shape did you and your partner finally decide on?_____.
Why?_____.

9. Which material would be best to use for a sail?
   a. Styrofoam b. straws c. tin foil d. toothpicks

10. Which material would be best to use for a mast?
    a. Styrofoam b. straws c. card board d. plastic bags

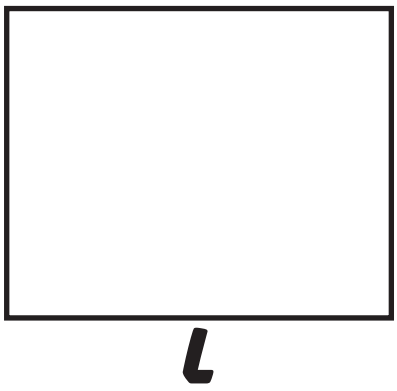
11. Which material would be best to use for a base?
    a. Styrofoam b. straws c. tin foil d. toothpicks

12. If needed, which material would be best to use for a sail frame?
    a. drink stirrers b. straws c. toothpicks d. a, b, and c

13. List at least one example of how your team could have improved your race time?
_____.

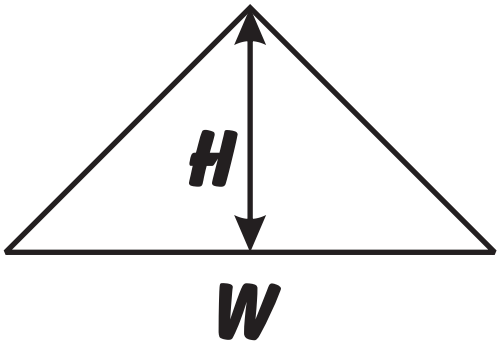
14. Overall, what did you like/dislike about the Mag Lev unit?_____.
_____.

AREA OF YOUR SAIL



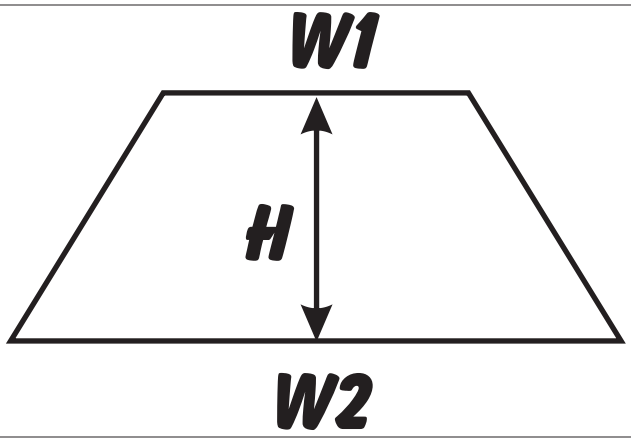
RECTANGLE OR SQUARE

$$L \times W$$



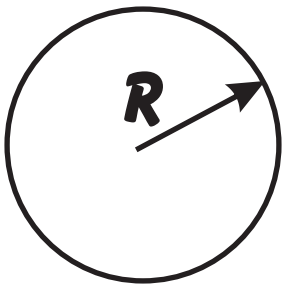
TRIANGLE

$$\tfrac{1}{2}\text{-}H \times W$$



TRAPEZOID

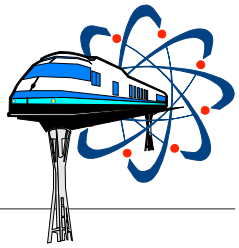
$$(\tfrac{1}{2}\text{-}W1 + \tfrac{1}{2}\text{-}W2) \times H$$



CIRCLE

$$3.14 \times R^2$$

Connection to Frameworks



Upon completion of this TLA students will have learned and / or demonstrated the following Frameworks Standards:

1 Materials, Tools, and Machines

1.1 Given a design task, identify appropriate materials (e.g., wood, paper, plastic, aggregates, ceramics, metals, solvents, adhesives) based on specific properties and characteristics (e.g., weight, strength, hardness, and flexibility).
1.2 Identify and explain appropriate measuring tools, hand tools, and power tools used to hold, lift, carry, fasten, and separate, and explain their safe and proper use.
1.3 Identify and explain the safe and proper use of measuring tools, hand tools, and machines (e.g., band saw, drill press, sanders, hammer, screwdriver, pliers, tape measure, screws, nails, and other mechanical fasteners) needed to construct a prototype of an engineering design.

2 Engineering Design

2.1 Identify and explain the steps of the engineering design process, i.e., identify the need or problem, research the problem, develop possible solutions, select the best possible solution(s), construct a prototype, test and evaluate, communicate the solution(s), and redesign.
2.2 Demonstrate methods of representing solutions to a design problem, e.g., sketches, orthographic projections, multi-view drawings.
2.3 Describe and explain the purpose of a given prototype.
2.4 Identify appropriate materials, tools, and machines needed to construct a prototype of a given engineering design.
2.5 Explain how such design features as size, shape, weight, function, and cost limitations would affect the construction of a given prototype.
2.6 Identify the five elements of a universal systems model: goal, inputs, processes, outputs, and feedback.

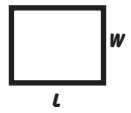
6 Transportation Technologies

6.1 Identify and compare examples of transportation systems and devices that operate on each of the following: land, air, water, and space.
6.2 Given a transportation problem, explain a possible solution using the universal systems model.
6.3 Identify and describe three subsystems of a transportation vehicle or device, i.e., structural, propulsion, guidance, suspension, control, and support.
6.4 Identify and explain lift, drag, friction, thrust, and gravity in a vehicle or device, e.g., cars, boats, airplanes, rockets.

NAME: _____ CLASS: _____.

RACE POINTS

1. Calculate the area of your sail now that your racer has been built

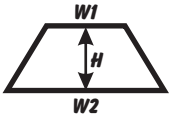


RECTANGLE OR SQUARE

L X W

TRIANGLE

½-H X W



TRAPEZOID

(½-W1 + ½-W2) X H

CIRCLE

3.14 X R²

L=LENGTH W=WIDTH H=HEIGHT R=RADIUS

2. Find the Design Accuracy of your racer by using the following calculations. This will tell you how accurately you built your racer compared to your final design. The more accurate you are the more points you will score.

Finished Racer SAIL AREA IN INCHES → [ ] **100** Potential Points

−

Final Design SAIL AREA IN INCHES → [ ] [ ] Design Accuracy

DESIGN ACCURACY → = [ ] = [ ] POINTS

Total Points earned from Design Accuracy → [ ]

3. Now weigh your racer and record weight in grams in the chart

+

WEIGHT	Weight in grams
In Grams	

POINTS

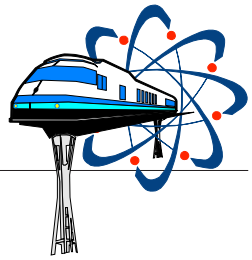
WEIGHT	Lightest	2nd Lightest	3rd Lightest	4th Lightest	5th Lightest	6th Lightest	7th Lightest	Heaviest
POINTS	20	18	16	14	12	10	8	6

→ [ ]

+

Total Points from this page → [ ]

RACE POINTS



4. Fill in the following chart to use in your calculations below.

	Race 1	Race 2	Race 3	Ave. Time
TIME IN SECONDS				

5. Calculate your percentage of improvement by using the following formula:

FT = First Time
BT = Best Time
IT = Improved Time

1 FT − BT = IT

2 FT) IT x 100 = IP%

6. What is your Improvement Percentage (IP) ?_____ %.

		POINTS
Improvement	2 points per %	
POINTS	Multiply your IP x 2	▭

+

Race #1	< 4 Seconds	< 4.5 Seconds	< 5 Seconds	< 5.5 Seconds	< 6 Seconds	
POINTS	20	18	16	14	12	▭

+

Race #2	1st Place	2nd Place	3rd Place	4th Place	5th Place	6th Place	7th Place	8th Place	
POINTS	20	19	18	17	16	15	14	13	▭

+

Race #3	1st Place	2nd Place	3rd Place	4th Place	5th Place	6th Place	7th Place	8th Place	
POINTS	20	19	18	17	16	15	14	13	▭

+

Average	1st Place	2nd Place	3rd Place	4th Place	5th Place	6th Place	7th Place	8th Place	
POINTS	20	19	18	17	16	15	14	13	▭

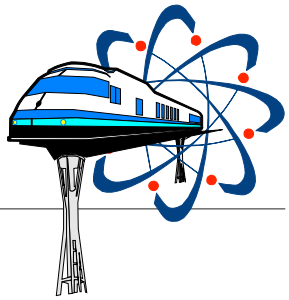
+

Total Points from the previous page	▭

7. Now add up all your points and see how you did .

TOTAL ▭

NAME: _____ CLASS: _____.



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_____.
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7. What do you feel is the most important factor in making your race vehicle the fastest?_____.
_____.

8. What sail shape did you and your partner finally decide on?_____.
Why?_____.

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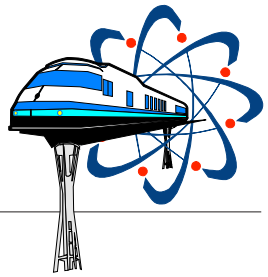
13. List at least one example of how your team could have improved your race time?
_____.

14. Overall, what did you like/dislike about the Mag Lev unit?_____.
_____.

NAME: _____ CLASS: _____

Mag-Lev RESEARCH



Step 2 Research the need or the problem	*10 points each*

1. How does Magnetic Levitation work?_____

2. List 3 ways Magnetic Levitation used for transportation_____

3. What is a transportation system?_____

4. List the subsystems of a Magnetic Levitation transportation system
   Structure:_____. Propulsion:_____
   What makes the train levitate?_____
   How do people get on and off the trains?_____
   What controls the train's movement?_____

5. List two advantages that Mag Lev trains have over traditional fuel-burning trains?_____

6. If a person wanted to ride on a Mag Lev train, where could he/she go (what city?)?_____

7. List at least two concerns that would arise in order to build a Mag Lev train here in Boston.

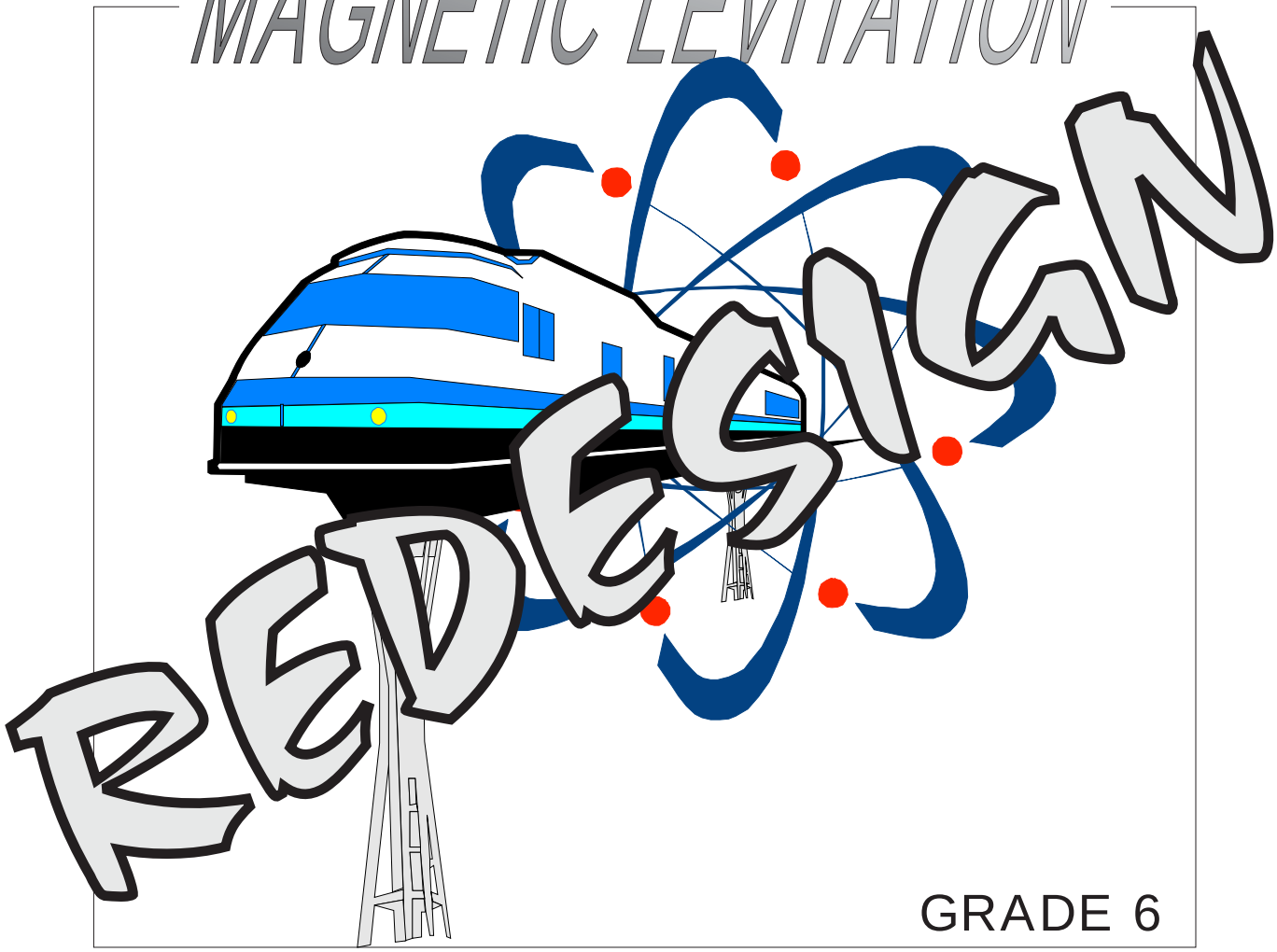
8. List at least two <u>positive</u> outcomes of building a Mag Lev train in Boston?_____

9. List at least five different types of transportation methods used in the world._____

10. What four forces are always acting on any object that is moving?
    1. _____
    2. _____
    3. _____
    4. _____

Introduction to Technology

MAGNETIC LEVITATION



GRADE 6

BIGELOW

MIDDLE SCHOOL
Newton, MA

TECHNOLOGY EDUCATION

0918

NAME: _____ CLASS: _____.

REDESIGN - Round 2

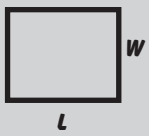
In this redesign round you will only have 1 class period to construct your racer. The track will be set up and you may do as many tests to your racer as you wish. Each team should fill out the race Test Data on the back side of this worksheet.

1. Students will break up in small teams.. Each team (2-3 students) will design one Mag Lev vehicle using only POST - CONSUMER materials. (Materials that will be thrown away or better yet be recyclable).
2. Materials will be the sole responsibility of the students to gather with the exception of glue, scissors, tape, etc.
3. You must use at least <u>three</u> different types of post - consumer materials in the construction of your racer.
4. The base of the racer can be no wider than <u>2.5</u> inches and no longer than <u>5</u> inches.
5. The maximum area of the sail shall not exceed 144 square inches.
6. Each group will get three attempts to complete the course. You will have time between each race to make modifications to your racer.
7. If a team fails to complete the course a “DNF” (Did not finish) will be recorded.

<u>When you meet as a team you should:</u>

- Review the problem and specifications.
- Once each team member has drawn at least 2 sketches/pictures of possible racer designs, the team should review them and select a final design.
- REMEMBER: Some times the best solution is a combination of several ideas.
- HINT: The object is to make the racer travel 8 feet in the shortest period of time. This means the more air the sail can gather, the faster the racer will proceed. (Aerodynamics, weight, height, width, symmetry, and material properties, all contribute to the performance of your racer)

Area Formulas

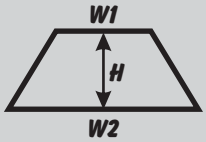


RECTANGLE OR SQUARE

L X W

TRIANGLE

½-H X W



TRAPEZOID

(½-W1 + ½-W2) X H

CIRCLE

3.14 X R^2

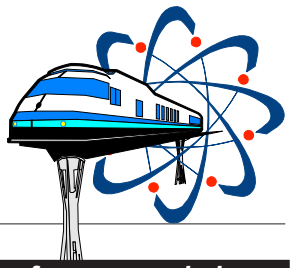
L=LENGTH H=HEIGHT R=RADIUS

Possible Materials

note cards	zip-lock bags	tin foil
straws	paper bags	drink stirrers
toothpicks	tissue paper	bottle caps
popsicle sticks	construction paper	news paper
sandwich bags	cardboard	mylar balloons

NAME: _____ **CLASS:** _____.

FINAL DESIGN



Step 8 Redesign your solution | ***Draw a final design of your racer below***

Include dimensions and the materials you plan to use.

SCALE: Each square = 1”

final design

CART

CART

MATERIALS:

Sail Frame:_____ Sail:_____

Mast:_____ Base:_____

Area of the Sail (use formulas on Problem Guidelines page) :_____

Test Data

Align to front of cart	*Align to center of cart*	*Align to back of cart*	*Align to front of cart*	*Align to center of cart*	*Align to back of cart*
WIND	WIND	WIND	WIND	WIND	WIND
1 BASE 2	1 BASE 2	1 BASE 2	2 BASE 1	2 BASE 1	2 BASE 1
CART SIDE VIEW	CART SIDE VIEW	CART SIDE VIEW	CART SIDE VIEW	CART SIDE VIEW	CART SIDE VIEW
_____ Time	_____ Time	_____ Time	_____ Time	_____ Time	_____ Time

NAME: _____ CLASS: _____.

Test Data

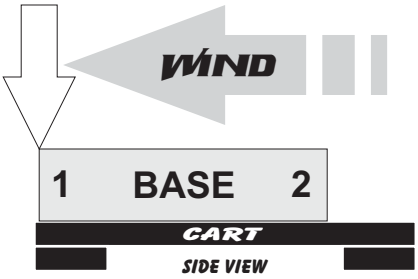
Step 1 Label the base of your racer as shown in the following diagram:

Write the number 1 on one end of the base and the number 2 on the other end.

Step 2 Place your racer on the Mag-Lev Cart and test your racer in each of the 6 locations below:

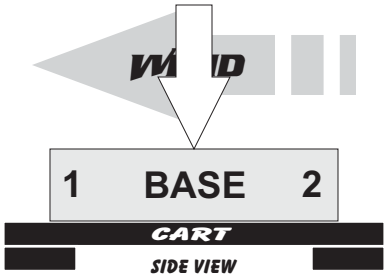
#1 as FRONT

Align to front of cart



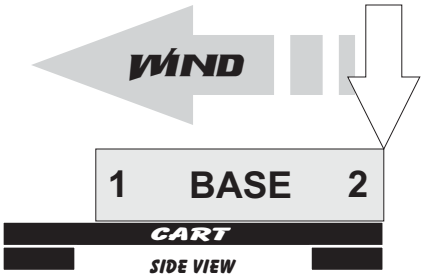
TIME: _____

Align to center of cart



TIME: _____

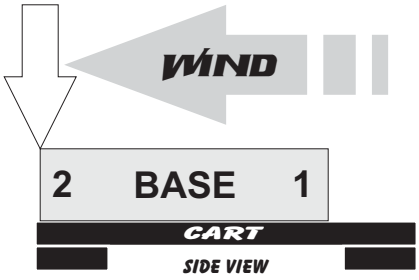
Align to back of cart



TIME: _____

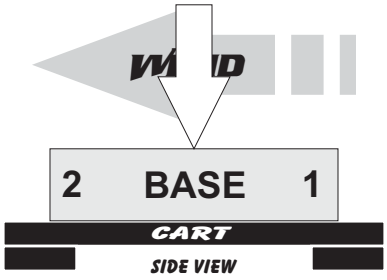
#2 as FRONT

Align to front of cart



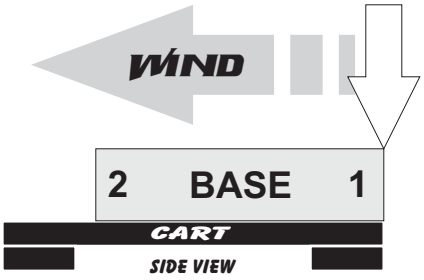
TIME: _____

Align to center of cart



TIME: _____

Align to back of cart



TIME: _____