

## Airport Security: Inspection-Friendly Baggage

14th Annual NEDC Problem Statement 2002-2003

### Design Brief:

The events of September 11, 2001, and the subsequent actions of the U.S. government are triggering more intensive screenings and searches of the traveling public, beginning with the aviation sector. Specifically, when passengers are identified for additional searches of their belongings, many bags or parcels must be unpacked to allow a thorough inspection. This requirement takes additional time and staff, and can cause embarrassment or other indignities to those having their belongings searched. Aviation has been a primary catalyst for the design and evolution of luggage over the past several decades, sparking features such as "soft-pack," nesting, wheels and rollers, compartmentalization, garment bags, and integrated personal/business luggage sets (matching briefcases, portfolios, sample cases).

The 2003 Design Challenge is to advance the state-of-the art of travel baggage to facilitate inspections in their speed and accuracy, while maintaining and protecting personal privacy. The project should develop a luggage set for both check-in and carry-on that:

- Maintains the ergonomics and conveniences that have evolved in luggage yet recasts them as inspection-friendly (for example, bag handles and their compartments for wheeled-luggage can quickly be seen to be safe and not a place of concealment);
- Can be opened, inspected and closed quickly with minimal unpacking;
- Protects personal privacies by concealing contents at times other than the actual inspection;
- Demonstrates a range of products for personal, business or combined possessions; and
- Works for persons with a range of disabilities.

Teams should understand the airport luggage inspection concerns at the national, airport, and individual levels. The working model may use substitute materials, with the production model materials identified. Evolution of the working-model design, rationale for design choices, assessment of market competition, approach to manufacturing and sales, and considerations for future design improvements should be identified. Appropriate safety procedures must be reflected in all aspects of the activities.

## Balloon Busters Design Brief



### The Design Brief:

Students will construct an invention that will use the power generated by a mousetrap to activate a chain of events that will burst a balloon.

### Specifications:

1. It must be activated from the power generated by a mousetrap.
2. Three different events in a chain of events must occur in sequence.
3. The mousetrap nor the balloon are considered to be a part of the three events within the chain of events. Three different events will need to be planned and scheduled.
4. An event should be considered as a separate entity. In other words, three dominos may be considered as one event, not three.
5. The last event or the third event will burst the balloon.
6. Safety is important! An event that utilizes a pointed object, such as a dart, pin, nail, etc., cannot travel a distance of more than one foot.
7. The mousetrap must be a measured distance of three feet from the balloon.

### Note:

This invention calls for a Rube Goldberg type of response to a problem. Goldberg, an American cartoonist, created bizarre comic-page "inventions" that dealt with simple problems and everyday nuances. He was a satirist who poked fun at twentieth century technology.

Encourage students to really stage an event with their inventions. Each event within the chain of events should be drastically different. After the inventions have been demonstrated, ask students to think in terms of combining their inventions with another invention. If possible, provide an opportunity for doing this. Often, it's the combination of ideas and the compromising of ideas that are the reality of any society.

### Multi-Disciplinary Expansions:

1. Provide Rube Goldberg illustrations from library books. Encourage students to identify some of the scientific principles involved in some of the cartoons.
2. Imagine you could write figures of speech you're tired of hearing on balloons before they burst. Which ones would you use?
3. In what ways could the invention concept be demonstrated from floor to ceiling? In a reverse fashion?
4. Do a flow chart of the invention concept on paper.
5. What kinds of accommodations could be made to cause one of the inventions to function as an alert system?
6. Demonstrate some of the inventions at a P.T.A. meeting or other school function.

## Balloon Busters Problem Solving

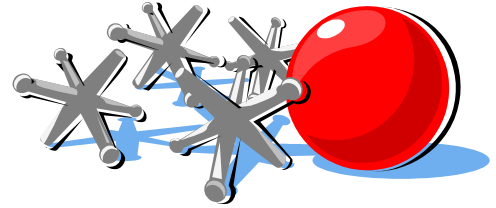
Level: \_\_\_\_\_ Team Numbers: \_\_\_\_\_

### Evaluation:

Criteria	Possible Points	Actual Points Recv=d
Activated by the mousetrap	5	
Event One- different than others, accomplishes task, works consistently, creative	15	
Event Two - different than others, accomplishes task, works consistently, creative	15	
Event Three - different than others, accomplishes task, works consistently, creative	15	
Additional Events- each different than above, accomplishes task, works consistently, creative	10 per event	
Last event bursts the balloon	5	
<b>Rules Violations</b>	-20	
Pointed objects cannot travel more than one foot		
Mousetrap must be exactly three feet from the balloon		

# Rubber Ball Shoot

Georgia Industrial Technology Education Association



## Design Brief:

Students will build a device to shoot a rubber ball 10 feet and hit a target. The device must be mounted to a pad and the rubber ball cannot be thrown.

## Tools and Materials: (Per Person or Team of 3-4)

1. 1 - Launch Pad (A board approximately 12" x 12")
2. 4 - Rubber Bands
3. 4 - Straws
4. 6 - Thumb Tacks
5. 1 - 1" Hard Rubber Ball (like the ones found in gumball machine)
6. 4 - Paper Clips
7. 2 - 1/4" x 1/4" Wood Sticks
8. 1 - Paper Cup (Dixie Cup)
9. Masking Tape (6 inches)
10. Kite String (12 inches)
11. Scissors
12. Ruler

## Limitations:

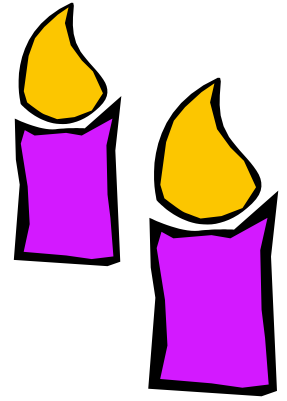
1. The student will use only the materials provided, however, they do not have to use all materials.
2. The rubber ball cannot be thrown.

## Procedure:

1. Have each student sketch two possible designs.
2. Separate the students into groups of 3-4.
3. Allow students to discuss the various ideas and decide upon a design.
4. Distribute materials to the groups.
5. Have students construct their devices.
6. Set up target for students to practice (Bulletin Board Paper).
7. Final testing should be done on a chalkboard. (The dust from the chalk will allow you to see where each ball hits the target.)

# Candle Snuffer

Pam Brown - Central Middle School



## Design Brief:

Students will design and construct a device that can be triggered to put out a candle.

## Tools and Materials: (Per Team of 2 or 3)

Cardboard  
Masking Tape - 8 inches  
Marble  
Balloon  
Clothes hangers  
String (3 feet)  
Cardboard tubes  
Aluminum foil  
2 Rubber Bands  
2 Styrofoam cups  
5 small paper clips  
2 clothes pins  
Glue or adhesive  
Scissors  
Wire Cutters

## Limitations:

1. You may use only the materials provided.
2. Device cannot be attached to the walls, ceiling, floor, door frames or doors.
3. Device must be able to be set to a ready position before testing and then be triggered for testing.

## Procedure:

1. Sketch the design/plan for your device.
2. Attain needed materials from your instructor.
3. Construct your device.

## Testing:

1. Students should set up their device for testing.
2. Instructor will provide candle for testing.
3. Students should place candle at appropriate place for device to work.
4. Instructor should light the candle.
5. Student should trigger the candle snuffer.

*Note:* For safety you should keep a fire extinguisher ready during testing.

# Cardboard Tower

Roger Jessup - Buford High School  
Georgia Industrial Technology Education Association

## Design Brief:

Students will design and construct a tower to support a much weight as possible.

## Tools and Materials: (Per Person or Team of 2)

1. Cardboard soda flat
2. Glue or other adhesive
3. Masking Tape
4. Straight Pins
5. Ruler
6. Scissors
7. Yard Stick (for class use)

## Limitations:

1. You may use only the materials listed.
2. You must remove the pins from the tower before testing.
  - Height - Minimum: 6 inches  
Maximum: 10 inches
  - Base size - Minimum length and width: 3 inches  
Maximum length and width: 8 inches
  - Top Size - Minimum length and width: 2 inches  
Maximum length and width: 5 inches

## Procedure:

1. Sketch the design/plan for your tower.
2. Build your tower.
3. Tower should be able to support as much weight as possible.
4. Instructor will provide weights that can be placed on top of the tower.
5. Instructor should place weights on the tower.





## **Recyclable Child's Toy**

Pam Brown - Central Middle School  
Georgia Industrial Technology Education Association

### **Design Brief:**

Students will design and construct a child's toy from recyclable items.

### **Tools and Materials:** (Per Person or Team of 2-3)

1. Soda cans
2. Cardboard
3. Plastic bottles/jars
4. Paper
5. Egg cartons or crates
6. Cloth
7. Glue or Glue Sticks
8. Aluminum foil
9. Styrofoam
10. Newspaper
11. Craft sticks
12. Paper towel tubes
13. String or yarn
14. Scissors
15. Ruler
16. Glue gun (preferably low temp./cool melt)

### **Limitations:**

1. You may use only the materials provided.
2. Toy should be no larger than a 12 inch cube.
3. Toy should be safe for small children

### **Procedure:**

1. Sketch the design/plan for your device.
2. Attain needed materials from your instructor.
3. Construct your toy.
4. Toys will be examined for durability and safety.
5. Toys will be judged on creativity and construction.



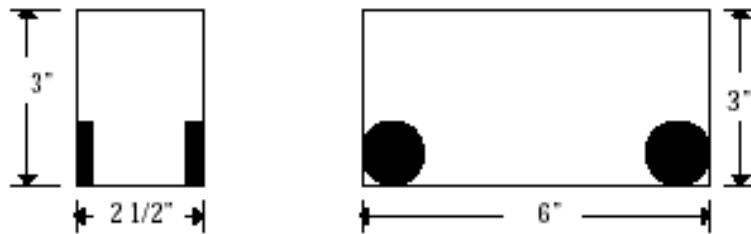
## Crash and Survive!!!! E.C.V. (Egg Crash Vehicle)

### Design Brief:

You are to design and build a vehicle that will allow a raw egg (crash dummy) to survive a 30° incline, 5' from the ground at 10' in length, crash into a block wall. The vehicle must be capable of traveling down the ramp and into a block wall without breaking the egg inside the vehicle.

### Specifications:

1. Interior restraint space for raw egg.
2. Shock-absorbing material in the interior.
3. wheels, 2 axles (old or broken toys)
4. Size limitations: (must fit inside the ramp track).



5. Access door for inserting the “dummy” egg.
6. Survive a crash at 30° incline at 10 to 15 mph.
7. Finished exterior design and appearance. (paint, markers, stickers)
8. Original model name on vehicle. (related to eggs, crashing)
9. Teacher will provide “raw” egg on crash day.

### Tools and Materials:

1. wheels
2. axles
3. Posterboard, foamboard, wood, plastic, existing body, as needed.
4. Interior shock-absorbing materials; foam peanuts, tissue paper, etc.



## **Cut It Out!**

Tech Directions Magazine

### **Design Brief:**

Paper comes in a wide variety of forms, depending on how it is to be used—paper towels, tissue paper, etc. You have been given a half sheet of standard writing paper. Now, cut the paper any way you wish into **one continuous strip**, then we'll tape an end onto the floor and extend the rest in one direction as far as possible without breaking it.

### **Materials:**

The **only** materials you may use are:

- One sheet of 5-1/2" x 8-1/2" paper
- One pair of scissors
- One piece of masking tape
- One tape measure

### **Contest Rules:**

1. Cut the paper into one continuous strip.
2. If the strip breaks, the pieces may not be fastened together.
3. Final distance is marked from the beginning point to the opposite end where the paper breaks.

### **Points will be awarded as follows:**

Total distance in inches reached:

120-180 Inches — 5 Points

181-240 Inches — 10 Points

241 Inches and Above —20 Points

### **What Did You Learn?**

1. What factors cause some paper strips to go farther than others?
2. How could your paper strip be changed to make it go further?

# Egg Bungee Jump

## What You Need

- nylon stockings
- rubber bands
- balloons
- yarn
- plastic sandwich bag
- pennies
- an egg
- newspaper
- ruler



## Engineering Scoop

When you **drop** the egg, the falling egg **stretches** the bungee cord. As the cord stretches, it **slows** the egg until it stops falling. Then the bungee cord **springs back**, pulling the egg up and away from the ground. The bungee cord stretches because it's made from materials that are **elastic**. Things that are elastic return **almost to their original shape** after they've been stretched or squashed by a force. The amount the bungee cord stretches depends on how **elastic** the materials are and how much the egg **weighs**. What **materials** did you use to make a stretchy bungee cord?

**Design a bungee jump so that the egg stops within 2 inches of the floor when dropped from 5 feet!**

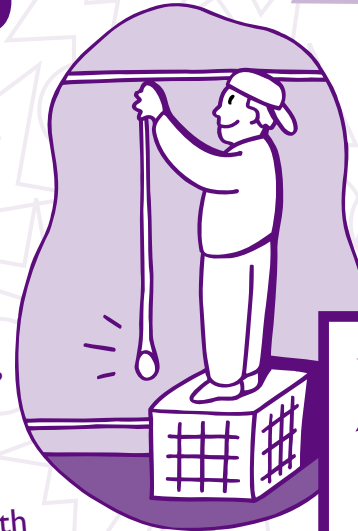
**1 Gather** the nylon stockings, rubber bands, balloons, and yarn. **Pull** each to test how **elastic**, or stretchy, they are. Then use these materials to make a **bungee cord**.

**2 Make a test egg:** fill a plastic bag with pennies until it weighs **about the same** as a **real egg**.

**3 Test** your bungee design with the test egg. **Measure** how close the test egg comes to the ground.

**4 Evaluate** your design. What **changes** can you make to improve your bungee design?

**5 When you're ready, try** your bungee design with a **real egg**. What happens?



Did the egg stop within **2 inches** of the floor? If not, what could you change so that it does? What happens if you change the **length** of the bungee cord? What happens if you change how you **arrange** the materials? Or, what happens if you add more **weight** to the egg? Choose one thing to change (that's the **variable**) and make a **prediction**. Then **test** it and **send** your results to ZOOM.

Sent in by Rachel K. of Champaign, IL

## "Fitness for Life"



### **Design Brief:**

Your team's task is to design a fitness system that helps people of all ages and physical abilities achieve and maintain good health. Specifically, your system should exercise arms, legs and torso while the users is sitting in a chair, standing and lying down; should accommodate different age groups; a range of fitness levels; is adaptable for paraplegics who use a wheelchair; can be used in a variety of settings and can be set up, disassembled and transported easily.



## "Get It! Easy"

13th Annual NEDC Problem Statement:

### Design Brief:

From time to time, we all need something that is just out of reach. While playing outside, your ball rolls under the front porch. Inside, the cash you made at your part-time job falls behind the couch, or your ring falls down the sink drain. You drop your car keys and accidentally kick them under the car during a rainstorm. Your grandmother is unable reach the medication she needs. Your little brother is unable not retrieve the ingredients he needs to make a healthy snack. At your job, a disabled manager cannot retrieve items from the bottom file drawer. Each of these items can be retrieved using different methods. However, is there a single device (possibly with attachments) that will help a wide range of people retrieve objects of different sizes and shapes from various places? That is your challenge — design and demonstrate a device that can accomplish as many of the following retrieving tasks as possible for people with a wide range of abilities.

### TASK ONE

As a corporate design team, your first task is to design and build a prototype device that will enable frail adults, people with disabilities, and even children to accomplish the following operations:

1. Retrieve a non-magnetic ring from a vertical PVC drainpipe that is 4' long by 3" around (ID);
2. Retrieve a flat, unfolded dollar bill from behind a couch;
3. Retrieve a 300 tablet Bayer<sup>®</sup> Aspirin bottle from the bottom shelf of a closed, overhead kitchen cabinet 73" off the ground; place it on a 36" high table, and then replace it;
4. Retrieve an 18oz. Box of Quaker Oats<sup>®</sup> from the bottom shelf (6" off the ground) of a closed kitchen cabinet; place it on a 36" high table; and then replace it; and
5. Open the bottom drawer of a file cabinet, retrieve one standard, non-hanging file folder from the middle position among at least 10 file folders. Remove it from the drawer, place it on top of a table, and then return it to the same position in the drawer and close the drawer.
6. Your device must be able to be used for each of the above tasks by:

**An elderly, moderate height (5' 4" maximum) frail adult.** This person has a weak grip and cannot pick up anything heavier than 5 lbs. He or she cannot bend at the waist or kneel, but does have use of both hands and arms. Tasks demonstrated for this type of person must be done from a standing position.

**A person who is in a wheelchair.** This person cannot bend at the waist and has the use of only one hand and one arm. He or she can lift 10 lbs. The device must, at least be: safe for the users specified; able to perform the specified tasks by the specified people; and, portable by the user.

## TASK TWO

Even a product that accomplishes all of the specified tasks will fail to benefit your company if it does not have a market or sufficient investment dollars behind it. Your team's second major task is to make the judges understand and appreciate your design and to convince them to invest in your design and product so you can begin full-scale production. For this program, assume that you are addressing a team of engineers, marketers, accountants, production supervisors and salespeople. Your presentation must address the engineering aspects of your design and it must convince the judges that your product is a viable one in which they should invest. Their investment is your score!

## BONUS

In order to "sell" your product to investors, you may have to show them its flexibility, expandability, and usefulness for other audiences and markets. To do this, your team may want to add tasks that go beyond item retrieval and replacement; demonstrate retrieval and replacement of additional items of your choice; add special or unique features to the product and demonstrate how these special features enhance its usefulness. Essentially, to receive bonus points, you must demonstrate these additional features or operations expand your product's value and utility. However, your device must accomplish at least half of the required tasks (i.e., receive 100 points from each Scoring Judge) before any bonus points will count. Scoring Judges will not notify you if you may attempt bonus points. That is solely your teams' decision and should be based on how the presentation and demonstration proceeds.



## Hole in One Design Brief

### Assignment:

Design and build a mechanism that will lift a golf ball vertically a minimum of 6 inches, then drop it into a paper cup located at the same height that it started.

### Requirements:

The cup will be placed 2 feet from the beginning location of the golf ball. The golf ball must start at the same level as the bottom of the cup. The cup must not tip over.

1. Any combination of simple machines may be used. Your team will receive points for each simple machine used to complete the operation.
2. A portfolio is required to be submitted with your finished solution. Each simple machine used must be identified on the sketches.
3. The apparatus must not use more than 15" x 24" of space. The entire apparatus must be attached to the surface provided, and placed on a table top to operate.
4. The mechanism must operate without human intervention, except to start the operation. The golf ball must be lifted and dropped without human assistance.
5. The device must complete its operation within 30 seconds and be able to be reset and run again within 1 minute.

### Materials:

You may use any materials that you can find in the lab or bring from home.



## Ultimate Gumball Machine

**Design Brief:** Create a machine that will sort gum balls!

### Tools and Materials:

15 Plastic bottles  
2 Dowel rods (4' long)  
100 Straws  
20 Film canisters  
20 Rubber bands  
10 Yogurt cups  
20 Plastic cups (assorted sizes)  
5 Plastic bags  
1 Roll of masking tape (may limit to 500 cm)  
5 Sticks of hot glue and gun  
100 Wooden craft sticks  
30 Pipe cleaners  
500 cm String  
10 Toilet paper (or paper towel) rolls  
20 Sheets of paper  
20 Index cards (assorted sizes)

### Also needed for competition:

100 Gumballs\* in three different sizes - small, medium, and large  
\* May substitute other small candy for the gumballs  
Stop watch

### Procedure:

1. Students may use all or part of the materials in the junk box. I allow the students to use any material inside the box. For example, if any of the materials come in wrappers or boxes, teams may use those for the device. The materials may be modified with the understanding that if a mistake is made they will not receive new materials. Leftover materials may be used to make repairs if the device breaks during competition. No major design changes are allowed!

### Competition Rules:

1. Each team will be provided with a junk box filled with materials that could be used to create a bubble gum sorting machine. Each team will receive only one set of materials. Teams may use all or part of the materials in their junk box and are not allowed to share materials with other teams. All unused materials should

be saved in case repairs are needed during competition.

2. Teams will be allowed time to build and test the machine. Competitors are allowed to bring diagrams to help during the building time. After the time is up, the device will be impounded and no changes will be allowed.
3. Requirements:
  - a. The machine must be able to sit unaided on the testing platform or table.
  - b. Your machine must have three individual containers to hold the sorted gumballs.
  - c. All gumballs must enter at the same location.
4. The winner is determined by the number of seconds it took to sort the gumballs, minus the number of incorrectly sorted balls.

## Hackie Sack Catapult

### Design Brief:

Design and build a medieval catapult that will hurl a hackie sack at a target.



### Background:

One of the most feared weapons of the middle ages was the catapult. This versatile weapon used several simple machines. Using a variety of materials build a catapult that will hurl a hackie sack accurately at a fixed target.

### Tools and Materials:

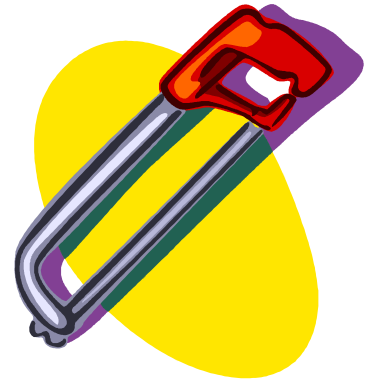
1. Cardboard
2. Paper plates, jar lids
3. Paint stirrers
4. Mouse trap
5. Rubber bands Ruler
6. glue (white, hot, instant)
7. Dowels, Toothpicks
8. Straws
9. String, dental floss
10. Scrape wood
11. Thumb tacks, paper clips
12. Coat hangers, wire

### Specifications:

1. Body can be no larger than 8" x 11".
2. Catapult arm must be locked in cocked position to launch.
3. Must be rolled into position for launching.
4. Hackie sack must travel at least 10'.
5. Hackie sacks hitting target within 3 attempts receive full credit.

# Hacksaw Handle Design Brief

Gary Bowers, Marion Co. Technical Center, West Virginia



## Assignment:

Hacksaw blades are very expensive and often break before they are worn out. Design and make a simple saw that will make use of pieces of broken hacksaw blades.

## Requirements:

1. Your design must hold the pieces of the blade safely and securely.
2. Your design must be able to be used in confined spaces where a full-size saw would be too big.
3. Your design must have a handle that is comfortable and easy to hold.

## Materials:

Your design can be made in wood, metal, plastic, cardboard or any combination of these materials.

## Tools:

Any tools that the teacher provides.

## Documentation:

1. Provide a sketch of the design of the hacksaw handle.
2. Include a response to the following questions in your documentation:
  - < In what sizes are broken blades usually found?
  - < What size is a standard hacksaw blade? (Measure the thickness and the depth.)
  - < How will the blade fit into the handle so that it can be easily removed?
  - < How will you find a suitable shape for the handle?
  - < How long should the handle be if it is to be used in a confined space?
  - < Are saws like this available in the shops? If so, could they be improved?



## "Home is Where I Want to Be"

Adapted from NEDC Problem Statement

### Design Brief:

According to MSNBC News, the 2004 Tsunami in Asia killed over 150,000 people, and more are sure to die due to disease and malnourishment.

Emergencies like this precipitate the urgent need for inexpensive, temporary shelters. You are to design a shelter that a minimum of four people could live in for an extended time period. This area is near the equator, and temperatures rarely get below 70 degrees, but often get up above 100 degrees.

These shelters should be:

- portable
- inexpensive
- set up and disassembled easily
- expandable to accommodate up to 8 people
- designed using universal design criteria

## **Lifeboat Rescue**

Tech Directions Magazine



### **Design Brief:**

You are on a boat with a leak that cannot be fixed. You must design a lifeboat that will rescue you and your partner, as well as 22 other passengers. To win the competition, design and build a lifeboat that rescues the most passengers.

### **Materials:**

The **only** materials you may use are:

- A 1 2" x 12' piece of aluminum foil
- 24 golf balls, representing the passengers

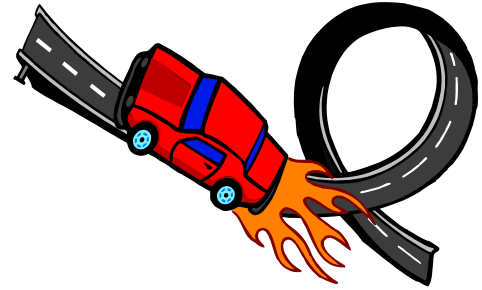
### **Points will be awarded as follows:**

First Place —20 points

Second Place — 10 points

Third Place — 5 points

# Low Bridge Racer



## Design Brief:

Your problem is to build a vehicle that will travel 10 feet. Along the way it must do the following:

- Travel within a 24" wide course
- Pass under a barrier 12" high
- Break 2 balloons along the way
- Be no longer than 24" and no wider than 10"
- Use any safe power source as long as it stays on the vehicle for the entire trip. (No flammable power sources allowed, check with your instructor if you have any questions)
- Go as fast as possible

## Specifications:

1. There will be 2 balloons along the course, 2 feet from each end, on the center line. The barrier (12" high) will be centered in the length of the course and cover the width of the course.
2. The entire self propelled vehicle must start on the floor behind the start line. The vehicle will be started at the signal. The time starts when the start signal is given.
3. The time ends when the forward most part of the car crosses the finish line.
4. For each balloon that is broken 2 seconds will be deducted from your time. The fastest time will be the winner.

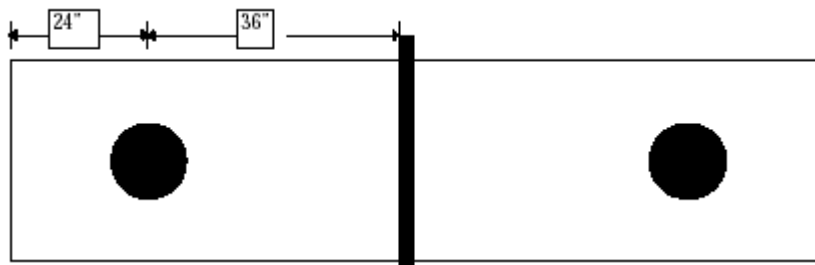
**Example:** 6.2 seconds to run from start to finish and one balloon is broken:

$$6.2 - 2 = 4.2 \text{ Final Time}$$

**Example:** 3.0 seconds to run from start to finish and two balloons are broken:

$$3.0 - 4 = -1 \text{ Final Time}$$

Barrier is 12" above the course. The barrier will be a yardstick held on a stack of books.





## "Making It, Easier"

12th Annual NECD Problem Statement

### Design Brief:

It is easy to go through life and take for granted our ability to go through our day-to-day activities: to open the door, walk to work, answer the phone, send an email, eat a meal. Whether it be for a short time, due to a broken bone, sprain, or other injury, or permanently due to stroke, amputation, disease or genetic conditions, or other causes of disability, many people have additional challenges to performing even the most simple of tasks.

With this in mind, your task is to design and fabricate a product that will help make life easier for people with disabilities. Assume that another individual can supply no assistance. To become financially successful and stay on the market, the product must appeal to the widest possible market. Therefore, you should consider a product that would benefit other segments of the population.

Products should fall under one or more of the following categories:

- computer/user interface
- food preparation and eating
- personal hygiene
- transportation
- clothing

The product should be:

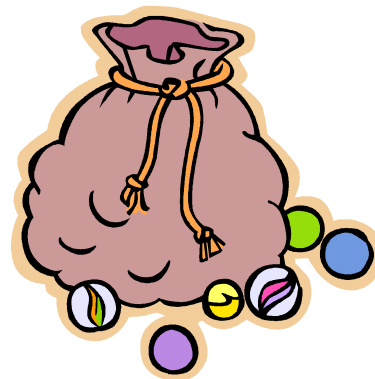
- usable without any outside assistance
- inexpensive
- safe
- durable

In addition to the above items, evaluation will consider:

- the significance to the user of the problem that the product solves
- the uniqueness of the solution with respect to existing solutions to the same problem
- the extent of the potential market for the product within the disabled community and what other groups could use this product
- thoroughness of the design (calculations included, where applicable)
- the effectiveness of the solution design
- the effectiveness of the presentation, which addresses all of the above criteria.

Logistically, solutions may be mechanical, electro-mechanical or electronic and must be able to sit on a standard 30" x 60" table. Solutions cannot be alive or be powered by any living thing other than the user.

## Marble Racer



### The Design Brief:

Students will design and construct a device that allows a marble to remain in motion for exactly one minute. The marble will be dropped from four (4') feet and take at least four changes in direction.

### Materials:

Students may use any materials that can be found in the lab or at home. If there is a question of safety, ask the teacher before using the materials.

### Specifications:

1. You may work in pairs as you complete the steps below. The number of points in parentheses shows the total number of points you can receive for each part of the project.
2. Design and construct a racetrack. (140 points) The racetrack should:
  - a. keep the marble in motion for as close to one minutes as possible
  - b. use three different simple machines
  - c. force the marble to change direction at least four times
  - d. not require hands, batteries, or electricity to move the marble.
3. Write a project summary. (140 points) It must be typed and list the project title and the names of the project members. Your summary must also include a paragraph on each of these items:
  - a. how group got started; where idea originated
  - b. how device works; what keeps it in motion
  - c. how it was built
  - d. problems encountered; solutions implemented
  - e. reflection -what happened on the day of the challenge
4. Draw a diagram of the racetrack. (140 points) Make a full color drawing of the racetrack using colored pencils or markers on 8 1/2" x 11" paper.
  - a. Use labels to indicate the type of materials used.
  - b. Include arrows and footnotes to show the path of the marble, and use numbers to mark where the marble changes direction.
  - c. Include names of project members and title of your project.

5. Use household or found materials to construct your racetrack. You should not have to buy any materials.
6. Your teacher will provide the marble on the day of the challenge. On the day of the challenge, you will be allowed a maximum time of five minutes to set up your racetrack.

# Marble Racers Problem Solving

Level: \_\_\_\_\_

Team Numbers: \_\_\_\_\_

Criteria	Possible Points	Actual Points Recv'd
<b>Racetrack:</b>		
Amount of time in motion: 1 point per second; minus one point for each second over or under 60 seconds, even if marble is off the track.	60	
20 points for each different simple machine. (3)	60	
5 points for each change in direction. (4)	20	
<b>Paper:</b>		
20 points for each required paragraph. (3)	60	
Mechanics and neatness	40	
Content	40	
<b>Drawing:</b>		
Marble path properly marked	40	
Accuracy of diagram	60	
Neatness	40	
<b>Total Points:</b>	<b>420</b>	

## Light a Match Under Water

### Design Brief:

Your challenge is to come up with a way to light a match under water. There will be a container (aquarium filled with water for you to place your device and light the match.

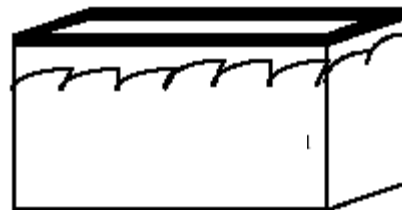


### Background:

You are working for an underwater research company. Your company has built a habitat on the ocean floor for a team of researchers to live in. As a safety measure, the company has decided that there needs to be a method of providing light from the outside of the habitat in case of a power failure. As the chief engineer, you have been given the task of designing a method of lighting a match inside the habitat, which would then light a candle.

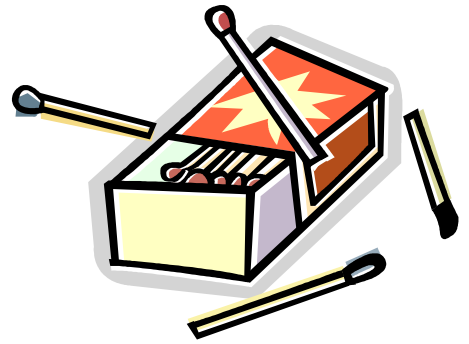
### Specifications:

1. There must be water surrounding the device that the match is in
2. The water does not have to touch the match
3. You may use your own matches
4. You may use any materials that you wish
5. You cannot touch the device after you have placed it in the water other than to stabilize the device
6. You must operate the device from outside the water
7. The match must burn for at least five seconds
8. The match must be lit while under water
9. Handout sheet must accompany device



# Light a Match Under Water

Student Activity Sheet



Student(s) Name

Sketch what your device will look like and label all parts.

How will you light your match?

What makes you think this idea will work?



## "Medicine At Your Command"

7th Annual NEDC Problem Statement:

### Design Brief:

Your grandmother is in her 90s and lives alone in the house in which she was born. She does not want to live with you or to move to a retirement community. She does not need nursing home care. She enjoys a full and generally active life when she is feeling well. Her daily medications improve her quality of life.

Unfortunately, her memory is fading and she often forgets what medications she must take and when she must take them. Further, your grandmother has difficulty seeing product labels and medical cautions, even those with very large print. She is hard of hearing. She has limited strength and can't easily grab small objects or open most medicine bottles. All of these are problems common to our elderly population.

You are able to visit your grandmother a few times each week. If a medicine dispenser that could overcome your grandmother's limitations existed, you could "load" it for her each time you visited or one of her younger friends could help out.

Your NEDC team is to develop and build a prototype of an original design that will enable your grandmother to take her medications on time, in the correct dosages and with the appropriate cautions. Prohibiting overdosing is also essential.



## "For Openers"

4th Annual NEDC Problem Statement

### Design Brief:

It was a bitter cold night in Hometown, USA "That was an outstanding basketball game?" claimed Jamie "But gosh," Chris rubbed his head, "did it ever give me a headache." "Here Chris," Jennifer rummaged in her pursue, "I just happen to have a new bottle of aspirin with me." Chris watched in dismay, though, as she struggled with the child-proof top. Alex strode over and took the bottle from her but his efforts were equally useless. Their friend, Susan, came over to the scene of this minor medical emergency. "I've got just the thing." And with her nail file, she popped the top. She has met this challenge before. Susan has rheumatoid arthritis.

A few minutes later, Alex was driving Susan home when suddenly the temperature light on the dashboard blinked on. "Uh-oh — engine's overheating," he sighted. "This car's not even w-warm yet," shivered Susan. "But the engine is," quipped Alex as he returned and hurried to the trunk for a plastic container of antifreeze. Alex tried repeatedly to open the safety cap, but his fingers were just too numb. Susan rubbed her arms to keep warm. "I think we have a problem my nail file isn't going to solve this time."

Alex and Susan have just crossed over into the famous Defiance Zone, a land where ordinary containers with contents you desperately need become locked monsters that defy opening. From time to time we have all been caught in the Defiance Zone, where innocent containers from plastic bags to glass bottles seem to challenge us with a will of their own.

Your team is to develop a solution that will enable a person to open and/or close containers commonly found in the home or office.



## Build a Better 'Possum Trap Design Brief

Ronnie Cheek, East Coweta HS, Georgia

### Assignment:

Design and construct a trap that will be triggered by rolling a basketball into the trap.

### Requirements:

1. The trap must automatically latch.
2. Use of the most materials in a functional manner will be a crediting factor.

### Materials:

You may use only the materials listed, but you do not have to use all of them.

2	Pieces cardboard 24" x 36"	8	Wood strips ½" x 1" x 3 feet
15	Square feet chicken wire	20	Feet bailing twine
10	rubberbands	10	Feet duct tape
1	Foot rubber hose	12	Straight pins
2	8" balloons	2	Clothes pins
6	Paper clips	2	Marbles
25	6d nails		Glue

### Tools:

Hammer  
Hand Saw  
X-Acto Knife  
Wire Snips

### Documentation:

1. Provide all necessary sketches for the manufacture of the trap, including, but not limited to: front, top and right side orthographic views and isometric views.
2. You must be able to describe the functionality of any material used.

# Ornament Display Package

Pam Brown - Central Middle School  
Georgia Industrial Technology Education Association



## Design Brief:

To design a package that will display a glass Christmas ornament. The package must be able to keep the ornament from breaking if it were to be knocked off of the shelf on which it is displayed. The shelf is located 6 feet above a concrete floor.

## Tools and Materials: (Per Person or Team of 2)

1. 10-low temperature glue sticks
2. 2 - sheets of 8 1/2" x 11" card stock
3. 2 - sheets of white copy paper
4. 1 - sheet of overhead transparency film
5. 1 -2 1/2" glass ornament
6. Scissors
7. X-acto knife
8. Ruler
9. Glue gun
10. Pencil
11. Cardboard Cutting Matt (only to be used for cutting on)

## Limitations:

1. The package must be constructed from only the materials listed.
2. Tools cannot become apart of the solution.
3. Be sure to carefully inspect your ornament for cracks or breaks.

## Requirements:

1. The package must allow the ornament to be viewed from at least 3 sides/faces. Each viewing window must be at least 2" tall and wide.
2. The package must be no larger than 4" in length, width, or height.
3. The package must be able to be opened and closed.

## Procedure:

1. Sketch the design/plan for your device.
2. Attain needed materials from your instructor.
3. Construct your device.
4. Test your package using either of the following tests:  
**Test 1:** Packages will be knocked from shelf placed at a height of 6 feet. Those that survive will then proceed to the next test.  
**Test 2:** All ornament packages will be placed in a large box and shipped through the mail or courier system to another school or back to your own school.

# Ping Pong Basketball

Dave Janoaz, Fair Lawn High School, New Jersey



## Design Brief:

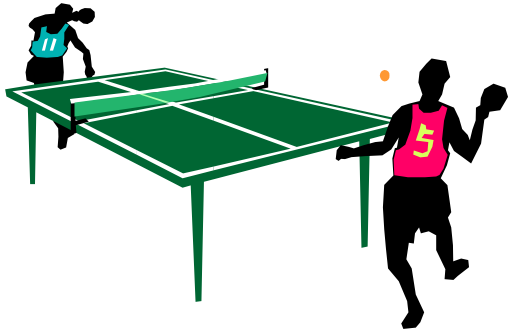
Many times when an engineer designs a product they are concerned with factors such as speed, accuracy, and durability. Design and make a device that will launch a ping pong ball into a target from a distance of ten feet away.

## Tools and Materials:

Scissors  
X-acto Knives  
Glue  
Miter saws  
Dowel rods  
Drinking straws  
Craft sticks  
String, paper clips, rubber bands

## Procedure|:

1. The device must be triggered by the touch of a finger.
2. The device must be able to be “reset” within thirty seconds after the last launch and must be durable.
3. You must complete a detailed drawing (include dimensions and materials) before you receive materials to construct your device.
4. The device that scores the most points wins. One point for each “basket.” Each group will get five shots. Ties broken in sudden death style.



## Ping Pong in Motion

### Design Brief:

Design a means to set in motion a ping pong ball that will travel a minimum of 12 inches in one direction using only the materials supplied. You may not physically move the ping pong ball or permanently affix anything to it. The winner will be the team that makes the ping pong ball travel the farthest.

### Tools and Materials: (per team)

#### Consumables:

- 4 plastic Q-tips
- 4 Coffee stir/craft sticks
- 1 ping pong ball
- 2 3 x 5 index cards
- 6 round toothpicks
- 12" kite string
- 2 paper clips (medium size)
- 2 tongue depressors
- 1 Spoon (plastic)
- 1 self-adhesive file folder label

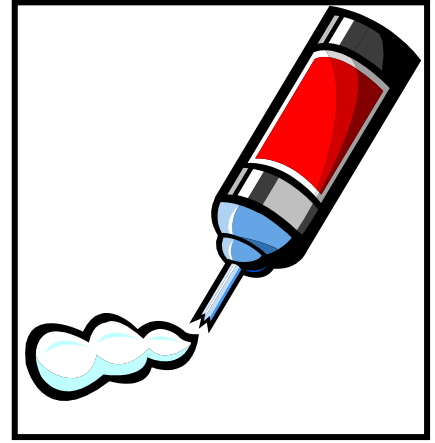
#### Non-consumables:

- 1 scissors
- 1 ruler
- 1 tape measure

# Product Photography

## Design Brief:

In this activity you will take pictures of a product for use in advertising. The picture will be a close-up and have eye-catching appeal. You will not include people in your photos.



## Tools and Materials:

1. product to be photographed
2. 35mm or digital camera
3. tripod
4. 400 ISO film or digital media
5. lights
6. background props

## Procedure:

1. Select a product you would like to photograph. It may be a box of crackers, a tube of toothpaste, a wristwatch, etc.
2. Think about why people buy the product. What is its appeal? Will that appeal affect your photos? For example, a tube of lipstick appeals to people's ideal of what is glamorous. A good product shot of a tube of lipstick might place the tube on a background of lace and satin.
3. Take at least ten different shots changing background, angles, lighting, focus, etc.
4. Make one print each of your photographs (or view them on-line).
5. Choose the best shot and make one 4" x 6" enlargement. Using notebook paper, write a brief paragraph telling why you chose that shot.

# "Projector Problem"

6th Annual NEDC Problem Statement



## Design Brief:

At the age of 70, May represents a growing segment of elderly people who are staying in the work force longer and longer. She is a productive worker, but she sometimes experiences severe arthritis pain in her back, shoulders and arms. This pain limits her activities and makes it difficult for her to bend or twist at the waist or to move her arms. In order to keep the pain at a minimum, May tries to keep her arms immobile, resting them on the armrests of her chair.

Because of her work experience she is often asked to give new employees a presentation about the company. To do this she must select overhead transparencies from a file drawer and use them as part of her presentation. While May's co-workers are happy to help her set up the overhead projector and take her files to the presentation room, once the presentation starts she is on her own.

Paul is a high school senior who is looking forward to a career that will involve public speaking. Paul has quadriplegia, caused by a diving accident (he broke his neck) and is a wheelchair user. Paul's arms lay motionless on the armrests of his wheelchair and he is unable to move the rest of his body--except for his head and neck. He too must be able to use an overhead projector.

Each team will develop a solution that will enable the operator to turn an overhead projector on and off, retrieve a file folder of transparencies from a file drawer, select and remove transparencies from the folder, display them on the overhead projector, return them to the file and return the file to the file drawer.



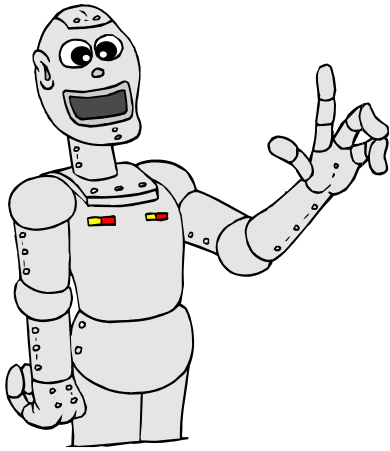
## "Just out of Reach"

3rd Annual NEDC Problem Statement

### Design Brief:

It happens all the time. It's the height of the sandlot game and the ball rolls under somebody's porch, just out of reach. The varsity player, home alone in bed with a broken leg, has dropped the TV remote control, just out of reach. A shopper puts parking meter change in her purse while in a questionable neighborhood and — clink — her car keys drop through the storm water grate. Fifty dollars of grocery money has fluttered off the counter and fallen behind the refrigerator. The five-year-old tries to reach his own cereal on the top shelf by climbing on a stack of boxes while the household sleeps. An eighty year-old, suddenly short of breath, finds her nitro-glycerin tablets are one shelf too high ... just out of reach!

Your team is to develop a solution that will enable a person to handle — place, retrieve, and manipulate — common household or office items that are beyond his/her ordinary reach.



## Reach for It Design Brief

Gary Bower, Marion Co. Technical Center, West Virginia

### Assignment:

Design and construct a device that can retrieve a marble placed in the center of a circle 36 inches in diameter. The marble must be raised at least one inch above its original elevation to a controlled resting state outside of the circle.

### Requirements:

1. No part of the body may go inside the circle at any time.
2. Only materials provided may be used for the solution.
3. Each group must use at least one (1) simple machine to retrieve the marble.
4. The marble must be moved from the center of a 36-inch diameter circle to a fixed location outside of the circle without direct contact from any student.
5. The marble must be resting in a controlled state at least one inch above the starting elevation.
6. Each group is required to keep accurate individual daily logs and a design log. The following questions must be answered in complete sentences by the group and turned in at the end of this activity:
  - < How did you group approach the problem?
  - < What other simple machines could have been used?
  - < What other materials could have been used?
  - < How can you increase the effectiveness of simple machines?
  - < How can you increase the control of the object's movement?

### Materials:

You may use only the materials listed, but you do not have to use all of them.

- 10 Craft sticks
- 1 Square x 5 index card
- 2 paper clips
- 1 drinking straw
- 18" tri-strand string
- 1 glue stick



## "Safe Shopping"

9th Annual NEDC Problem Statement

### Design Brief:

Redesign the standard shopping cart so that it reduces or eliminates the possibility that a two-year-old child will fall out of it or climb out of it and that it resists tipping when a child leans over the edge or and elderly person leans on it improperly. Your new-style cart should be used for shopping by parents, siblings, childcare providers, the elderly and people with disabilities. The cart must be designed to be used in existing store aisles and so that no modifications would be needed to aisle width or store checkout lanes.



## "Signs of the Times"

1st Annual NEDC Problem Statement

### Design Brief:

In a maximum area of 30' x 30' demonstrate a replacement for a human highway construction flagger. It must have the capacity to warn drivers to: stop, go, slow down, speed up, maintain speed, resume normal speed, drive at a specific speed, and maintain a certain path.

# Slow Coaster

Ron Barker - Georgia Department of Education

## Design Brief:

Students will design and construct a device that will control the fall of a marble, allowing the marble to roll as slowly as possible.



## Tools and Materials: (Team of 2 or 3 students)

1 - 18" x 24" cardboard or poster board base

24 strands of dry spaghetti

24- 3" x 5" index cards

1-marble

6 sheets of 8 1/2" x 11" copy paper

36 inches masking tape

Scissors

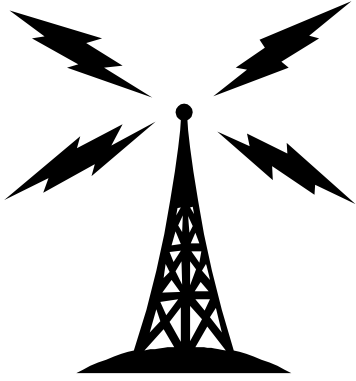
Ruler

## Limitations:

1. You may use only the materials provided.
2. The marble must start in one corner of the base and, change directions at least 3 times.
3. The marble must come to a resting point at any corner other than the one it started from.
4. There must be a triggering mechanism that can be released to start the marble. The triggering mechanism must be able to be reset for multiple tests.

## Procedure:

1. Sketch the design/plan for your device.
2. Attain needed materials from your instructor.
3. Construct your device.
4. A stopwatch will be needed to time the fall of each marble.
5. Once the marble has begun its journey, no one may touch the marble.
6. Students will be allowed to place the marble at the starting position and release the starting mechanism.
7. Each device will have three attempts and each time will be recorded.
8. Time will begin when the marble is released from point A and end when the marble reaches point B.
9. Appearance and construction will be considered in grading.



# Straw Tower

Georgia Industrial Technology Education Association

## Design Brief:

Students will build a straw tower as tall as possible that can support the weight of a tennis ball.

## Tools and Materials: (Per Group)

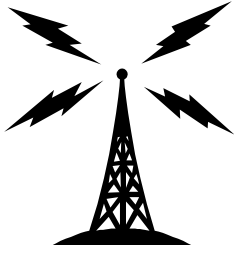
- 100 - Plastic Straws
- Straight Pins (many)
- 1-Tennis Ball

## Limitations:

1. The students will use only the materials provided.
2. The students may not cut the straws.
3. The tower must support the tennis ball for 30 seconds.

## Procedure:

1. Groups of 3 students work best.
2. The students will draw a design for their tower.
3. The students will then obtain 100 straws and a container of pins from the instructor.
4. The students will build their structure.
5. The instructor will test the towers at the end of the allotted time frame (usually 3 to 5 days).



## Straw Tower

Georgia Industrial Technology Education Association

### Design Brief:

Students will build a straw tower as tall as possible that can support the weight of a tennis ball.

### Tools and Materials: (Per Group)

100 - Plastic Straws

Straight Pins (many)

1-Tennis Ball

### Limitations:

1. The students will use only the materials provided.
2. The students may not cut the straws.
3. The tower must support the tennis ball for 30 seconds.

### Procedure:

1. Groups of 3 students work best.
2. The students will draw a design for their tower.
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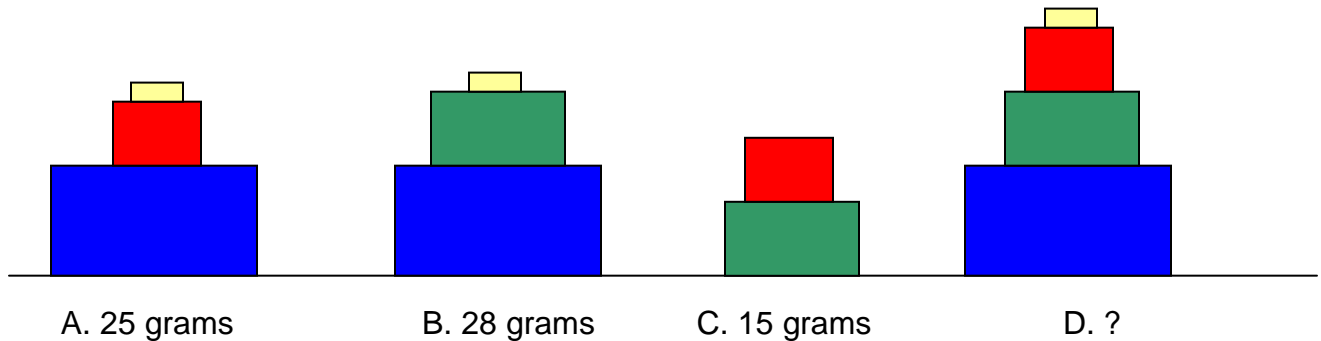
# Weighty Puzzle

Rich Latta, Plainfield, IL.



## Assignment:

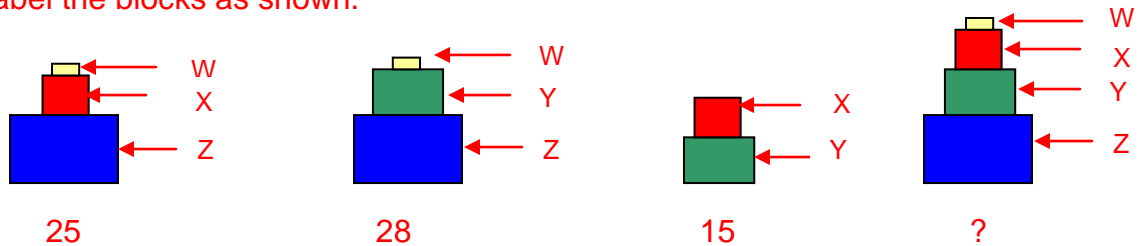
A total weight is given for three of the four sets of blocks shown below. Using the information from the given weights for A, B, and C, can you figure out the total weight for D?



## Solution:

Figure D weighs 34 grams. Here is one way to determine the answer:

1. Label the blocks as shown.



2. Figures A and B are the same except the middle blocks. The difference between the weight of A and B is 3 grams, so the difference between x and y is 3.

$$28 - 25 = 3 \quad \text{so,} \quad y - x = 3 \quad \text{or} \quad y = x + 3$$

3. From Figure 3, we know that  $x + y = 15$ . If you substitute  $(x + 3)$  for y you get

$$\begin{aligned}x + (x + 3) &= 15 \\2x + 3 &= 15 \\2x &= 12 \\x &= 6\end{aligned}$$

4. If  $x = 6$ , then from Figure B we can substitute 6 for  $x$  and get

$$x + y = 15$$

$$6 + y = 15$$

$$y = 9$$

5. Since Figure A has all the blocks except  $y$ , if you add the weight of  $y$  to Figure A you will get the weight of Figure D.

$$25 + 9 = 34$$