



## Engineering Hats Design Challenge

In this design challenge, students are asked to create a hat that meets student determined criteria and constraints. Ideas about material properties (physical science) and engineering are used. This design challenge highlights the idea that the same general object (a hat) can be designed to solve a variety of problems and that often the best designs can solve more than one problem.

### STEP 1: Provide students with a broadly stated design challenge.

Make a functional hat with only the materials provided. Does anyone have any questions?

### STEP 2: Guide students as they think deeply about the design challenge.

At this point someone will probably say “what kind of a hat?” or what do you mean by “functional”? You can say, “Remember, engineers solve problems, so what kinds of problems can be solved by hats?”

Give students a moment to think on their own and then take ideas from the class. Some ideas students might give are in the table below.

#### TIPS:

- If, instead of stating problems, students state general criteria such as “it shouldn’t fly off your head in the wind” ask if that is only true of one kind of hat or if ALL hats should stay on in the wind. If it is something that ALL hats should do, that is not a problem, that is a criteria for success. List the student’s ideas as a criteria and then go back to problems.
- If students provide solutions (“Keep your head dry”), ask them to restate it as a problem (“head gets wet in rain”). You can say things like “How is having a dry head a problem?” or “Remember, engineers solve problems. What is the problem?”
- If students are having trouble identifying problems, you could show pictures of many kinds of existing hats and ask students what problems each hat solves.

Stated as a problem	Stated as a solution to the problem
Sun in eyes	Keep sun out of eyes
Sunburn (on face, ears, neck)	Prevent sunburn
Rain (wet head, water in eyes, etc)	Keep head dry, keep water out of eyes
Cold head, ears, and/or neck	Keep head, ears, and/or neck warm
Head injury	Protect head from impact injuries or other injuries
Need a place to store things (golf tees, fishing lures, a drink, etc)	A place to store things on your head
Being recognized when you don’t want to be	A disguise
Being unfashionable or underdressed	Fashion, decoration, or to meet dress code



Not being recognized as a friend/member of group/member of profession	Identify someone as a member of a group (sports team fan, police officer, military unit, etc) or as part of a uniform
Religious or cultural rules or restrictions	Allows the wearer to participate in religious/cultural practice
Hair (falling in front of eyes, getting in food or in way of work, etc)	Keep hair contained
"Bad hair day"	Cover up bad hair day

### STEP 3: Guide students as they consider the criteria for success

It will be up to you to decide which problem or problems your hat solves, but there are some things that all hats should do. These are called "criteria". What ideas do you have about criteria? How will we know if the criteria are met?

Some ideas of what students might say include:

Criteria	Ideas on how to evaluate or measure it?
Stay on head in a variety of conditions	Wind - test for ## seconds ## feet in front of a fan Stay on while person walks ## feet in ## seconds Stay on while the person nods, shakes head, runs, hops, etc?
Solve at least one problem	Depends on the problem chosen--if you say it keeps head dry, will it work if we pour water on it? Do students get "bonus" if they solve more than one?
Is durable	Can put on/take off ## times in ## seconds without damage No damage from other testing
Is comfortable to wear	Weight of hat below ## grams Reported comfort of wearers
Fits	Does it have to fit one person or a variety of people? Do they get a bonus if it fits a range of sizes?

### STEP 4: Guide students as they consider the limitations or constraints.

Constraints are limits on our work. I have already told you that the hats must be made of only the materials here. Are there any other limits or constraints that you would like to know about?

- Time - how much time do they have before they have to evaluate/present their hats?
- Is there a limit on the quantity of materials? Or just the type?
- Safety constraints?

#### Tips

- If, during their work, students discover new problems, you can accept their ideas for new problems. However, try to avoid setting new criteria or constraints after the students begin work.