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| <p>Description During this engineering-based lesson, learners design and build a device that can survive a drop in order to deliver emergency supplies.</p> | |
| <p>Grade Levels K-12</p> | <p>Objectives Students will:</p> <ul style="list-style-type: none"> • Learn that they can take a design parameter and explore it through rapid prototyping. • Practice analyzing a problem with a team. • Practice comparing and optimizing solutions. |
| <p>Duration 50 minutes</p> | <p>Standards Connections K-2-ETS1-3. Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs. 3-5-ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem. MS-ETS1-4. Develop a model to generate data for iterative testing and modification of a proposed object, tool or process such that an optimal design can be achieved.</p> |
| <p>Tech Tips Innovation Design Process Brainstorming Sharing Solutions</p> | <p>Grade Level Modifications The activity can be scaled. Those who are older or more experienced with building will engineer more sophisticated designs in less time, resulting in more iterations and complex designs. Younger students may need help with parts of their build that require fine motor skills (such as tying knots or using a hole punch).</p> |

Device Materials
The materials listed are merely suggestions, categorized by function to get you started. You should use materials you have on hand or can easily obtain; you do not need ALL the materials listed. The quantity will depend on the number of learners you have participating. Quantities below assume a group of approximately 30 in teams of 3-4.

| All-purpose materials - 70 total | Connectors* |
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| <ul style="list-style-type: none"> • Tongue depressors (wide craft sticks) • Straws • Cardboard tubes, various sizes • Dowels 3/16" diameter • Chopsticks • Pieces of cardboard/bass wood | <ul style="list-style-type: none"> • Brads - 20 • Twist ties - 30 • Rubber bands - 30 • Pipe cleaners/chenille stems - 30 • String - either one ball, or 30 pieces about 12cm long • Binder clips (multiple sizes) - 20 • Clothespins - 15 • Wine corks - 15 |

This lesson is part of:
The Tech Challenge, presented by Dell

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| Net or basket-like materials - 30 total | Cushioning materials |
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| <ul style="list-style-type: none"> • Strawberry baskets • Clean paper cups/fry baskets/condiment cups/paper bowls • Fabric scraps • Netting pieces | <ul style="list-style-type: none"> • Foam • Bubble wrap • Tissue paper |

| Other tools and materials |
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| <ul style="list-style-type: none"> • Crop-a-diles or hole punches — One for every four participants. (Crop-a-diles are excellent for punching holes in plastic and cardboard). • Scissors — One for every 2-4 participants • For each team: <ul style="list-style-type: none"> ◦ 2" diameter binder ring or 2" long small carabiner ◦ One light up bouncy ball |

*We leave tape and glue off the materials list on purpose. Though classified as “connectors,” they are not ideal for this challenge. Forgoing tape and glue will allow for rapid iteration on designs and more prototypes, a key part of the process. Also, it allows you to recycle and reuse materials for another session more easily.

| Test Rig Materials (Don't have time to build the test rig? Just have an adult hold and drop the devices from about a 6-foot height.) | |
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| All-purpose tools | Building materials * |
| <ul style="list-style-type: none"> • Drill with driver bit, 1/4" drill bit, 3/32" drill bit • Screwdriver • Safety glasses • Scissors • Sandpaper • Pencil | <ul style="list-style-type: none"> • Wood: <ul style="list-style-type: none"> ◦ One piece at 1" x 2" x 24" ◦ One piece at 2" x 4" x 8" • Gate latch <ul style="list-style-type: none"> ◦ Four 1 1/4-inch wood screws (generally included with gate latch) • Two 1.5" screws • Ten feet of string or twine |
| Rig materials | Completed test rig |
| <ul style="list-style-type: none"> • One 6-foot step ladder • Two C clamps (with an opening big enough to secure the 2x4 to the top of the ladder — approximately 4-6 inches) • One gate latch release system |  |



Prep and Set Up

1. Collect materials listed above.
2. Build a solution (or solutions) yourself, or with other educators or kids you know. This will give you practice with the materials and tools to be able to anticipate student questions.
3. Plan your lesson. Create a fun story about a situation in which your students might need to drop a protected payload somewhere. Make it relevant to your learners and setting. . Think of ways for learners to test and demonstrate devices that suit your timing and learning goals.
4. Build the test rig (instructions attached).
5. Set up classroom for the activity including the testing area (set up ladder and clamp the gate latch system to the top of the ladder).

Run the Design Challenge

- Introduce the purpose of the design challenge with a group discussion. (7 minutes)
 - *When/Where do we need to drop supplies or equipment from above? (Possible answers include: Mars/moon exploration, rescue missions.)*
 - *Can you think of a way to drop a box filled with emergency supplies from a roof or throw it out the airplane door and have it land without breaking?*
 - *Why is it important that your device doesn't break when it's dropped?*
- Frame the challenge. (3 minutes)
 - *Your challenge today is to build a device that will keep the emergency supplies (represented by a light up bouncy ball) from breaking when dropped from the test rig.*
 - Divide students into teams of 2 to 4.
 - Share criteria and constraints
 - Criteria
 - Device must remain intact.
 - Ball must NOT light up when your device hits the floor.
 - Constraints
 - Ball may not be modified in any manner.
 - Ring or clip must be exposed so that it can be clipped to the gate latch.
 - Ball must be visible to allow view of flashing light. You can't completely cover it up.
 - You have 20 minutes to build.
- Brainstorm. (5 minutes)
 - Allow students time to explore the materials and start to think up and discuss designs with their team.
 - See "Tech Tip" Brainstorming for suggestions on more formalized brainstorming. (Be aware, more formalized brainstorming could take more time.)
- Build/test/iterate. (20 minutes)
 - Time to build, test and iterate in teams!
 - Remind them to test, revise their design and retest!
 - Station yourself (or another person, if available) at the testing station to ensure teams test their device properly and to prompt them to think about the next steps in their design.
 - Have teams share what they observed about their device.
 - What do they observe when they test?
 - What part of their design is working and what parts need improvement?
 - What other materials could they try?



- Addressing device failure — Remind teams not to be discouraged if their devices do not perform as expected. This is a part of the process and should inform their next version/iteration.
- Share solutions. (15 minutes)
 - Having participants share their designs is important when modeling growth mindsets and reinforces the idea that process is more important than product. Sharing sessions also allow for learners to articulate their ideas and reflect on their process and rationale. Adjust the format and duration of sharing to match your timing and setting.
 - See Tech Tip “Sharing Solutions” for more suggestions.
 - Helpful questions to encourage youth to examine their process could be:
 - How is your device intended to work?
 - What would you do next to improve your design?

Remember, it is possible that not all participants will have a completed design at this time; some may be in the middle of an iteration and have a partial build. That is OK — have them discuss their device design and any previous tests, as well as what they would do next.

Extensions

After teams have made a successful design, offer additional challenges/constraints.

- Give them a more sensitive bouncy ball to drop as their payload.
- Challenge groups to use one type of material, like only rigid or only flexible materials in their next design.
- Challenge groups to make their device more reliable. (*Your device seems to work every third drop....can you make it work every time?*)