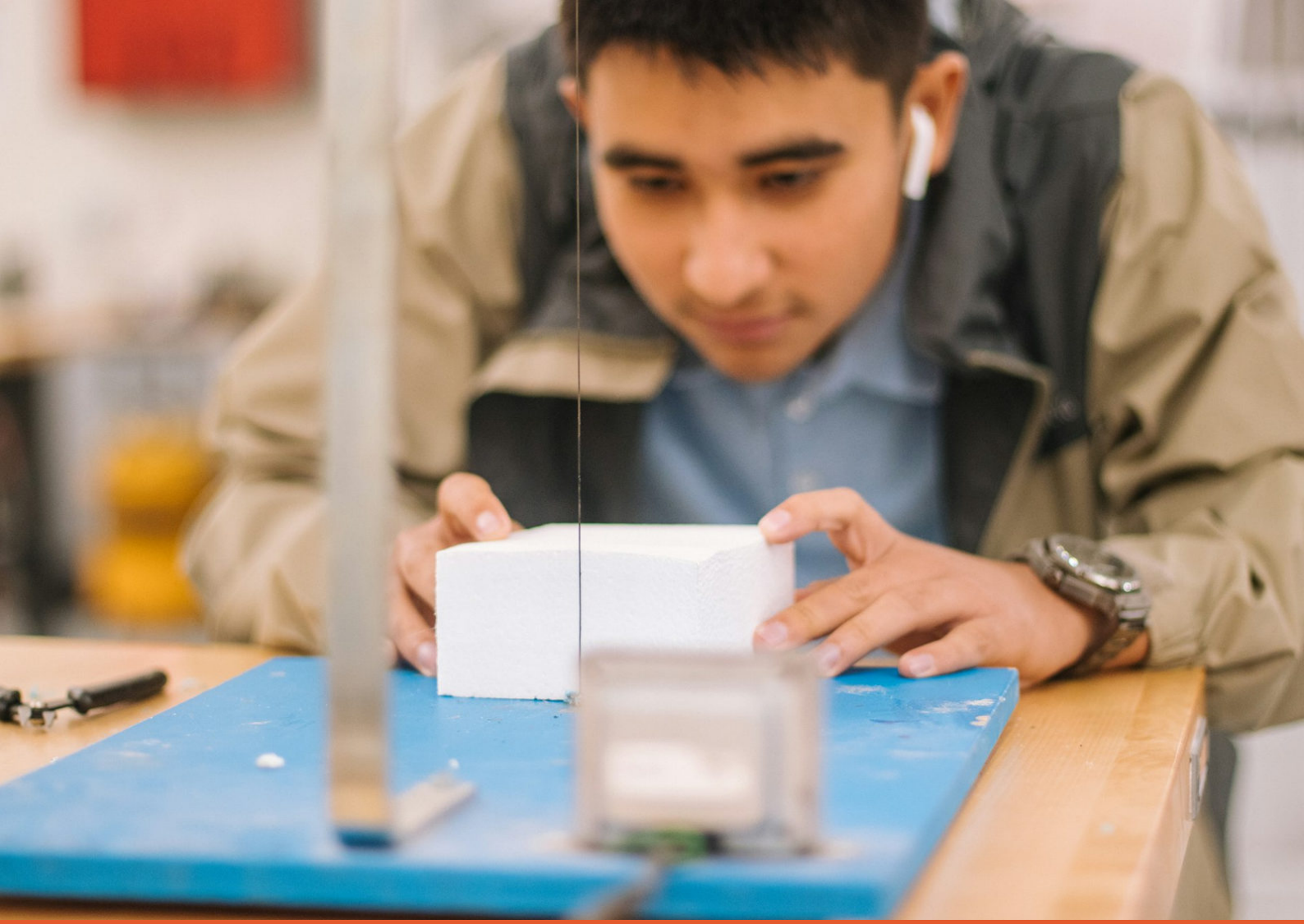


EduTrend Contents

W4C · SCIENCE & ENGINEERING · MIDDLE SCHOOL

Protect the Payload

Design a package that stops an egg from breaking

Ages 11–14	Level: Core	2 × 50 minutes	Teams of 3	Activity 03

Inside: activity at a glance · step-by-step session plan · facilitator notes · 3 student worksheets · assessment checklist

ACTIVITY 03 · AT A GLANCE

Protect the Payload

Teams design a package that protects a raw egg dropped from 2 metres, working to a points budget for materials. They test at 1 m and then 2 m, record what happened and redesign. The activity links forces and collisions to real design problems such as car crumple zones and delivery packaging.

Learning outcomes

By the end of the session students can:

- explain that increasing the time taken to stop reduces the force on the payload;
- describe how a parachute reduces landing speed by increasing air resistance;
- plan and carry out repeated drop tests, recording results clearly;
- justify a redesign using evidence from testing and the budget.

KEY WORDS

force · impact · collision · momentum · air resistance · crumple zone · constraint · budget · prototype

CURRICULUM LINKS

Physics: forces, motion and collisions. Design & technology: design to a brief with constraints. Newton's third law in collisions (NGSS MS-PS2-1); engineering design (NGSS MS-ETS1).

1	2	3	4	5	6
DEFINE	**RESEARCH**	**DESIGN**	**BUILD**	**TEST**	**REDESIGN**
Read the brief	How is impact reduced?	Sketch and cost	Make a prototype	Drop at 1 m, then 2 m	Use the evidence

Materials (per team, bought with points)

- 10 drinking straws: 1 point each
- 1 sheet of A4 card: 3 points
- 2 sheets of A4 paper: 1 point each
- 1 plastic bag for a parachute: 4 points
- 1 m of string: 2 points
- 5 elastic bands: 1 point each
- 50 cm of masking tape: free
- Budget: 20 points. Each team also receives 1 raw egg in a sealed zip bag.
- For the class: a tarpaulin or tray, a metre rule, paper towels, scissors

Before the session

- Check the class for egg allergies. If needed, use a small water balloon as the payload instead.
- Seal each egg in a zip bag before the lesson.
- Choose a safe drop point at 2 m that an adult can reach from a stable step, and put the tarpaulin underneath.
- Print price lists and one set of worksheets per student.

SAFETY

Only an adult drops from above head height, using a stable step, never a chair. Eggs stay sealed in bags. Wash hands after handling eggs.

ACTIVITY 03 · SESSION PLAN

Step by step

Session 1 covers the brief, research, design and building. Session 2 covers testing, redesign and reflection. Keep the prototypes safe between sessions.

Time	What happens	Say or ask
S1 0–10 min Hook	Drop two sealed egg bags from 30 cm: one onto a hard tray, one onto a thick folded towel. The first usually cracks and the second usually survives.	*"Both eggs fell the same distance. Why did one break?"*
S1 10–20 min Research	Teams list ways to protect a falling object: cushioning, crumple zones, parachutes, spreading the load. Show images of car crumple zones and delivery packaging.	*"What do all these designs have in common?"*
S1 20–50 min Design & build	Teams plan their package on Worksheet 1, spend no more than 20 points, sketch the design and start building.	*"Which part of your design makes the stopping time longer?"*
S2 0–20 min Test	An adult drops each package from 1 m, then from 2 m if the egg survives. Teams record the landing and the result on Worksheet 2.	*"Did it land the way you expected? What evidence do you have?"*
S2 20–40 min Redesign	Teams make one evidence-based change within any points they have left and test again from 2 m.	*"What does your first test tell you to change?"*
S2 40–50 min Reflect	Teams present their final design and results. Students complete Worksheet 3.	*"How would a packaging engineer reduce cost without losing protection?"*

CHALLENGE CARD (print or copy onto the board)

Design and build a package that protects a raw egg dropped from 2 m onto a hard floor. Your budget is 20 points. The winning design keeps the egg intact with the lowest cost and mass.

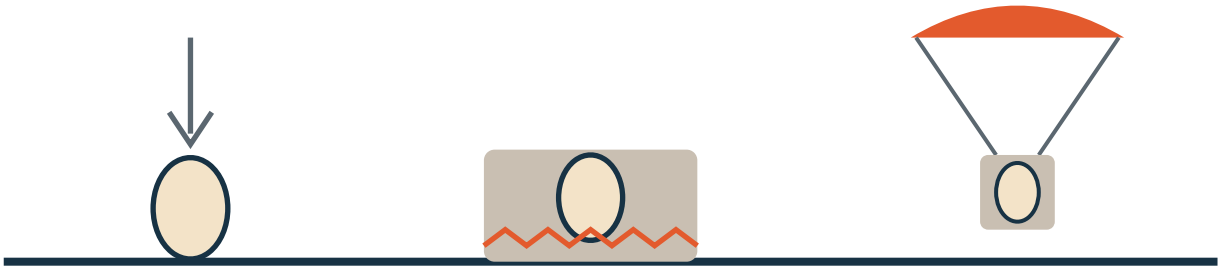
ACTIVITY 03 · FACILITATOR NOTES

The science in brief



Photo: Aedrian Salazar / Unsplash

A falling egg gains speed as it falls. From 2 m, ignoring air resistance, it would hit the floor at about 6 m/s. To stop, its momentum must fall to zero. The force needed depends on how quickly that happens: stopping in a very short time needs a very large force. Cushions and crumple zones make the stopping time longer, so the force on the egg is smaller.



No protection: very short stopping time, large force

Cushion or crumple zone: longer stopping time

Parachute: slower landing speed

Air resistance gives a second strategy. A parachute has a large surface area, so it pushes against more air and reaches a lower top speed. A slower landing means less momentum to remove and less energy to absorb. Car designers combine both ideas: crumple zones extend the stopping time and seat belts and airbags spread the force over the body.

Common ideas to listen for

- "The egg breaks because it is heavy." It breaks because it stops too quickly; the same egg survives on a cushion.
- "More padding always wins." Extra padding adds cost and mass, and a heavier package lands with more momentum.
- "A parachute stops the egg falling." It reduces the landing speed; the egg still needs protection at impact.

Adapting the activity

Support

Provide a partly built frame of straws and let teams focus on adding cushioning. Drop from 1 m only.

Stretch

Estimate the impact speed using $v^2 = 2gh$ for drops of 1 m and 2 m. Calculate the gravitational potential energy of a 60 g egg at 2 m (about 1.2 J) and discuss where that energy goes on landing.

WORKSHEET 1

Design brief and budget

Name: _____ Class: _____ Date: _____

Plan your package before you build. Keep within the budget of 20 points.

Shopping list

Material	Points each	Quantity	Total points
Straws			
A4 card			
A4 paper			
Plastic bag (parachute)			
String (1 m)			
Elastic bands			
TOTAL (max 20)			

Our design

Label where the egg sits and which part increases the stopping time.

Why we think it will work

WORKSHEET 2

Drop test record

An adult drops the package. Record exactly what you see: how it landed and the state of the egg.

Results

Test	Height (m)	How it landed	Egg: intact, cracked or broken
1			
2			
After redesign: 3			
4			

Mass of final package (g)

What the evidence told us to change, and why

WORKSHEET 3

Evaluation

Reflect on your design as an engineer would.

Self-assessment

I can…	Not yet	Partly	Confidently
explain why a longer stopping time means a smaller force			
explain how a parachute helps			
record test results clearly			
justify a design change with evidence			
work within a budget			

Explain in your own words why your egg survived or broke

Where else is this idea used?

Give two real examples of products that protect people or objects by increasing stopping time.

FOR THE TEACHER

Assessment checklist

Use during the session. One sheet covers up to eight students; copy as needed.

Student	Explains stopping time and force	Tests and records systematically	Justifies redesign with evidence

Suggested codes: W = working towards · E = expected · G = greater depth

ABOUT THIS ACTIVITY

Protect the Payload is a sample activity from the EduTrend Contents W4C Science & Engineering programme (middle school, level: core). Every activity in the programme follows the same format: a practical challenge, a clear session plan, facilitator notes and ready-to-print worksheets, so that teachers, club leaders and parents can run it without extra preparation.

Full 15-, 20- and 32-week programmes are available from EduStore at edutrend.org.

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