Grip Without Power

Model a sea star's water vascular system to solve a real problem

ZOO.6.8 "Enrichment: Use an engineering design process to model the water vascular system in hydraulic systems to meet a societal need.*"

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline the sea star parts and circle the gripper parts that model them, then number the team's goal, test, and change 1, 2, and 3 to trace the design process.

A Sea Star Inspired Gripper

1. After an earthquake, a clinic may need to retrieve glass medicine bottles from a gap behind a damaged shelf. Reaching in by hand could cut a worker or break a bottle. A sea star offers a model for a gentle gripper. In its water vascular system, fluid travels through canals to many tube feet. Each tube foot has a muscular, fluid-filled sac called an ampulla. When an ampulla contracts, it pushes fluid into its tube foot, extending it. The foot can attach with secreted adhesive, then release; muscles help pull it back. The system moves without an electric motor.

2. An engineering team sets a goal: lift a 120 g glass bottle 20 cm in at least 9 of 10 trials without cracking it. The tool must fit into a narrow gap and work when electricity is unavailable. The team builds a long, handheld gripper with a squeeze bulb, water-filled tubes, and flexible tips. Squeezing the bulb moves water through the tubes, making the tips extend against the bottle. Silicone pads hold the glass by friction rather than the adhesive used by sea stars. Releasing the bulb lets the flexible tips retract as water flows back.

3. To test the model, the team uses a 120 g glass bottle filled with water, not medicine. Each trial lifts it 20 cm and checks for cracks. Smooth pads grip only 6 times in 10 trials; the bottle slips when its surface is wet. The team replaces the pads with textured silicone, keeping the same bulb and tubes. In a second set of 10 trials, the gripper lifts the bottle 9 times, with no cracks in any trial. This change meets the original target under those test conditions, but a wider range of bottle sizes still needs testing before clinic use.

2 ANSWER WITH EVIDENCE

Use the passage

1. Which gripper parts model the ampulla and tube feet? Explain what each part does.

2. How does the gripper address the clinic's need to work without electricity?

3. What test result led the team to change the pads, and how did the change address the problem?

4. Did the revised gripper meet both parts of the team's performance goal? Use the test results to support your answer.

3 YOUR TURN

Your own words

Design a hand-powered hydraulic tool for a community need other than retrieving medicine bottles. In about five sentences, name the need, explain how two parts model the ampulla and tube feet, set a measurable success goal, describe a test, and propose a change you would make if the tool fails.

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PART 1 · READ AND MARK

Underline the sea star parts and circle the gripper parts that model them, then number the team's goal, test, and change 1, 2, and 3 to trace the design process. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	Which gripper parts model the ampulla and tube feet? Explain what each part does.	**The squeeze bulb models the ampulla by pushing water into the tubes. The flexible tips model tube feet by extending to contact the bottle.**
2	How does the gripper address the clinic's need to work without electricity?	**A worker squeezes the bulb by hand to move water and extend the tips, so the gripper needs no electric motor.**
3	What test result led the team to change the pads, and how did the change address the problem?	**The smooth pads gripped in only 6 of 10 trials because they slipped on wet glass. The team added textured silicone pads to improve grip.**
4	Did the revised gripper meet both parts of the team's performance goal? Use the test results to support your answer.	**Yes. It lifted the 120 g bottle 20 cm in 9 of 10 trials, and no trial cracked the glass.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

My tool would collect plastic litter from a stream without scraping plants. A hand-squeezed bulb models an ampulla by pushing water through tubes, while soft gripping tips model tube feet by extending to contact the litter. It must lift a 30 g plastic lid from the water in at least 8 of 10 trials without touching stream plants. I would test ten pickups in a tank with plastic plants and count successful lifts and plant contacts. If the tips slip on wet plastic, I would add soft ridges and repeat the test.

Accept other workable hydraulic designs that connect fluid pressure to movement in parts modeled on the ampulla and tube feet. The proposed test should measure the stated goal, and the change should address a possible failure.