Steps Toward a Solution

Designing and testing a prosthetic leg

HAP.4.7 "Enrichment: Use an engineering design process to develop, model, and test effective treatments for bone disorders (i.e., prosthetics).*"

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline the two design criteria, circle the weight constraint, and number one example each of modeling, testing, and revising in the order they occur.

A Better Fit for Maya

1. When bone cancer required Maya's lower leg to be removed, a prosthetic limb could help her walk, but it could not treat the cancer. Her care team first made sure her surgical wound had healed before an engineer began fitting a device. Maya wanted to climb the steps to her school bus without pain. The team set design criteria: the foot must support her weight on a step, and the socket, the part around her remaining limb, must not cause painful pressure. A key constraint was that the device had to be light enough for her to lift repeatedly.

2. To explore options before making a final device, the engineer built two adjustable socket models with different padding layouts. Both attached to the same foot, so a test could focus on the sockets. With a clinician supervising, Maya tried each model during short walks and a single low step. The team recorded the number of steps she completed and asked where she felt pressure. Model A allowed ten steps but caused pressure at the front of her limb. Model B allowed eight steps and spread pressure more evenly. Neither result alone proved the device was ready for daily use.

3. Next, the team changed Model B's padding and repeated the same short walk and low step under clinical supervision. Maya completed twelve steps and reported no painful pressure during that trial. The engineer kept the foot and test route the same so the new padding was the main change. The result supported further fitting, not a guarantee that the prosthesis would work all day. The team would check her skin after use and continue testing on longer routes. If redness persisted or climbing felt unstable, they would revise the socket or foot and test again.

2 ANSWER WITH EVIDENCE

Use the passage

1. Which design criterion addresses Maya's comfort, and which constraint limits the device's weight?

2. Why did the engineer attach both socket models to the same foot during testing?

3. Why was Model B a reasonable choice to revise, even though Maya took fewer steps with it than with Model A?

4. What evidence supported further fitting of the revised Model B, and what test was still needed?

3 YOUR TURN

Your own words

A student who lost a forearm after a serious bone infection needs a prosthetic arm to carry a light lunch tray. In one paragraph, propose a model, give two measurable design criteria, describe a safe test, and explain how one possible result would guide a revision.

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PART 1 · READ AND MARK

Underline the two design criteria, circle the weight constraint, and number one example each of modeling, testing, and revising in the order they occur. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	Which design criterion addresses Maya's comfort, and which constraint limits the device's weight?	**The socket must not cause painful pressure. The device must be light enough for Maya to lift repeatedly.**
2	Why did the engineer attach both socket models to the same foot during testing?	**Keeping the foot the same helped the team compare the padding layouts without a different foot affecting the results.**
3	Why was Model B a reasonable choice to revise, even though Maya took fewer steps with it than with Model A?	**Model B spread pressure more evenly, while Model A caused pressure at the front of Maya's limb.**
4	What evidence supported further fitting of the revised Model B, and what test was still needed?	**Maya took twelve steps without reporting painful pressure during the short trial. The team still needed to test longer routes and check her skin after use.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

I would make a cardboard-and-foam model of a forearm attachment with two supports under the tray and test it on a stand, not on the student. It should hold a tray with two foam blocks for 30 seconds and keep the tray tilted less than 10 degrees. I would repeat three trials with the same load and measure tilt with a protractor. If the tray tilted too far, I would move the supports farther apart and repeat the test. A clinician would oversee any later fitting.

Accept other feasible prosthetic arm models if the response includes two measurable criteria, a safe test, and a revision linked to a possible result. A model test should not be presented as proof that the device is ready for daily use.