

The Cheerleader and the Football Player:

Physics and Physical Exertion

by

Malati Patil

Department of Electrical Engineering
University at Buffalo, State University of New York

“They’ll never be able to do it! We’re gonna win!” Dave, the captain of the football team, told his teammates.

It was already a school-wide wager, but soon people from the city came in to drop off their spare change into either the football team’s jar or the cheerleading squad’s jar. The rules were simple: whichever team acquired the most money had to lift a member of the opposite team off the ground. It was unthinkable! A cheerleader lifting a 300-pound football player off the ground? Nobody thought it possible, and everybody wanted to see the cheerleaders try to do it.

Dave laughed, “Can you imagine Tracy—the tiniest girl ever—trying to lift one of us?” All of Dave’s friends laughed. As they discussed the challenge further, the team decided to make it their goal to ensure that the task would fall to the cheerleaders. They organized a campaign and lobbied the student body to donate their money to the cheerleading squad’s jar. The boys had a week in which to raise as much money as possible. The event would take place at Friday’s pep rally and the donated money would go to the favorite charity of the winner in the contest. If the cheerleaders were given the task and couldn’t do it, then the money would be donated to the football team’s charity, the Make a Wish Foundation, but if the cheerleaders were chosen and somehow managed to lift a football player off the ground, then the money would go to the American Cancer Society.

The contest had just been announced earlier that morning, but already the jars were half full. “This is going to be a great fund-raiser!” noted Principal Robinson. “I can’t wait to see what the cheerleaders will come up with this time!” The high school had a history of fundraisers like this—bets between the football team and the cheerleading squad—though nothing this demanding.

Each team wanted the money to go to their charity. Both teams were found huddled in between classes, discussing their strategy. For the football players it was simple, “All we need to do is lift one of the girls onto our shoulders. That should be good enough for the judges,” said Darren, the quarterback. They all agreed and decided that Dave, the biggest guy on the team, would do the lifting if the football team earned the most money, and that he’d be the one the girls would have to lift if the cheerleaders ended up with the most money in their jar.

“Let’s see how tough we can make it on them!” laughed Dave as the team dispersed after lunch.

On the other hand, the girls were hard at work. They had an idea of what they wanted to do and just needed time to execute their plan. Many of the girls stayed after practice to formulate their strategy. “Don’t worry, girls! We know what it takes to win and we definitely have what it takes!” encouraged Nikita, one of the seniors on the squad. “We’ve been through a lot of these bets and we’ve been undefeated since I’ve been here. Let’s keep up the tradition!”

The girls took her encouragement to heart and came up with a master plan to outwit the football team. It would be Tracy's job to lift the football player using a special apparatus that the girls had developed. "The rules don't say anything about us using something that we've built to help us, so let's go for it!" Tracy exclaimed. "We're definitely going to keep this tradition alive!"

The day was fast approaching. The girls were hard at work on their project and weren't telling anyone about it. Students and community members kept filling and refilling the jars with change. Since Principal Robinson was in charge of the jars and the money, no one had a clue which team would have to perform the task.

"It's Friday!" exclaimed Dave. "Are we ready, guys?"

"Yeeaaaahhh! We're gonna beat them and win all that money for our charity!" screamed the football team.

You could feel the tension between the football players and the cheerleaders during the pep rally. Each team was thinking of their strategy and couldn't wait to see the results.

After a rousing cheer from the audience, Principal Robinson took the microphone to announce the details of the contest: "Thank you students, faculty, and community members for contributing to this worthy cause. We raised over \$500 in only one week! We should all congratulate ourselves on this tremendous generosity, but it's not over yet! I have the results of the competition and it seems that the cheerleaders will be given the task of trying to lift one of the football players off the ground!"

The crowd went wild. This was what they had come to see, but they quickly quieted down when Tracy, a member of the cheerleading squad, took the microphone. "We expected this to happen and we're ready for the challenge! I will be lifting Dave into the air with a little help from my friend, the pulley!"

No one in the crowd moved. They hadn't expected this. "I wonder what is going to happen?" said a few students. "Do they really think they can lift a 300-pound football player over two feet in the air with just a pulley and some rope?"

The crowd watched expectantly as the cheerleading squad set up their apparatus. From the ceiling descended four pulleys, all connected by a single rope. There was a sling connected to the two lower pulleys for Dave to sit in. As he sat in the sling, he wondered if the girls were really going to be able to pull it off. They certainly seemed to have thought of everything they needed to do the job.

The moment of truth came for Tracy. She pulled the rope gently and watched as Dave was lifted off the ground and into the air. She pulled the rope a little harder as the crowd gasped.

"The impossible has been made possible. Tracy has just lifted Dave off the ground! The cheerleaders win the bet and the money raised by this contest will go to the American Cancer Society! Congratulations, girls!" announced Principal Robinson. "But we have one question for you. How did you know what to do? Dave weighs at least twice as much as Tracy does. She couldn't possibly have lifted him that high."

Questions

1. How did the pulleys aid the cheerleaders in their quest to beat the football players?
2. What is the minimum weight of a person pulling the rope in order to lift a football player who weighs 300 pounds (approximately 136 kg) by just hanging on the rope?
3. What if the cheerleaders had only set up a 2-pulley system? Would this 2-pulley system require more or less force than the 4-pulley system? Would a person weighing 120 pounds be able to lift the 136 kg football player, using the 2-pulley system, by just hanging on the rope?

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