2.8 Explore

2.8 Investigate New Brake Designs

2.8: Part 1 of 4- Think about the Brake’s Design

Earlier you noticed that when the truck traveled over different surfaces, each surface changed the stopping distance of the truck. You also found that the use of a brake shortened the stopping distance. Both of these effects were because of friction, but what if the friction in your brake wasn’t enough to prevent an accident? The target vehicle (car) from your earlier tests was positioned well before the average impact location. As an engineer, you have tested one solution but now you must modify it based on the test results in order to improve it. How might you redesign the brake to improve the stopping distance? (We’ll refer to the brake that you tested earlier as the “basic brake design”.)

Think, Pair, Share: On your own brainstorm how we can further reduce the stopping distance of the brake. Consider the criteria and constraints for the challenge when you are brainstorming new ideas. Record your ideas on the Brainstorm New Brake Designs sheet. Afterwards, you will work with your group to discuss your ideas, and then share some of these ideas with your class. Your teacher will record these ideas on the board.
2.8: Part 2 of 4- Investigate Different Brake Design Options

Now you will test a change to the brake design (that your class probably came up with) to see how it affects stopping distance. Your teacher will assign your group a variable (either a different material to attach to the basic brake or a new brake shoe design) to test. The new materials to test are: felt, plastic wrap and foil. The different brake shoe designs include: a large shoe (Figure 2.8.2), a small shoe (Figure 2.8.3) or a rake shoe (Figure 2.8.4). Your group will be assigned one of these designs to test and compare to the basic brake results. Iterative design is a cyclical process to help you achieve the best possible result for the problem you are working on. It involves testing a design, analyzing the results, modifying the design and then re-testing and possibly modifying the design again.
2.8 Explore

After you test this variable (the new design) you will be able to compare these results to the stopping distance results from your investigation of the basic brake design (Section 2.6). This will let you determine if the new design is more effective than the basic brake design.

It would take too long for each group to test every variable, so we will split the work and have different groups test different variables. Later, all of the groups will share and compare their test results and data. Therefore you will need to decide upon a class procedure and a set of controls for your test.

**CLASS**

Complete the *Procedure Design Sheet* to record your procedure and the details for your tests.

**GROUP**

Run your investigation following class procedure. Record your results on the *Investigation Data Sheet*.
2.8 Explore

2.8: Part 3 of 4- Share your results

Now that your group has collected data testing modified brake designs, your teacher will ask each group to collaborate and share their data with the class. Your data will be added to a class data log so that it can be analyzed and compared to the data other groups collected.

Record and graph the class data on the Investigation Class Data Sheet.

2.8: Part 4 of 4- Reflect & Connect

As a class, you will reflect on what you learned from the investigation. You can use the following questions to help start the discussion.

• How did your data compare to the basic brake design data?
• How did the data compare between the different brake designs?
• Does the data look consistent between the groups?
• Were any brakes effective? How do you know?

Complete the Investigation Data Sheet to mathematically compute the percent change of the new brake design.
2.8 Explore

Now that you have collected and analyzed truck braking data, you can communicate your findings to others by crafting an argument. Your communication will include a claim about the effectiveness of the brake design that you used (either different material attached to the basic brake or a new brake shoe structure) and how it compared to the basic brake design. Support your claim with the strong evidence that you collected and analyzed. Recall that the criteria for strong claims and evidence can be found in Section 2.2, Part 3 and your rubric.

Complete the top half of the *Claim and Evidence Sheet* following the directions provided. When writing your claims and evidence, consider the characteristics of a strong argument. You will be sharing your argument with members of your class.
2.8 Explore

Two key components of scientific communication are 1) written and oral arguments and 2) peer-review of investigations, results, and conclusions. Peer-reviewed science work provides a trusted form of scientific communication because other scientists are independently evaluating the work. Even if you are unfamiliar with a science topic you can trust peer-reviewed work to meet certain standards of quality. Since scientific knowledge builds on itself, this trust is particularly important.

It can be difficult to imagine how the peer review process occurs in science and/or even in school. To help you feel more comfortable with this important skill you will watch a video to see it in action. Afterwards, discuss the following questions with your class:

- How did the two individuals interact? Was it respectful or was it adversarial?
- What was the purpose of the interaction?
- What were some comments that they made?

Watch Tutorial
Video 6

Like in the video, you are now going engage in the peer-review process. You will trade papers with a partner to assess each other’s scientific argument. When finished you will discuss your assessment with your partner and make suggestions for how the argument could be improved.

Swap your Claim and Evidence Sheet with your partner. Evaluate your partner’s argument using the reminders for strong claim and evidence statements. When finished, discuss the argument with your partner and make suggestions for how your partner could strengthen it.
Consider your partner’s comments and re-evaluate your claim and evidence statements. How strong were your statements when your partner evaluated them? Were they as appropriate, reliable and relevant as you thought? What could be improved? Revise and rewrite them on the bottom half of the *Claim and Evidence Sheet*.

Revise and rewrite your argument statement on the bottom half of the *Claim and Evidence Sheet*.