SN EDUCATOR GUIDE

February 29, 2020

Concussion Leaves Clues in the Blood

Activity Guide for Students: Protective Headgear Design Challenge

Directions for students:

Background questions
Answer the following questions to assess your knowledge of physics concepts related to collisions. Use your notes or classroom resources as needed.

1. During a collision, each object exerts a force on the other object. From Newton's third law, what must be true of the two forces?

2. During a collision, each object exerts a force on the other object. From Newton's second law, what factors affect the amount of force?

3. When two objects collide, they undergo changes in momentum. If no other forces act on the two objects, what happens to total momentum of the system before and after a collision?

Impulse-momentum theorem
Answer the following questions to assess your understanding of the impulse-momentum theorem, $F\Delta t = \Delta p$.

4. In the impulse-momentum theorem, F is the average force of the collision and Δt is the time over which the collision occurs. If the change in momentum and the mass of the object in two collisions is the same, how could you make one of the collisions occur with less force?

5. Change in momentum, Δp, is equal to $m\Delta v$. If the change in time and the mass of the object in two collisions is the same, how could you make one of the collisions occur with less force?

Observing collisions 1
Discuss the differences in an egg colliding with a wall and an egg colliding with a sheet that is not taut. Then answer the following questions.

6. Which collision had less force? Explain your reasoning.

7. Assume both eggs have the same mass and are tossed the same way in both collisions. Is the change in momentum the same or different in the two collisions? Explain your reasoning.

8. Assume both eggs have the same mass and are tossed the same way in both collisions. Is the change in time the same or different in the two collisions? Explain your reasoning.

9. Do the observations from the demonstrations support your conclusion about how to reduce force in a collision?

Observing collisions 2

Discuss the differences in a bouncy ball colliding with a hard surface and a soft surface. Then answer the following questions.

10. Which collision had less force? Explain your reasoning.

11. In both cases, the ball's velocity before it collides with the floor is the same. However, the velocity of the ball after it collides is not the same. Is the change in momentum the same or different in the two collisions? Explain your reasoning using an equation.

12. Is the change in time over which the collision occurs the same or different in the two collisions? Explain your reasoning.

13. Do the observations from the demonstrations support your conclusion about how to reduce force in a collision?

Testing materials

Head injuries occur in different ways in different sports. Choose a sport, such as football, cycling, basketball, hockey, lacrosse or soccer. Working in a group, answer the following questions.

14. For the sport you have chosen, what are two common impacts on the head that can occur?

15. Draw force diagrams that show the common impacts you described.

16. Your class will develop a standard testing protocol for materials that might protect the head during collisions. Summarize the protocol after your class discussion. Record the standard thickness and standard height the bouncy ball will be dropped from. Also determine how many times you will test each material or combination of materials.

17. Examine the materials available for testing. Brainstorm any additional materials you have at home that you would like to test and record them here.

18. Using the protocol, test a variety of materials. Create a data table, and carefully record the materials and the height the ball bounces for each trial.

19. Share your testing data with the class. Analyze this data to determine which materials or combination of materials you would use in protective headgear and record your choices below.

Designing protective headgear

Working with your group, brainstorm two or three designs for protective headgear for the sport you selected. Consider the protection afforded and the extent to which the design will affect the ability to play the sport by taking into account shape of the headgear, type of materials, order of layering of materials, thickness and weight.

20. Record your group's ideas below and then discuss the pros and cons of each design.

21. Choose a final design. Create a detailed sketch of your final design and describe why your design will be effective according to the concepts discussed earlier. Label your sketch with the materials you would use in a prototype of your design. Write down your reasoning for your choice of materials that includes the testing results and other factors such as relative weight of the materials. Title your design sketch in a way that makes clear which sport you are addressing.