**PHYSICS 2021 - 22 November 15, 2021**

**Today’s Agenda (Day 55)**

1. HOUSEKEEPING ITEMS

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1. HOMEWORK CHECK:

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1. CLASS ACTIVITY

🡪 CONT’D: Chapter 9 PPT Review

1. **Section 9.1 – Impulse and Momentum**
2. Section 9.2 – Conservation of Momentum

🡪 LAUNCH: Project – Water Bottle Rocket Competition

HOMEWORK:

* READ: Chapter 9 – Momentum and Conservation
* COMPLETE: Chapters 9 & 10 Vocabulary
* CONSTRUCT: Water Bottle Rocket & Launcher
* STUDY: Chapter 9 Vocabulary AND Test

<http://glencoe.mheducation.com/sites/0078807220/student_view0/self-check_quizzes.html>

Chapter 9 & Chapter 10 Vocabulary

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| --- | --- | --- | --- | --- | --- |
| Impulse | Momentum | Impulse-momentum theorem | Angular momentum | Angular impulse-momentum theorem | Closed system |
| Isolated system | Law of conservation of momentum | Law of conservation of angular momentum | Work | Joule | Energy |
| Work-energy theorem | Kinetic energy | Translational kinetic energy | Power | Watt | Machine |
| Effort force | Resistance force | Mechanical advantage | Ideal mechanical advantage | Efficiency | Compound machine |

REMINDERS:

* Chapters 9 & 10 Vocabulary – Nov. 17
* **TEST: Chapter 9 & Vocabulary 🡪 Nov. 18**
* **TEST: Chapter 10 & Vocabulary 🡪 Nov. 23**
* ~~QUIZ: Chapter 9 & 10 Vocabulary 🡪 Nov. 24~~
* **Project: Water Bottle Rocket – Nov. 24**
* **TEST: Chapter 11 🡪 Dec. 2**
* **TEST: Chapter 12 🡪 Dec. 9**
* **Midterm Exam:** Chapters 1 - 13

**PHYSICS 2021 - 22** CHAPTER REVIEW

**PRACTICE PROBLEMS 9.1**

1. A compact car, with a mass of 725 kg, is moving at 115 km/h toward the east. Sketch the moving car.
2. Find the magnitude and direction of its momentum. Draw an arrow on your sketch showing the momentum.
3. A second car, with a mass of 2175 kg, has the same momentum. What is its velocity?
4. The driver of the compact car in the previous problem suddenly applies the brakes hard for 2.0 s. As a result, an average force of 5.0 x 103 N is exerted on the car to slow it down.
5. What is the change in momentum, or equivalently, what is the magnitude and direction of the impulse on the car?
6. Complete the “before” and “after” sketches and determine the momentum and velocity of the car now.
7. A 7.0 kg object, moving at 2.0 m/s, receives two impulses (one after the other) along the direction of its motion. Both impulses are illustrated in Figure 2, p. 239 of the textbook. Find the resulting speed and direction of motion of the object after each impulse.
8. The driver accelerates a 240.0 kg snowmobile, which results in a force being exerted that speeds up the snowmobile from 6.00 m/s to 28.0 m/s over a time interval of 60.0 s.
9. Sketch the event, showing the initial and final situations.
10. What is the snowmobile’s change in momentum? What is the impulse on the snowmobile?
11. What is the magnitude of the average force that is exerted on the snowmobile?
12. A 0.25 m diameter circular saw blade in a workshop rotates at 5.0 x 103 rpm, as shown in Figure 7, p. 243 of the textbook. After the electrical power to the saw is turned off, it takes several seconds for the blade to slow to a complete stop. The moment of inertia of the blade is 8.0 x 10-3 kg•m2. Friction in the axle provides an average torque of 2.3 x 10-1 N•m to slow the blade. How many seconds does it take for the blade to stop?
13. A baseball pitcher can throw a 132 km/h (82 mph) curve ball that rotates about 6.0 x 102 rpm. What is the angular velocity of the thrown ball? The pitcher’s throwing motion lasts about 0.15 s, and the moment of inertia of the ball is 8.0 x 10-5 kg•m2. What average torque did the pitcher exert on the ball?
14. As a bowler releases the ball onto the alley, the ball does not roll but slides. Slowly the friction of the alley surface causes the ball to roll and have a final angular velocity of 7.00 x 101 rad/s. The moment of inertia of the ball is 0.0350 kg•m2, and the ball moves down the alley in 2.40 s. What are the angular impulse and the average torque that the alley surface exerts on the bowling ball?
15. A bicycle clamped upside down on a workbench for the bicycle repair woman to repair a front wheel axle. She gives the front wheel a spin with her hand, and the wheel rotates at 5.0 rev/s. What is the angular velocity of the wheel? If the moment of inertia of the wheel is 0.060 kg•m2 , what angular impulse did the repair woman give the wheel?

**PRACTICE PROBLEMS 9.2**

1. Two freight cars, each with a mass of 3.0 x 105 kg, collide and stick together. One was initially moving at 2.2 m/s and the other was at rest. What is their final speed? Define the system as two cars.
2. A 0.105 kg hockey puck moving at 24 m/s is caught and held by a 75 kg goalie at rest. With what speed does the goalie slide on the ice after catching the puck? Define the puck and the goalie as a system.
3. A 35.0 g bullet moving at 475 m/s strikes a 2.5 kg bag of flour at rest on ice. The bullet passes through the bag and exits at 275 m/s. How fast is the bag moving when the bullet exits?
4. The bullet in the previous problem strikes a 2.5 kg steel ball that is at rest. After the collision, the bullet bounces backward at 5.0 m/s. How fast is the ball moving when the bullet bounces backward?
5. A 4.00 kg model rocket is launched, expelling burned fuel with a mass of 50.0 g at a speed of 625 m/s. What is the velocity of the rocket after the fuel has burned? *Hint: Ignore the external forces of gravity and air resistance.*
6. A thread connects a 1.5 kg cart and a 4.5 kg cart. After the thread is burned, a compressed spring pushes the carts apart, giving the 1.5 kg cart a velocity of 27 cm/s to the left. What is the velocity of the 4.5 kg cart?
7. A 925 kg car moving north at 20.1 m/s collides with 1865 kg car moving west at 13.4 m/s. After the collision, the two cars are stuck together. In what direction and at what speed do they moved after the collision? Define the system as the two cars.
8. A 1345 kg car moving east at 15.7 m/s is struck by a 1923 kg car moving north. They stick together and move with a velocity of 14.5 m/s at ø = 63.5⁰. Was the north-moving car exceeding the 20.1 m/s speed limit?

**PHYSICS 2021-22 Lab Activity**

**Physics Water Bottle Rocket Competition**



**http://aplusphysics.com/projects/water\_rockets.html**

**Event Description:** Teams of two or three people will build a water bottle rocket that will stay can be vertically-launched AND horizontally-launched into the air for a maximum amount of time

**Specifications:**

1. Rockets are to be constructed from a 2-liter soda bottle.
2. The soda bottle must remain intact.
3. Additional materials such as fins, nose cones, parachutes, etc. are permitted, within reason.
4. The bottle will have water and 40 psi of compressed air put into it. When the pressure is released, the rocket should fly.
5. Launcher should be able to accommodate both a vertical and horizontal launch of the water bottle rocket. Launcher cannot be hand-held during pressure-infusion.

**Resources**:

* [All About Water Rockets](http://exploration.grc.nasa.gov/education/rocket/BottleRocket/about.htm)
* [Hayhurst's Quick and Easy Bottle Rockets](http://www.lnhs.org/hayhurst/rockets/)
* [Water Bottle Rockets](http://home.comcast.net/~timhesterberg/WaterRockets.html)
* [Water-Powered Bottle Rocket](http://www.tclauset.org/21_BtlRockets/BTL.html)
* [Rockets Away Software Demo](http://extension.osu.edu/rockets/cgi-bin/design_zone.cgi)
* [Principle of the Rocket](http://www-istp.gsfc.nasa.gov/stargaze/Srocket.htm)
* [Sim Water Rocket](http://www.et.byu.edu/~wheeler/benchtop/sim.php)
* [Bottle Rocket Construction](http://sections.asme.org/sandiego/Meetings/waterrocketconstruction.pdf)
* [Bottle Rocket Launcher Construction](http://users.soe.ucsc.edu/~karplus/abe/soda-bottle-rocket.pdf) (provided by instructors for project)
* [Cadre Water Rocket](http://alain.juge.pagesperso-orange.fr/English/EnFrame.htm)

**Procedure**:

1. Get into groups of 3.

2. Research how to design and construct a water bottle rocket, pressure-driven from reliable resource.

3. Agree on a design, where and when to construct apparatus.

4. Gather materials.

5. Begin assembly. Be mindful of all safety precautions and use all necessary safety gear (ie. eye goggles, etc).

6. Using your safety gear, test functioning of constructed apparatus (rocket launcher with “rocket”); be sure that you have the “trigger” that can release from a **safe** distance away! Ensure that your device can undergo multiple launches without breakdown of its foundation. **PREPARE THREE ROCKETS!!**

7. Bring apparatus to school at scheduled date, as per teacher’s notification. BRING BOTH ROCKETS & LAUNCHER ON DAY OF COMPETITION!

**\*Capture the step-by-step process via still photos or video!**

**\*Completed product must be a representative product of your age-level, knowledge and skills set!**

**POST-ACTIVITY**

**Team Reflection:** As a team, submit your answers to the following questions:

1. Analyze your rocket's motion:
	1. How long was your rocket in the air?
	2. Estimate your rocket's maximum height. Show and explain all calculations.
	3. What was your rocket's maximum velocity? Show and explain all calculations.
2. Did you have to do anything/employ different concepts to ensure that your rocket could be launched bi-directionally?
3. What role did friction play in the performance of your rocket? Did it aid or hinder? Explain.
4. Beginning with the stored mechanical energy in the pressurized rocket, explain the multiple transformations the energy goes through. See Unit II of Physics Textbook.
5. How did undertaking this project improve your understanding of work and energy?
6. How did you feel about this project when it was first assigned?
7. How do you feel about this project now that it has concluded?
8. What would you have done differently as you and your team worked through this project?

**Scoring:** Scoring will be based 50% on rocket performance, 50% on your team's reflection.

## **SELF-REFLECTION ON LEARNING**

Spend a few minutes to analyze your performance on group and individual tasks.

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| **Name:** |  |
| **Project Name:** |  |
| **Describe the project in a sentence or two:** |  |
| **What is the most important thing you learned during this project:** |  |
| **What do you wish you had spent more time on:** |  |
| **What big idea(s) did this project help you understand?** |  |
| **What do you wish you had done differently:** |  |
| **What part of the project did you do your best work on:** |  |
| **What was the most enjoyable part of this project:** |  |
| **What was the least enjoyable part of this project:** |  |
| **How could your teacher(s) change this project to make it better next time:** |  |