**PHYSICS 2021 - 22 November 19, 2021**

**Today’s Agenda (Day 59)**

1. HOUSEKEEPING ITEMS

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1. HOMEWORK CHECK:

🡪 Chapters 9 & 10 Vocabulary

1. CLASS ACTIVITY

🡪 CONSTRUCT: Water Bottle Rocket & Launcher

🡪 CONT’D: Chapter 10 PPT Review

1. Section 10.2 - Machines

HOMEWORK:

* READ: Chapter 10 – Energy, Work & Simple Machines
* COMPLETE: Chapter 11 AND 12 Vocabularies
* 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:

* **TEST: Chapter 9 & Vocabulary 🡪 Nov. 23**
* Chapter 11 Vocabulary – Nov. 24
* **Project: Water Bottle Rocket – Nov. 24**
* **TEST: Chapter 10 & Vocabulary 🡪 Nov. 30**
* Chapter 12 Vocabulary – Dec. 2
* **TEST: Ch 11 & Vocab🡪 Dec. 7**
* **TEST: Ch 12 & Vocab 🡪 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** CHAPTER REVIEW

**PRACTICE PROBLEMS 10.1**

1. Together, two students exert a force of 825 N in pushing a car a distance of 35 m.
2. How much work do the students do on the car?
3. If their force is doubled, how much work must they do on the car to push it the same distance?

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1. A rock climber wears a 7.5 kg backpack while scaling a cliff. After 30.0 min, the climber is 8.2 m above the starting point.
2. How much work does the climber do on the backpack?
3. If the climber weighs 645 N, how much work does she do lifting herself and the backpack?
4. Two people lift a heavy box a distance of 15 m. they use ropes, each of which makes an angle of 15◦ with the vertical. Each person exerts a force of 225 N. How much do the ropes do?
5. An airplane passenger carries a 215 N suitcase up the stairs, a displacement of 4.20 m vertically and 4.60 m horizontally.
6. How much work does the passenger do on the suitcase?
7. The same passenger carries the same suitcase back down the same set of stairs. How much work does the passenger do on the suitcase to carry it down the stairs?
8. A rope is used to pull a metal box a distance of 15.0 m across the floor. The rope is held at an angle of 46.0 ◦ with the floor, and a force of 628 N is applied to the rope. How much work does the rope do on the box?
9. A 575 N box is lifted straight up a distance of 20.0 m by a cable attached to a motor. The box moves with a constant velocity and the job is done in 10.0 s. What power is developed by the motor in W and kW?
10. You push a wheelbarrow a distance of 60.0 m at a constant speed for 25.0 s by exerting a 145 N force horizontally.
11. What power do you develop?
12. If you move the wheelbarrow twice as fast, how much power is developed?
13. An electric motor develops 65 kW of power as it lifts a loaded elevator 17.5 m in 35 s. How much force does the motor exert?

**PRACTICE PROBLEMS 10.2**

1. A sledgehammer is used to drive a wedge into a log to split it. When the wedge is driven 0.20 m into the log, the log is separated a distance of 5.0 cm. A force of 1.7 x 104 N is needed to split the log, and the sledgehammer exerts a force of 1.1 x 104 N.
2. What is the IMA of the wedge?
3. What is the MA of the wedge?
4. Calculate the efficiency of the wedge as a machine.
5. A worker uses a pulley to raise a 24.0 kg carton 16.5 m, as shown in Figure 15 on p. 280 of the textbook. A force of 129 N is exerted, and the rope is pulled 33.0 m
6. What is the MA of the pulley?
7. What is the efficiency of the pulley?



1. A winch has a crank with a 45 cm radius. A rope is wrapped around a drum with a 7.5 cm radius. One revolution of the crank turns the drum one revolution.
2. What is the ideal mechanical advantage of this machine?
3. If, due to friction, the machine is only 75 percent efficient, how much force would have to be exerted on the handle of the crank to exert 750 N of force on the rope?
4. You exert a force of 225 N on a lever to raise a 1.25 x 103 N rock a distance of 13 cm. If the efficiency of the lever is 88.7%, how far did you move your end of the lever?
5. Classify each tool as a lever, a wheel and axle, an inclined plane, or a wedge. Describe how it changes the force to make the task easier.
6. Screwdriver c) chisel
7. Pliers d) nail puller
8. A worker is testing a multiple pulley system to estimate the heaviest object that he could lift. The largest downward force he can exert is equal to his weight, 875 N. When the worker moves the rope 1.5 m, the object moves 0.25 m. What is the heaviest object he could lift?
9. Takeshi raises a 1200-N piano a distance of 5.00 m using a set of pulleys. He pulls in 20.0 m of rope.
10. How much effort force would Takeshi apply if this were an ideal machine?
11. What force is used to balance the friction force if the actual effort is 340 N?
12. What is the output work?
13. What is the input work?
14. What is the mechanical advantage?
15. A motor with an efficiency of 88% runs a crane with an efficiency of 42 percent. The power supplied to the motor is 5.5 kW. At what constant speed does the crane lift a 410-kg crate?

**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 and 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:** |  |