**PHYSICS 2021 - 22 November 3, 2021**

**Today’s Agenda (Day 49)**

1. HOUSEKEEPING ITEMS

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1. HOMEWORK CHECK:

🡪 Chapter 7 & 8 Vocabulary

🡪 Paper Airplane Lab Report & PPT

1. CLASS ACTIVITY

🡪 CONT’D: Chapter 8 PPT Review

1. **Section 8.2 – Rotational Dynamics**
2. Section 8.3 - Equilibrium

🡪REVIEW CHAPTER 7 PRACTICE PROBLEMS

🡪SECTION REVIEW QUESTIONS:

\*Work in PAIRS to complete EITHER odds or evens of **Section 8.1 Practice Problems**

HOMEWORK:

* READ: Chapter 8 – Rotational Motion
* STUDY: Chapter 7 Test

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

Chapter 7 & 8 Vocabulary

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Kepler’s first law | Kepler’s second law | Kepler’s third law | Gravitational force | Law of universal gravitation | Inertial mass |
| Gravitational mass | Radian | Angular displacement | Angular velocity | Angular acceleration | Lever arm |
| Torque | Moment of inertia | Newton’s second law of rotational motion | Center of mass | Centrifugal “force” | Coriolis “force” |

REMINDERS:

* **TEST: Chapter 7 🡪 Nov. 4**
* **TEST: Chapter 8 🡪 Nov. 9**
* **QUIZ: Chapter 7 & 8 Vocabulary 🡪 Nov. 10**

**PHYSICS 2021 - 22** CHAPTER REVIEW

**7.1 PRACTICE PROBLEMS**

1. An asteroid revolves around the Sun with a mean orbital radius twice that of Earth’s. Predict the period of the asteroid in Earth years.
2. Venus has a period of revolution of 225 Earth days. Find the distance between the Sun and Venus as a multiple of Earth’s average distance from the Sun.
3. Uranus requires 84 years to circle the Sun. find Uranus’s average distance from the Sun as a multiple of Earth’s average distance from the Sun.
4. The Moon has a period of 27.3 days and a mean distance of 3.9 x 105 km from its center to the center of Earth.
5. Use Kepler’s laws to find the period of a satellite in orbit 6.70 x 103 km from the center of Earth.
6. How far above Earth’s surface is this satellite?
7. What is the gravitational force between two 15 kg balls whose centers are 35 m apart? What fraction is this of the weight of one ball?
8. If Earth began to shrink, but its mass remained the same, what would happen to the value of *g* on Earth’s surface?

**7.2 PRACTICE PROBLEMS**

*For Questions #1 – 3, assume a circular orbit for all calculations.*

1. Suppose that the satellite in Example Problem 2 (p. 188 of the textbook) is moved to an orbit that is 24 km larger in radius than its previous orbit.
2. What is its speed?
3. Is this faster or slower than its previous speed?
4. Why do you think so?
5. Uranus has 27 known moons. One of these moons is Miranda, which orbits at a radius of 1.29 x 108 m. Uranus has a mass of 8.68 x 1025 kg.
6. Find the orbital speed of Miranda.
7. How many Earth days does it take Miranda to complete one orbit?
8. Use Newton’s thought experiment on the motion of satellites to solve the following:
9. Calculate the speed that a satellite shot from a cannon must have to orbit Earth 150 km above its surface.
10. How long, in seconds and minutes, would it take for the satellite to complete one orbit and return to the cannon?
11. The Moon is 3.9 x 105 km from Earth’s center and Earth is 14.96 x 107 km from the Sun’s center. The masses of Earth and the Sun are 5.97 x 1024 kg and 1.99 x 1030 kg, respectively. During a full moon, the Sun, Earth, and the Moon are in line with each other, as shown in Figure 18 (p. 193 of the textbook).
12. Find the ratio of the gravitational fields due to Earth and the Sun at the center of the Moon.
13. What is the net gravitational field due to the Sun and Earth at the center of the Moon?
14. Chairs in an orbiting spacecraft are weightless. If you were on board such a spacecraft and you were barefoot, would you stub your toe if you kicked a chair? Explain
15. The mass of the Moon is 7.3 x 1022 kg and its radius as 1785 km. What is the strength of the gravitational field on the surface of the Moon?
16. Two satellites are in circular orbits about Earth. One is 150 km above the surface, the other is 160 km.
17. Which satellite has the larger orbital period?
18. Which has the greater speed?
19. Why is Einstein’s description of gravity called a theory, while Newton’s is a law?
20. What would be the strength of Earth’s gravitational field at a point where an 80.0 kg astronaut would experience a 25.0 percent reduction in weight?

**PHYSICS 2021 - 22** CHAPTER REVIEW

**8.1 PRACTICE PROBLEMS**

1. What is the angular displacement of each of the following hands of a clock in 1.00 h? State your answer in three significant digits.

**a.** the second hand

**b.**the minute hand

**c.** the hour hand

1. A rotating toy above a baby’s crib makes one complete counter clockwise rotation in 1 min.

**a.**What is its angular displacement in 3 min?

**b.** What is the toy’s angular velocity in rad/min?

**c.**  If the toy is turned off, does it have positive or negative angular acceleration? Explain.

1. If a truck has a linear acceleration of 1.85 m/s2 and the wheels have an angular acceleration of 523 rad/s2, what is the diameter of the truck’s wheels?
2. The truck in the previous problem is towing a trailer with wheels that have a diameter of 48 cm.

**a.**How does the linear acceleration of the trailer compare with that of the truck?

**b.** How do the angular accelerations of the wheels of the trailer and the wheels of the truck compare?

1. You replace the tires on your car with tires of larger diameter. After you change the tires, how will the angular velocity and number of revolutions be different, for trips at the same speed and over the same distance?
2. The Moon rotates once on its axis in 27.3 days. Its radius is 1.74×106 m.

a. What is the period of the Moon’s rotation in seconds?

b. What is the frequency of the Moon’s rotation in rad/s?

c. A rock sits on the surface at the Moon’s equator. What is its linear speed due to the Moon’s rotation?

d. Compare this speed with the speed of a person on Earth’s equator due to Earth’s rotation.

1. A movie lasts 2 h. During that time, what is the angular displacement of each of the following?

a. the hour hand

b. the minute hand

c. the second hand

1. In the spin cycle of a clothes washer, the drum turns at 635 rev/min. If the lid of the washer is opened, the motor is turned off. If the drum requires 8.0 s to slow to a stop, what is the angular acceleration of the drum?
2. A CD-ROM has a spiral track that starts 2.7 cm from the center of the disk and ends 5.5 cm from the center. The disk drive must turn the disk so that the linear velocity of the track is a constant 1.4 m/s. Find the following:

a. the angular velocity of the disk (in rad/s and rev/min) for the start of the track

b. the disk’s angular velocity at the end of the track

c. the disk’s angular acceleration if the disk is played for 76 min

**8.2 PRACTICE PROBLEMS**

1. Consider the wrench in Example Problem 1. What force is needed if it is applied to the wrench pointing perpendicular to the wrench?
2. If a torque of 55.0 N◦m is required to turn a bolt and the largest force that you can exert is 135 N, how long a lever arm must you use to turn the bolt?
3. If you have a 0.234 m long wrench. A job requires a torque of 32.4 N◦m, and you can exert a force of 232 N.

a. What is the smallest angle, with respect to the handle of the wrench, at which you can pull on the wrench and get the job done? b. A friend can exert 275 N. What is the smallest angle she can use to accomplish the job?

1. If you stand a bicycle pedal, as shown in Figure 7. Your mass is 65 kg. If the pedal makes an angle of 35⁰ above the horizontal, and the pedal is 18 cm from the center of the change ring, how much torque would you exert?
2. If the pedal in the previous problem is horizontal, how much torque would you exert? How much torque would you exert when the pedal is vertical?
3. Ashok, whose mass is 43 kg, sits 1.8 m from a pivot at the center of a seesaw. Steve, whose mass is 52 kg, wants to seesaw with Ashok. How far from the center of the seesaw should Steve sit?
4. A bicycle-chain wheel has a radius of 7.70 cm. If the chain exerts a 35.0 N force on the wheel in the clockwise direction, what torque is needed to keep the wheel from turning?
5. Two people are pulling on ropes wrapped around the edge of a large wheel. The wheel has mass of 12 kg and a diameter of 2.4 m. One person pulls in a clockwise direction with a 43 N force, while the other pulls in a counterclockwise direction with a 67 N force. What the net torque on the wheel?
	1. **PRACTICE PROBLEMS**
6. What would be the forces exerted by the two sawhorses if the ladder in Example Problem 5 had a mass of 11.4 kg?
7. A 4.5 m long wooden plank with a 24 kg mass is supported in two places. One support is directly under the center of the board, and the other is at the end. What are the forces exerted by the two supports?
8. A 85 kg diver walks to the end of a diving board. The board, which is 3.5 m long with a mass of 14 kg, is supported at the center of mass of the board and at one end. What are the forces on the two supports?
9. Give an example of an object for each of the following conditions.
10. rotational equilibrium, but not translational equilibrium
11. translational equilibrium, but not rotational equilibrium
12. Can the center of mass of an object be located in an area where the object has no mass? Explain.
13. Why is a modified vehicle with its body raised high on risers less stable than a similar vehicle with its body at normal height?
14. Where is the center of mass on a roll of masking tape?
15. Why does a gymnast appear to be floating on air when she raises her arms above her head in a leap?

**PHYSICS 2021 - 22** LAB ACTIVITY

**Paper Airplane Mini-Project**

**http://sciencefair.math.iit.edu/projects/airplane/**



**Objective**

To test and conclude the best designs for paper airplanes with respect to flight time, distance, and accuracy.

**Concept**

There are numerous designs of paper airplanes. Each design is unique and alters the plane's flight. Some are made for distance, others for flight time, and some for accuracy. We will test these different models to see what planes are really the best. Use designs that you know of or find online *(*[***www.bestpaperairplanes.com***](http://www.bestpaperairplanes.com/)*suggested).*



**Materials**

* Several pieces of 8 1/2" x 11" paper
* Scissors
* Hula hoop
* String
* Stopwatch
* Measuring tape

**Safety Note:** Be aware of others around you when you are throwing these airplanes. Some designs have a sharp nose and can fly very fast.

**Hypothesis**

When you have all of your plane choices, guess which design will fly the farthest, for the longest time, and with the most accuracy.

**Procedure**

1. Working in pairs or threesomes, research how to design the most suitable paper airplanes for each of the criteria listed above (ie. for distance, for duration of flight and for accuracy).
2. Make all of the paper airplanes that you plan on using (min. of 3). Label them.
3. In an open area with plenty of room to fly, throw all of the planes and **record the distance** that they flew. Repeat this until you have 5 - 10 trials for each plane.
4. After you have finished with the distance, get your stopwatch for the timed flight portion.
5. Hold the stopwatch in one hand and the paper airplane in the other hand. Start the timer as you release the airplane from your other hand. Stop the timer as the plane hits the ground. **Record the times** and repeat until you have 5 trials for each plane.
6. For the accuracy portion of the experiment, tie one end of the string to the hula hoop and the other end to something to hang from (basketball hoop, tree branch, etc.)
7. Stand about 15-20 feet away from the hanging hula hoop.
8. For each plane, throw it at least 15 - 20 times to try to get it to fly through the hula hoop. Record the number of times that each plane successfully makes it through the hula hoop.
9. Try different throwing techniques during each procedure to find the best way to throw each plane for each aspect you are going for (ex: try throwing fast, slow, throw with some angle, etc.). Record your observations.
10. Prepare a Lab Report at the conclusion of the lab. Use Lab Template.
11. Prepare Presentation Slides to review your experiment and discuss the physics behind the mechanics and functioning of a paper airplane.

**Results**



a) For the first and second parts of the procedure, average out the distances and times for each plane.

b) Make three graphs: one with the distances for each plane, one for the times of each plane, and one for the number of times that each plane made it through the hula hoop.

c) How do the results for each plane compare?

d) Any exceptionally good or bad planes?

e) Was your hypothesis correct?

f) Why do you think the best planes performed as well as they did?

**Discussion**

Use your knowledge of conceptual physics, which you have learned to date (ie. the mechanics of physics: *motion, velocity, acceleration, effect of gravity/drag force/fluid forces/forces of friction, Newton’s Laws of Physics, and forces in two dimensions*)

You will need to prepare a short Power Point Presentation discussing your airplanes’ designs and why they were most suited for the criteria detailed in the hypothesis section.

You will be assessed not only on the design features of your airplanes but also in the explanation of the integration of the concepts covered in class as to each of the planes’ performance.

**Extension**

* Can you create your own paper airplane design that is better than the planes that you used in the experiment?
* What if you were allowed to have attachments on the planes? How would these affect the performance of your plane?
* What would work best to improve the results of any of the planes? Explain in detail.