GreatHearts®

Physics I

May 18 – May 22

Time Allotment: 40 minutes per day

Student Name: ________________________________

Teacher Name: ________________________________

Packet Overview

Date	Objective(s)	Page Number
Monday, May 18	Angular Quantities Review	1-3
Tuesday, May 19	Angular Quantities Review	4-5
Wednesday, May 20	Mechanical Waves Review	6-9
Thursday, May 21	Reading Isaac Newton's General Scholium	10-13
Friday, May 22	Minor Assessment	14-17

Academic Honesty

I certify that I completed this assignment independently in accordance with the GHNO Academy Honor Code.

Student signature:

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I certify that my student completed this assignment independently in accordance with the GHNO Academy Honor Code.

Parent signature:

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Physics I
May 18 – May 22

Monday, May 18

Physics Unit: Rotational Motion
Lesson 1: Review of Angular Quantities
Requirements: Complete the guided worksheet below.

Objectives: Be able to do this by the end of this lesson.

1. Define rigid object, axis of rotation, and radian.
2. Convert radians to degrees, and degrees to radians.

Introduction to Lesson 1: For this first review day, I'd like us to take a look back at Section 8-1. We saw a lot of amazing physics that you can do with rotational motion (moment of inertia, angular momentum, wowing Mr. Donoho, etc.), but I think the most important lesson from Chapter 8 is the fundamentals. Let's spend some time today looking back at those foundational concepts to see how far we've come.

The reading for Lesson 1 will be **pages 194-195** in the Giancoli text provided in this packet. Read these pages carefully, and then fill out the worksheet below.

1. Define a <u>rigid body</u> –

2. Define the <u>axis of rotation</u> –

In the space below, draw figure 8-1(a). Label all points and angles.

Now find the axis of rotation for the circle. Put your pencil on the point. Imagine the circle rotating around your pencil tip. That is the axis of rotation. Amazing! Draw an 'x' at this point.

3. How do we indicate how far an object has rotated?

4. A point *P* moves through an angle θ when it travels ____

____.

5. The mathematics of circular motion is much easier if we use ____________________________ for angular measure.

6. Define a <u>radian</u> –

Draw Figure 8-1(b) in the space below and label all parts.

7. Write Equation **(8-1a)** in the space below.

8. What will theta equal if the arc length is equal to the radius? ________ rad (always use this unit!)

9. Explain why an arc length equal to the circumference of a circle is $l = 2\pi$.

10. Show the steps demonstrating that $\theta = 2\pi$ rad in a complete circle.

Finally, do Problems 1-4 on p. 219.

1.

2.

3.

4.

Tuesday, May 19

Physics Unit: Rotational Motion
Lesson 2: Angular Quantities Review

Objective: Be able to do this by the end of this lesson.
1. Define constant angular acceleration.
2. Write the kinematic equations of rotational motion. Identify which variables are different but have the same function as the ones in the kinematic equations of linear motion.

Introduction to Lesson 2: The reading for Lesson 2 will be **p.201** in your physics textbook. What is motion? Do we need to broaden our definition of motion to include rotating bodies? Think about this: Newton's First Law tells us a body in motion stays in motion unless acted upon by an outside force. What if I'm spinning a tennis ball on a frictionless table but not rolling the ball across the table? Is it moving? Will it take an outside force to stop the ball rotating? Do we then need to include rotation into Newton's Laws of Motion?

Remember these quantities? Fill them in and look back at 8-1 if you need help.

θ -

ω –

α -

2. Make a table of equations like the one on the top of p. 201. Write down the linear equations of motion first in the right-hand column. Remember them from Quarter 1? Now write down the angular equations found in the left-hand column.

3. Look at the two columns you made. What do the two sets of equations have in common? Which variables are substituted when we move from the linear equations to the angular ones?

Finally, do Problems 15-17 on p. 219.

15)

16)

17)

Wednesday, May 20

Physics Unit: Vibrations and Waves
Lesson 3: Deriving the Wave Equation

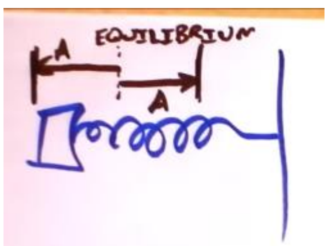
Physics Unit: Vibrations and Waves

Lesson 1: Deriving the Wave Equation

Requirements: Follow the instructions on the guided worksheet below. Optional: Much of this lesson comes from Doc Schuster's YouTube video titled, "Simple Harmonic Motion Introduction" that you can watch here: https://www.youtube.com/watch?v=iNDRQnhIMK8&list=PLLUpvzaZLf3K-Tl6n_GD3ZEebgQ83QynE

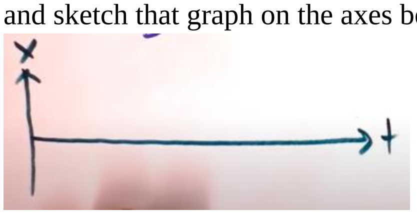
Objectives: Be able to do this by the end of this lesson.
1. Graph the motion of a mass on a spring being pulled back and released.
2. Model that motion with the cosine function.
3. Derive an equation to relate the position and time of the moving mass.

Introduction to Lesson 3: This is such an important concept to learn in Physics I to take to Physics II that I am once again asking you to work through it. If you didn't get it the first time a few weeks ago, now is your chance to master it. Please come to guided instruction to ask about this if you're still confused.

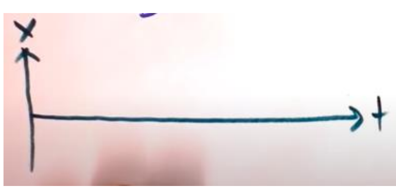


Take a look at this drawing of a spring attached to a wall on the right and mass on the left. When you leave it alone, it stays at an equilibrium position. When you pull it or push it, the distance you pull or push is giving the spring an amplitude, **A**.

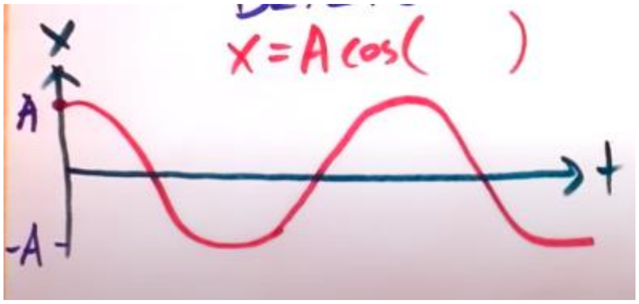
1. Say we pull the mass on the spring to the right and plot its back and forth motion on a graph. Go ahead and sketch that graph on the axes below:



2. Now say we pull the mass on the spring back twice as far and thus double the amplitude. Sketch that graph on the axes below. Feel free to extend the x-axis to fit your graph.

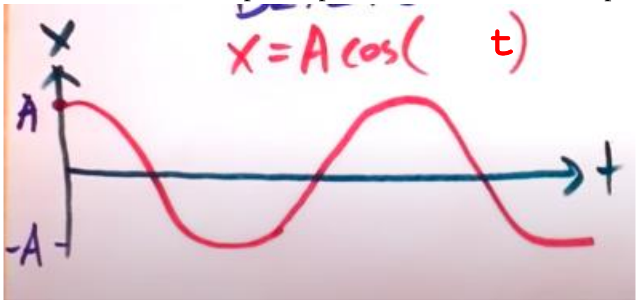


3.



Hopefully the shape of your graph looks something like this, and you can see that we're using the cosine function. We can make the function "taller" by multiplying by a number greater than 1. We can also make it "shorter" by multiplying by a number less than one. This is what the amplitude A does. Now what needs to go inside the parentheses? Take a guess and write something inside of them. Hint, think about what the function takes as its input (time), and how to express that input in radians.

4.To decide what to put in parentheses, we need to put in *t*, because the output, *x*, depends on time.

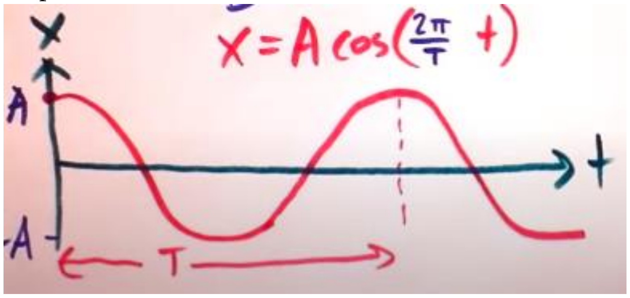


But we've got a problem because we want our final output, x, to be a measure of displacement, which does not include time. How can we cancel time? We can multiply time by a fancy version of 1, in this case, $\frac{2\pi}{T}$. Go ahead and write that to the left of the t in the parentheses in the equation above.

5. Let's make sure this works. In the space below, write what happens to $x = A\,cos(\frac{2\pi}{T}t)$ when t = T. What is cos (2π) ?

6. Do the same thing, except write what happens to $x = A\,cos(\frac{2\pi}{T}t)$ when t = 2T.

7. So this equation works. Whenever we plug in any integer number times T for t, we get a multiple of 2π, which “resets” the cosine wave and gives us the local maximum point, which is the magnitude of the amplitude.



$x = A\,cos(n2\pi)$, where n is any integer. Then, x = cos (n2π) will equal 1, and x = A.

Try it out! Plug in 2, 3, 4, and 10 for n in x = cos (n2π) in the space below and write the number you get. Did you get the same answer for all of them?

8. Let’s go back to $x = A\,cos(\frac{2\pi}{T}t)$. What is the $\frac{2\pi}{T}$ part? Look familiar? Take a guess, and then read below.

We haven’t seen exactly this form before, but what we’re looking at is a measure of radians over time, or angular velocity. Because we’re looking at bit T, or period, and not little t, or time, we’re going to call $\frac{2\pi}{T}$ **angular frequency**. We’ll use the same symbol ω (omega) for angular frequency. For the last item of the day, in the space below, substitute ω in for $\frac{2\pi}{T}$ and rewrite the wave equation $x = A\,cos(\frac{2\pi}{T}t)$ above.

Congratulations, you’ve just derived the wave equation: one of the most important equations describing the position of a wave in terms of time!
Do Problem 1 on p. 317.

Do Problem 3 on p. 317.

Do Problem 21 on p. 317.

Thursday, May 21

Physics Unit: Readings from Newton
Lesson 4: A Selection from the General Scholium of Isaac Newton's *Principia Mathematica*
Requirements: Read and annotate the passage. Complete the guided worksheet below.

Introduction to Lesson 4: Isaac Newton, Aristotle, Ptolemy, Galileo, and Lucretius have been the five philosophers who have guided us through some of the philosophical foundations of physics we have explored in this class. From Newton's work the *Principia Mathematica*, we read his preface to the reader, his definitions, and his laws of motion, located at the beginning of his text. As we are now at the end of our course, it seems fitting for us to read some passages from the last chapter in his work, the General Scholium. Here, Newton tries to tie together the theoretical basis for his law of universal gravitation to the astronomical observations and observations of the ocean tides on Earth he made, confirming his theory. He also asks these questions: What is gravity? Where did it come from? What is it's root, it's source? These are the big questions Newton grapples with in his final chapter of his work. Hopefully these are questions that you also have, after having studied gravitation for most of the year. As you read, keep our guiding quote for the year from Albert Einstein in mind: "One cannot help but be in awe when he contemplates the mysteries of eternity, of life, of the marvelous structure of reality. It is enough if one tries merely to comprehend a little of this mystery each day."

From Isaac Newton's General Scholium

The six primary Planets are revolved about the Sun, in circles concentric with the Sun, and with motions directed towards the same parts and almost in the same plane. Ten Moons are revolved about the Earth, Jupiter and Saturn, in circles concentric with them, with the same direction of motion, and nearly in the planes of the orbits of those Planets. But it is not to be conceived that mere mechanical causes could be caused by so many regular motions: since the Comets range over all parts of the heavens, in very eccentric orbits. For by that kind of motion they pass easily through the orbits of the Planets, and with great rapidity; and in their aphelions, where they move the slowest, and are detained the longest, they recede to the greatest distances from each other, and thence suffer the least disturbance from their mutual attractions. This most beautiful System of the Sun, Planets, and Comets, could only proceed from the counsel and dominion of an intelligent and powerful being. And if the fixed Stars are the centers of other like systems, these, being formed by the like wise counsel, must be all subject to the dominion of God; especially since the light of the fixed Stars is of the same nature with the light of the Sun, and from every system light passes into all the other systems. And lest the systems of the fixed Stars should, by their gravity, fall on each other mutually, He hath placed those Systems at immense distances from one another.

Hitherto we have explained the phenomena of the heavens and of our sea, by the power of Gravity, but have not yet assigned the cause of this power. This is certain, that it must proceed from a cause that penetrates to the very centers of the Sun and Planets, without suffering the least diminution of its force; that operates, not according to the quantity of surfaces of the particles upon which it acts, (as mechanical causes use to do,) but according to the quantity of the solid matter which they contain, and propagates its virtue on all sides, to immense distances, decreasing always in the duplicate proportion of the distances. Gravitation towards the Sun, is made up out of the gravitations towards the several particles of which the body of the Sun is composed; and in receding from the Sun, decreases accurately in the duplicate proportion of the distances, as far as the orb of Saturn, as evidently appears from the quiescence of the aphelions of the Planets; nay, and even to the remotest aphelions of the Comets, if those aphelions are also quiescent. But hitherto I have not been able to discover the cause of those properties of gravity from phenomena, and I contrive no hypotheses. For whatever is not deduced from the phenomena, is to be called an hypothesis; and hypotheses, whether metaphysical or physical, whether of occult qualities or mechanical, have no place in experimental philosophy. In this philosophy particular propositions are inferred from the phenomena, and afterwards rendered general by induction. Thus it was that the impenetrability, the mobility, and the impulsive force of bodies, and the laws of motion and of gravitation, were discovered. And to us it is enough, that gravity does really exist, and act according to the laws which we have explained, and abundantly serves to account for all the motions of the celestial bodies, and of our sea.

And now we might add something concerning a certain most subtle spirit, which pervades and lies hid in all gross bodies; by the force and action of which spirit, the particles of bodies mutually attract one another at near distances, and cohere, if contiguous; and electric bodies operate to greater distances, as well repelling as attracting the neighbouring corpuscles; and light is emitted, reflected, refracted, inflected, and heats bodies; and all sensation is excited, and the members of animal bodies move at the command of the will, namely, by the vibrations of this spirit, mutually propagated along the solid filaments of the nerves, from the outward organs of sense to the brain, and from the brain into the muscles. But these are things that cannot be explained in few words, nor are we furnished with that sufficiency of experiments which is required to an accurate determination and demonstration of the laws by which this electric and elastic spirit operates.

Please answer the following questions using complete sentences. And if you find you are particularly passionate about a question, feel free to grab some more paper to keep writing or come to guided instruction to chat about it!

1. What are the six primary planets Newton discusses?

2. Compare and contrast the motion of the planets and moons with that of comets.

3. Write the equation for Newton's universal law of gravitation (it's the one that has "big G" in it!). How can this equation describe the motion of planets, moons, and comets that you wrote about above?

4. How does Newton describe where the sun, planets, and comets came from?

5. What does Newton say about the distant stars? How does he know they are similar to our sun?

6. Newton says he can explain the phenomena of our solar system and the tides in the oceans by the laws of gravity. How does Newton describe how gravity works? What can gravity penetrate? What is required for gravity to exist? Where is it stronger? Where is it weaker?

7. Why do you think Newton says he doesn't know what the cause of gravity is?

8. What do you think the "spirit" is in the last paragraph? Name at least 5 properties of this spirit that Newton mentions.

"But these are things that cannot be explained in few words, nor are we furnished with that sufficiency of experiments which is required to an accurate determination and demonstration of the laws by which this electric and elastic spirit operates." And this is how the *Principia* and in turn our Physics I class ends: in mystery. What is this spirit? How does it cause signals to be sent from the brain to muscles to allow animals to move? How does it generate heat and light and electrical effects? Is this spirit anything like gravity? Well, these are all Physics II questions and questions that physicists after Newton will try to answer!

Friday, May 22

Physics Unit: Review
Lesson 5: Minor Assessment
Requirements: Take the minor assessment that follows on the next page.

Introduction to Lesson 5: Take 10-15 minutes to study for the minor assessment on this review week's packet work. When you're ready, flip over to start.

Physics I – Minor Assessment on Review Packet Name: ___________________________

1. Draw the graph of a mass on a spring pulled back and then released. How many radians does the graph "restart"?

2. Write the equation for the force exerted by a spring. What does the minus sign indicate? What is the proportionality constant?

4. A 0.5kg grapefruit oscillates from a vertically hanging light spring once every 2.7s. Write the equation giving the weight's position *y* as a function of time, assuming it started by being compressed 0.58m from the equilibrium position (where y = 0) and released. The following equations may be helpful.

$f = \frac{1}{T}$, $\omega = 2\pi f$, $Y = A\cos \omega t$

5. Write the equations that these quantities are equal to:

θ =

ω =

α =

6. The blades in a blender rotate at a rate of 6500rpm. When the motor is turned off during operation, the blades slow to rest in 3.0s. What is the angular acceleration as the blades slow down?

7. What was the most important or valuable thing you learned in physics this year? This is an open-ended question. You can also say what your favorite thing we did in class was, or what you thought was most wonderful.