Schedule

Topics

Demos

Labs

Questions

ToDos

Week 1

Day 1: Inertia

26 February 2024

■ Prep

1. Set up grade book
2. Print Day 1 docs
3. Get MLB DuoTangs
4. Get Readers
5. Set up demos and labs; Check stop watches and batteries

UTC is 3 hours behind ADT and 10 hours ahead of EST.

■ Opening

- Verse and attendance
- Opening questions and HW check

Opening questions

1. **What is inertia, and where does it come from?**
2. **Is inertia related to gravity?**
3. **How does friction affect inertia?**
4. **Where does inertia go when it disappears?**

■ New

☐ Topic: Class goals and expectations

1. Assign Readers
2. Hand out MLB Binders
3. Review Syllabus and Lab Safety Guidelines
    1. Attendance, preparation and timeliness
    2. Seating and breaks
    3. Lab safety, cleanup, and emergencies
    4. Opening and closing questions, and quizzes
    5. Topics and demos
    6. Labs and projects
    7. Student notes, homework, and MLB pages
    8. Readers

∡ Demo 1: Objects at Rest Tend to Stay at Rest

Materials

- 1 – steady surface, such as a flat desktop
- 2 – pieces of satin cloth
- Large number of toilet paper rolls

Procedures

1. Lay one cloth on table. Might help to tape it down. This cloth helps reduce friction.
2. Lay second cloth over first.
3. Place pile of toilet paper rolls on cloth.
4. Confirm Aristotle's conclusion that the natural state of all objects is rest.
    1. Slowly pull on the top cloth to move the TP tower.
    2. Note how as long as you pull, the tower moves too, but as soon as you stop, the tower stops moving.
5. Confirm that all objects resist movement.
    1. Pull the top cloth fast. (TP rolls resist motion.)
    2. Increase height of TP tower.
6. If students are interested, set up two towers and have students compete to see who can keep the tallest tower stationary.

Observations

1. From Aristotle's point of view, why does the TP stay at rest?
2. From Aristotle's point of view, why does the TP move when pulled slowly?
3. Common sense and everyday experience seem to confirm that Aristotle was right, i.e., that the natural state of all objects is at rest, unless either another object moves them or the "unmoved mover" causes movement.

Conclusions

1. Do Aristotle's ideas make good sense? Why or why not?
2. What reasonable evidence supports Aristotle's ideas?
3. Can you think of any other exceptions to Aristotle's ideas besides stars and falling objects?
4. Do Aristotle's ideas make good sense? Why or why not?
5. Does the idea of an "unmoved mover" seem reasonable? (Perhaps by a different name?)
6. If the an "unmoved mover" does not seem reasonable, how would you answer such fundamental questions as:
    1. Why is there something rather than nothing?
    2. How did something begin, and what was there before something?
    3. If we think there was something before something (the "unmoved mover", God, the Word, the void, etc.), what was there before that?

∡ Demo 2: Inertia of Objects in Motion

Materials

1. Big inertial ramp (2×4)
2. Various balls (bowling, metal, glass, pong pong, tennis…)
3. Vacuum or hair dryer (for air pressure)
4. Plenty of flat space for balls to keep rolling

Procedures

1. Set up ramp at about 15 degree angle, and plenty of space for ball to keep rolling after leaving the ramp.
2. Roll various balls down the ramp, and observe them until they stop.
3. Use air pressure to affect the speed or direction.

Observations

1. Why do the TP rolls stay still?
2. From Aristotle's point of view, why do the balls roll down the ramp, and why do they stop after a while?
3. What is motion?
4. What is inertia?
5. What is resistance?
6. Is there a relationship between speed and inertia? If so, what is it?

Conclusions

Inertia is the tendency of an object to stay at rest if it is at rest, or to stay in motion if it is in motion."

☐ Topic: Galileo's Inclined Plane Experiment

While under house arrest for daring to challenge the Roman Catholic world view, Galileo wrote down a description of the inclined plane experiment that led him to his "radical" views. In his day, people did not have the technology to time falling object accurately. Galileo hoped (correctly) that the physical rules for objects falling vertically would be the same as for objects rolling (or falling) at an angle down a ramp — as long as the motion was uniform (in a straight line), air resistance was negligible, and friction from the ramp was minimized.

More or less in Galileo's own words, here's what he did:

"In a wooden beam or rafter about twelve *braccia* (yards) long, half a *braccia* wide, and three inches thick, a channel was rabbeted in along the narrowest dimension, a little over an inch wide, and made very straight; so that this would be clean and smooth, there was glued within it a piece of vellum, as much smoothed and cleaned as possible. In this there was made to descend a very hard bronze ball, well rounded and polished, the beam having been tilted by elevating one end of it above the horizontal plane from one to two *braccia*, at will. As I said, the ball was allowed to descend along the said groove, and we noted (in the manner I shall presently tell you) the time that it consumed in running all the way, repeating the process many times, in order to be quite sure as to the amount of time, in which we never found a difference of even the tenth part of a pulse-beat."

Note

1. The ratio of beam length to height was about 12 to 1.
2. Galileo measured time by the pulse of his heart.

$\sum$ Lab 1: Galileo's Inclined Plane Experiment

Purpose

To reproduce Galileo's inclined plane experiments for slowing down the effect of gravity on falling objects so that it will be easier to measure acceleration due to gravity.

Lab Teams

1. Divide the class into teams of two - three students.

Materials (per group)

1. L-track (inclined plane)
2. 2 or more different sized metal balls
3. Electronic stopwatch
4. Ruler and pencil
5. Clamp stand and clamp
6. Ball catcher (paper cup, etc.)

Procedures

1. Choose which end of the L-track you will elevate, and mark it. (Careful! Elevating the wrong end after you've marked the L-track can cause errors.)
2. Carefully measure the L-track at 1 foot increments beginning at the end you choose to elevate. If the L-track is already marked, check all marks for accuracy.
3. Clamp the elevated end of the L-track to the clamp at a height less than 6 inches. (Lower heights cause the balls to roll more slowly, enabling more accurate measurements.)
4. Working one at a time with each of the 1-foot marks, measure the time it takes for a ball to reach the mark. To ensure accuracy, each measurement at each mark should be repeated at least five times, and an average reading taken. Throw out any measurements that seem inaccurate.
5. As each accurate reading is taken, record it in a table.
6. Once you have at least five accurate measurements at one of the marks, move on to the next mark using the same ball and keeping the ramp at the same angle.
7. Repeat the entire procedure for a second ball of a different size and with the ramp still at the identical height/angle.
8. Change the ramp elevation to a different height, and repeat all the above steps.

Observations

1. For each ball type, plot two graphs on grid paper.
2. The origin of both graphs is 0 seconds (horizontal axis) and 0 feet (vertical axis). This allows us to begin the data starting from the position of rest (zero motion).
3. On the first graph, mark the horizontal axis in time (rounded tenths of a second).
4. On the second graph, mark the horizontal axes in time^2.
5. On both graphs, the vertical axes are marked in feet from 0 to 5 (or more if your ramp was long enough).

First elevation

All times in seconds (tenths & hundreths)	Table of Results												
	Height of Ramp =												
	First ball (description):							Second ball (description)					
Foot Mark >	0	1	2	3	4	5		0	1	2	3	4	5
Time 1	0							0					
Time 2	0							0					
Time 3	0							0					
Time 4	0							0					
Time 5	0							0					
Average Time	0							0					
(Average Time)^2	0							0					

Second elevation

All times in seconds (tenths & hundreths)	Table of Results												
	Height of Ramp =												
	First ball (description):							Second ball (description)					
Foot Mark >	0	1	2	3	4	5		0	1	2	3	4	5
Time 1	0							0					
Time 2	0							0					
Time 3	0							0					
Time 4	0							0					
Time 5	0							0					
Average Time	0							0					
(Average Time)^2	0							0					

Conclusions

1. What seems to affect the accuracy of your measurements? Carefully note any sources of error.
2. How does gravity affect motion?
3. What is the relationship between distance and time^2?
4. Write up you report on a separate sheet following standard lab report directions.

∡ Demo 1: Roller Coaster

After observing how all objects sooner or later fall to the ground and come to rest, Aristotle, an ancient Greek philosopher. stated that an object's natural state is at rest. Galileo challenged this with the idea of "Inertia", the tendency of an object to to resist change to it's current motion. He observed that if an object is in motion, it stays in motion in a straight line unless a force interferes with it's motion or direction, and that an object at rest remains at rest unless a forced causes it to move.

1. Adjust to various heights to find the point at which the ball balances in the second hump. Measure and compare the heights.
2. Questions:
   1. Why does the ball rise up the second hump? Inertia. An object in motion stays in motion unless a force alters its direction.
   2. Why must the second height be lower? Friction from air and the ramp surface.
   3. Why do some balls travel further up the second hump than others? Greater mass = greater momentum.

■ Closing

Closing questions

Today's Assignments		**Due**	✓
ℍ𝕎	Read Syllabus and Lab Safety Guidelines	Next class	
ℍ𝕎	Review and edit today's journal entries	Next class	
ℍ𝕎	Lab 1 Report: Galileo's Inertial Ramp Experiment	Wednesday	

Day III Assignments		**Due**	✓
ℍ𝕎	Lab 1 Report: Testing how to create an ass list.	Wednesday	

More Information

Day 2: Galileo and the Birth of Modern Science

27 February 2024

■ Prep

1. Copy Opening Questions Quiz

■ Opening

1. Verse and attendance
2. Opening questions and HW check

Opening questions

1. **What is motion?**
2. **What causes motion?**
3. **Why is there something rather than nothing?**
4. **How can nothing create something. But if there was always something, where did something come from?**
5. **What is reality made of?**
6. **What is matter, time, space, energy, life, consciousness...?**
7. **What is real and true?**
8. **How do we know if an idea is real, true, accurate, complete...?**
9. **Is reality predictable? If it is not predictable, how would we know?**
10. **Is there anything ”outside” of the universe? How can we find out?**
11. **Was there anything ”before” of the universe? How can we find out?**
12. **What is consciousness? Is is a part of matter?**
13. **If something/someone created the universe, what created that (ad absurdum)? Is it turtles all the way down?**
14. **How can we answer these kinds of questions?**
15. **Are there questions about reality that can never be answered? If so, how can we tell the difference between answerable and unanswerable questions?**
16. **What is the best way to find good answers to questions that can be answered?**

■ Review

☐ Topic: Lab 1 Conclusion

1. Inertia is the tendency of any object to resist change in it's state of motion. If it is at rest, it remains at rest. If it is in motion, it remains in motion in a straight line unless acted upon by another force.
2. Inertia is a function of mass. The greater an object's mass, the more force is needed to overcome inertia.
3. Example: Place a heavy brick on your hand and hit it with a hammer. The brick will resist movement, and your hand won't be hurt (hopefully).
4. Review plots on board:
    1. $Distance = y$ and $Time = x$
    2. $Distance = y$ and $Time = x^2$
    3. Conclusion: Acceleration is uniform, and distance is directly proportional to t^2. If a continuous force (such as gravity) is applied to an object, then velocity increases as a function of time.
5. Clarify precision vs. accuracy

■ New

☐ Topic: Early Ideas About Inertia

1. Chinese and water pumping
2. Arabic Golden Age

☐ Topic: Aristotle's Ideas About Motion

Aristotle (384 BCE – 322 BCE), one of the great ancient Greek philosophers

He observed that the cause must itself be in motion for it to induce a motion in something else: a stationary object cannot induce another to move.

1. The long term stable state of all objects is at rest.
2. Motion needs a cause to make it happen.
3. Continuous motion needs a continuous cause.
4. There is an unseen property of air that keeps the arrows flying.

Aristotle extended these ideas by arguing that, since all observed motion in nature is movement caused by another object that is itself in motion, there must be a primordial "unmoved mover" that is the seed cause behind all motion. He drew parallels between the concepts of "unmoved mover", "active intellect", and "God". It seems that for almost all terrestrial motion experienced by humans, there is nothing logically wrong with these observations — with two major exceptions:

1. the motion of falling objects toward the unmoving Earth, and
2. the motion of living things which seem to move of their own will without the help of another moving object.

Aristotle's explanation for these exceptions was based on the ancient belief that there is one set of rules for everything on earth and another set for the heavens.

"Even though the motion of heavenly bodies seems to be unceasing and uncaused,
they are kept in motion by the unmoved mover".

Because the idea of an "unmoved mover" seemed to support Christian theology, Aristotle's ideas were incorporated into official dogma by the Roman Catholic Church. For thousands of years, any deviation from church dogma was punishable by torture and/or death.

☐ Topic: Galileo's Thought Experiment

1. Aristotle said that objects fall at a rate proportional to their weight. (Everyday experience tells us that heavier objects fall faster.)
2. Imagine two objects of unequal weight tied together.
3. If objects fall at a rate proportional to their weight, then by being tied together they should weigh more and fall faster.
4. But, if one object is lighter than the other, then it should fall slower and hold the other back.
5. You can't have it both ways.

☐ Topic: Philosophy of Science

The Scientific Method

1. **Observations:** wonder, curiosity, questions, ideas…
2. **Hypythesis:** Develop a **testable** hypothesis that can explain the observation. A testable hypothesis must testable using empirical evidence, which is:
    1. **Observable:** If we can't see, then we can only believe in it. There is no why to know for sure. (This DOES NOT mean that it's not true!)
    2. **Measurable (Quantifiable):** If we can measure our observations, then we can describe them with more precision. Precise descriptions are easier to repeat with accuracy. This is why math is the language of science.
    3. **Repeatable:** A phenomenon that only occurs once may be very real and important, but it can not be tested and therefore falls outside the bounds of the scientific method.
3. **Test:** Develop a test to prove or disprove the hypothesis.
    1. Perform the test enough times to be sure the results are relevant and accurate.
    2. If the results support your hypothesis, publish your results for others to verify.
    3. If the results do not support your hypothesis, develop a new hypothesis and begin again.
4. **Peer Review:** By publishing detailed and accurate descriptions of our experiments, others can repeat the process to verify, correct, refute, or build on our work.
5. **Scientific Fact:** If the hypothesis survives peer review, it may become a "scientific fact".
6. **Scientific Theory:** If the hypothesis appears to be true in all known situations (or at least more true than any other hypothesis), it may become a "scientific theory".
7. **Scientific Law:** If a scientific theory seems to be absolutely true for all known situations everywhere in the universe, and if it is fundamental to our understanding of reality, it may elevated to a "scientific law". Scientists are very reluctant to create scientific laws, and in fact there are not very many. In other words, there are few theories that the scientific community is so absolutely sure of that they are willing to call them "laws of the universe".

Avoiding Error

The Scientific Method has evolved over time, and there are many ways it can be described. The only purpose is to help us to help us avoid errors. Each step in the process is designed to avoid or identify potential errors. As society evolved, new steps were added and the rules changed, but the underlying goal remains the same: identify and avoid errors.

Causes of Error

No one is exempt.

1. **Biases:** pride, prejudice, greed, ego, tradition
2. **Assumptions:** thinking we already know
3. **Ignorance:** ("ignoring truth"): limits of our understanding

Terms

Scientific Method
: TK

Hypothesis
: A proposed and testable explanation for a particular natural phenomenon

Empirical Evidence
: Observable, measurable/quantifiable, repeatable.

Scientific Theory
: An explanation of the natural world that can be repeatedly tested and verified using the scientific method. Scientific theories are not guesses, but rather reasonable explanations for how a certain natural phenomenon works.

Confirmation Bias
: Humans like to to believe that their own ideas and opinions are correct. We are inclined to seek evidence that supports our opinions, and ignore or discount evidence that challenges or contradicts our opinions. This means that we have a bias toward evidence that confirms what we already believe to be true.

Falsification
: A primary goal of science is to identify ideas that evidence shows to be false and replace them with hopefully better ideas. This is done by setting up experiments that attempt to prove an idea wrong. Falsification in scientific practice is significant because it counteracts are natural tendency toward confirmation bias. Science fights against this cognitive tendency by encouraging individual scientists to think critically about their own work, and through the process of peer review for the scientific community to be skeptical of any claim until it is supported by solid evidence.

Scientific Law
: Implies that there is a causal relationship involving the elements of a system. Laws differ from scientific theories in that they do not include an explanation. The applicability of a law is limited to circumstances resembling those already observed, and the law may be found to be false when extrapolated. Like theories and hypotheses, laws make predictions; specifically, they predict that new observations will conform to the given law. In science, nothing is certain; long established laws can be falsified if they contradict new data.

Example: Newton's Three Laws

1. **Law of Inertia:** An object at rest or in uniform motion will continue to be at rest or in uniform motion until and unless a net external force acts on it.
2. The acceleration of an object is directly proportional to the magnitude of the net force and inversely proportional to the object's mass.
3. **Law of Conservation of Energy:** There is an equal and opposite reaction for every action.

■ Closing

Closing questions

1. **Why did Aristotle (and pretty much everyone else) think the natural state of all objects was at rest?**
2. **Why did Aristotle think there had to be an "unmoved mover"?**
3. **Can you think of any current examples of confirmation bias, whether in science, current events, politics, economics, wars, religion?**
4. **How does "confirmation bias" distort our views of reality, and how does the scientific method attempt to avoid this problem?**
5. **What caused Galileo to doubt Aristotle's ideas about motion?**

	Today's Assignments	**Due**	✓
$\mathbb{QZ}$	Early Ideas About Inertia	In class	
$\mathbb{HW}$	Journal Notes: Review and edit	Next class	

Day 3: Acceleration Due To Gravity

28 February 2024

■ Opening

1. Verse and attendance
2. Opening questions and HW check

Opening questions

1. **How are our ideas of mass and inertia related?**
   (a) In Newtonian physics, inertia is a function of mass.
   (b) In modern quantum physics, because it is difficult to calculate the exact mass of matter, the idea is reversed: The mass of an object is calculated using its measured inertia. Note that objects have the same inertia even in a vacuum.
2. **How does gravity reach through space; how far does it reach?**
   Gravity seems to reach across the entire universe, but it becomes weaker as it goes further from it's source.
3. **What are the similarities and differences between mass and weight?**
   (a) Diff: The mass of an object is the same everywhere, but the weight of an object is a function of the net gravity on the object.
   (b) Sim: The weight of an object is a function of its mass. The heavier an object the more it weighs within a field of gravity.
4. **What are the similarities and differences between the forces of gravity and magnetism?**
   (a) Sim: Both gravity and inertia are invisible forces.
   (b) Diff: Gravity attracts and never repels; magnetism has two poles, and can both attract and repel.
   (c) Diff: Gravity affects all matter; magnetism only affects matter capable of magnetic alignment.
   (d) Diff: All matter has gravity, but not all matter has magnetism.
   (e) Diff: Gravity is a function of mass, but magnetism is a function of the electrical alignment within atoms and molecules.
   (f) Diff: Magnetism is one manifestation of the electromagnetic field. The other is electricity. Magnetism and electricity always occur together.
   (g) Sim: Gravity extends across the entire universe; magnetism, as part of the electromagnetic spectrum, extends across the entire universe, for example as light energy.

■ Review

■ New

☐ Topic: Acceleration Due To Gravity

<u>**Terms**</u>

Inertia

The tendency of any object to resist change in it's state of motion. If it is at rest, it remains at rest. If it is in motion, it remains in motion in a straight line unless acted upon by another force.

Gravity

Gravity is fleating!

Motion

A change in position in space.

Time

One of the great mysteries of which we know very little. For now, we can simply imagine time as the flow of events and objects from the past, through the present, to the future.

Direct proportionality

If the ratio of x to y is a constant k, then x and y are directly proportional ($x \propto y$). The general formula is ($y = kx$), where k is the constant of proportionality. For example, in free fall the distance traveled is directly proportional to t^2, ($d \propto t^2$).

Speed

Distance traveled divided by the time traveled $s = \frac{d}{t^s}$.

Acceleration

A change in speed or direction (a).

Acceleration due to gravity

The same as Acceleration (a), but the variable (g) is usually used when dealing with gravity. At sea level on earth, this value is about 9.8067 $meters/seconds^2$. For most calculations it can be rounded to 9.8 $meters/seconds^2$ or 10 $meters/seconds^2$

Velocity

A vector quantity whose magnitude (size) is an object's speed and whose direction is the object's direction of motion (v).

∡ Demo 3: Electronically Measuring Acceleration due to Gravity

<u>**Purpose**</u>

To determine the constant value of acceleration due to gravity on earth near sea level (g) using light sensors.

Materials

- Vertical stand
- Electronic timer with two sensors
- Two small metal balls or marbles

Procedures

1. Set a ball in the clip.
2. Set one sensor on the vertical stand just below the clip.
3. Set the other sensor at 50 cm ($\frac{1}{2}$ *meter*) lower than the first.
4. Set the timer for "Interval" and "Reset" it.
5. Release the ball five times and record the intervals (in seconds).
6. Calculate the average time for all five drops.
7. Switch to a second ball of a different weight, and repeat.
8. Adjust the vertical stand to a different height, and repeat all steps for each ball.

Observations

1. Record your drop times in the table below.
2. Record the mass of each lead weight.
3. 1. Mass of ball 1: ______________________
4. Mass of ball 2: ______________________
5. Calculate the acceleration of gravity for each height and weight in $\frac{meters}{second^2}$.
6. Use $d = \frac{1}{2}at^2$ transformed into $\frac{2d}{t^2} = a$ to calculate your experimentally derived acceleration of gravity.

	Height 1		**Height 2**	
Time	**Weight 1**	**Weight 2**	**Weight 1**	**Weight 2**
Time 1				
Time 2				
Time 3				
Time 4				
Time 5				
Avg. Time				
Avg. Time^2				

$\sum$ Lab 2: Acceleration Due To Gravity

Purpose

To determine the constant value of acceleration due to gravity on earth near sea level (g) using weights and stop watches.

■ Closing

Closing questions

Day 4: Measuring Time and Motion

29 February 2024

■ Opening

1. Verse and attendance
2. Opening questions and HW check

Opening questions

■ Review

■ New

- Galileo, Clocks, Isochronous Time
- The idea of motion requires the concept of time.

Terms

Isochronous Time

A sequence of events is isochronous if the events occur regularly, or at equal time intervals. The term isochronous is used in several technical contexts, but usually refers to the primary subject maintaining a constant period or interval (the reciprocal of frequency), despite variations in other measurable factors in the same system. Isochronous timing is a characteristic of a repeating event whereas synchronous timing refers to the relationship between two or more events.

■ Closing

Closing questions

Day 5: Newton's First and Second Laws

1 March 2024

■ Opening

1. Verse and attendance
2. Opening questions and HW check

Opening questions

■ Review

■ New

■ Closing

Closing questions

Week 2

Day 6: Static Forces

4 March 2024

■ Opening

1. Verse and attendance
2. Opening questions and HW check

Opening questions

■ Review

■ New

■ Closing

Closing questions

Day 7: Design and Construction of Bridges

5 March 2024

■ Opening

1. Verse and attendance
2. Opening questions and HW check

Opening questions

■ Review

■ New

■ Closing

Closing questions

Day 8: Newton's Third Law

6 March 2024

■ Opening

1. Verse and attendance
2. Opening questions and HW check

Opening questions

■ Review

NEW

☐ Topic: Newton's Third Law Conservation of Energy

Newton's Three Laws

1. **Law of Inertia:** An object at rest or in uniform motion will continue to be at rest or in uniform motion until and unless an external force acts on it.
2. The acceleration of an object is directly proportional to the magnitude of the net force and inversely proportional to the object's mass.
3. **Law of Conservation of Energy:** There is an equal and opposite reaction for every action.

■ Closing

Closing questions

Day 9: Momentum

7 March 2024

■ Opening

1. Verse and attendance
2. Opening questions and HW check

Opening questions

■ Review

■ New

□ Topic: Momentum and Collisions

□ Topic: Momentum vs. Energy

■ Closing

Closing questions

Day 10: Elastic and Inelastic Collisions

8 March 2024

■ Opening

1. Verse and attendance
2. Opening questions and HW check

Opening questions

■ Review

■ New

☐ Topic: Elastic and Inelastic Collisions

∡ Demo 3: Newton's Cradle

Example of conservation of energy.

The energy is transfer from one ball to the next until it reaches the last ball.

Because there is no where to transfer the energy, the last ball takes on the momentum of the initial ball.

∡ Demo 4: Bouncing Balls

Conclusion

1. Example of kinetic energy. Energy is transferred through the ball from one side to the other.
2. A flat ball does not transfer the energy as efficiently; more of the energy is absorbed by other movements.

∡ Demo 5: Seismic Accelerator

1. Similar to Newton's Cradle, but the elastic balls have more kinetic energy.

Inertia is a function of mass. The greater the mass, the more force is required to overcome inertia.

The principle of inertia is one of the fundamental principles in classical physics. It is still used today to describe the motion of objects and how they are affected by the applied forces on them.

We don't actually know what mass or inertia are, or what causes them. All we can do is notice the phenomena, try to find patters, and give them names.

■ Closing

Closing questions

Week 3

Day 11: Potential and Kinetic Energy

9 March 2024

■ Opening

1. Verse and attendance
2. Opening questions and HW check

Opening questions

■ Review

■ New

■ Closing

Closing questions

Day 12: Centripetal Acceleration

12 March 2024

■ Opening

1. Verse and attendance
2. Opening questions and HW check

Opening questions

■ Review

■ New

☐ Topic: Centripetal Acceleration

∡ Demo 8: Down the Drain

Directions

1. Fill a sink with water. Although it isn't essential, the rounder the sink, the more obvious the effect.
2. Keeping the drain closed, stir the water around in one direction. To make the water's motion more visible, float a few small objects in it.
3. Wait until the water is barely moving, open the drain, and watch the action.
4. Repeat the process, now at first stirring in the opposite direction.

Conclusion

This is an example of the Conservation of Angular Momentum. Although it might be too slow to notice, the water already has some random motion before opening the drain. As the water moves toward the drain, its rotational motion is amplified, i.e., it starts swirling faster. The change in speed has to do with angular momentum, which is the product of three quantities:

1. the mass of the object
2. the radius of the object
3. the speed of the speed

$$\textit{Angular Momentum } = \textit{mass (kg)} \times \textit{radius (m)} \times \textit{speed (sec)}$$

Other Examples of the Same Effect

1. An ice skater spinning slowly with arms and leg extended begins to spin faster while pulling arms and leg in closer to the body.
2. Tornados and hurricanes—The air gets pushed toward the low-pressure region at the center, causing its circulation to speed up.
3. Tetherball—As the ball goes around, the rope winds around the pole, pulling the ball closer, which causes the ball to speed up.

4. Gymnast or diver doing a flip—After divers jump off diving boards, they tuck their bodies into a ball to increase the speed of rotation. Then they extend the body to slow down the rotation for the final plunge. Comet—As a comet orbits the Sun, its orbit is elongated, so it sometimes gets closer to the sun and sometimes farther away. As it gets closer, it speeds up; farther from the Sun, it slows down.

∡ Demo 6: Centrifugal Force

Directions

1. Hold spinning bicycle wheel and stand on rotating platform.
2. Turn bicycle wheel. You will rotate as rotational energy (or Centrifugal Force) is transferred from the wheel to you.

∡ Demo 7: Egg Game

1. A spinning egg can be kept in perpetual motion as long as the right amount of energy in the right direction is applied from outside the system.

■ Closing

Closing questions

Day 13: Theory of Flight

13 March 2024

■ Opening

1. Verse and attendance
2. Opening questions and HW check

Opening questions

■ Review

■ New

□ Topic: Physics of Flight

$\sum$ Lab : Paper Plane Contest

$\sum$ Lab : Frisbees

■ Closing

Closing questions

Day 14: TBD

14 March 2024

■ Opening

1. Verse and attendance
2. Opening questions and HW check

Opening questions

■ Review

■ New

■ Closing

Closing questions

Day 15: TBD

15 March 2024

■ Opening

1. Verse and attendance
2. Opening questions and HW check

Opening questions

■ Review

■ New

■ Closing

Closing questions

Week 4

Day 16: TBD

18 March 2024

■ Opening

1. Verse and attendance
2. Opening questions and HW check

Opening questions

■ Review

■ New

■ Closing

Closing questions

Day 17: TBD

19 March 2024

■ Opening

1. Verse and attendance
2. Opening questions and HW check

Opening questions

■ Review

■ New

■ Closing

Closing questions

{2024-03-20}

Day 18: Kepler's Three Laws

20 March 2024

■ Opening

1. Verse and attendance
2. Opening questions and HW check

Opening questions

■ Review

■ New

■ Closing

Closing questions

Day 19: Newton's Derivation of the Universal Force of Gravity

21 March 2024

■ Opening

1. Verse and attendance
2. Opening questions and HW check

Opening questions

■ Review

■ New

■ Closing

Closing questions

Day 20: Bridge Project Contest

22 March 2024

■ Opening

1. Verse and attendance
2. Opening questions and HW check

Opening questions

■ Review

■ New

■ Closing

Closing questions

Index

Glossary

acceleration A change in speed or direction (a).. 22, 50

acceleration due to gravity The same as Acceleration (a), but the variable (g) is usually used when dealing with gravity. At sea level on earth, this value is about 9.8067 $meters/seconds^2$. For most calculations it can be rounded to 9.8 $meters/seconds^2$ or 10 $meters/seconds^2$. 22, 50

ADT Atlantic Daylight Time. 10, 50

direct proportionality If the ratio of x to y is a constant k, then x and y are directly proportional ($x \propto y$). The general formula is ($y = kx$), where k is the constant of proportionality. For example, in free fall the distance traveled is directly proportional to t^2, ($d \propto t^2$).. 22, 50

EST Eastern Standard Time. 10, 50

gravity Gravity is fleating!. 22, 50

inertia The tendency of any object to resist change in it's state of motion. If it is at rest, it remains at rest. If it is in motion, it remains in motion in a straight line unless acted upon by another force.. 22, 50

Isochronous Time A sequence of events is isochronous if the events occur regularly, or at equal time intervals. The term isochronous is used in several technical contexts, but usually refers to the primary subject maintaining a constant period or interval (the reciprocal of frequency), despite variations in other measurable factors in the same system. Isochronous timing is a characteristic of a repeating event whereas synchronous timing refers to the relationship between two or more events.. 25, 50

isochronous time A sequence of events is isochronous if the events occur regularly, or at equal time intervals. The term isochronous is used in several technical contexts, but usually refers to the primary subject maintaining a constant period or interval (the reciprocal of frequency), despite variations in other measurable factors in the same system. Isochronous timing is a characteristic of a repeating event whereas synchronous timing refers to the relationship between two or more events.. 50

motion A change in position in space.. 22, 50

speed Distance traveled divided by the time traveled $s = \frac{d}{t^s}$.. 22, 50

time One of the great mysteries of which we know very little. For now, we can simply imagine time as the flow of events and objects from the past, through the present, to the future.. 22, 50

UTC Coordinated Universal Time. 10, 50

velocity A vector quantity whose magnitude (size) is an object's speed and whose direction is the object's direction of motion (v).. 22, 50