Days 1-6 - Let’s get started! Summer is over, folks!

Textbooks, Tardy/Cut Policy, Seating Chart (when?), “Cheap” scientific calculator

Website <http://ryono.net/index.html>

Website2 <http://members.fortunecity.com/jryono1>

Assignment (1) Find the website and bookmark it. (2) Download and install Acrobat Reader. (It’s free and allows you to read .pdf files (exams, notes, illustrations).) There is a link to the download on our website’s main page. Or go to www.adobe.com and check the bottom of the page for a yellow button. The download will take perhaps 20 minutes. (3) Look around the website using the sidebar. (4) Then show your parents our website and go to X-Files>Parent Information and obtain a parent signature saying they’ve read the warning about going on the internet. Or print out the parent information page and have them sign that.

Grading Policy (final exam, tests, quizzes, homework, classwork, class participation, extra credit) Classroom maintenance. Desks and equipment care and responsibilities. Under Class Business see The Rule Book!

Notes 1. **Sig Figs** - On a “Sig Fig Quiz” we say the area of a 3 meter by 4.1 meter rectangle is 1×10^1 m^2 (10 sq meters is a bit ambiguous since it isn’t clear to what ‘place’ we rounded, and 12 sq meters would presume 2 significant figures which is not correct). See the rules for multiplication/division and addition/ subtraction. Assuming we don’t need to ‘review’ sig figs, we will now institute our own set of sig fig rules for homework and tests. We will assume that all quiz data are accurate to 3 sig figs and allow answers to be rounded to as few as 2 sig figs. Now when we see 3m x 4.1m we’re thinking... 3.00 x 4.10 = $12.3m^2$ and we will also accept $12m^2$ (not $12.0m^2$) as an answer. (Now $10m^2$ dosn’t even get partial credit!) **Warning -** Losing a point for every insignificant digit could get expensive if you ever write 2/3 or .667 as .66666667 or even worse .666... (notice the meaning of the 3 dots!) or with a bar over a six!

2. **Rounding** - If we knew a number had only two sig figs and our calculator gave us an answer of 0.0145, would we round to .014 or .015? Rules such as ‘round up’ or ‘round to the even digit’ are arbitrary. I really don’t care which way you round but it probably should be random rather than always up or down. Without going into the details, it might be most practical to always round up. Another problem in rounding comes with the limited displays on calculators. For example, try entering 1.45×10^{-8} into an inexpensive calculator. Quite often after hitting the ‘=’ sign, you will get the following display .000000014 with the ‘5’ hidden. Now multiply by 10 to see the hidden digit! **Warning -** Roundoff errors can be more expensive than sig fig errors in the short run (ie, often no partial credit!).

3. **SI** (systeme internationale) or **MKS** (meters,kilograms,seconds) **units** will be assumed of all data if no units are given in the problem. Always put units on your answers. Hardly ever put units in your work. After this class, you’ll be an advocate of the SI metric system!

4.**Kinematics in one dimension** - Definitions (**position, displacement, distance traveled, average velocity, average speed, position-time graphs**. English vs physics meanings of common words such as speed, velocity, acceleration, work, etc.

5. **Slope of a secant line** on a position-time graph is average velocity. The **derivative** or **slope of a tangent line** on a position-time graph is **instantaneous velocity**. What does slope mean? What meaning can a numerical value for a slope have if there are no units?

6. When is velocity zero? What’s happening at sharp (non-differentiable) points on the x-t graphs? How is left/right motion on the x-axis related to the up/down aspect of the x-t graphs? Study x-t graphs.

7. The 'Dangerous Merton Rule' for computing average velocity? It's dangerous for computing other averages also.

Assignments 1. Cover **textbook** and put your name inside the cover.

2. Get a "cheap" scientific **calculator** as the more advanced calculators have sufficient memory to store test answers, formulas, notes, and often have programs to solve physics problems.

3. Get the adobe reader installed and show your parents our website (signature).

4. Get 2 phone numbers from friends in the class for when you're absent.

Day 1 - Review Chapter 1 / Read Sections 2.1 and 2.2 / p.47 #1-7 odd

Day 2 - Read Class Notes (handouts) on Kinematics / p.47 #4,6,8,9

Day 3 - Practice Quiz 1.4H on position-time graphs / p.48 #12-15

Day 4 - p.47 #16,17,18,22

Notes - **Differentiation** (including the Power Rule, Product Rule, Quotient Rule, Chain Rule, and the derivatives of sine and cosine) **Instantaneous Speed** vs **Instantaneous Velocity**, **Average Acceleration** and **velocity-time graphs**. **Instantaneous Acceleration**. In English, acceleration generally means a car is speeding up. Deceleration is used when a car is slowing down. However, in physics, acceleration (a vector concept hence with magnitude and direction) has to do with the force (magnitude and direction) acting on an object. **Negative acceleration** does not mean an object is slowing down. On the x-axis, it means the net force on the object is to the left or negative-x direction. If a car already has a left or negative velocity, it will speed up. If the car had a right or positive velocity, a left or negative force (acceleration) would slow it down. If the force (and hence acceleration) is sideways (**centripetal**), the speed of an object doesn't change, but the direction of its velocity (vector) changes. On a velocity-time graph, the slope of the secant line is another **average rate of change**, in this case, average acceleration. On a velocity-time graph, the slope of a tangent line is an **instantaneous rate of change**, here, instantaneous acceleration.

Assignments 1. See calculus film. Try taking a practice exam (quiz) on the website on Sig Figs. (Answers to all practice exams and even numbered problems are on the website.)

2. Prepare for our first 'surprise' quiz on position-time graphs, etc.

Day 5 - p.48 #19, 20,23a

Day 6 - p.50 #48,49,54

Days 7-16 - You're probably already behind? You have to learn to memorize the definitions as you get them in class and in your notes. Besides a lot of memorization, there are some very important concepts about slopes of graphs, instantaneous rates of change, acceleration, vectors, etc.

Notes 1. Realize that you've probably never studied acceleration in mathematics. **Constant acceleration** (nonzero) is an important special case of acceleration. In one dimension, the force or acceleration changes the speed and sometimes also changes the direction of a moving object's velocity (vector).

2. **Stopping Distance** and **Stopping Time** are typical constant acceleration problems.

3. **The Law of Falling Bodies** is important from a practical, theoretical and historical perspective. Understand what every letter and number (especially subscripts) in the following equation stands for:

$y = -\,{}^{1}/_{2}gt^2 + v_0t + y_0$ also, is v_0 here always positive?

$y = -4.9t^2 - 5t + 8$

$y = -16t^2 + 5t + 11$ (ft)

4. Here are some good questions to ask yourself.

(1) If a ball is thrown vertically upward, what is its acceleration at the top?

(2) How many feet does a dropped ball fall in one second? Assume negligible air resistance as with most all of our falling body problems.

(3) If an elevator is going down and slows to a stop, is the acceleration negative?

(4) What is the final velocity of a falling object as it 'just' gets to the ground?

5. Notice while we are still trying to master this material, we will begin to discuss **vectors**. Vector mathematics will be a crucial tool throughout the year.

Assignments 1. Besides a possible re-quiz on x-t graphs, we need to test ourselves on velocity-time graphs and acceleration. (See Kinematics Practice Quiz 2.0H)

2. Study the notes on Constant Acceleration. Memorize and understand the three formulas (four if you count the Merton Rule for average velocity which always works with constant acceleration).

3. See the Film on Galileo's Law of Falling Bodies

Day 7 - Kinematics Practice Quiz 2.0H / p.48 #25,27,29
Day 8 - Read constant acceleration notes / p.48 #24,26,28
Day 9 - p.49 #31,33,35
Day 10 - p.49 #30,32,36,37
Day 11 - p.49 #38,39,41,46,55
Day 12 - Read Vector Notes / p.49 #24,40,42,44,52
Day 13 - p.49 #43,45,47,50 / Vector Notes Problems #1,3,5,7
Day 14 - p.50 #51,53,56,57 / Vector Notes Problems #2,4,6
Day 15 - Uniform Acceleration Quiz 3.0H #1-5
Day 16 - Uniform Acceleration Quiz 3.0H #6-10

Days 17-25 While continuing to learn our definitions and new terminology, we've worked with constant acceleration. While continuing to re-test on constant acceleration, vectors have been introduced. Now we will be able to deal with kinematics in two dimensions. In particular we'll study **projectile motion**. Another concept which can be studied in both one and two dimensions is that of **relative velocity**.

Notes 1. We derive the solution to the **Monkey and Hunter Demonstration**.

2. We also derive the **Range Theorem** and **Maximum Height Theorem**.

3. What is the velocity of a projectile at the highest point in its trajectory?

4. See the film on Galileo and the Law of Inertia.

Assignments

Day 17 - p.69 #4,6,13,15
Day 18 - p.69 #9,11,14,25
Day 19 - p.69 #10,12,16,26
Day 20 - p.70 #17,19,21,27
Day 21 - Projectile Motion Quiz 5.0H / p.70 #18,20,22,28
Day 22 - p.70 #23,24,36,37
Day 23 - p.71 #42,44,46
Day 24 - p.72 #41,45,50
Day 25 - p.72 #47,48,49 / p.99 #1,7,15

Days 26-38 **Newton's Laws** (N1,N2,N3) An important concept in physics is that of **equilibrium**. In physics this doesn't just mean that an object is at rest. After all, whether an object is at rest or not depends upon one's **frame of reference** or point of view. Unlike Aristotelian natural philosophy, Galileo understood that an object's 'natural state' is not to be 'at rest' but rather that it is natural to retain one's state of motion whatever it is. Equilibrium in physics means that there is **no unbalanced force** (net force is zero) which is equivalent to saying that **acceleration is zero**. N1 or the Law of Inertia states that an object at rest will remain at rest or if in motion, the object will continue with that motion unless acted upon by a net outside force or agent.When there is an unbalanced force, we have N2 or Newton's 2nd Law: **Force equals mass times acceleration**. Newton's 3rd Law (N3) which I call the **Action-Reaction Law** says that if object A acts with a force on B, then B acts with an equal (in magnitude) but opposite (in direction) force on A.

There are some contact forces which the students will encounter frequently. They will need to be able to represent them in drawings (with vector arrows) in their homework, notes, and exams. The **tension** force of a rope on an object should be shown as an arrow drawn on the rope or parallel to the rope pointing away from the point of attachment of the rope to the object. The **normal** force is a component of a surface contact force. It is drawn perpendicular or orthogonal to the contact surface. Another component of this surface contact force is **friction** which is drawn parallel to the contact surface.

Another important point and confusing because of our English language is the difference between **weight (w)** and **mass (m)**. Weight in physics will be defined as the **Force of Gravity** (or often just the magnitude of the force of gravity). Mass, on the other hand, is a measure of an object's **inertia**, it's tendency to resist acceleration or any change in its state of motion. A massive object is difficult to slow down whether it's being accelerated by the force of gravity on earth or by rockets in **deep space**. Deep space will be defined to be a place so far from any star systems that the gravitational force is effectively zero. If mass is measured by the amount of protons and neutrons in an object, then that massive object has the same mass falling on earth as it does accelerating in space or on the moon or on jupiter, etc. On earth or even on the moon or jupiter, that massive object has weight. As we'll see it's weight or the force of gravity may vary from planet to planet but even in orbit around the earth, it has weight, ie there is a gravity field acting on it. In deep space, it is weightless as by definition, we said the force of gravity would be zero in deep space.

A student standing on a scale in an elevator would find the reading of the scale (the normal force would tell the student his/her **apparent weight (w')** changing as the elevator accelerated going up and/or down. If the student in the elevator was in a free fall, the scale and hence apparent weight would be zero, w' = 0 N(newtons) or 0 lb(pounds). The force of gravity near the surface of the earth is fairly constant so we, in physics, say that the student's weight (w) does not change in this free fall.

The acceleration of falling objects in a vacuum near the earth's surface is about 9.8 m/s^2 downward or -32 ft/s^2 and the magnitude of this gravitational acceleration (a_g) is usually written as g (= 9.8 m/s^2). Since $F_{Net} = ma$, if we assume negligible air resistance and constant gravitational force, then we can replace F_{Net} with F_g or w and replace 'a' with g and get: $w = mg$ It's important for students to learn the distinction between weight in newtons and mass in kilograms, so as in the AP Physics Exam, we let the students use $g=10\ m/s^2$. Now we can say 5kg weighs 50N or a 600N object has a mass of 60kg without having to reach for our calculators. The American unit of mass is the **slug**. Yup, 96 lb of weight has a mass of 3 slugs!

Assignments 1. See Mechanical Universe film on Newton's Laws

2. See both regular physics quizzes on Newton's Laws and honors level quizzes.

Day 26 - p.99 #3,9,18
Day 27 - p.99 #4,8,11,17
Day 28 - p.99 #5,6,13,16
Day 29 - p.99 #10,12,21,23,30
Day 30 - p.99 #14,19,22,35
Day 31 - p.100 #20,24,32,36
Day 32 - p.100 #25,26,30,37
Day 33 - p.100 #27,29,70,75
Day 34 - p.101 #28,31,39,65,73 (friction)
Day 35 - p.101 #33,40,62,67,72
Day 36 - p.101 #34,66,76,78,83
Day 37 - p.102 #38,41,79,82
Day 38 - p.102 #42,44,77,81 / p.199 #3,4

Days 39-55 Friction Force is a surface contact force (like the normal force). Friction is the component parallel to the surface. If someone tries to push horizontally against a block with a force magnitude of 8N and the block does not move, then there is a **static friction force** of 8N in the opposite direction on that same block. (Notice this is not an action-reaction pair. Both the pushing and the friction force were acting on the block. Neither one is the block reacting back on pusher or the frictional surface.) If that same person pushed downward and the block does not break through the table top, then the normal force is 8N upward. Now back to pushing the block horizontally across the table top. Eventually the block will slip as we increase the pushing force. Just before it moves or just as it moves, we have reached or found the **maximum static friction force**. The size or magnitude of this force depends upon the roughness of the surfaces involved and how hard the block pushes into the table, the normal force. Once the object is sliding across the table, a usually smaller **kinetic friction force** retards the motion of the block.

Circular motion is also introduced with the distinction between **tangential** or **linear speed** (v_t) and **angular speed** (ω). **Tangential acceleration** (a_t) is similarly related to **angular acceleration** (α). **Uniform circular motion** means constant linear or tangential speed and angular speed, so tangential acceleration and angular acceleration are zero. There is still the radially inward **centripetal acceleration** (a_c) not to be confused with the 'fictitious' centrifugal acceleration. Students need to finally come to understand what a 'radian' measure is.

Newton's Laws only work in an inertial reference frame (ie, non-accelerated).

Kepler's Laws (K1,K2,K3) are explained by Isaac Newton and his **Universal Law of Gravity**.

Assignments 1. See films on (a) Kepler's Laws (b) **The Apple and the Moon** and (c) from the 1960's **Frames of Reference**.

Day 39 - p.102 #43,47,48,80 / p.199 #5,6,9
Day 40 - p.102 #52,53,55,59 / p.199 #7,8,10
Day 41 - p.102 #51,54,84 / p.200 #11,12
Day 42 - p.102 #56,86 / p.200 #13,15
Day 43 - p.200 #14,16,17 / p.103 #45,57,58
Day 44 - p.203 #61,62,63 / p.103 #46,49,74
Day 45 - p.200 #18,19 / p.106 #85,89
Day 46 - p.200 #20,21 / p.106 #87,90

Day 47 - p.200 #22,23 / p.106 #88,91
Day 48 - p.200 #24,27,29 / p.104 #71,92
Day 49 - p.200 #25,28,30 / p.104 #93 / Practice Quiz #1,2
Day 50 - p.201 #26,31,32 / Practice Quiz #3,4
Day 51 - p.201 #33,34,35 / Practice Quiz #5,6
Day 52 - p.201 #36,37,38 / Practice Quiz #7,8
Day 53 - p.202 #39,41,47,61,65
Day 54 - p.202 #42,43,49,62,63
Day 55 - p.202 #44,45,50,66,67

Days 57-65 **Work** has something to do with force applied over a distance, but it isn't that easy! When a block slides across the floor the work done by the force of gravity and the normal force of the floor on the block are both **zero**. The work done by the kinetic friction force is **negative** and if a person is pushing the block in the exact direction that it's moving in that person is doing **positive** work. Work can be considered a **transfer of energy**.

Kinetic Energy is the energy associated with a moving mass, $\mathbf{K = {}^1/_2 mv^2}$.

Gravitational Potential Energy is a calculation of the work that the force of gravity would do when a particular mass is moved from a particular position in a gravitational field. The work done by the force of gravity when an object is moved to the earth's surface from a height of h above the earth's surface is $\mathbf{U_g = mgh}$.

Elastic Potential Energy is the amount of work that a spring would do in moving a mass from a compressed or stretched spring position of 'x' back to the equilibrium or unstretched position when x=0m, $\mathbf{U_e = {}^1/_2 kx^2}$ where little k is the **spring constant** (N/m).

Mechanical Energy is defined as the sum of all three of these energies, $\mathbf{E = K + U_g + U_e}$. Quite often, especially when there's no friction, we can use the **Conservation of Mechanical Energy** to solve problems, using $\mathbf{E_0 = E_f}$. An important theorem which relates the net amount of work done to the change in kinetic energy of an object is the **Work-Energy Theorm**: $\mathbf{W_{Net} = \Delta K = K_f - K_i}$. [W] = Nm = J (joules) and [K] = J (joules, also).

Pendulums and **spring-mass systems** are also related to uniform circular motion and the sine waves that are studied in trigonometry. **Simple Harmonic Motion** (SHM) results when a restoring force is proportional to the displacement of an object from it's equilibrium position. **Resonance** is the increased amplitude of vibration that results when an external, periodic force is applied at the resonant frequency of the disturbed system.

Assignments 1. See the film on Resonance.
Day 56 - p.202 #48,51,68 / p.135 #1,5,9
Day 57 - p.202 #51,75 / p.135 #2,3,6,8
Day 58 - p.203 #70,74 / p.135 #10,13,14,l6
Day 59 - p.203 #71 / p.135 #11,12,15,22,55
Day 60 - p.203 #69 / p.135 #17,19,24,56,58
Day 61 - p.203 #64 / p.135 #18,25,26,57,59
Day 62 - p.136 #27,29,31 / p.449 #1,2,6,7
Day 63 - p.136 #28,30,32 / p.449 #3,5,9
Day 64 - p.136 #33,35,38 / p.449 #4,8,14
Day 65 - p.136 #36,39,40 / p.449 #10,11,65

Days 66-85 **Impulse** (vector concept, **J**) is how much force is applied over a given amount of time, and hence [**J**] = Ns. **Momentum** (vector concept, **p**) is mass time velocity, and hence [**p**] = kg m/s. The **Impulse-Momentum Theorem** (similar to the Work-Energy Theorem) states that the **net impulse equals the change in momentum**, and hence Ns = kg m/s, ie interchangeable units. Collisions between two objects can be considered a closed system with no outside force or impulse to change the total momentum of the system. Hence, we can use the **conservation of momentum** to solve collision problems. This is also true of rocket and recoil problems. An **inelastic** collision results in the two objects sticking together. A **semi-elastic** collision has the two objects bouncing off each other with some loss of energy in the form of heat, Q. An idealized case is the **elastic** collision where the total kinetic energy is the same after the collision as before, ie a collision with no heat! The **elastic, headon collision theorem** is used to approximate the solution of two steel balls colliding or a cue ball colliding with an object ball all in one dimension (headon collision).

The **center of gravity** of an object is a useful concept when trying to keep track of a system of objects. Try restating the Law of Inertia for **rotational equilibrium** of an object.

Rotational Dynamics is the culmination of our classical mechanics semester. Just as force results in linear acceleration, **Torque** results in **angular acceleration**, $\boldsymbol{\tau_{Net} = I\alpha}$. Consider a yoyo or spin a top!

Rotational Inertia or **Moment of Inertia** is a measure of an objects resistance to angular acceleration. The difference here is that for a point-mass, $I = mr^2$, and notice that not only does mass result in resistance to angular acceleration but also the larger the ‘r’ or the farther out the mass is, the greater the resistance to angular acceleration. Which wins the race down the ramp? The hollow hoop, the solid disk, or the solid sphere? (rolling without slipping, same mass, radius, and frictional factors).

Rotational Kinetic Energy, $\boldsymbol{K_\theta = {}^1/_2 I\omega^2}$ and **Angular Momentum**, $\boldsymbol{L = I\omega}$, problems are solved in a similar fashion as their related translational problems.

Assignments 1. See the film on Momentum.

2. Elastic Collision in Two Dimensions Lab

Day 66 - p.137 #41,61,66 / p.450 #20,21,26 / p.163 #2,3,8
Day 67 - p.137 #42,65,67 / p.450 #22,23,24 / p.163 #4,6,8
Day 68 - p.137 #43,71 / p.450 #27 / p.234 #1
Day 69 - p.137 #44,72 / p.450 #28 / p.234 #2 / p.164 #9,15
Day 70 - p.137 #70,75 / p.453 #67 / p.234 #4 / p.164 #10,16
Day 71 - p.139 #78 / p.164 #17,23,41 / p.234 #5,7
Day 72 - p.139 #79 / p.164 #18,19,24,44 / p.234 #8
Day 73 - p.139 #80 / p.164 #20,25,26,28,45 / p.234 #10
Day 74 - p.139 #81 / p.164 #21,27,29,32,62 / p.234 #11
Day 75 - p.139 #82 / p.164 #22,30,71 / p.234 #12,69,85
Day 76 - p.168 #34,70,75 / p.203 #72 / p.242 #76,90
Day 77 - p.168 #32,63,71 / p.203 #73 / p.242 #77,91
Day 78 - p.168 #35,37 / p.242 #92,93
Day 79 - p.234 #9,18,24,31,40,47
Day 80 - p.234 #19,25,32,41,48,75
Day 81 - p.234 #20,26,33,41,49,79
Day 82 - p.234 #21,27,34,43,52,83
Day 83 - p.234 #22,28,38,44,53,84,89
Day 84 - p.234 #23,29,37,45,86,94
Day 85 - p.234 #30,38,46,74,87