Physics 121 Syllabus

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Welcome to Physics! Physics is where basic knowledge of the environment, in which we exist, begins. Part I of this two semester course will develop the techniques required to describe and investigate the forces on and movements of objects in the physical world. Developmentally, physics is an interplay of math and reason, both of which are necessary in modern technical fields.

Our classroom is designed for collaboration and hands-on learning. We will devote as much class time as possible to creating our own data, taking measurements or working on theoretical problems in your table groups.

Classroom Etiquette: Laptops should be closed when not in use for classroom activities, checking email (or how many "likes" you've received) is a distraction for everyone. Everyone should participate in classroom activities by having note paper and their own calculator out at all times.

Book: The Bookstore listed book can be acquired in many formats. The online interactive software–used mostly for homework–is available separately if you have a second hand book of some kind, or packaged with either a hard cover or an ebook. If you have neither component and prefer an ebook, both can be purchased at the time of registration directly from https://www.masteringphysics.com/site/login.html. This login link is also in the first announcement on blackboard where you will find the **unique registration code** for our class. **Book and online homework assignments will start during the first week so do not waste time getting the materials.**

Grading Scheme: Your final grade will be calculated according to the weighting below on the condition that you maintain a passing average grade $> 60\%$ for your examinations (quizzes, mid-term, final). **Earning an average of less than** 60% **for your examinations will result in an F for the course.**

Grading Category	Weighting
In-class (*gedanken-experiments*)	10%
Experimental	15%
Homework	20%
Quizzes	20%
Mid-Term	15%
Final Exam	20%

Experimental: Missed labs will result in zero credit. The work we do on lab days will be submitted individually at the end of class (data) or at the start of the next class (summary). You will record and organize the data collected as well as describe your results verbosely. We will

utilize all of the two hours available each day, often starting with an introductory lecture. If you finish an experiment "early", you should check your data and retake and refine any low quality data, there will be optional extensions for each experiment, or you should work on your submission file for that day.

Pre-lecture Material: The book is to be used for supplemental reading to correlate with the lecture notes. It is intended that you always stay a few sections (1 or 2 should be good) of reading ahead of the lecture as a base for analyzing examples in-class. In this way we will try to minimize the in class "derivations" and focus on applying the techniques to various examples.

Pre-lecture assignments will be assigned weekly and will keep you ahead of the lecture with the book reading. These will be assigned through Mastering Physics and will be shorter and different than the homework assignments; or just as general reminder to read each day.

Homework: You will allocate most of your study work to homework assignments. I generally recommend **not** buying the solutions manual for our book—it easily becomes a crutch and you risk setting yourself up for bad exam performance, a much larger portion of your grade. We will be using "Mastering Physics" to practice the problem solving techniques we cover in class. Please register using your QU email address and QCard ID by following the link in the first blackboard announcement and using the listed registration code. The software has many helpful hints, links, videos and tutorials to use while working through your assignment. You have unlimited attempts available for numerical questions with a small penalty for each incorrect attempt. Multiple choice questions must be thought through carefully. If there are 3 incorrect answers, you are penalized 33% for each incorrect attempt.

Exams: There will be six 30-minute quizzes, a 2-hour mid-term and a comprehensive final exam during final exam week. An equation sheet is provided on every exam—the final exam's equation sheet is attached below. A non-graphing scientific calculator is required for exams as well as every lecture. Any calculation done on an exam will be analytic and you are expected to use your own ability and not a calculator shortcut. **Absences from a quiz or exam will result in zero credit. You cannot request a make-up after the rest of the class has completed a quiz/exam. See attendence policies for emergency or pre-approved scenarios.**

Attendance: Attendance is essential for you to do well in this (or any) course. You are expected to attend every lecture. Most lectures will contain in-class work which will be collected and graded—physical labs cannot be rescheduled except for medical or athletic conflicts. Missed classwork will receive zero credit. If you will miss a class due to a medical issue or a pre-planned athletic event, contact me BEFORE by email and we will deal with it on a case-by-case basis.

Academic Integrity: A copy of the university's academic integrity policies can be found on our blackboard page. There, you can read the procedures for addressing dishonest behavior and how serious they are. Students may also submit a report of misconduct committed by a peer.

In short, everyone benefits from an honest and productive atmosphere. Produce your own work.

Extra Help: First, ask me. I have office hours every week for the occasional homework problem or concept that is giving you an issue. Email me with a question for a quicker response. The Learning Commons in the library has a number of tutors and programs (free) designed to give students extra help if they desire. Visit their office for sign-up information. Consider also forming

study groups to discuss class material.

University Curriculum Breadth Reflection: As a UC course in your degree plan, you will write a reflection piece towards the end of the semester about how your experience in the course relates to your educational objectives. An incomplete essay will result in an INCOMPLETE in the course. I will require revisions if the assignment was not attempted in earnest. You will also save this essay in your ePortfolio to aid in your academic progress.

Learning accommodations: Students with disabilities who wish to request reasonable accommodations should contact the Coordinator of Learning Services in Arnold Bernhard Library – north wing at (203) 582-5390. Quinnipiac University complies with the Americans with Disabilities Act and Section 504 of the Rehabilitation Act.

Outline: Below is a list of topics, quizzes and exams, with their associated book chapters, which will be covered in the course. Each Quiz and exam will be scheduled on the day the last homework for that chapter is due.

Chapter	**Topic**	**Sections**
1	Units, quantities and vectors	all
	Ch. 1 Quiz	
2	Motion along a straight line	all
	Ch. 2 Quiz	
3	Motion in two or three dimensions	all
	Ch. 3 Quiz	
4	Newton's Laws of Motion	all
	Ch. 4 Quiz	
5	Applying Newton's Laws of Motion	all
1 through 5	Mid-Term	
6	Work and kinetic energy	all
	Ch. 6 Quiz	
7	Potential energy and energy conservation	all
8	Momentum, impulse and collisions	all
9	Rotation of Rigid bodies	all
10	Dynamics of rotational motion	10.1–10.6
1 through 10	Final Exam	

PHY121 Final Exam Equations

Vectors

Addition properties

$\vec{a}+\vec{b}=\vec{b}+\vec{a}$ commutative addition

$(\vec{a}+\vec{b})+\vec{c}=\vec{a}+(\vec{b}+\vec{c})$ associative addition

2-D Vector Components (assuming polar angle θ

$a_x = a\cos\theta$ $a_y = a\sin\theta$

$a=\sqrt{a_x^2+a_y^2}$ $\tan\theta=\frac{a_y}{a_x}$

3-D Unit Vector Notation

$\vec{a}=a_x\hat{i}+a_y\hat{j}+a_z\hat{k}$ $a=\sqrt{a_x^2+a_y^2+a_z^2}$

$\vec{r}=\vec{a}+\vec{b}$ vector addition

$r_x=a_x+b_x$

$r_y=a_y+b_y$ add components

$r_z=a_z+b_z$

Scalar Product

$\vec{a}\cdot\vec{b}=\vec{b}\cdot\vec{a}=ab\cos\theta$

$\vec{a}\cdot\vec{b}=(a_xb_x)+(a_yb_y)+(a_zb_z)$

Kinematics

One dimensional motion

$\Delta x=x_2-x_1$ displacement

$\bar{v}_x=\frac{\Delta x}{\Delta t}=\frac{x_2-x_1}{t_2-t_1}$ avg velocity

$\bar{s}=\frac{distance}{\Delta t}$ avg speed

$v_x=\lim_{\Delta t\to 0}\frac{\Delta x}{\Delta t}=\frac{dx}{dt}$ velocity

$\bar{a}_x=\frac{\Delta v_x}{\Delta t}=\frac{v_{2x}-v_{1x}}{t_2-t_1}$ avg acceleration

$a_x=\lim_{\Delta t\to 0}\frac{\Delta v_x}{\Delta t}=\frac{dv_x}{dt}$ acceleration

$x_f=x_i+\int_{t_i}^{t_f}v_x\,dt'$

$v_{xf}=v_{xi}+\int_{t_i}^{t_f}a_x\,dt'$

Constant acceleration, $t_0=0s$

$v_x=v_{x0}+a_xt$ missing $x-x_0$

$x-x_0=v_{x0}t+\frac{1}{2}a_xt^2$ missing v_x

$v_x^2=v_{x0}^2+2a_x(x-x_0)$ missing t

$x-x_0=\frac{1}{2}(v_{x0}+v_x)t$ missing a_x

$x-x_0=v_xt-\frac{1}{2}a_xt^2$ missing v_{x0}

For Free Fall, use $x \Rightarrow y$

and $a_y=-9.80\,m/s^2$

2-D and 3-D Motion

Measurable Quantities

$\vec{r}=x\hat{i}+y\hat{j}+z\hat{k}$ position

$\Delta\vec{r}=(x_2-x_1)\hat{i}+(y_2-y_1)\hat{j}+(z_2-z_1)\hat{k}$ displacement

$\vec{v}_{avg}=\frac{\Delta\vec{r}}{\Delta t}$ avg velocity

$\vec{v}=\frac{d\vec{r}}{dt}=v_x\hat{i}+v_y\hat{j}+v_z\hat{k}$ velocity

$v_x=\frac{dx}{dt}$, $v_y=\frac{dy}{dt}$, $v_z=\frac{dz}{dt}$

$\vec{a}_{avg}=\frac{\Delta\vec{v}}{\Delta t}$ avg acceleration

$\vec{a}=\frac{d\vec{v}}{dt}=a_x\hat{i}+a_y\hat{j}+a_z\hat{k}$ acceleration

$a_x=\frac{dv_x}{dt}$, $a_y=\frac{dv_y}{dt}$, $a_z=\frac{dv_z}{dt}$

Projectile Motion

$x-x_0=v_{0x}t$ $v_{0x}=v_0\cos\theta_0$

$v_y=v_{0y}-gt$ $v_{0y}=v_0\sin\theta_0$

$y-y_0=v_{0y}t-\frac{1}{2}gt^2$

$v_y^2=v_{0y}^2-2g(y-y_0)$

$t_\pm=\frac{-b\pm\sqrt{b^2-4ac}}{2a}$ for $at^2+bt+c=0$ Uniform Circular Motio

$1\,rev=360^\circ=2\pi\,rad$

$a_{rad}=\frac{v^2}{R}$ $T=\frac{2\pi R}{v}$, period

Force and Motion

Newtons 2^{nd} Law

$\vec{F}_{net}=m\vec{a}$ $1\,N=1\,\frac{kg\cdot m}{s^2}$

$F_{net,x}=ma_x$, $F_{net,y}=ma_y$,

$F_{net,z}=ma_z$

Gravitational Force

$w=mg$ magnitude

Newtons 3^{rd} Law

$\vec{F}_{B\,on\,C}=-\vec{F}_{C\,on\,B}$

Friction

$F_{s,max}=\mu_sN$ Static (N normal force)

$F_k=\mu_kN$ Kinetic

Centripetal Force

$F_c=\frac{mv^2}{R}$

Kinetic Energy and Work

$\frac{1}{2}mv^2$ kinetic energy

$W=\vec{F}\cdot\vec{s}=Fs\cos\theta$ work for constant force

$\Delta K=K_f-K_i=W_{tot}$ work-kinetic energy theorem

Work Done by a Variable Force For Any Path

$W=\int_{P_i}^{P_f}\vec{F}\cdot\vec{dl}$

$W=\int_{x_i}^{x_f}F_x\,dx$ if $\vec{F}$ only has an x-component

Power

$P=\frac{dW}{dt}=\vec{F}\cdot\vec{v}$, $P_{av}=\frac{\Delta W}{\Delta t}$

Energy Conservation

Gravitational and Elastic Potentials

$W_{grav} = mgy_1 - mgy_2$
$= U_{grav,1} - U_{grav,2}$
$= -\Delta U_{grav}$

$F_x = -kx$ spring force in 1-D

$W_{el} = \frac{1}{2}kx_1^2 - \frac{1}{2}kx_2^2$
$= U_{el,1} - U_{el,2}$
$= -\Delta U_{el}$

Mechanical Energy Conservation (conservative forces)

$K_2 + U_2 = K_1 + U_1$

Non-conservative or external forces

$W_{other} = \Delta E_{mech} = \Delta K + \Delta U$

Total Energy Conservation (no ext forces)

$0 = \Delta K + \Delta U + \Delta U_{int}$ $\Delta U_{int} = -W_{non-c}$

Potential Energy Curves

$F_x(x) = -\frac{dU(x)}{dx}$

Center of Mass and Momentum

Linear Momentum and Newtons 2nd Law

$\vec{p} = m\vec{v}$

$\vec{F}_{net} = \frac{d\vec{p}}{dt}$

Collision and Impulse

$\vec{J} = \Delta\vec{p} = \vec{p}_f - \vec{p}_i$ single particle

$\vec{J} = \int_{t_i}^{t_f} \vec{F}(t)\,dt$

$\vec{J} = \vec{F}_{avg}\Delta t$

Conservation of Linear Momentum

$\vec{P} = \vec{p}_A + \vec{p}_B + ...$

$\vec{P}_f = \vec{P}_i$ (if $\Sigma\vec{F} = 0$)

$\vec{r}_{cm} = \frac{1}{M}\sum_{i=1}^{n} m_i\vec{r}_i$

$x_{cm} = \frac{1}{M}\sum_{i=1}^{n} m_i x_i$ $y_{cm} = \frac{1}{M}\sum_{i=1}^{n} m_i y_i$

$z_{cm} = \frac{1}{M}\sum_{i=1}^{n} m_i z_i$

$\vec{F}_{net} = m\vec{a}_{cm}$ $\vec{P} = m\vec{v}_{cm}$

Rotation

Angular Position

$\theta = \frac{s}{r}$, (radian measure) s arc length

$1\,rev = 360^\circ = 2\pi\,rad$

$\Delta\theta = \theta_2 - \theta_1$ angular displacement

$\omega_{avg} = \frac{\Delta\theta}{\Delta t}$ angular velocity

$\omega = \frac{d\theta}{dt}$

$\alpha_{avg} = \frac{\Delta\omega}{\Delta t}$ angular acceleration

$\alpha = \frac{d\omega}{dt}$

Kinematics for Constant α

$\omega = \omega_0 + \alpha t$

$\theta - \theta_0 = \omega_0 t + \frac{1}{2}\alpha t^2$

$\omega^2 - \omega_0^2 = 2\alpha\Delta\theta$

$\theta - \theta_0 = \frac{1}{2}(\omega + \omega_0)t$

Linear and Angular Relations

$s = \theta r$ linear distance traveled

$v = \omega r$ linear speed

$a_t = \alpha r$ (tangential) tangential acceleration

$a_r = \frac{v^2}{r} = r\omega^2$ (radial) centripetal acceleration

$T = \frac{2\pi}{\omega} = \frac{2\pi r}{v}$ period

Rotational Kinetic Energy and Rotational Inertia

$K = \frac{1}{2}I\omega^2$ rotating about fixed axis

$I = \Sigma m_i r_i^2$ moment of inertia

Torque

$\tau = rF_{tan} = \pm lF = rF\sin\phi$

Newtons 2^{nd} Law in Angular Form

$\tau_{net} = I\alpha$

Work and Rotational Kinetic Energy

$W = \int_{\theta_i}^{\theta_f} \tau\,d\theta$

$W = \tau\Delta\theta$ for constant torque

$P = \frac{dW}{dt}$

$\Delta K = K_f - K_i = \frac{1}{2}I\omega^2 - \frac{1}{2}I\omega_0^2 = W$

Rolling

Rolling Bodies (about center of mass)

$K = \frac{1}{2}Mv_{cm}^2 + \frac{1}{2}I_{cm}\omega^2$

$\tau_{net} = I_{cm}\alpha$

$\vec{F}_{net} = M\vec{a}_{cm}$

$v_{cm} = \omega R$ if rolling without

$a_{cm} = \alpha R$ slipping