

PHY111 HS2020  
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Here is a guide for things you should know, and things you should know how to do if you want to do well on the final. You can learn these items best by using them to do your homework exercises and the lecture exercises. Every physics textbook has additional exercises you can use to test your knowledge. **In physics, you have to practice exercises to learn !**

## "What you should know for the final exam"

- 1) Know how to add vectors, and how to calculate dot products and cross-products.
- 2) Know how to identify the forces we have studied: gravitational force, spring force, centripetal force, frictional force, normal force, pulling, pushing, tension. The formulas for these will be provided on the formula sheet.
- 3) Know Newton's three laws, and how to use them to determine the forces and movement of objects, both in the case of equilibrium and in the case of a net force.
- 4) Know how to figure out the work done by a force.
- 5) Know how to figure out the potential energy stored by an object, and how it relates to the work done by a force.
- 6) Know how to calculate the stored potential energy starting with the forces, using the formula for work,  $W = -\Delta U = \int \mathbf{F} \cdot d\mathbf{x}$ . You should be able to do this for the forces in (2).
- 7) Know how to use energy conservation to calculate kinetic energy plus potential energy conservation is appropriate to use.
- 8) Recognize elastic and inelastic collisions, and know which quantities are conserved.
- 9) Know how to use momentum conservation, and when it is appropriate to use.
- 10) Know how to apply energy conservation to solve problems with potential energy, and kinetic energy for rotational and linear systems.
- 11) Know how to use the work-energy theorem.
- 12) Know how to determine whether a force is conservative or not.
- 13) Be able to use the formulas for constant acceleration.
- 14) Be able to use the formulas for constant angular acceleration.

- 15) Know how to calculate position, velocity, and acceleration for 2-D motion with either gravitational acceleration or centripetal acceleration.
- 16) Know how to use X,Y,Z coordinates, as well as r, theta, phi coordinates.
- 17) Know how force, momentum, and impulse relate.
- 18) Know how to calculate the center of mass of a system.
- 19) Know how to calculate the moment of inertia of a rotating object. You should be able to do this for simple objects like rods, disks, cylinders or spheres.
- 20) Know how to apply the parallel axis theorem (Steiner's theorem) to calculate the moment of inertia through an arbitrary axis.
- 21) Know how to calculate torque in terms of force and radius, as well as Newton's law for rotation that relates the sum of torques to moment of inertia and angular acceleration.
- 22) Know how to calculate the angular momentum of a rotating object.
- 23) Know when and how to apply angular momentum conservation.
- 24) Know how torque and angular momentum are related.
- 25) Understand how to use the right-hand rule for torque and angular momentum, as well as changes in angular momentum resulting from torque.
- 26) Be able to study a problem and determine which direction these vectors point :  
 **$\theta$ ,  $\omega$ ,  $\alpha$ ,  $L$ ,  $\tau$ .**
- 27) Know how to determine the kinetic energy of rotation, and the work and power done to rotate an object.
- 28) Know how much rotational kinetic energy and linear kinetic energy an object has. Know how the angular velocity, acceleration, and position are related to the linear velocity, acceleration, and angle for a rolling object (rolling condition).
- 29) Know what precession is, and how to calculate it from a system with changing angular momentum due to a torque.
- 30) Know your units for all variables. Know how to convert units.
- 31) Know the conditions for static equilibrium and how to determine the torques and forces.
- 32) Know how to find the center of gravity, and when objects are stable.

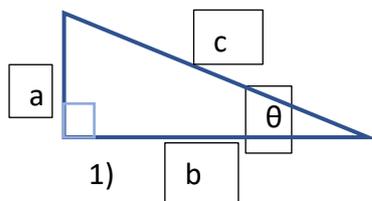
- 33) Be able to use the sum of the forces to recognize a simple harmonic oscillator by the acceleration being proportional and opposite sign to the displacement. Know the equation of motion for a simple harmonic oscillator. Know how to find the angular velocity from the equation of motion. Know the solution to the equation of motion.
- 34) Understand the basic simple harmonic oscillators: spring, simple pendulum, pendulum of an object with rotational inertia, torsion pendulum
- 35) Know how to determine the total energy in a simple harmonic oscillator from the amplitude.
- 36) Know how a damped simple harmonic oscillator with damping force  $-b \cdot v$  differs from a harmonic oscillator, recognize its equation of motion, and understand its solution. Know how the energy and amplitude change. Note that some of the formulas for this are on the formula sheet.
- 37) Know how to add a driving force and what the Q factor is.
- 38) Know what a pseudo force is, and how to determine it. The exam will **not** cover specific cases of pseudoforces.
- 39) Fluids: know how force and pressure relates.
- 40) Know how to apply Pascal's principle with force and area.
- 41) Know how to apply Archimedes' principle to understand pressure at different heights, and buoyant forces.
- 42) Know how to apply the Continuity equation to fluid motion, and relationship between velocity, area, and flow rate.
- 43) Know how to use Bernoulli's equation for many different types of problems.
- 44) Understand the Venturi effect and how to calculate pressure  $\leftrightarrow$  velocity.
- 45) Laminar flow / adhesive / cohesive forces / surface tension, Reynold's number will **not** be on the exam.
- 46) Understand the formula for a wave propagating.
- 47) Be able to solve problems for a wave propagating on a string, and how tension and mass per length affect velocity.
- 48) Waves: know how to determine wavelength, wave number, amplitude, angular frequency, frequency, period, etc.
- 49) Know how frequency, wavelength, and wave velocity relate.

- 50) Know what standing waves are. Know how to find nodes and anti-nodes.
- 51) Be able to determine the allowed wavelengths and frequencies (the harmonic frequencies and wavelengths) from the velocity of the wave and the number of nodes and anti-nodes within a length  $L$ .
- 52) Know how to get standing wave functions from amplitude, wavelength/wavenumber, and frequency/angular frequency.
- 53) Know how to combine two waves with same frequency and wavelength but different phases.
- 54) Know how to add standing waves.
- 55) Know how to check if a function is a solution to the wave equation.
- 56) Understand how to calculate the speed of sound in a fluid or a solid.
- 57) Know how to figure out allowed frequencies and wavelengths of sound waves.
- 58) Understand how to use the formulas for sound intensity.
- 59) Know how to use the equations for Young's modulus and Bulk's modulus.
- 60) Understand conditions for constructive and destructive interference of two waves.
- 61) Calculate Doppler shift of moving source or receiver.
- 62) Lecture in week 13 on complex math and Fourier series and Fourier transforms will **not** be on final exam.

**Formulas you should memorize and learn how to use.** All formulas you need will be on the formula sheet provided. But you should be familiar with the following.

General things to know :

- 1)  $\alpha = a/r, \omega = v/r, \theta = s/r$  (Relation between rotational  $\leftrightarrow$  linear motion;  
( also these are the rolling conditions)  
(Notice : you can derive many of the rotational equations from the linear equations using these relationships)
- 2)  $\mathbf{c} = \mathbf{a} \cdot \mathbf{b} = ab \cos\theta$  dot product of vectors
- 3)  $\mathbf{c} = \mathbf{a} \times \mathbf{b} = ab \sin\theta$  cross product of vectors
- 4) Know basic derivatives and integrals of polynomials,  $\sin \theta, \cos \theta$
- 5) Know relationship between  $\omega$  and period,  $T$
- 6) Know how to convert between degrees and radians
- 7) Know geometric rules for a triangle :



$$\begin{aligned}\sin \theta &= a/c \\ \cos \theta &= b/c \\ \tan \theta &= a/b \\ a^2 + b^2 &= c^2\end{aligned}$$